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SUMMARY

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SOIL SCIENCES

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SOIL CO_2 EMISSIONS UNDER CONVENTIONAL AND CONSERVATIONAL TILLAGE METHODS IN SOYBEAN CULTIVATION IN CUKUROVA PLAIN OF TURKEY

Davut AKBOLAT[1], Zeliha B. BARUT[2], M. Murat TURGUT[3], İsmail ÇELİK[4]

[1]Suleyman Demirel University, Agricultural Faculty, Department of Agricultural Machinery & Technologies Engineering, 32260 Isparta,Turkey
[2]Cukurova University, Agricultural Faculty, Department of Agricultural Machinery & Technologies Engineering, 01330 Adana, Turkey
[3]Dicle University, Agricultural Faculty, Department of Agricultural Machinery & Technologies Engineering, 21280 Diyarbakir, Turkey
[4]Cukurova University, Agricultural Faculty, Soil and Plant Nutrition Department, 01330 Adana, Turkey

Corresponding author email: davutakbolat@sdu.edu.tr; davut_akbolat@yahoo.com

Abstract

In this study, the carbon dioxide (CO_2) emissions for soybean cultivated in Adana province according to conventional tillage practices for chisel tillage with stubble burning (CT), and conservational tillage practices with stubble for disc tillage (DT), rotary tillage (RT) and direct seeding (DS) were determined. Soil carbon dioxide (CO_2) emission measurements were started after tillage using a portable CO_2 measurement system and were carried out at various intervals over a period of 55 days.
According to the obtained results, CO_2 emissions in CT, DT, RT and DS treatments were determined as 0.028, 0.036, 0.029, and 0.025 g CO_2 m^{-2} h^{-1}, respectively. It was determined that the CO_2 emission level in the DS treatment was lower in comparison with those of the other three treatments. The soil evaporation (H_2O) amounts were determined for CT, DT, RT and DS treatments as 4.37, 4.38, 4.21 and 3.50 g H_2O m^{-2} h^{-1}, respectively. Soil temperature was measured on average for CT, DT, RT and DS treatments as 28.7, 28.8, 28.7 and 28.9^{o}C, respectively. The average soil evaporation of DS treatment was found to be lower than the other three treatments. The difference between the soil moisture depending on treatment was not significant.

Key words: *direct seeding, seedbed preparation, soil CO_2 emission, soybean, tillage systems.*

INTRODUCTION

Soil management practices such as tillage and fertilization affect carbon build up in soil or the amount of atmospheric CO_2 (Nyakatawa et al., 2012). Soil mixing intensity has an effect on the amount of carbon (C) that disappears from the soil in the form of CO_2. In other words, increasing aeration in the soil usually increases soil CO_2 emissions due to decomposition (Dao, 1998). The amount of soil CO_2 emissions also depends on soil moisture and temperature regime, soil type, land usage and production method as well as the amount of soil organic carbon (Johnson et al., 2007; Chianese et al., 2009; Shrestha et al., 2009; Davidson et al., 2000). It has been reported that higher amounts of soil CO_2 emissions are obtained from rotary tillage with residue in comparison with rotary tillage without residue treatment in sugarcane production (Teixeria et al., 2011). It has been stated that emissions of CO_2 decreased by 1.2 times in burned soil compared to soil where residue was incorporated, but emissions of N_2 increased by 4.1 times and the increase in inorganic N from N mineralization was 1.4 times (Montoya-González et al., 2009).
Brye et al. (2006) determined that the soil surface CO_2 flux when using a conventional tillage system including stubble burning was 37.6% higher in comparison with that of a no-till system in wheat-soybean double crop production in Mississippi. In a study to determine the effect of tillage practices with or without residue on soil CO_2 emission, higher emission rates were found in tillage with residue than in tillage without residue in sugarcane production (Teixeria et al., 2013).

Soil CO_2 emission rates are generally lower with less intensive alternatives relative to moldboard plowing, with the greatest difference occurring at the time immediately following tillage practices. Al-kaisi & Yin (2005) found that cumulative soil CO_2 emissions were 19% to 41% lower for less intensive tillage treatments than for moldboard plowing and that it was 24% lower for no-tillage with residue than without residue during a 480-h measurement period.

CO_2 emission rate decreases as the number of tillage equipment is reduced during tillage. In studies carried out to determine CO_2 emissions from the soil due to tillage equipment used, Akbolat et al. (2009) found that the highest CO_2 emission rate was from plowing tillage, whereas the lowest CO_2 emission rate was observed in the no-till method. Another study comparing conventional tillage (CT), reduced tillage (RT) and no-till (NT) systems in terms of CO_2 emissions has yielded that the highest C sequestration was obtained in NT treatment, followed by RT and CT treatments (Zhang et al., 2012). In a short term study examining CO_2 emissions in sugar beet cultivation via conventional, reduced and no-till cultivation systems, the highest CO_2 emission rate was recorded in the conventional system, followed by reduced and no-till systems (La Scala et al., 2006). Short term studies during which CO_2 emissions are determined from soil, it is stated that CO_2 emission rate rapidly increases following tillage, after which it decreases to low levels probably due to the discharge of gases accumulated in the pores and cavities prior to the process or an attack of rapidly developing microorganisms (Reicosky, 2002; Rasmussen & Rohde, 1998). These results indicate that seedbed preparation methods for different growing plants affect soil CO_2 emissions. Also, seedbed preparation practices differ according to the plant grown. Winter wheat-summer soybean rotation allows farmers to produce two crops per year but the extensive application of this rotation has increased stubble burning in the Cukurova plain. The objective of this study is to determine the effect of chisel tillage without stubble (CT), disc tillage with stubble (DT), rotary tillage with stubble (RT) and direct seeding with stubble (DS) practices used for second crop soybean cultivation on soil CO_2 emission.

MATERIALS AND METHODS

Study area

The study was carried out during June 3rd and July 26th, 2010 at Cukurova University Research Farm in Adana province located in Cukurova plain. Cukurova University Research Farm is located between 37° 03'47" N latitude and 35°20'12"E longitude with an altitude of 23 m. The soil texture of the study area is clay (C) class consisting of 50% clay, 33 % silt and 17% sand with an organic matter content of 0.9% (Barut et al., 2012). A characteristic Mediterranean climate prevails in the study area.

Summers are hot and dry whereas winters are mild and rainy. The annual average precipitation is 625 mm. Temperatures differ between -8,1°C and +45,6°C and most of the rain falls during the winter. Rain is very scarce in summer (Anonymous, 2013). Definitions regarding the methods used in the trials are given in Table 1.

Table 1. The description of treatments used in seed bed preparation

Treatments	Description
CT (Chisel tillage)	*Stubble burning, Chisel tillage* one pass (tillage depth 35 cm), *disc harrow* two pass (depth of 15 cm) followed by scraper two pass (depth of 5 cm), plus *Single single-seed pneumatic planter* (seeding depth of 5 cm).
DT (Disc tillage)	*Stubble chopping, Heavy disc harrow,* two pass (tillage depth of 18 cm, tillage width of 200 cm) followed by *scrapper*, two pass (tillage depth of 5 cm, tillage width of 200 cm) plus *single-seed pneumatic planter* (seeding dept of 5 cm).
RT (Rotary tillage)	*Stubble chopping, Rototiller*, one pass (tillage depth of 15 cm, tillage width of 200 cm, followed by *scrapper*, two pass (tillage depth of 5 cm, tillage width of 200 cm), plus *single-seed pneumatic planter* (seeding dept of 5 cm) .
DS (Direct seeding)	*Direct seeder,* (working width of 200 cm, seeding depth of 5 cm)

Plot width and length used in the trial was 12 and 40 m, respecively. A randomized complete block design with three replications was selected for the trial.

A 52 kW tractor was used during the trials. The engine speed was held constant at 2000 rpm. Wheat stubble except from CT treatment was chopped and spread on the soil surface before seedbed preparation. Stubble was burned in CT treatment before seedbed preparation. The average stubble amount was determined as 2500 kg per hectare in DT, RT and DS treatments. The average stubble height was around 30 cm. Wheat residues except from stubble were removed from the soil surface before seedbed preparation.

Soil CO_2 measurement

In-situ soil respiration was measured using a CFX-2 soil CO_2 flux system (PP Systems, Hitchin, UK) consisting of an integral CO_2 analyzer and H_2O sensor, soil respiration chamber, and soil temperature probe (Akbolat et al., 2009). Measurements of soil net CO_2 emissions in g m^{-2} h^{-1} are based on concentration differences between air entering and leaving the chamber and the flow rate under normal soil atmosphere exchanges, with an accuracy better than 1% and 2% for CO_2 and H_2O concentrations, respectively. A soil CO_2 emission chamber was installed 1.5 cm deep into the randomly selected locations for the plots, and thus was isolated from the outer atmosphere. The records were made more frequently during the days following tillage, whereas afterwards they were carried out at wider intervals. The measurements were taken 0, 1, 4, 5, 7, 8, 11, 13, 19, 22, 30, 37, and 55 days after tillage. First the measurements of soil CO_2 emissions were taken five minutes after tillage. Nine records were taken on the same randomly selected points from every plot for each measurement.The trial was completed when CO_2 emission reached contant level. In addition, evaporation (H_2O emissions) and soil temperature were concomitantly measured.

Soil sampling and analyzing

Volumetric soil moisture content in 0-20 cm soil depth was determined using a Field Scout TDR 300 portable moisture meter (Spectrum Technologies, Inc., Plainfield, IL, USA). Soil moisture records were not determined on the first two days due to irrigation. Organic matter was determined according to the Walkley-Black, (1934) method, whereas texture was determined according to the Bouyoucos hydrometer Bouyoucos (1951) method.

Statistical procedure

The data were analyzed using the General Linear Model (GLM) procedures of SAS (SAS Inst. Inc. Cary, NC) by including treatments in the model, and PDIFF statements were used to compare treatment means for dependent variables (SAS, 1999). As for the significance level, ($P<0.05$) was accepted to be statistically significant.

RESULTS AND DISCUSSIONS

The treatment of CT is mostly used for seedbed preparation in second crop soybean cultivation in Cukurova plain. In this treatment stubble is burned intensively after the wheat harvest. Therefore, this treatment has negative effects in terms of soil conservation and environmental protection. In this research the soil CO_2 emission rates were determined in the conservation tillage treatments (DT, RT, and DS) and conventional tillage (CT) treatment.

The results of the experiment based on tillage practices are given in Table 2. The maximum soil CO_2 emission from all tilled treatments excluding the the 30th day was observed immediately after tillage pratices.

Table 2. The means of soil carbon dioxide emission, evaporation, temperature and moisture content

Treatments	Soil CO_2 emission (g CO_2 $m^{-2}h^{-1}$)	Soil Evaporation (g H_2O $m^{-2}h^{-1}$)	Soil Temperature (^oC)	Soil moisture content *(%)
CT (*n*=350)	0.028^{ab}	4.37^{a}	28.7^{c}	20.2
± SD	0.0030	0.15	0.045	0.27
DT (*n*=351)	0.036^{a}	4.38^{a}	28.8^{ab}	20.0
± SD	0.0029	0.14	0.044	0.27
RT (*n*=351)	0.029^{ab}	4.21^{a}	28.7^{bc}	19.6
± SD	0.0029	0.14	0.044	0.27
DS (*n*=342)	0.025^{b}	3.50^{b}	28.9^{a}	20.3
± SD	0.0030	0.15	0.046	0.27

*Means followed by the same capital letter within a column are not significantly different according to Duncan's test at the 5% level. *Sample number for soil moisture content of CT, DT, RT and DS is 99, 99, 98 and 96 respectively.*

The average soil CO_2 emissions from maximum to minimum were determined from DT, RT, CT and DS respectively (Table 2). The averages of the soil CO_2 emissions were measured for CT, DT, RT and DS treatments as 0.028, 0.036, 0.029 and 0.025g CO_2 m^{-2} h^{-1} respectively. The cumulative soil CO_2 emissions were determined for DT, RT, CT and DS treatments as 48.5, 41.9, 40.0 and 34.1 g CO_2 m^{-2} respectively in the experimental period. A positive linear relationship between cumulative CO_2 emission and time was observed. This result was in accordance with Al-Kaisi & Yin (2005).
When the CO_2 emissions on different days of the experiment were examined, it was observed that the difference between the treatments were statistically significant for days 0, 1, 4, 11, and 19. There were no differences among CT, RT and DS treatments in terms of average soil CO_2 emissions, but that the soil CO_2 emission was statistically ($p<0.05$) lower in DS treatment than DT treatment.
Although the tillage depth of CT treatment was higher than it was for DT and RT, the soil CO_2 emission rate in this treatment was equal or very close to those of the other treatments. Therefore, high CO_2 emissions in the CT would be expected in comparison to the treatment of DT and RT. Scala et al. (2001) reported that the soil CO_2 emission rate for the chisel plow was the highest of the all treatments. Therefore, stubble is removed in CT treatments, as stated by Montoya-González et al. (2009) and Teixeria et al. (2011).
The lowest CO_2 emission rate was determined in DS treatment on days 0, 11, 13, 19 and 37 (Figure 1a). CO_2 emissions reached their lowest value on the 22nd day after tillage and the lowest emission was observed in the RT treatment. The highest CO_2 emissions were observed on the 30th day after the first tillage operation. However, differences between the treatments were not significant ($p>0.05$) on that day since the measurement was taken soon after irrigation. As has been reported (Orchard & Cook 1983), high soil moisture content increased soil CO_2 emissions by soil microbial respiration. Negative CO_2 emission values were recorded 0 and 11days after tillage in the DS treatment.

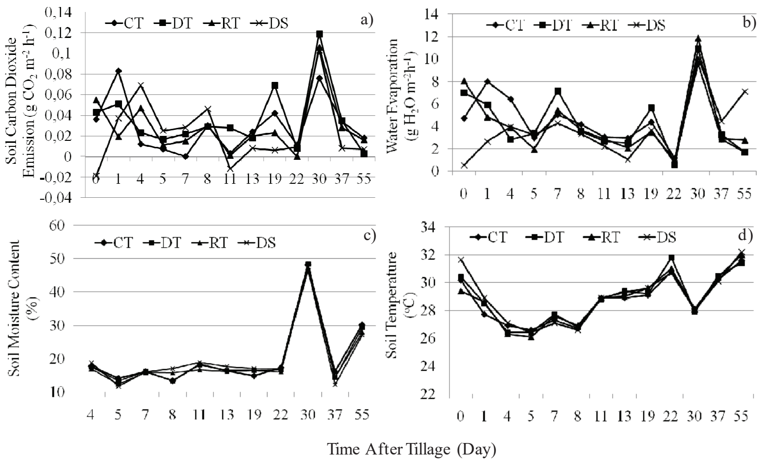

Figure 1. Soil Carbon Dioxide (CO_2) Emission, soil water evaporation, soil moisture content, and soil temperature after the tillage

CO_2 emissions measured in all treatments immediately after tillage were high and had a tendency to decrease. A sharp increase in CO_2 emissions immediately following tillage is often attributed to an increase in soil aeration due to disturbance (Dong et al., 2009). Reicosky & Lindstrom (1993) have also reported that a greater CO_2 emission rate immediately after tillage was due to greater physical CO_2 emission from soil. The CO_2 emission found in the study is lower than those determined by Akbolat et al. (2009) in semi-arid climatic conditions. However, in the same study, a CO_2 emission of 0.030 g CO_2 m^{-2} h^{-1}

obtained for the no-till system was extremely close to the emission of 0.025 g CO_2 m^{-2} h^{-1} obtained in our study.

Statistical differences among the treatments were significant on the recording days of 0, 1, 4, 11, and 19. No difference was determined between thetreatments regarding CO_2 emission (5, 7, 8, 13, 22, 30, 37 and 55th days) on other days. The lowest CO_2 emission value was determined during the first record of the DS treatment. One of the reasons for the lowest CO_2 emission value for the DS treatment is the lowest evaporation value in this recording. The evaporation of DS treatment was 0.52 g H_2O $m^{-2}h^{-1}$ in the first record (Figure 2). The lowest average water evaporation value was determined in the DS treatment. There was a linear relationship between the soil CO_2 emission and water evaporation values in these records (day 0 and 1).

The averages of soil evaporation values were measured for CT, DT, RT and DS treatments as 4.37, 4.38 4.21 and 3.50 g $H_2Om^{-2}h^{-1}$ respectively. Soil evaporation that was generally parallel with CO_2 emission was determined to be quite high for all treatments except for DS treatment at the time immediately following tillage but it gradually decreased in the following days. Soil evaporation values of DS treatment during the first and second records were lower in comparison with other treatments (Figure 1b).

The average soil moisture values measured for CT, DT, RT and DS treatments were 20.2%, 20.0%, 19.6% and 20.3%, respectively. In terms of average soil moisture content, no statistically significant (p>0.05) differences were found between the treatments. Whereas no difference in the soil moisture values was detected on most record days, a lower soil moisture value was determined for the DS treatment on the 37th and 55th days (Figure 3). Soil moisture content of the DS treatment was statistically higher than those of the other three treatments on only the 7th day. High soil moisture content for the DS treatment was explored with soil thermal conductivity (Silva-Olaya et al., 2013). In addition, this pattern indicates that tillage methods involving less physical disturbance help conserve soil moisture.

The soil moisture content of treatments on the 30th day was higher than for all other record days (Figure 1c). The reason for this was that the measurement was taken soon after irrigation. In the other words, irrigation increased the soil water content.

The averages of soil temperature values (Figure 1d) were measured for CT, DT, RT and DS treatments as 28.7 ^oC, 28.8 ^oC, 28.7 ^oC, and 28.9 ^oC respectively. While the average soil temperature of DS treatment was higher than those of CT and RT treatments, it was not different from DT treatment (Table 2). No linear correlation between soil temperature and CO_2 emissions was found. These results are in accordance with the study by Akbolat et al. (2009). Differences between the temperatures of 0, 1, 4, 5, 7, 19, 22, 55th records were significant. The average soil temperature of DS treatment in our study is higher than for the other treatments, as was the case in the study carried out by Akbolat et al. (2009).

However, this average difference of soil temperature did not increase soil CO_2 emission. The difference in average soil temperature among the treatments was very low. Thus, there were other parameters besides temperature and moisture that changed the soil CO_2 emission in different treatments.

The lowest CO_2 emission was obtained in direct seeding treatment during this study carried out in order to determine the soil CO_2 emissions for tillage practices applied in second crop soybean cultivation in the Cukurova plain of Turkey. The differences between soil temperatures do not support differences between CO_2 emissions. However, the differences between average soil water evaporation support differences between soil CO_2 emissions.

As was the case in our study, the lowest soil CO_2 emission rate in many tillage studies is obtained for DS treatment in a no-till system. According to the obtained results, the cumulative CO_2 emissions obtained for CT, DT, RT and DS treatments were 40.0, 48.5, 41.9 and 34.1 g CO_2 m^{-2}, respectively. It was observed that the cumulative CO_2 emission rate in the DS treatment was 1.4 times lower than that of DT treatment, 1.2 times lower than that of CT treatment, and 1.2 times lower than that of RT treatment.

CONCLUSIONS

As a result, chisel based tillage practice characterizes regional seedbed preparation methods. Higher soil CO_2 emissions would be expected in this treatment due to deep tillage. However, soil CO_2 emission of this treatment was lower in contrast to the references due to burned stubble.

Although the soil CO_2 emission was lower, the chisel based tillage with stubble burning method cannot be recommended because of the environmental effects and the decreases in soil organic carbon.

The importance of direct seeding method incrases due to lower inputs in comparison with other methods as well as high organic matter gain in the long run for the soil along with environmental friendliness.

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POTENTIAL OF THE LAND IN ARCHAR VILLAGE FOR CREATION OF VINES FOR HIGH-QUALITY WINE GRAPE VARIETIES. SOIL SPECIALITY OF THE TERROIR

Mladen ALMALIEV, Krasimir TRENDAFILOV, Violeta VALCHEVA, Nedialka YORDANOVA, Nikolay MINEV

Agricultural University, 12 Mendeleev Blvd., 4000, Plovdiv, Bulgaria

Corresponding author email: mladenalmaliev@abv.bg

Abstract

The aim of this study was to make the soil characteristics of the land in Archar village and to assess their suitability for creation of new vineyards for growth of high-quality wine grape varieties. Successively were studied the characteristics of the terroir - soil texture and physical properties of the soil, determined was the soil reaction, the content of active calcium, humus, water-soluble salts and the content of nutrient macro elements. Based on the preliminary study results was determined harmful acidity and saturation degree of the soil with bases and has proposed a plan for amelioration of the problem areas and recommended fertilization rates. The presented work was an attempt to systematize of the complex study on the suitability of one complicated terrain in terms of its topography and erosion conditions with regard to its suitability for transformation into vine terroir.

***Key words**: soil, vines, terroir, wine grape varieties.*

INTRODUCTION

The aim of this study was to make the soil characteristics of the land in Archar village and to assess their suitability for creation of new vineyards for growth of high-quality wine grape varieties. The preparation of the terrains for vineyards stipulates for formation of terroir. The concept of the terroir in wine viticulture increasingly released from the context of descriptive and analytical characteristics of the areas that were traditionally identified as vineyard terroirs and is directed towards the development of predictive models for the terrain potential for its convert to terroir.

MATERIALS AND METHODS

The object of the study is located in Archar village, Dimovo municipality, Vidin region "Long Meadow" place and the total area of the studied properties was 69.1 ha. The studied objects belong to the Northern wine region "Danubian Plain" and according to the plan for land division of Archar village were within the borders of lands 174 and 175. In the course of this study was accepted a model to take soil samples, where each sample was taken from the terrain with a soil probe, as sample points were located within the borders of the terrain in a square grid. Samples were taken in three depths 0-25, 25-50 and 50-75 cm. After standard preparation, soil samples were analyzed to establish the indicators: soil texture with fotosedimentograf (Trendafilov and Popova, 2007), hydrological characteristics of the soil (Trendafilov and Popova, 2007), bulk density of the soil by paraffin method, relative density - pycnometrically, pH - potentiometric in aqueous extract (Arinushkina, 1970), content of total and alkaline earth carbonates - gas metrically by Scheibler apparatus (Arinushkina, 1970), active calcium precipitable with $(NH_4)_2C_2O_4$ - Druinnot-Gallet (NO1085/ NFX31-106), humus content by Turin method (Trendafilov and Popova, 2007), water-soluble salts (BDS ISO 11265:2002), content of easily absorbable iron, total nitrogen in the soil (BDS ISO 11261: 2002), mobile forms of phosphorus and potassium (GOST 26209-91/01.07.93).

Based on the obtained results from the preliminary study was determined harmful acidity and the degree of saturation of soil bases and is proposed plan for melioration of the problem areas and recommended fertilization rates.

RESULTS AND DISCUSSIONS

Within the studied object are distributed Haplic luvisols. The depth of the soil profile was more than 100 cm and the humus horizon about 25 cm. The location of the sampling points shown in Figure 1.

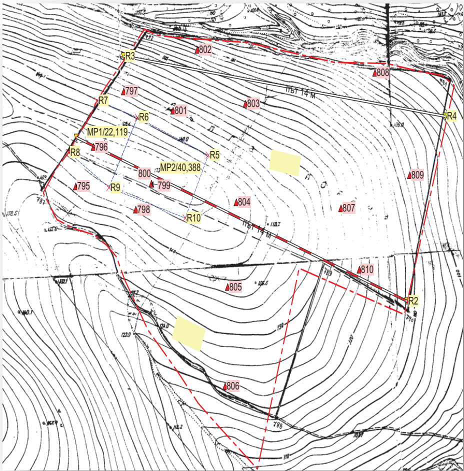

Figure 1. Location of the sampling points

Soil texture and physical properties of the soil

The average content of physical clay and particles <0.001 mm in the studied depths shown in Table 1.

Table 1. Average values of the physical indicators of Haplic luvisols by depths

Indicators	Depth (cm)		
	0-25	25-50	50-75
Physical clay (%)	46.6	55.5	52.7
Particles <0.001 mm (%)	5.5	5.9	5.8
Specific density (g/cm^3)	2.68	2.71	2.71
Bulk density at saturation	1.39	1.47	1.49
Porosity (%)	48.16	45.59	44.98

The average content of the physical clay in a depth from 0 to 75 cm was 51.6% and increased in the depth of the profile. The soil texture in the topsoil horizons was sandy clay. In the subsoil horizons was also sandy clay. The texture coefficient had value 1.08 and was not limitation on the adjustment of the soil for vineyards. The total porosity of the soil was assessed as satisfactory. The saturation was low with an average value 20.96%. In the topsoils horizon the saturation was higher - 24.99%. The maximum total water reserve for the topsoil 1 meter horizon in the terrains with sufficient profile depth was 3000 m^3/ha. In the shallower profile the maximum water reserve did not exceed 2300 m^3/ha. In the moisture at wilting point in the profiles, whose depth exceeds 1 m contains about 2000 m^3/ha not absorbable water reserve. In shallow profiles (with depth up to about 75 cm) the volume of not absorbable water reserve did not exceed 1500 m^3/ha. The approximate estimates for the volumes of easily absorbable and total absorbable water reserve in the deep and shallow (profile depth between 60 and 100 cm) soil profiles of the studied Haplic luvisols shown in Table 2.

Table 2. Water reserve of the soil at different moisture

Hydrological indicator	Haplic luvisols - deep	Haplic luvisols - shallow
Maximum water reserve at saturation (m^3/ha)	3000	2300
Water reserve at field capacity (m^3/ha)	2300	1800
Maximum water reserve at wilting point (m^3/ha)	2000	1500
Easily absorbable water reserve (m^3/ha)	700	500
Total absorbable water reserve (m^3/ha)	1000	800

Soil pH

The average value of the indicator pH (H_2O), found for the whole studied object was 5.58 with a confidence interval from 5.46 to 5.70. The indicator pH in the topsoil horizon had average value 5.3 with a confidence interval from 5.06 to 5.55. The soil reaction of the topsoil horizon was acidic. In the depth of the soil the values of pH increased. The reaction of subsoil horizons was also defined as acidic.

Content of total alkaline earth carbonates

Not found

Active calcium content

The average content of active calcium for the area, occupied by Haplic luvisols was 0.12% and vary in the ranges of confidence interval from 0.06 to 0.18%. The maximum value of the active Ca^{2+}, established within the distribution of the studied soil difference was 0.65%. The average value of the active calcium content for the topsoil horizons was 0.07%.

The distribution of Ca^{2+} in the depth of the soil profile shown in Figure 2. The figure shown, that the content of the active Ca^{2+} increases in the depth of the profile. The difference in the values of the indicator was very high.

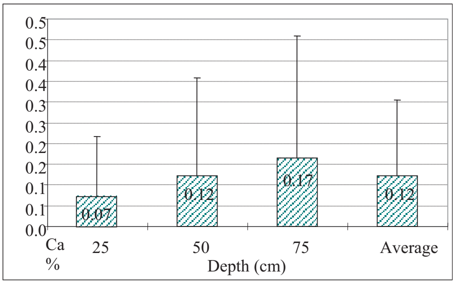

Figure 2. Content of active Ca and distribution in the soil profile

Humus content

The humus content for the topsoil horizon of the studied Haplic luvisols was 1.85% and assessed as low. The humus content highly decreased to 0.73% in depth 25-50 cm and to 0.48% in depth 50-75 cm. It can be expected, that in the depth of the trench horizon will establish low humus content - 1.01%, which will vary within the confidence interval from 0.83 to 1.19%.

The correspond to the humus total nitrogen content in the studied soil was average 0.11% in the top horizon; 0.04% in a depth 25-50 cm and average 0.08% for the depth of the trench soil layer. The total nitrogen reserve in the layer with depth 0-50 cm was 5 t/ha. About 70% of this reserve was in the top 25 cm of the profile.

Content of nutrients macro elements

The content of ammonium, nitrate and total nitrogen in the soil and the content of absorbable phosphorus and potassium shown in Table 3. The content of nitrate, ammonium and total nitrogen was very low and the soil was poorly reserved with nitrogen.

The soil in samples No. 802 and 810 was average reserved with absorbable phosphorus and in samples No. 796 and 807 was well reserved.

In regard to absorbable forms of potassium the soil was average reserved in samples No. 796, 807 and 810 and well reserved in sample No. 802.

Table 3. Content of nutrients macro elements in Haplic luvisols

Sample No.	Content of NH_4, (mg/1000 g soil)	Content of NO_3, (mg/1000 g soil)	Content of total N in the soil (mg/1000 g soil)	Content of P_2O_5 in the soil (mg/100 g soil)	Content of K_2O in the soil (mg/100 g soil)
796	2.8	5.6	8.4	11.2	14
802	2.8	2.8	5.6	9.1	24
807	1.4	1.4	2.8	11.2	16
810	1.4	1.4	2.8	6.5	14

Harmful acidity and lime requirement of the soil

Determinate were the soil reaction in extract with 1m KCl and the content of easily mobile exchange Al^{3+}, H^{+}, Mn^{2+}, Ca^{2+} and Mg^{2+}. Calculated was the degree of saturation of the permanent sorption positions in the soil with easily mobile exchange bases (BDS 17.4.4.07-97). The results of the determination of the harmful acidity indicators shown in Table 4.

Table 4. Results of the determination of the indicators of the harmful soil acidity

Sample No.	Depth (cm)	pH $_{(H2O)}$	pH $_{(KCl)}$	Al+H (meq)	Mn (meq)	Ca+Mg (meq)	V_3 %[1]
795	0-25	5.00	3.80	0.82	0.16	10.49	92
	25-50	5.45	4.00	0.28	0.13	11.04	96
	50-75	5.70	4.10	0.23	0.14	12.42	97
796	0-25	4.55	3.55	2.34	0.07	8.51	78
	25-50	5.40	3.90	0.54	0.14	13.94	95
	50-75	5.40	4.15	0.17	0.1	13.2	98
797	0-25	5.60	4.00	0.34	0.13	10.53	96
	25-50	5.75	3.90	0.53	0.17	16.47	96
	50-75	5.60	4.30	0.11	0.15	16.68	98
798	0-25	5.90	4.50	0.05	0.12	14.49	99
	25-50	5.70	4.10	0.26	0.17	16.42	97
	50-75	6.00	4.15	0.22	0.18	16.56	98
799	0-25	4.35	3.40	6.61	0.13	5.52	45
	25-50	4.70	3.30	9.26	0.18	8.17	46
	50-75	5.50	4.10	0.2	0.11	16.56	98
800	0-75	5.40	3.60	3.06	0.13	12.93	80

The results shows, that regardless of the prevailing acidic reaction in the studied terrains, established in almost all samples, a low degree of saturation of the permanent sorption positions with easily mobile exchange bases cations was found only in a few samples, characterized relatively small area of the terrain. The highest degree of acidification was found in sample 799. However, this sample characterized local spot about 0.1-0.2 ha in the high part of the terrain and its morphology characterized as Planosol with clear signs of secondary hydromorphic as a result of highly differentiated profile. The morphological features of this soil type were not established in other parts or sections of the terrain and therefore, the rate of calcium containing meliorants was not consistent with the calculated for neutralization of the harmful acidity in this soil profile. Based on the obtained results of the analysis were calculated balance lime rates shown in Table 5. The rates in active substance were recalculated in nature based on content of CaO in the liming material 48% and 4% moisture.

Table 5. Balance rates of liming on soil samples

Sample No.	Depth (cm)	Rate CaO, by layer (kg/ha)	Rate CaO for the section (kg/ha)	Rate liming material (kg/ha)
795	0-25	0	0	0
	25-50	0		
	50-75	0	3290	7100
796	0-25	3290		
	25-50	0	0	0
	50-75	0		
797	0-25	0	0	0
	25-50	0		
	50-75	0	0	0
798	0-25	0		
	25-50	0	0	0
	50-75	0		
799	0-25	8660	20650	44400
	25-50	11990		
	50-75	0	4760	10200
800	0-75	4760		

The extrapolation of the data from the analyzes to the area of the studied terrain allow to individuate two ameliorative subsections with a total area of 6.2507 ha. The main benchmarks of the meliorative subsections were coordinated in system UTM - coordinates of the benchmarks marks shown in Table 7.

Table 6. Quantitative account for liming materials

Meliorative subsections	Area, ha	Quantity CaO, kg/ha	Quantity liming material, kg/ha	Liming material for ameliorative rate, t
MP 1	2.2119	3290	7000	154.83
MP2	4.0388	4760	10000	403.88
Total	6.2507			558.71

Organization of the terrain and technology for introduction of lime materials in the soil

Within the studied terrain provides passage of two main roads with a width of 14 m. The routes of the main roads of the plantation shown in Figure 3.

Table 7. Coordinates of the main benchmarks for tracing of ameliorative subsections - Archar object

Benchmarks	OX	OY
R1	653975	4849102
R2	655002	4848714
R3	654132	4849278
R4	655142	4849120
R5	654389	4849053
R6	654169	4849141
R7	654043	4849182
R8	653948	4849069
R9	654071	4848989
R10	654310	4848915

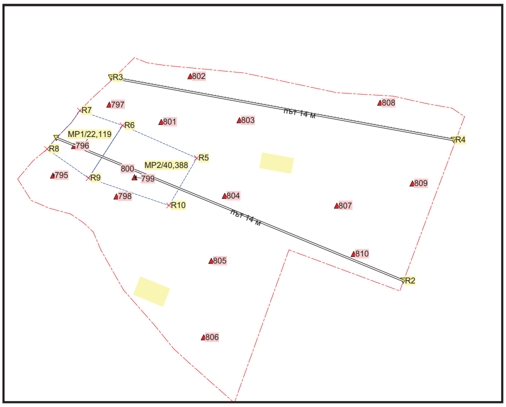

Figure 3. Sketch, M1: 7500 of the main roads

For neutralization of the established harmful soil acidity in the project study and to prevent greater soil acidification in the growth process of the vine plantation was necessary to perform differentiated liming of the sections with acidification. The rate for the amount of calcium oxide for liming of acidic soils is calculated in order to achieve neutralization of the harmful acidity and to cover the cost components in the balance of calcium in the soil. The cost elements in the balance of calcium, which are covered by lime rate were:

Neutralization of the toxicity in regard to the crops effect of the easily mobile exchangeable aluminum, hydrogen, and manganese.

Recovery of the losses from the uptake of calcium with the plant biomass.

Neutralization of the acidification effect of the mineral nitrogen fertilizers accounted by planning balance fertilization rates for the project period, including five years after the liming.

Saturation of the sorption cation capacity with calcium.

Mobilization of nutrient macro and microelements in the soil and regulation of the mineral nutrition of the plants.

Recovery of the losses from partially leaching and compensation of the positional inaccessibility of calcium containing chemical ameliorants.

As a chemical ameliorant for liming it provides for the use of ground limestone, fraction 0-5 mm. Limestone provided for soil application in terms of particle size and content of active substance meets the requirements of technologies for chemical melioration of acidic soils.

The effect of liming depends on the regular distribution of the lime materials in the soil. It is known, that the available fertilizing spreader machines (centrifugal spreader) have limited ability in regard to the quantity of fertilizers and ameliorants what can apply in hectare no more than 800-1000 kg in a single pass of the machine.

The designation of the ameliorative sections of the terrain was performed by marking. It is envisaged that the marking is performed by grooving to their borders with a plow or cased, aggregated with tractor class 14 kN, if this is impossible - by chainage. After scattering of the lime materials in the field was performed the soil tillage provided within the main technological process, associated with the creation of the vine plantation.

Fertilization of the area

Before trenching on the area is performed stockpiling fertilization with phosphorus and potassium fertilizers. The rates for stockpiling fertilization with nutrient macro elements by analyzed soil samples shown in Table 8.

Table 8. Rates for stockpiling fertilization, kg/ha

Sample No.	Rates for stockpiling fertilization with P_2O_5 kg/ha	Rates for stockpiling fertilization with K_2O kg/ha	Rate triple superphosphate, kg/ha	Rate potassium sulphate, kg/ha
796	28.6	10.8	68	22
802	34.5	0	82	0
807	28.6	5.2	68	10
810	41.8	10.8	99	22

Recommended for stockpiling fertilization with phosphorous to be performed with triple superphosphate in rate 790 kg/ha for the whole terrain.

Despite the differences in the rates of potassium fertilization, in order to achieve better ripening of the vine shoots, on the terrain can be performed stockpiling fertilization with potassium sulfate in rate 220 kg/ha.

After performing of stockpiling fertilization, should not apply phosphorus and potassium fertilizers until the third year, or until vine fruit-bearing.

After planting the vines is recommended performance of foliar fertilization twice, as the first one should be performed one month after vines leafing and the second one until the end of July.

In the second and third year applies the following schedule of fertilization: during the vegetation period is performed three or four times a foliar fertilization. The first spraying is performed one month after leafing, and the second and third in two - three weeks.

After the third year during the vegetation period is performed three or four times with a foliar fertilization as using the rates for the second and third year.

Table 9. Fertilization rates with nutrient macro elements during the fruit-bearing

Sample No.	Variety	Fertilization rate N kg/ha	Fertilization rate P_2O_5 kg/ha	Fertilization rate K_2O, kg/ha
796	Cabernet	161.3	97.4	80
	Merlot	112.6	74.3	40
	Pamid	138.6	101.4	90
	Riesling	146.5	107.9	90
802	Cabernet	165.7	100.6	30
	Merlot	117	77.6	50
	Pamid	143	104.7	50
	Riesling	150.9	111.2	40
807	Cabernet	170.1	97.4	70
	Merlot	121.4	74.3	30
	Pamid	147.4	101.4	80
	Riesling	155.3	107.9	80
810	Cabernet	170.1	104.7	80
	Merlot	121.4	81.6	40
	Pamid	147.4	108.8	90
	Riesling	155.3	115.2	90
Average for the terrain	Cabernet	166.8	100	65
	Merlot	118.1	76.9	40
	Pamid	144.1	104	77.5
	Riesling	152	110.5	75

The fertilization rates, after vine fruit-bearing shown in Table 9. The rates are approximate. The accurate determination of the fertilization rates should be performed after annual analysis of soil samples for content of nutrient macro elements.

CONCLUSIONS

The studied terrain was suitable for creation and growth of vineyards in direction of high quality red and white wines. The established values of physical clay shown, that the soil texture was not a restriction on the suitability of the soil for growth of vines.

The established in the analysis pH represents minor restriction for the growth of the vine. To prevent possible soil acidification in the growth process of the vines was necessary to avoid fertilization with ammonium nitrate. The necessary nitrogen for the plants is provided through the use of urea. In the sections with harmful soil acidity is performed liming.

The content of active calcium in the soil was no restriction of the choice of pad for planting.

The content of water soluble salts in the soil was very low and did not exceed the limit of harmfulness (0.25%) and was not a restriction for the growth of the vine.

Recommended for stockpiling fertilization with phosphorous to be performed with triple superphosphate in rate 790 kg/ha for the whole terrain.

Despite the differences in the rates of potassium fertilization, in order to achieve better ripening of the vine shoots, on the terrain can be performed stockpiling fertilization with potassium sulfate in rate 220 kg/ha.

After performing of stockpiling fertilization, should not apply phosphorus and potassium fertilizers until the third year, or until vine plantation fruit-bearing.

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PRODUCTIVITY ELEMENTS IN CONSERVATIVE AND CONVENTIONAL TILLAGE SYSTEMS

Valentina ANDRIUCA, Ion BACEAN, Nicolai CAZMALI, Lucia MACRII, Rodica MELNIC

State Agrarian University of Moldova, 44 Mircesti Str., Chisinau, Moldova

Corresponding author email: valandriuca@yahoo.com

Abstract

We have studied productivity elements - soil moisture, agro-physical properties, soil disturbance, edaphic volume and the root system in the conservative non-tillage system as compared to the traditional system - ploughing.
The experiments included 7 soles and 3 agrocoenoses - winter wheat, maize as a repeated culture (34 years), rotation of maize and beans. The soil from the studied agricultural ecosystem is sandy loam carbonate chernozem, the content of physic loam (<0.01 mm) is 22-25%.
It was stated that soil moisture in the conservative no-tillage system is directly influenced by agrocoenoses, the stage of plant development and more compact horizons (20-30 cm) greatly favour the location of the root system closer to the surface, which causes the inhomogeneity of water content available on the soil profile. The data showed that we should study water on the whole humified profile in the conservative tillage system.
We found out that the no-tillage conservative system increases water reserves in soil during the periods subject to pedologic droughts. It is more evident, when cultivated crops, such as maize, are planted. There was identified a close correlation between penetration resistance and bulk density of the ecosystem soil - winter wheat (r = 0.73-0.78).
We have also noticed that the weight of winter wheat roots in the conservative tillage system is 1266 g/m^2, as compared to the traditional ploughing (1017 g/m^2).
In the farming year 2014-2015, a year of great droughts according to hydrothermal indices (Seleaninov), the agricultural ecosystem of winter wheat, preceded by winter barley showed a higher level of productivity (2809 kg/ha) in the no-tillage system as compared to the ploughing (1789 kg/ha).
We have found out that crop productivity and moisture in agrocoenoses are influenced by a forecrop, tillage system and conditions of the root system.

Key words: *agricultural ecosystems, no-tillage works, soil moisture, root system, crop structure.*

INTRODUCTION

The conservative system of agriculture requires scientific harmonious combination and application of all anthropogenic components of sustainable agriculture: soil tillage; crop rotation; control of weeds and diseases; conservation of resources - soil, water, air, biodiversity, energy (Cerbari, 2011; Jigau, 2011; Rusu et al., 2013; Boincean, 2013).
We need to study the conservative no-tillage system as compared to the traditional system in various climatic zones, including the Republic of Moldova, where the conservative system is used without any detailed scientific grounding of the benefits and problems that may arise.
You may often find contradictory and incoherent information on the production and average performance of the conservative no-tillage system in the scientific literature.
The conservative tillage system requires specific adaptation to soil conditions, climate, humidity, crop rotation, weed control, maintaining soil biological activity and vitality and developing some environmental conditions that will be favourable to agricultural crops and stimulate crop formation. Even if the conservative system does not increase the productivity of the agricultural ecosystem through harvest, its application is justified (if it is scientifically recommended), taking into consideration those environmental benefits which accompany it: reduced time for sowing; reduced fuel and energy consumption (by 30-40%); reduced number of purchased agricultural machinery; reduced soil compaction; restructuring; reduced surface and subsurface erosion; improved water in soil; favourable development of the root system; increased microbial activity.

The elements of efficient fertility play an important role, when the conservative tillage system is applied, special components of the agricultural ecosystem, which greatly contribute to the development of plants and crop formation.

The following ecological productive determinants of the conservative tillage system were studied during the growing season in different experimental variations: soil moisture, agro-physical properties, the root system, structural elements of the crop.

The conservative no-tillage system (the first year of application) mobilized the upper layer of 0-30 cm, providing more favourable conditions to winter wheat root systems, which resulted in an increased yield by 1.1-1.5 times, as compared to the conventional tillage system – the ploughing.

MATERIALS AND METHODS

The research was conducted in the agricultural year 2014-2015 at the educational and experimental station of SAUM "SDE Chetrosu". The case study included 7 soles with 3 agrocoenoses - winter wheat (2 soles, Antonovca variety), maize (Porumbeni 458) as a repeated culture (34 years), rotated maize I and II (2 soles) and beans (2 soles). The experiments were distributed to long-term research variants - ploughing and conservative activities - paraplow.

According to agro-ecological monitoring methods that were applied (Cerbari, 1997, 2010) there were determined: soil texture; physical and chemical indices; soil moisture (% and mm); wilting coefficient; soil density, bulk density and total porosity; resistance to penetration both in the field and in the laboratory. Root systems of winter wheat, maize and beans were studied by taking the organic mass of the 0-50 cm layer on the area of 0.25 m^2 in four repetitions. In July we conducted a biometric research of the studied cultures: winter wheat and maize grains. The production of the agricultural ecosystem was appreciated by structural elements of the crop and field crops.

The assessment of agricultural climatic conditions for the station Chetrosu in 2014-2015 showed that the annual average temperature was 11.2°C, by 1.8°C higher than the multiannual average temperature (9.4°C). The annual amount of deposition was reduced by 50.8 mm (472.2 mm) as compared to the annual average (523 mm). The amount of precipitations during the summer period was 52% of the multiannual average: in May - 48%; in June - 80%; in July - 61% and in August – 0.6% respectively.

According to the hydrothermal index (HTI) and the temperature regime over 10°C, the agricultural year 2014-2015 was extremely dry, especially during the active growing season, an extremely dry year as the annual average air temperature exceeded the multiannual average air temperature.

The hydrothermal index (HTI after Seleaninov) during the active growing season (from May to September) deviates significantly from the multiannual average, which during the last 50 years (1946-1995) used to decrease from March to May, from 2.71 (III) to 1.00 (IV) and 0.89 (V), while in June, due to the increased precipitation, it equals to 1.14, and, then, it decreases as temperatures rise: 1.14 (VI), 0.96 (VII) and 0.72 (VIII) at the educational station Chetrosu. According to our calculations, the agricultural year 2014-2015 was characterized by the semi-arid climate, the hydrothermal index (HTI) ranged from 0.5 to 0.94. In March it was 2.66, in April – 0.94 and in May it was half as much as compared to the multiannual average.

The detailed assessment showed that plants had long periods of climatic stress, they were forced to adapt to HTI great deviations in summer, when it deviated significantly, in June, July and August respectively: 0.93; 0.53; 0.4 - a huge shortage of rainfall. Climatic conditions in March deviated from the multiannual average significantly.

RESULTS AND DISCUSSIONS

The soil of the studied agricultural ecosystems (year 2015) is represented by calcareous black soil under moderate humified moderately deep sandy loam to sandy loam, which is characterized by the under moderate humus content (2.2-2.5%), the class of total cation exchange the capacity being average, the amount of adsorbed cation is from 22 to

25 me/100 g of soil in the upper part of the profile. Carbonates are present throughout the profile, ranging from 1.0-1.4% in the upper layer to 6-8% at a depth of 110-120 cm. Soil reaction is slightly alkaline.

Soil moisture. We have also studied the humidity in dynamics as deep as 120 cm. The results showed that at the early stages of the biological active development of winter wheat (the first decade of May), the moisture of ploughed soil was 18-20% (Figure 1), in the conservative tillage system it was about 2% lower, as the plants here were better developed. In a month (in June) moisture in the upper soil profile from the agrocoenoses of winter wheat, the ploughing variant had 9-15% or 72 mm in the layer of 0-50 cm. Moisture in May-June, mm is reflected in Figure 2. Comparative data of soil moisture in mm do not highlight water conservation in the layer of 0-50 cm. However, the data evaluation for the depth of 60-120 cm showed that moisture had been used more productively, by 2-3% higher in the no-tillage variant as compared to the ploughing variant (Figures 1 and 2). The coefficient of soil constant wilting was 11-13%, and in June soil moisture was close to the wilting coefficient, in the no-tillage variant reserves of water available to plants were greater at the depth of 60-120 cm.

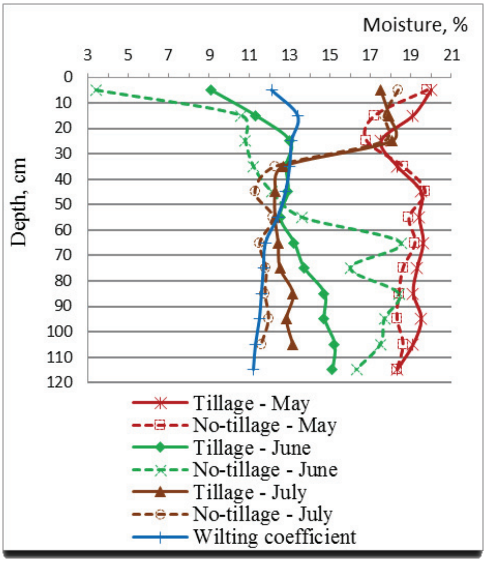

Figure 1. Soil moisture (%) in the traditional (ploughing) and conservative tillage (no-tillage) systems

The results of soil moisture changes with the development of agrocoenoses are most visible, when soil moisture is presented in mm (Figure 2). The comparative assessment of moisture reserves in soil at the beginning of the active growing season (May) for various agrocoenoses showed the following: 113-114 mm by winter wheat, Figure 2; 123-137 mm by maize repeated culture; 112-116 mm by beans. The data obtained in June indicated preservation of soil moisture (102 mm as compared to 94 mm) in maize, the conservative no-tillage variant. The results showed different water conservation degrees, depending on the agricultural system that was applied and agrocoenoses, the type of the root system. It should be noted that the assessment of soil moisture should be expressed both in % and mm, and the content of soil moisture requires thorough research not only in the upper layer (0-50 cm), but throughout the whole layer of soil (Figure 1), as water from the surface layer is actively consumed by root systems.

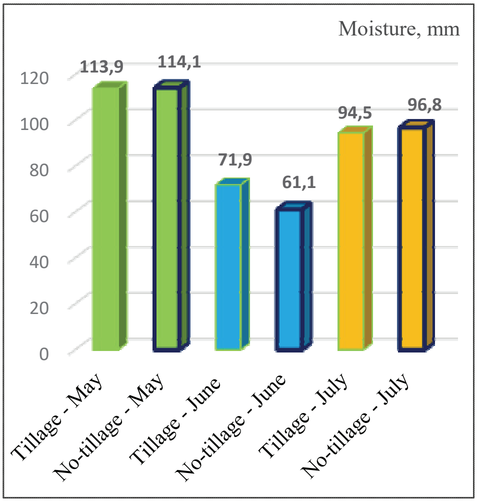

Figure 2. The variation of soil moisture, mm in the winter wheat agrocoenoses in May-July, 2014-2015

The bulk density. It was found that the bulk density reflects significantly the forecrop and the tillage system. The soil density in the layer of 0-50 cm is higher in agrocoenoses of the conservative no-tillage system (1.21-1.33 g/cm^3) as compared to the ploughing system, and namely: 1.21 g/cm^3 - winter wheat; 1.22 g/cm^3 - maize, repeated culture; 1.16g /cm^3 -

beans (Figure 3). We observed compaction of the layer of 20-30 cm by winter wheat both in the ploughing and no-tillage systems; this fact was also reflected in the data regarding penetration resistance (Figure 4). It was found out that soil moisture influences directly the penetration resistance. We identified a strong correlation between the bulk density and penetration resistance of the soil. The correlation coefficient is r = 0.78 for the variant winter wheat - ploughing, and r = 0.73 for the variant winter wheat - no-tillage.

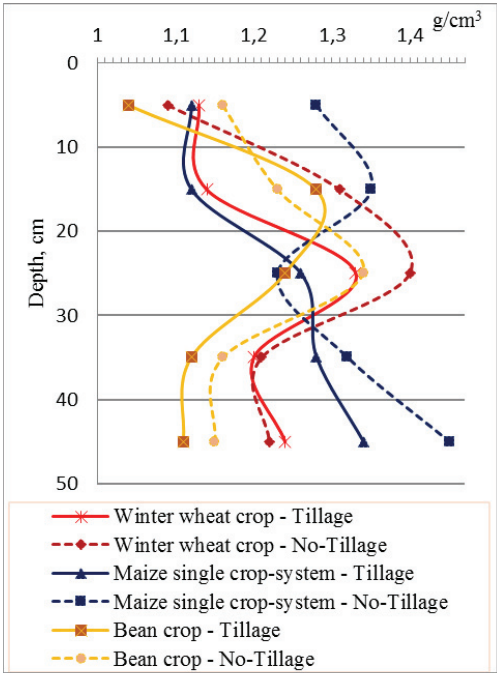

Figure 3. Comparative evaluation of soil density depending on the agrocoenoses and soil tillage

Penetration resistance. The data on the soil penetration resistance from the agricultural ecosystem of winter wheat in May and June show that ploughing contributes to the formation of a loose layer of 0-20 cm (5-9 kgf/cm^2) and in the no-tillage variant at the depth of 10-20 cm the penetration resistance is 19 kgf/cm^2 (Figure 4). The same thing was observed in the agrocoenoses of maize as a permanent crop, before sowing. Penetration resistance of both arable and under-arable layer in rotated maize was more homogenous, with the values that were lower than the arable and under-arable layer of maize as a permanent crop. In June, moisture decreases and penetration resistance increases for virtually all the agrocoenoses of the studied variants, yet the maximum values of penetration resistance was recorded in the upper layer (0-10 cm deep) and in the layer of 30-40 cm in agrocoenoses of winter wheat, where resistance equalled to 29 kgf/cm^2.

Soil penetration resistance was studied for all agrocoenoses depending on moisture. We observed an increase in penetration resistance in the no-tillage variant in July, which is explained by the root system that was better developed under the conditions of the conservative tillage system and the increased amount of consumed water.

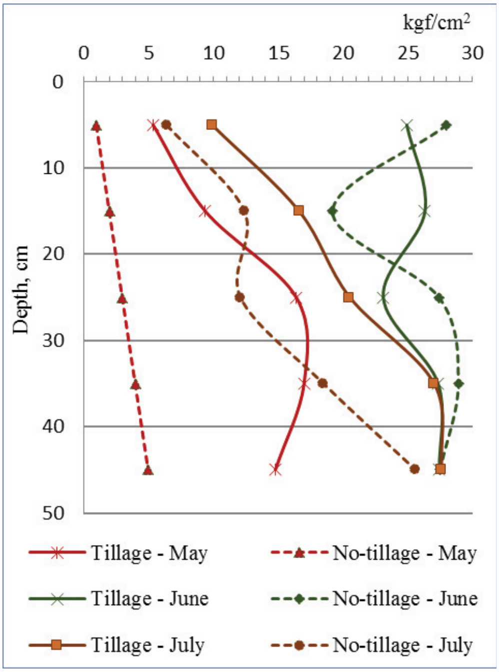

Figure 4. The dynamics of the soil penetration resistance change depending on the tillage system in winter wheat

We have also carried out some biometric assessments of fully ripened winter wheat, maize as a permanent crop and maize as a rotated crop at the flowering stage, beans at the stage of ripening. The data on agrocoenoses of maize under both the conservative system and ploughing (Table 1).

The data show that the maximum height of maize plants as well as the number of cobs was recorded in rotated maize under ploughing. The smallest stem diameter (2 cm) was registered in maize as a permanent crop in the ploughing variant, in other variants the stem diameter was from 2.3 to 2.4 cm and the plants were more vigorous.

The crop structure. We have also studied structural elements of the winter wheat crop, including the mass of roots (Table 2) in both maize as a permanent culture and in rotated maize (Table 3) according to their morphological characteristics. There was assessed crop productivity in the field, depending on the tillage system that had been applied (Table 4). The crop structure was assessed on the plots with the area of 0.25 m^2 and 1 m^2 each.

The technological harvest (productivity) of winter wheat in fields 1 and 7, both tillage systems correlate with the biological crop structure, determined per 1m^2. The parallel determination of structural elements of winter wheat harvest on the surface of 1m^2 and 0.25 m^2 by four repetitions, shows the use of only one crop gathered from the parcels of 1 m^2.

Table 1. Biometric features of the studied maize, July, 2015

Biometric measurements	The variant			
	Maize as a permanent crop (34 years)		Maize (1) - rotation	
	Ploughing	No-tillage	Ploughing	No-tillage
Height, cm	204	211.6	221.5	202.5
Number of leaves	13.0	11.4	12.6	12.1
Number of cobs	2.0	1.8	2.1	1.5
The length at the height of the 4th leaf, cm	62.7	76.2	71.3	70.6
The width at the height of the 4th leaf, cm	7.6	8.4	8.6	9.3
Stem diameter, cm	2.0	2.4	2.3	2.3

Table 2. Structural elements of winter wheat (1 m^2), 2014-2015

The variant	The number of stems	The mass of stems, grams	The number of heads	The mass of grains per 1 m^2, g	The mass of 1,000 grains, g	Harvest, kg/ha	The mass of roots, g
Ploughing	430	201.7	405	186.3	35.4	1863	1017
No-tillage	543	265.7	508	281.4	34.7	2814	1266
$DL_{0,05}$	366	72.0	320	76.0	2.2	756	448

Table 3. Structural elements of maize (6 cobs), 2015

The agrofond	The length of cobs (cm)	The cob diameter (cm)	The number of rows per cob	The number of grains per row	The total mass of cobs (g)	The total mass of grains (g)	The share of grains in the mass of cobs (%)	The mass of 1,000 grains (g)
Maize as a permanent crop (Field 3)								
Ploughing	20.8	4.2	13	43	1216.7	999.3	82.1	316.6
No-tillage	22.3	4.6	15	41	1488.5	1232.1	82.8	348.7
Rotation of maize (Field 4)								
Ploughing	20.3	4.2	14	41	1277.7	1051.9	82.3	349.9
No-tillage	20.7	3.5	14	39	1243.5	1020.1	82.0	354.0

The studied productivity of field crops. The results showed that the productivity of crops studied in the agricultural year 2014-2015 was directly influenced by forecrops, the tillage system (Table 4), and the conditions of the root system development (Table 2). The agricultural ecosystem of winter wheat (Table 4), preceded by winter wheat, the no-tillage variant showed a higher level of productivity (2809 kg/ha) as compared to the ploughing variant (1789 kg/ha).

The data on field crops correlate with the data on the harvest of winter wheat (Tables 2 and 4).

The data show a positive influence of the no-tillage system on the productivity of maize as a monoculture and as a rotated crop (Table 4).

Table 4. The productivity of field crops by the tillage system (kg/ha) within Rotation 1, Chetrosu, 2014 -2015

The culture	The variant	Harvest, kg/ha	DL 0.05
Winter wheat (the forecrop winter wheat - Field 1)	Ploughing	1789	188
	No-tillage	2809	
Beans (1) (the forecrop maize, the 3rd year - Field 2)	Ploughing	695	477
	No-tillage	634	
Maize as a permanent crop (34 years) - Field 3	Ploughing	4203	78
	No-tillage	4791	
Maize (1) (the forecrop maize, the 3rd year - Field 4)	Ploughing	5266	496
	No-tillage	6093	
Beans (2) (the forecrop maize, the 2nd year - Field 5)	Ploughing	792	385
	No-tillage	524	
Winter wheat (the forecrop winter wheat - Field 7)	Ploughing	3278	795
	No-tillage	3243	

CONCLUSIONS

The application of the conservative no-tillage system in the Republic of Moldova requires comprehensive adaptation to soil conditions, climate, agrocoenoses, plant protection technologies and the surface of the agricultural ecosystem, technological conditions and methods of water conservation in soil.

We found out that disturbance of soil from the agricultural ecosystem, expressed by the bulk density, penetration resistance and moisture significantly reflects the forecrop and the conservative tillage system offers more favourable conditions for the root system of plants with high density as compared to row crops (maize, beans). Water conservation in the conservative tillage system of carbonate chernozem (no-tillage) occurs at the depth of 60 cm.

As to the assessment of water available to plants in the conservative tillage system, water reserves at the depth of 1 m play a significant role here.

There were less water reserves in soil during the active growing stage of winter wheat in compacted layers as compared to adjacent horizons.

We stated a positive correlation between the bulk density and soil penetration resistance under winter wheat (r = 0.73-0.78). In case of moisture available to plants (17-20%) as compared to the wilting coefficient of 12-13%, soil moisture and penetration resistance correlated negatively (r = 0.6-0.7).

During the period of pedological drought the conservative no-tillage system has greatly preserved water available in agrocoenoses with maize as a repeated culture.

Biometric features of maize by the studied variants demonstrated that the maximum height of plants and the greatest number of cobs were observed in the variant, where ploughing was applied and maize was used as a rotated culture.

The agricultural ecosystem of winter wheat, the no-tillage variant, the forecrop is winter wheat showed a higher level of productivity (2809 kg/ha) as compared to the ploughing variant (1789 kg/ha).

The variant of no-tillage winter wheat provided more favourable conditions for the development of agrocoenoses expressed by the number and mass of stems, the number of heads, the mass of grains and the total mass of roots per 1 m^2.

The harvest of winter wheat was significantly high in the no-tillage variant (the forecrop winter wheat), while there was registered no crop increase in the winter wheat ploughing variant, (the forecrop winter wheat).

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QUALITY ASSESSMENT OF AN IRRIGATED FLUVISOL

Valerian CERBARI[1], Gheorghe STEGARESCU[2]

[1]Institute of Soil Science, Agrochemistry and Soil Protection "N. Dimo", 100 Ialoveni Street, Chisinau, Republic of Moldova
[2]State Agrarian University of Moldova, 42 Mircesti Street, Chisinau, Republic of Moldova

Corresponding author email: gstegarescu.eco@gmail.com

Abstract

Irrigated fields are playing an important role in assuring world population with qualitative food products. However intensive cultivation combined with irrigation lead to negative changes in soil physical and chemical properties. There have been done few comprehensive studies on how irrigation affects soil physical fertility. This article presents an evaluation of an irrigated Fluvisol from the Inferior Dniester floodplain, in the Republic of Moldova. The results reveal that 50 years of irrigation and intensive cultivation of Eutric Fluvisol with clay texture had a negative impact on the soil physical quality. Low inputs of organic fertilizer lead to a decrease in soil organic carbon content, negatively influencing soil properties. Major changes were reflected in the distribution of structural aggregates, so that the proportion of clods in the first layer was moderate (38.2%), but in the subsequent layer was very high (81.7%). Due to the high clay content, it has a high water stability of macroaggregates in both 0-20 cm and 20-38 cm layer. The results also show that soil has an increased bulk density, low total porosity which is decreasing with the depth, and high compaction degree. This study will be used as a start point for the future research of the utilization of the cover crops in irrigated agriculture.

Key words: *irrigation, fluvisol, soil physical properties, conventional tillage.*

INTRODUCTION

Nowadays agriculture is facing major challenges in producing more food, but also to achieve to fulfil the purposes of sustainable agriculture, where production is simultaneously environmentally friendly, socially fair and economically beneficial (Wezel et al., 2014).

Irrigation became one of the most powerful innovation 6000 years ago. Agricultural lands were intensively irrigated leading to water shortages, soil salinization and soil degradation (Stranieri, 1999). The increasing number of world population and current trends of climate change are the major constraints to meet the food production demand. Therefore, the importance of irrigated soils should not be underestimated, as the food security is an important goal to achieve.

It is already known that "a good soil physical quality is one that is "strong" enough to maintain good structure, hold crops upright, and resist erosion and compaction; but also "weak" enough to allow unrestricted root growth and proliferation of soil flora and fauna" (Reynolds et al., 2002). Good soil physical state contributes to a better water retention and water infiltration (Martens, 1992). Previously was studied that intensive crop production can cause the degradation of the physical quality of agricultural soils (Abu-Hamda et al., 2000; Dexter, 2004; Pilatti et al., 2006). Some specific studies have shown that irrigation practices are playing an important role in soil degradation especially in structure degradation (Pagliai et al., 2004). Also, there was observed that irrigation has a negative effect on soil total porosity and structural porosity (Mathieu, 1982). More than that combined with conventional tillage as well has a negative impact on the soil physical properties (Crittenden et al., 2015; Özgöz, 2009). However, there have been few rigorous studies on how irrigation affects soil physical properties was related by some authors (Murray and Grant, 2007).

The main purpose of the study was, to assess the impact of agriculture on fluvisols physical properties under irrigation. To demonstrate the importance of this study and its application in the future, a fluvisol under irrigation regime will be investigated.

MATERIALS AND METHODS

The study area is located in the Dniester river meadow, South-Eastern part of Republic of Moldova (46°74'07.2" N, 29°62'69.2" E). The soil is a Eutric Fluvisol according to FAO classification. The territory of the study site was a marshy area due to periodical floods. Around 60 years ago soils were dried as a consequence of installed drainage system. The area is used for irrigation and tilled already for 50 years. As a result soils already have their own specific regimes different from the natural, unusual for floodplain soils. The water used for irrigation has a good quality. The climate of the region is, characterized by annual medium temperatures of 9-11°C, and annual medium precipitations of 490-510 mm.

In order to assess what is, the present soil qualitative state 4 profiles were made in a triangle form. The principal profile is settled in the center with a depth of 2 m, and another three profiles are located around it, each of them having 1 m depth, the distance between them is 50 m. All of them were described from the morphological point of view, following the profile method. In the field were taken samples for the determination of the bulk density using the cylinder method in 3 repetitions for each horizon. The texture was determined using pipette method, but first, the soil was prepared according to Kaczynski method.

Further were taken samples from 0-20 and 20-38 cm depth to measure aggregate composition, macroaggregates (0.25-10mm), micro-aggregates (<0.25mm) and clods (>10mm) using dry method (Sainju, 2006) and wet sieving method by Savinov to measure the aggregates water stability. From soil physical parameters were calculated also the total porosity and degree of compaction. Another parameter that was determined in the laboratory was hygroscopicity by an air-drying method in the drying stove at a temperature of 105°C. Hygroscopicity of the soil is the phenomenon of attraction and retention of water molecules on the surface of soil elementary particles, spread in the gaseous phase of the soil. Also, it was determined the maximum hygroscopic moisture through Nikolaev method (Gajić, 2002), which depends on the soil texture, being higher for clay soils and lower for sandy soils. Soil density was determined using pycnometer method. Total N content was determined by the Kjeldahl method and soil pH was measured in H_2O (Mattigod and Zachara, 1996). The soil organic carbon was determined (SOC) by using Tiurin method (Mebius, 1960). All the samples were taken from the different depths according to the identified horizons.

RESULTS AND DISCUSSIONS

Soil profile description

The morphological organization of this soil profile due to the deposition of alluvial deposits is very variable in width and depth. Also due to the low frequency of the flooding processes and the construction of drainage system, the upper part of the soil profile is more or less homogenous and it is completed by buried and gleyic horizons in the inferior part. The Abhg layer, at the depth of 79-95 cm, is characterized by a humus horizon, formed in the prehistoric period. Under this horizon can be highlighted a gley layer divided by thin humus layers. The morphological characteristic of the principal soil profile is presented in Figure 1.

The soil profile is characterized by a homogenous texture. The medium content of the physical clay in arable layer varies from 82.6% to 88.7 % and the fine clay content constitutes 49.4-61.8 %. That proves that the bottom layer has a high concentration of clay material. From a qualitative point of view this soil with such concentration of clay represents a difficult object for irrigation because it has a low permeability for water, and reduced capacity for infiltration.

Soil aggregates distribution (dry sieving)

According to the obtained results, the proportion of clods was 38.2%, macroaggregates – 64.8% and microaggregates 1.8%, in the upper layer. But the 20-38 cm layer has lower quality as the a number of clods is higher and it constitutes 81.7%, macroaggregates 20.1% and 1.1% for microaggregates. From an agronomic point of view, the favorable dimensions of aggregates for plants are formed by aggregates of 10-7 mm to 0.5-0.25 mm.

Soil aggregates water stability (wet sieving)

The results are showing that aggregates from layers, 0-20 cm, and 20-38 cm, have a high stability of the aggregates, because of the extremely high content of clay. As it can be seen from the Figure 2, the distribution of aggregates that have a high water stability is the following 31.4% for 2-1 mm, 25% for <0.25 mm, in the first layer. The bottom layer has 23% for 3-2 mm, 28.4% for 2-1 mm and 21.5% for <0.25 mm aggregates

The high water stability of aggregates can be explained by that fact that it has a heavy texture, which gives to the soil the property of having low permeability.

In that case, it is a negative characteristic which makes the soil have low resistance to compaction. The stability of aggregates is important for a good water and air regime of the soil, which plays an important role for plants.

Figure 1. The soil profile characteristics: Ahp1 (0-20)-Ahp2(20-38)- ABh(38-57)- Bhg(57-80)- Abhg (80-95)-Bbhgk(95-115)- Gk1(115-135)- G 2(135-160)- G 3(160-200)

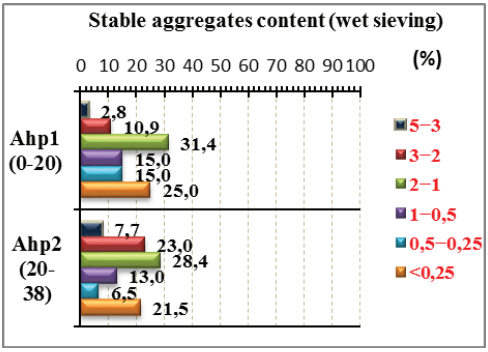

Figure 2. Aggregates water stability distribution by size, %

Hygroscopicity of the soil and maximum hygroscopic moisture

The soil hygroscopicity is proportionally related to the humus content and to fines of the soil particles. In the irrigated fluvisol soil the hygroscopicity varies from 6.6±0.9 % in the arable layer to 9.1 % ±0.5 % in the gley horizon. This is due to high content of clay. The precision of the determinations varies between 7.1-9.8 %. The variation coefficient is 5.7% in the upper horizon to 19.6% in the deeper horizons.

The maximum hygroscopic moisture constitutes 9.6-12.0 %. The square mean deviation value equals 0.3-0.4%. The precision of the determinations of the mean values is 2.9-3.9% and variation coefficient 6.3-7.8%.

Soil bulk density and density

The bulk density of the soil is characterized by a value of 1.23±0.14 g/cm^3 in the arable layer and with the depth, the bulk density increases till 1.44±0.08 g/cm^3. The 0-20 cm layer has an optimal value of the bulk density but the deeper soil horizons are affected by compaction. This can be easily observed in Figure 3.

The density of the soil profiles varies between 2.65±0.14% in the upper horizon or arable horizon to 2.75±0.13% at a depth of 95-110 cm. The precision of the indicators mean varies from 1.86% to 3.03%, variation coefficient does not exceed 6.1 %.

From the graph, it can be revealed that this soil has a heavy mineralogical composition and lower organic part. The higher the density concentration the lower will be the organic content.

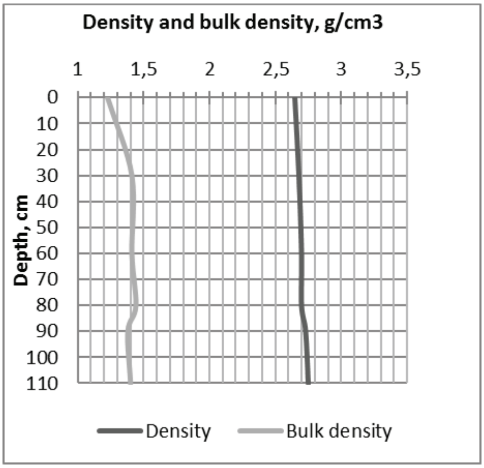

Figure 3. Variation of the soil profile density and bulk density

Soil total porosity and compaction

The total porosity of the studied soils profiles is not homogenous. The values of the total porosity of the irrigated fluvisol soil are relatively medium in the recent arable layer 0-20 cm (53.7±0.9%). Due to its medium structure in the superior layer (0-20 cm) the soil profile has a moderate total porosity. That can't be said about the underlying layers where the total porosity is suddenly decreasing to 49.4±0.5%. Soil total porosity depends on the soil texture, aggregates structure, soil organic matter content and microbiological activity in the soil (Jordán et al., 2010).

The highly related parameter to the soil organic matter content is also the degree of compaction which has a low value in the superior layer 0-20 cm - 3.3±1.3% and high values in the underlying horizons - 16.0±1.2%. According to the obtained results, the eutric fluvisol is characterized by a moderate degree of compaction of the superior horizons and a high degree of compaction in the underlying horizons 11.5-16.0 % (standard deviation ±0.8 and ±1.2 %). Soil compaction adversely affects soil physical fertility, particularly storage and supply of water and nutrients, through increasing soil bulk density, decreasing porosity, increasing soil strength, decreasing soil water infiltration, and water holding capacity (Hamza and Anderson, 2005).

Soil chemical properties

According to the obtained results demonstrated in Table 1, it can be undoubtedly reported that the soil is slightly alkaline. The soil pH varies between 8.0-8.1±0.3. As for soil organic carbon (SOC), it can be observed that the first layer has 2.98% of SOC and is decreasing till 2.29% at the depth of 79 cm.

Table 1. Soil chemical characteristics of the fluvisol

Depth, cm	pH	SOC, %	N total, %	C:N
0-20	8.0±0.3	2.98±0.45	0.153±0.094	10.7±0.7
20-38	8.0±0.3	2.71±0.44	0.153±0.067	10.3±0.7
38-58	8.1±0.3	2.51±0.33	0.149±0.075	9.8±0.5
58-79	8.1±0.3	2.27±0.49	-	-
79-95	8.1±0.3	2.69±0.31	-	-
95-111	8.0±0.3	2.18±0.32	-	-

What is interesting for this parameter is that the SOC increases at the depth of 79-95 cm to 2.69% and again decreases from the depth of 95 cm. That proves that this horizon was buried as a result of the previous flooding depositions.

The results show a low SOC that can appear also as a result of intensive tillage and irrigation. The increase and maintenance of the SOC are the major problem for this soils to keep the soil quality and production capacity in long-term.

The present findings also support Gajic (2013) study which concluded that tillage of fluvisol leads to significant deterioration of soil physical properties, bulk density, and total porosity, but also negative changes of soil organic matter (Gajici et al., 2010; Gajić, 2013). The study made by Naranjo et al. (2006) have shown that after practicing monoculture on fluvisol from Mexico the decline in total N, organic carbon, P and available K occurred after 10 years of sugarcane cultivation, despite that the fluvisols assured yield increases by 67,7 during 30 years due to fertilization (Naranjo de la F. et al., 2006).

Even if irrigation is widely thought to provide 40 % of the world's food from around 17 % of the cultivated area (Thenkabail et al., 2009). There is still little information on how irrigation affects soil physical fertility. What is known till now, and it was proved by other authors is that there is a decline in organic matter content on irrigated fields (Nunes et al., 2007).

Studied fluvisol is under conventional tillage for a long time. It is already known that tillage

has a negative effect on soil physical properties in irrigated conditions and can lead to an increased bulk density (Alletto and Coquet, 2009). But anyway the medium structural composition of aggregates in the first layer of the profile is the result especially of the plowing, harrowing and other agricultural activities (Hermawan and Bomke, 1997). Soil tillage can have also a significant effect on soil porosity on a silt loam fluvisol soil in irrigated conditions reports Cameira (2003). Reinert et al. (2015) found that heavy machinery leads to soil compaction which is in good agreement with the results of the present study.
Researchers have studied the effect of organic matter on the soil physical properties (Franzluebbers, 2002; Hubbard et al., 2013; Dunjana et al., 2012; Papadopoulos et al., 2014). Thus, organic soil management is needed to improve soil structure and increase soil organic matter. But still further researches are needed to study the effects of organic agriculture on irrigated fluvisol.

CONCLUSIONS

The purpose of the current study was to evaluate the impact of agriculture on the fluvisol under an irrigated regime. The following conclusions can be drawn from the present study, intensive tillage, irrigation and low quantities of organic fertilizers had negative effects on soil physical state. The present agricultural management lead to an increase of bulk density, decreased soil porosity, soil structure degradation, and an increase of soil compaction of the Eutric Fluvisol. Also, the high clay content makes these soil a difficult object for irrigation. Anyway, more detailed study is needed regarding the effects of the irrigation on the soils. This research will serve as a base for future studies and it can be also as a source for new studies.

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AGROCHEMICAL STATE OF BROOMRAPE AFFECTED CHERNOZEMS OF CENTRAL AND SOUTH REGION OF THE REPUBLIC OF MOLDOVA

Elena CERNOLEV, Adriana ACCIU, Olesea TABARA, Gheorghe JIGAU

University of Academy of Sciences of Moldova, 2/3 Academiei str., Chisinau, Republic of Moldova

Corresponding author email: cezodra@gmail.com

Abstract

Fertility is a soil genetic trait, the interaction and dynamics of elementary processes product, which occurs at various levels of structural-functional organization of the soil ecosystem. Through this ideas prism may be expressed by functional status (physical, biochemical, agrochemical, etc.) which represent forms of integration, content, mobility thresholds and soil substances accessibility, materialized in plants supply degrees with all necessary. Thereat, the driving force of soil ecosystem functionality is represented by the abiotic and biotic factors interactions.

Key words: *soil fertility, soil processes dynamics, agrochemical ecosistem state, evolutionary process of humus state.*

INTRODUCTION

Despite the fertility, as pedogenesis product and its performance precondition is unmeasurable feature in contemporary agropedology and ecopedology and for its evaluation are used 30-36 parameters, depending on soil type and subtype.
Starting from simplistic approach of soil fertility, confusing by ecosystems productivity, had been used for this purpose special parameters, emphasis being placed on their subsequent optimization, according to crop needs, agrochemical and agro-technical methods. Meanwhile, recent evaluations have shown that for most agricultural crops yield formation in the region, about 92-93% is natural soil production potential. The last is the interaction and biotic and abiotic dynamics processes product that arising in the soil and which biological activity is the "engine" of system soil" (Florea et al., 2014).
The necessary to carry out these processes energy is ensured by organic debris resulting from biological activity and transformed soil by contributing the humus formation and nutrients producing. Humus and mineral products resulting from biocatalytical alteration and soil microorganisms ensure bioproductive soil function.
Organic matter as a source of humus, unlike mineral base material is incorporated into the soil continuously in annual installments. Thus, nature, quantity, composition and its incorporation mode in soil may change relatively quickly in time, depending on ecosystem biocenosis and biotope evolution. At the same time weather conditions dynamic (seasonal, annual) has an impact on the soil processes dynamic. This entails dynamic processes that determine soil bio-productive capacity, suggesting that ground potential is indicated for the evaluation of physical, chemical, physico-chemical, redox, biochemical and agrochemical ecosystem functioning.
Dynamics and arable soil status is influenced by pedogenetic factors (Dudal et al., 2002).
The conducted analysis, seen through pedogenetic factors conception consider that this factor is not a binding factor in the pedogenesis achievement (Jigău, 2009), its role being reducing only to partial climate change and greater to biological factor.
A greater role on the natural tipogenic processes rests to anthropogenic factor, involving new types of reactions and processes (Jigău, 2009).

MATERIALS AND METHODS

The research involved the field and laboratory studies application. In the field applications were collected soil samples from 0-30cm arable layer infected with broomrape, according to the instructions in force. Each field was divided

into elementary plots, surface 12 hectares (Jigău et al., 2007). Within each plot 30 samples were collected on individual plots, which were subsequently formed mixed samples.
Laboratory studies were performed under the Republic of Moldova standardized methods.

Table 1. Assessment methods of soil agrochemical indices determination

Nr.	Determined parameters	Measurement units	Determining methods	STAS
1.	The humus content		Tiurin în modificare TINAO Tiurin modification in TINAO	26213-91
2.	P_2O_5 content	mg/100g of soil	Macighin	26205-91
3.	K_2O content			26423-85
4.	$N\text{-}NH_4$ content		TINAO	26489-85
5.	$N\text{-}NO_3$ content		ionometric	26951-86
6.	pH values		potentiometric	26423-85

RESULTS AND DISCUSSIONS

By the agrochemical assessment, the humus content interest is explained by several nutrients backup substance function.
According to calculations, humic substances provides to soil more than 20% of nitrogen content, about 35 to 65% of the total phosphorus content, and on the soil desalted up to 70% of the sulfur, thus, by mineralization an important contribution to the necessary mineral crop nutrition (Ianoş and Goian, 1995). Therefore, the the agrochemistry literature is frequently used as an indicator of the evolutionary trend of soil fertility.
In this regard, the calculations made in this research shows the predominance in both regiion: the center and south of Republic of Moldova soils with moderate humus content (78-81%) values are ranged in 2-4% (Tables 2 3, 4, 5).
Soils containing humus in relatively optimal levels (4-5%) are 7-8%. The humus content less than 2% is represented by 12-14%**.**
We conclude that the evolutionary processes of the chernozems humus state in space between the Prut and Nistru rivers lead to the blurring of genetic distinctions between moderat and low humus tipical chernozems of the central zone and carbonate and weak humus in the south.
It must be concluded that both contemporary cernozems developments in central and southern areas is determined by the same factors and the same process.
The main mentioned factor is, significantly reducing of the organic plant waste falling in pedogenesis.
Over the last 80 years, as a result of bicenosis substitution with agrocoenoses, ecological communities have been significant changes.
Therefore, in this stage of pedogenetical process, the annual loss of humus due to mineralization processes are not compensated by the contribution of newly formed humic substances.
A stable culture practicing that did not provide humus mineralized offset by newly formed humus, annual decreases, were thereby determine the decrease of humus content to the critical level of 3%, and in some cases the values are lower (Burlacu, 2000).
The phenomenon is not newly, being defined as in other regions as a consequence of traditional to intensive agriculture shift. (Ковда, 1983; Dobrovoliskii, 2000; Ianoş and Goian, 1995), associated with humus enhancing mineralization by increasing the aeration of arable layer (Jigău, 2009).
For areas with rugged terrain, another reason constitutes areal and linear erosion. Thus, B.A. Ковда claims that anthropogenic factors, by altering the ecological balance of the landscape has turned slow geological erosion into accelerated erosion leading to soil degradation (Ковда, 1985).
Recent research has shown that was reduced the formation of arable chernozems humus due to aerohidric regime and hidrotermical degradation (Jigau, 2015).

Table 2. Agrochemical indices of moderately and poorly humus typical chernozem of central region of Republic of Moldova (0-30 cm layer)

Distict, Settlement	The soil solution reaction		Humus content		Total azote content		Azote insurance		Mobile phosphorus insurance		Exchangeable tassium Insurance	
	pH	Specifi cations	%	Specifi cations	%	C:N	IN	insurance	mg/ 100g	Specifi cations	mg/ 100g	Specifi cations
Telenești, Verejeni	7.50	moderate alkaline	2.25	moderate	0.24	medium	2.25	medium	5.9	increased	60.6	very increased
Telenești, Căzănești	8.00	alkaline	1.85	low	0.31	high	1.85	low	9.3	very increased	64.0	very increased
Telenești, Brînzeni	7.80	alkaline	2.95	moderate	0.28	high	2.95	medium	2.7	moderate	51.6	increased
Orhei, Ciocâlteni	7.80	alkaline	3.65	moderate	0.26	medium	3.65	medium	1.5	low	29.0	optimal
Criuleni, Izbiște	7.80	alkaline	2.55	moderate	0.24	medium	2.55	medium	3.5	optimal	25.8	optimal
Dubăsari, Holercani	8.05	very alkaline	3.55	moderate	0.22	medium	3.55	medium	2.4	moderate	27.0	optimal
Dubăsari, Molovata veche	7.60	moderate alkaline	3.55	moderate	0.22	medium	3.55	medium	3.0	optimal	26.4	optimal
Mun. Chișinău, **Bacioi**	7.70	moderate alkaline	2.50	moderate	0.19	medium	2.50	medium	3.2	optimal	21.4	medium
Mun. Chișinău, **Sângera**	7.30	low alkaline	3.70	moderate	0.20	medium	3.70	medium	1.2	low	28.2	optimal
Anenii-Noi, Floreni	7.95	very alkaline	2.00	low	0.15	medium	2.00	low	0.8	very low	18.2	low
Hâncești **Buțeni**	8.20	very alkaline	3.05	moderate	0.19	medium	3.05	medium	1.5	low	30.2	optimal
Hâncești, **Sărata-Mereşeni**	7.40	low alkaline	2.65	moderate	0.26	medium	2.65	medium	3.8	optimal	26.6	optimal
Hâncești, **Fundul-Galbenei**	7.40	low alkaline	2.65	moderate	0.16	medium	2.65	medium	1.4	low	25.8	optimal
Strășeni,**Rassvet**	7.90	alkaline	4.05	optimal	0.16	medium	4.05	good	1.9	low	50.0	increased

Humus formation and accumulation processes in this region (central and south region of Republic of Moldova) are influenced by the contemporary landscape evolution involving aridity-desertification elements (Jigău, 2015).

Central and southern region are endowed with soils containing moderate values of total nitrogen, limit being 86 and 84% on the evaluated areas. However, the central area about 14% of soils are high nitrogen content and 16% southern area of the land is characterized by low content of total nitrogen.

Thus, we may conclude that total reduced nitrogen content in the process of pedogenesis with organic debris consists the bordering factor in forming humus process.

Aceasta se datoreşte faptului că culturile leguminoase au fost excluse practic din asolamentul culturilor în republica Moldova. Anume prin aceasta agrofitocenozele cultivate se detaşează radical de biocenozele naturale.

It happens because were practically excluded from crop rotation leguminous cultures. Notably through this, agrocoenosis grown radically detaches by natural biocensis.

Carried research highlight the mobile phosphorus high variability degree of both chernozems in the central and south region of the republic as caused by landscape-anthropogenic pedogenetic natural evolution By litogenetic point of vieux, central area soils were formed on clay-loam and loam-clay deposits, while those in the south were formed mainly on silty loess deposits. Accordingly, investigated soils is characterized by a diverse phosphate potential. At the same time other 2 factors had been significantly engaged - the carbonates content and soil pH.

Table 3. Agrochemical indices of moderately and poorly humus typical chernozem of south region of the Republic of Moldova (0-30 cm layer)

Distict, Settlement	The soil solution reaction		Humus content		Total azote content		Azote insurance		Mobile phosphorus insurance		Exchangeable potassium Insurance	
	pH	Specifi cations	%	Specifi cations	%	Specifi cations	IN	Specifi cations	mg/ 100 g	Specifi cations	mg/ 100g	Specifi ctions
Cazangic, Leova	7.45	low alkaline	3.30	moderate	0.15	medium	3.30	medium	1.3	low	21.4	moderate
Gura-Galbenei, Cimişlia	7.80	alkaline	4.00	relatively optimal	0.14	low	4.00	medium	0.6	wery low	14.8	Very low
Grigorievca, Căuşeni	8.00	very alkaline	2.60	moderae	0.14	low	2.60	medium	4.3	increased	53.4	increased
Ermoclia, Ştefan-Vodă	8.00	very alkaline	3.45	moderate	0.22	medium	3.45	medium	3.7	relatively optimal	24.6	moderate
Talmaza, Ștefan-Vodă	8.05	very alkaline	1.40	low	0.24	medium	1.40	low	9.6	foarte sporita	54.0	increased
Congaz, Comrat	8.30	low alcalină	2.00	low	0.22	medium	2.00	low	1.2	low	20.6	Moderate
Chirsova, Comrat	8.30	low alcalină	2.30	moderate	0.18	medium	2.30	medium	1.6	low	24.6	Moderate
Beşalma, Comrat	8.20	very bazică	2.50	moderate	0.18	medium	2.50	medium	4.0	sporita	29.4	Moderate
Svetlîi, Comrat	8.25	low alkaline	2.30	moderate	0.18	medium	2.30	medium	1.8	low	23.4	Moderate
Carabetovca, Basarabeasca	8.30	low alkaline	1.80	moderate	0.18	medium	1.80	low	1.4	low	19.0	low
Corteni, Ceadîr-Lunga	8.30	low alkaline	2.15	moderate	0.16	medium	2.15	medium	1.6	low	22.2	Moderate
Taraclia, Taraclia	8.30	low alkaline	2.80	moderate	0.14	medium	2.80	medium	1.4	low	23.2	Moderate
Alexanderfild, Cahul	7.75	alkaline	3.45	moderate	0.16	medium	3.45	medium	4.2	increased	32.0	relatively optimal
Manta, Cahul	7.75	alkaline	3.25	moderate	0.24	medium	2.35	medium	3.9	relatively optimal	19.0	low
Slobozia-Mare, Cahul	7.90	very alkaline	3.25	moderate	0.24	medium	3.25	medium	8.0	very increased	25.0	moderate
Crihana-Veche, Cahul	7.80	very alkaline	2.10	moderate	0.21	low	2.10	medium	4.8	increased	59.4	increased

Table 4. Surfaces share with different degrees of macroelements content(%) and humus assurance of moderate and low humus typical chernozems of the Republic of Moldova central region

Category	Humus content, %	Total azote total, %	Azote insurance	Mobile phosphorus insurance mg/100g of soil	Exchangeable potassium Insurance mg/100g of soil
Very low	-	-	-	-	-
Low	14	-	14	36	7
Moderate	78	86	78	14	8
Relatively optimal	8	-	8	22	57
Increased	-	14	-	7	14
Very increased	-	-	-	7	14

Table 5. Surfaces share with different degrees of macroelements content(%) and humus assurance of moderate and low humus typical chernozems of the Republic of Moldova south region

Category	Humus content, %	Total azote content, %	Azote insu-ramce	Mobile phosphorus insurance mg/100g of soil	Exchangeable potassium Insurance mg/100g of soil
Very low	-	-	-	6	6
Low	12	16	12	44	13
Moderate	81	84	81	-	56
Relatively optimal	7	-	7	12	6
Increased	-	-	-	26	19
Very increased	-	-	-	12	-

The southern soils formed on loess-clay deposits are rich in carbonates due to this fact it is less phosphorus mobility and the soil solution reaction is strongly alkaline (pH 7.8 to 8.2).

Following this the southern area of about 50% of investigated soils is characterized by low (44%) and very low (6%) content of mobile phosphorus.

Half of south studied area are characterized by relatively optimal (12%) or increased (26%) level of mobile phosphorus, while the central area are characteristic only 14% land supply increased and very phosphorus increased and the optimal supplied 22%.

So, the soils phosphorus difference is highly influenced by the human factor, which shows that the previous phosphorus fertilizers use was sometimes inadequate. Moreover, analyzing the current situation, on supply phosphorus state, we decide that the effect of applied in the past phosphorus fertilizers is limited in time. Thus, couldn’t form large mobile phosphorus reserves that can be maintained a longer period in soil.

Potassium content is more stable due to the nature and origin of this element circuit. The total reserves of potassium in the soil comes from parental rocks, primary and secondary minerals, organic waste and in the last 80 years of mineral fertilizers. Its passage by inerting state to colloidal network by dissociation and diffusion in roots, exchangeable potassium is the direct source for plant nutrition.Opposed to phosphorus, potassium weak influence the carbonate content and soil solution reaction.

Research rezults shows that more than 80 percent of the soils are supplied at the optimum, high or very high level of potassium. So, the vast majority of soils spontaneously regenerate mobile potassium content on account of primary and secondary minerals of potassium adsorption. This process is facilitated by roots by deeper soil horizons potassium translocation. Therefore, according to research, we conclude that, physicochemical mechanism for mobile potassium recovery even more evident as the soil condition assuring mobile potassium is better (Ковда, 1973).

This often involves the idea that this region chernozems do not require potassium interventions. But according to calculations chernozems had lost about 41% of initial potassium reserves, thus potassium fertilization is indicated (Носко и др., 1983).

CONCLUSIONS

Cernozems evolution current stage between the Nistru and Prut rivers area is characterized by a humus and total nitrogen tense regime, caused by significantly changing the humus formation and accumulation process, but also due to aerohidric, hydrothermal and redox soil regimes changes.

Soil supply status with phosphorus is due to parental rocks and is determined by the carbonates content of and soil solution reaction. Phosphorus endowment is determined by anthropogenic involvement.

Investigated soils retain regenerative capacity of potassium plant accessible reserves and potassium regime as a result central and southern Moldova’s chernozems has anthropogenic involvement low limit.

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EFFECT OF SOIL WORKS ON CORN PRODUCTION IN SOUTH EAST BARAGAN

Claudiu CHIȚOI[1], Costică CIONTU[2]

[1]School of Technology no.1 Borcea, Calarasi County
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, Bucharest, Romania

Corresponding author email: claudiu.chitoi@yahoo.com

Abstract

Gălăţui town, is located in the center of Calarasi County on DJ 307, between the towns Balcescu and Independence. Soil tillage systems both conventional and especially unconventional designed to ensure optimal growth conditions development and plant, soil and water conservation as well as obtaining higher quality productions with high economic efficiency.
The research was conducted on a sample belonging to TC Gălăţui demonstration, County Calarasi, on a typical chernozem. The paper presents the production results obtained in the area shown above, the maize grain under the influence of soil works basic, conventional and unconventional.
It was tested a maize hybrid with good productivity and resistance to water stress, a phenomenon commonly found in Southeast Baragan.

***Key words**: soil tillage, suitability, potential, crop production.*

INTRODUCTION

Tillage systems both conventional and especially unconventional designed to ensure optimal growth conditions development and plant, soil and water conservation as well as obtaining higher quality productions with high economic efficiency (Gus et al., 2001; Marin, 2004; Rusu et al., 2009).
The research was conducted on a sample belonging to TC Gălăţui demonstration County Calarasi, a typical mold. The paper presents the production results obtained in the area shown above, the maize grain under the influence of soil works basic, conventional and unconventional.

Figure 1. Location territory studied

It was tested a hybrid of maize had Monsanto with good productivity and resistance to water stress, a phenomenon commonly found in Southeast Bărăgan.

MATERIALS AND METHODS

Scientific research topics fall into doctoral internship period 2015-2017. Point research, Gălăţui territory belongs District Calarasi area of 10 ha.
The experience was organized in a three-year rotation (1. sunflower, 2. wheat, 3. maize) and comprises six graduations factor "tillage systems", as follows:
a_1 – plowing 20 cm; a_2 – plowing 30 cm; a_3 – scarified 30 cm; a_4 – scarified 40 cm; a_5 – tiger 20 cm; a_6 – tiger 30 cm.
Basic works were executed in the autumn, with CASE 280 CP tractor in the period September 15 to 25, and the maintenance culture tractor with CASE 140 CP, the same day all variants. (Figure 2).
The biological material used: corn variety DKC 4590 with a density of 60 000 plants/ha. Were sown on 20 April 2015 and sprung full 05/01/2016.

On April 25, was executed Adengo first herbicide and the second herbicide on 21/05/2015 using RECORD package consisting of: Kelvin Top, Cambio and DAS (adjuvant). (Figure 3).

During the growing season, had three rain culture as follows: 3.8 l / sqm (05/06/2015) 15 l / m (06.21.2015) and 10 l / m (07.03.2015). They were executed mechanical and manual hoeing as follows: 20/06/2015 06/04/2015.

The climatic conditions during the research were forecasted by the weather station Calarasi, where the average annual rainfall is 504 mm and the average annual temperature of 11.60 C.

Biometric measurements were made between 05/22/05 and 11/07/05 on all variants, the evolution of plant growth is nearly uniform, with small differences in the first phenological phases of growth.

It was calculated leaf area index (LAI), the results are conclusive yields.

RESULTS AND DISCUSSIONS

The research results are based on biometric measurements and production all of which are fully compliant, according tillage variants.

Biometric measurements, referring to the phenophases plant height and number of leaves per plant are shown in Table 1.

It is noted that corn plant height ranged between 160 -180 cm higher values were registered variant - plowing 30 cm followed by variant - plowing 20 cm.

Table 1. Biometric measurements on corn crop in april - september 2015 (Galatui, Calarasi)

Date	*Variant*	*Plant height (cm)*	*No. leaf*
22.05.05	Plowing 20 cm	23-24	5-6
	Plowing 30 cm	23-24	5-6
	Scarified 30 cm	19-20	4-5
	Scarified 40 cm	19-20	4-5
	Tiger 3 MT 20 cm	17-18	4-5
	Tiger 3 MT 30 cm	17-18	4-5
30.05.05	Plowing 20 cm	36-37	7-8
	Plowing 30 cm	36-37	7-8
	Scarified 30 cm	29-30	6-7
	Scarified 40 cm	29-30	6-7
	Tiger 3 MT 20 cm	27-28	5-6
	Tiger 3 MT 30 cm	27-28	5-6
06.06.05	Plowing 20 cm	56-58	8-9
	Plowing 30 cm	56-58	8-9
	Scarified 30 cm	40-42	7-8
	Scarified 40 cm	40-42	7-8
	Tiger 3 MT 20 cm	37-40	6-7
	Tiger 3 MT 30 cm	37-40	6-7
13.06.05	Plowing 20 cm	80-85	9-10
	Plowing 30 cm	80-85	9-10
	Scarified 30 cm	68-72	8-9
	Scarified 40 cm	68-72	8-9
	Tiger 3 MT 20 cm	66-68	7-8
	Tiger 3 MT 30 cm	66-68	7-8
20.06.05	Plowing 20 cm	123-126	11-12
	Plowing 30 cm	123-126	11-12
	Scarified 30 cm	95-100	10-11
	Scarified 40 cm	95-100	10-11
	Tiger 3 MT 20 cm	85-90	9-10
	Tiger 3 MT 30 cm	85-90	9-10
27.06.05	Plowing 20 cm	160-170	13-14
	Plowing 30 cm	160-170	13-14
	Scarified 30 cm	150-160	12-13
	Scarified 40 cm	150-160	12-13
	Tiger 3 MT 20 cm	150-160	11-12
	Tiger 3 MT 30 cm	150-160	11-12
04.07.05	Plowing 20 cm	170-180	14-15
	Plowing 30 cm	175-180	14-15
	Scarified 30 cm	160-175	13-14
	Scarified 40 cm	165-175	13-14
	Tiger 3 MT 20 cm	165-170	13-14
	Tiger 3 MT 30 cm	165-175	13-14

Figure 2. Preparing the ground for seeding

The number of leaves per plant was between 13 and 15 leaf the highest values were recorded all the basic variants that work was plowing.
At the end phenophase intensive growth of plants was calculated and leaf area index. (LAI), Table 2.

Figure 3. Aspects of maize, in the early stages of vegetation

The analysis of the data it can be seen that the leaf area index recorded the highest values at work plowing - 30 cm of 3.5, followed by plowing - 20 cm of 2.95 and the smallest variants scarified 30 cm and Ag. C. - Tiger 3MT 20 cm 2.43.
Leaf area index (LAI) representative graphic is shown in Figure 4.

Table 2. Maize leaf area index in april - september 2015 (Galatui, Calarasi)

Variant	*Work*	*LAI*
V1	Plowing 20 cm	*2,93*
V2	Plowing 30 cm	*3,5*
V3	Scarified 30 cm	*2,43*
V4	Scarified 40 cm	*2,62*
V5	Ag. C Tiger 3 MT 20 cm	*2,43*
V6	Ag. C Tiger 3 MT 30 cm	*2,75*
**LAI – leaf area index*		

After analyzing the data in the table, one can see that the leaf area index (LAI) presented the highest value variant V2 (plowing to 30 cm) and the lowest values were found in variants V3 (scarified 30 cm) and V5 (tiger 3 MT 20 cm), plotted in figure 4.

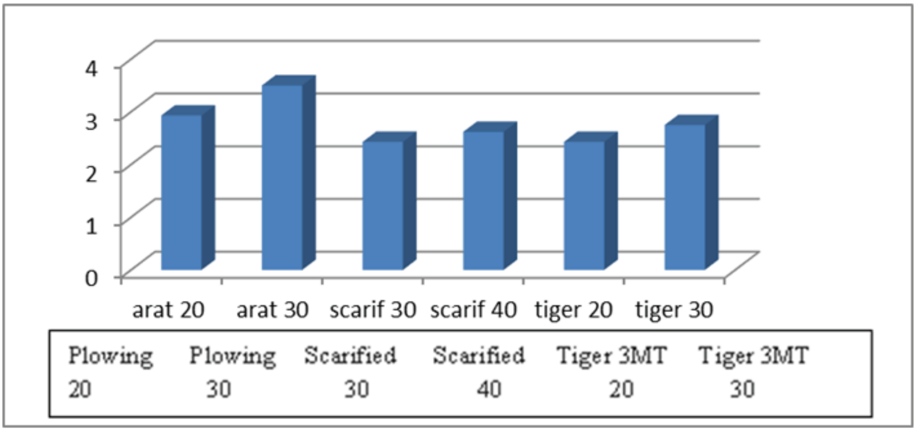

Figure 4. The influence of soil tillage on leaf area index (LAI)

Results of production and thousand seed weight (TSW) obtained from maize are shown in Table 3.
It is found that the largest grain production was obtained from the classic V2 (plowing to 30 cm) of 10,030 kg / ha which were recorded and the high average length of 18.0 cm and ears of most valuable thousand seed weight (TSW) of 252G.
Option 1 shows at 20 cm, which was statistically considered for calculating the control, with 9100 kg / ha, with the same values

of thousand seed weight (TSW) of 252G but with an average length of 17.33 cm smaller cobs are ranked situated II in the production of grain.

The production of grains less than 7000 kg/ha was obtained in which variation of the ground-based work was performed with the combined aggregate - Tiger 3MT to a depth of 20 cm, which is very significant negative.

Similar results very significantly negative, were recorded and variants: 3. V V 6. scarified 30 cm and aggregate combined - Tiger 3mt 30 cm. The graphical representation of production of maize is shown in figure 5.

Table 3. Results of production obtained obținute on production zea mays, 2015 (Gălățui, Călărași)

The basic ground work	***Elements of production***					
	length of the cob	*Prod of cobs (kg/ha)*	*Production crop*			*TSW (g)*
			(kg/ha)	*Dif.*	*Semnif.*	
V 1. Plowing 20 cm	17.33	10.050	9.100	Mt.	-	252
V 2. Plowing 30 cm	18.00	11.400	10.030	930	**	252
V 3. Scarified 30 cm	16.75	8.500	7.200	- 1900	ooo	240
V 4. Scarified 40 cm	16.66	9.500	8.200	- 900	oo	245
V 5. Ag.C.-Tiger 3MT 20cm	16.83	8.200	7.000	- 2100	ooo	230
V 6. Ag.C.-Tiger 3MT 30cm	16.00	8.600	7.400	- 1700	ooo	234
Dl 5% = 434 kg/ha; Dl 1% = 645 kg/ha; Dl 0.1 % = 956 kg/ha						

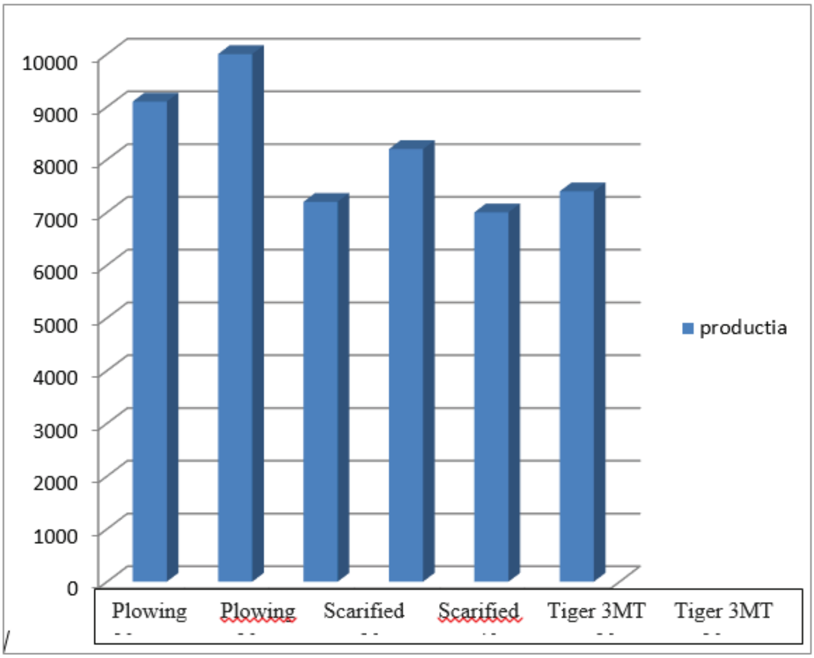

Figure 5. Influence of soil tillage on production of *Zea mays*

CONCLUSIONS

In terms of the agricultural year in 2015 on the influence of tillage on corn crop in Regina irrigated yields in Southeast Bărăganului are appreciable characteristic hybrid tested.

Corn plant height was between 160 -180 cm higher values were îregistrat variant - plowing 30 cm followed by variant - plowing 20 cm. The number of leaves per plant was between 13 and 15, the highest values were recorded in basic variants that work was plowing.

Leaf area index recorded the highest values at work plowing - 30 cm of 3.5 followed by plowing - 20 cm of 2.95 and the lowest in variants scarified 30 cm and work with combined aggregate - Tiger 20 cm 2.43.

The biggest grain production was obtained from the classic V2 (plowing to 30 cm) of 10,030 kg/ha where they recorded the longest average of 18.0 cm cobs and most valuable TSW of 252G.

Basic work - plowing 20 cm, considered the control, gave a yield of 9100 kg / ha and 930 kg / ha me less than 30 cm plowing. The production of grains less than 7000 kg / ha was obtained in which variation of the ground-based work was performed with the combined aggregate - Tiger at a depth of 20 cm, which is very significant negative. Very significant negative results were recorded in variants: Rippers 30 cm and aggregate combined - Tiger 30 cm.

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ANTROPIC DEGRADATION OF TYPICAL CHERNOZEMS AND THEIR RESTORATION UNDER STEPPE VEGETATION

Tatiana CIOLACU

"Nicolae Dimo" Institute of Soil Science, Agrochemistry and Soil Protection, 100 Ialoveni Str., MD-2070, Chisinau, Republic of Moldova

Corresponding author email: balantatiana@gmail.com

Abstract

The paper aimed to emphasize again the problem of degradation of soils used in agriculture. Also, it was studied remediation of deep ploughed soil under steppe vegetation after 30 years of fallow. It was established that investigated arable soil lost 2.12% of humus from 0-25 cm layer or 1.60% from 0-50 cm layer (in comparison with fallow). Besides humus loss, arable soil was depleted in nitrogen and phosphorus. Soil structure of arable soil also underwent changes and became unfavorable for plants growing. It was established that during 30 years of fallow use, the former arable soil partially restored its structure. Humus content of this soils also increased by 0.66% in arable layer 0-25 cm and by 0.57% for layer 0-50 cm (0.02% annually).

***Key words**: soil degradation, humus loss, soil structure, bulk density.*

INTRODUCTION

The problem of land degradation became more acute in the last years due to increasing population of the Earth and the shrinking of arable land for different reasons.

This problem persists in Moldova, being complicated by excessive land parcelling (Cerbari et al., 2010) which prevent the application of complex agro-technical measures to protect and conserve soils.

Currently in Moldova are highlighted and described 5 types and 40 types of soil degradation (Krupenikov, 2008).

The most widespread are soil erosion, salinization and solonization, landslides, humus content decrease, structure loss and secondary compaction, nutrient deficiency (Andries et al., 2012).

Thus in the Republic of Moldova humus balance is negative minus 700 kg/ha, on lands affected by erosion minus 1100 kg/ha.

It was established that 80% of agricultural land is characterized by low humus content (less than 3%) (Andries et al., 2011).

In this context, we tried to emphasize again the current state of arable chernozem and necessity of elaboration of ecological methods for their remediation.

MATERIALS AND METHODS

The research was conducted on typical chernozems located in the northern part of Moldova, Rascani district, Grinauti village.

As the object of study were used soils from the following three sites:

1. Arable land;
2. Former arable land, 30 years ago here was made a buffer strip with steppe vegetation and walnut trees. Before planting the trees, soil was deep ploughed (at the depth of 50 cm) and fertilized with organic and mineral fertilizers. Nowadays, from time to time the place is used for animal grazing;
3. Fallow land never used in agriculture with steppe vegetation characteristic for this region of Moldova, located on a slope with an angle of inclination about 5-10^0.

During the field research, at the each site we founded a key set of polygons in the form of a square with sides of 50 m with a main profile in the center and four secondary profiles at the peaks of the square.

Laboratory tests were performed according to the standard methods approved in the Republic of Moldova: soil bulk density was determined by core method, total porosity by calculation. The organic matter content was determined by Tiurin method, total nitrogen content by Kjeldahl method, mobile phosphorus and potassium by Machighin method, soil pH by electrometric method.

RESULTS AND DISCUSSIONS

Arable typical chernozem is characterized by the next soil profile: Ahp1 - Ahp2 - Ah - Bh1 - Bhk2 - BCk1 - BCk2 - Ck (Figure 1).

Figure 1. Soil profile of arable typical chernozem

Recently arable layer Ahp1 (0-25 cm) is dark grey, with blocky structure. The next layer Ahp2 (25-40 cm), that was ploughed until '90 years, now is compact, with prismatic or blocky structure.

Horizon Ah (40-50 cm), never ploughed, has glomerular structure, slight compact or compact.

The former arable typical chernozem (Figure 2) have the next soil profile: Ahpt1 - Ahpt2 - Ahp - Bh1 - Bhk2 - BCk1 - BCk2 - Ck.

Fallow horizons Ahpt1 (0-10 cm) and Ahpt2 (10-28 cm) are weak compacted because they have restored glomerular structure.

The next horizon Ahp (28-49 cm), that was also deep ploughed at the foundation of the buffer strip, is compacted. The structural aggregates are prismatic, large and medium by size, practically with no pores.

Figure 2. Soil profile of the former arable typical chernozem

The fallow chernozem (Figure 3) from the third research site have the next soil profile: Aht1 - Aht2 - Ah - Bh1 - Bh2 - BCk1 - BCk2 - Ck.

Figure 3. Soil profile of the fallow typical chernozem

Humus horizons of the fallow chernozem have excellent grainy structure, are weak compacted and very rich in organic material and plants roots.

Typical chernozems from the research sites are characterized by comparatively homogeneous texture in the whole profile. On average

physical clay content is 62-66%, and the fine clay - 36-39%. The soils are classified as clay loamy.
As a result of such a texture, the investigated soils are predisposed to compaction, crusting and loss of structure. All these negative effects have been established both in the field investigations and laboratory analysis. Thus, the arable typical chernozem is characterized by medium quality of soil structure with moderate content of clods in the arable horizon Ahp1 (0-25 cm), see Figure 4.

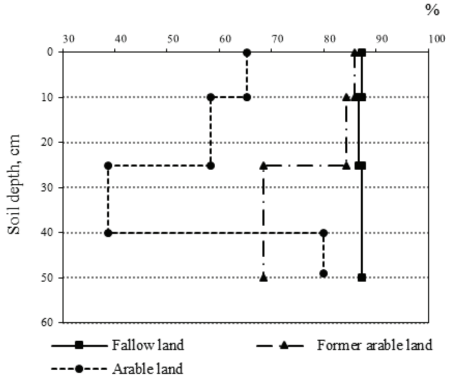

Figure 4. Content of soil aggregates 10-0.25 mm at dry-sieving analysis

The next layer Ahp2 (25-40 cm) has poor structure with high content of clods. The structural elements are prismatic. As it was mentioned above, soil layer Ahp2 was worked until ’90 that have led to loss of soil structure and its resistance to compaction. As a result, for today the layer is extremely compacted.
The underlying horizon Ah was not modified by agricultural works and is characterized by excellent structure and small clods content.
We determined that soil structure of the former arable land (the second research site) was restored in the 0-25 cm layer. Soil structure of the underlying layer 25-50 cm is partially restored, but it still contains some prismatic aggregates.
Low water resistance of structural elements in arable layer indicate degradation of soil structure (Figure 5).
As a result, there is a risk of compaction and formation of soil surface crust after the fall of precipitations and drying of soil.

Water resistance of aggregates from the former arable land is very high both in the upper layer 0-25 cm and the next layer 25-50 cm.

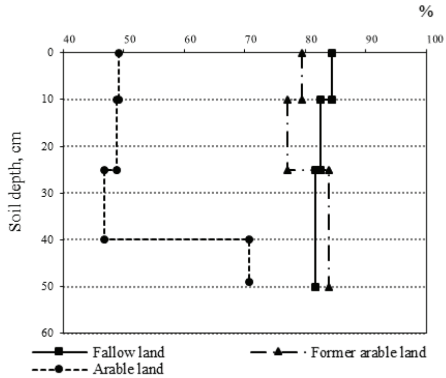

Figure 5. Content of soil aggregates 10-0.25 mm at wet-sieving analysis

The fallow land is characterized by excellent soil structure and water resistance.
The upper layer 0-10 cm of Ahp1 horizon of arable soil is worked throughout the year and is characterized by comparatively low degree of compaction, bulk density is 1.21 g/cm^3 (Figure 6).

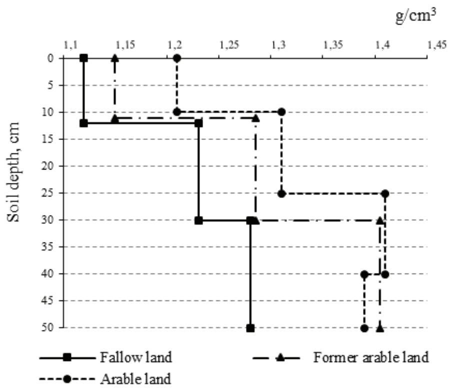

Figure 6. Bulk density of typical chernozems

The lower layer 10-25 cm of Ahp1 horizon have middle degree of compaction, its bulk density is 1.31 g/cm^3. Under the arable layer can be noticed a compact horizon Ahp2 with the bulk density of 1.41 g/cm^3 and high degree of compaction. That layer was formed due to losses of soil structure and humus, and as a result of the intensive use of soil in agriculture and heavy machinery. The next horizon Ah

(40-49 cm) was not plowed and is not compacted, the bulk density is 1.39 g/cm^3.

Fallow soil profiles are characterized by low values of bulk density 1.15-1.29 g/cm^3 in the superior layers. Horizon Aht is loose, horizon Ah is low compacted.

Total porosity values of investigated soils correlate with bulk density values (Figure 7).

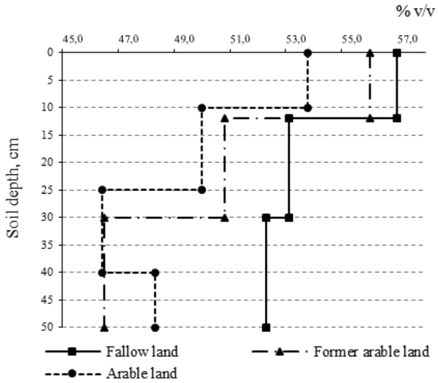

Figure 7. Bulk density of typical chernozems

Thus, in the arable soil total porosity is medium (50-54%) in the Ahp horizon (0-25 cm) and low in the Ahp2 horizon (25-40 cm) - 46%. Fallow soils have high porosity in all Aht horizons - 50-57%.

Data about chemical characteristics of investigated typical chernozems are shown in Table 1. Arable typical chernozem is characterized by average values of pH 6.3 in Ahp horizon and 8.0 in horizon Ck. Soil layer 0-50 cm of fallow soils have lower pH, because of the influence of organic matter from steppe vegetation rich in calcium. The pH values are between 6.5 and 7.0.

Hydrolytic acidity of arable is low (2.0-2.4 me/100 g soil) in Ah horizon and very low (1.0 me/100 g soil) in Bh1. Fallow soils are characterized with very low values of the index.

Humus accumulation in chernozems of Moldova has a specific character: in the upper horizon, humus content is 4-5%, its amount decreases gradually with depth and at 1 m there is only a third part of its amount in comparison with the superior layers. As a result, the reserves of humus in typical chernozems are quite large (Zaimov, 1969).

Typical chernozems from the research sites are characterized by deep humiferous soil profile: in arable soils the average thickness is 91 cm; in the former arable soil - 94 cm, soil under the fallow - 88 cm. Investigated arable chernozems have moderate humus content while the former arable soil and fallow soil have high humus content. Because of agricultural use, the arable typical chernozem lost 2.12% of humus from 0-25 cm layer or 1.60% from 0-50 cm layer. Humus content of 0-25 and 0-50 cm layer of arable soil compared to fallow land reduced respectively by 34 and 29 percent. The former arable chernozems, being under the fallow for 30 years, increased humus content in comparison with arable soil, by 0.66% in arable layer 0-25 cm and by 0.57% for layer 0-50 cm (0.02% annually).

Total nitrogen content in the investigated soils is 0.18-0.23% and correlates with humus content.

Total phosphorus content in fallow and the former arable chernozem profiles varies from 0.17 in Aht1 horizon to 0.10% in Ck horizon. Arable soils have a lower content of total phosphorus from 0.14% in Ahp1 horizon to 0.10% in Ck horizon.

Mobile phosphorus content in fallow typical chernozem is moderate in Aht1 horizon and low in Aht2 and Ah. The former arable chernozem is characterized by moderate phosphorus content throughout genetic Ah horizon. In arable soil phosphorus reserves decreased substantially in arable and former arable layers up to 1.2-1.3 mg/100 g soil.

Content of mobile forms of potassium in these soils is optimal in the arable layer and moderate in former layer.

The fallow chernozem is characterized by a very high content of mobile potassium in the horizon Aht1 - 44-48 mg/100 g soil.

The underlying horizons have an optimal contain of mobile potassium in Aht2 horizon (30-34 mg/100 g soil) and moderate in Ah horizon (15-24 mg/100 g soil). Thus, reserves of mobile phosphorus and potassium in the investigated arable typical chernozems are lower than in the fallow chernozem, due to their intensive use in agriculture.

Table 1. Chemical characteristics of typical chernozems used in agriculture and under fallow

Horizon and depth, cm		pH	Hydrolytic acidity, me/100 g sol	$CaCO_3$	P_2O_5 total	Humus	N total	C:N	Mobile forms of, mg/100 g sol	
				%					P_2O_5	K_2O
Arable land										
Ahp1	0-25	6.3±0.2	2.4±0.2	0	0.14±0.01	4.05±0.13	0.193±0.009	12.2±0.5	1.3±0.1	30.0±3.5
Ahp2	25-40	6.3±0.2	2.3±0.2	0	0.13±0.01	3.94±0.08	0.188±0.008	12.1±0.5	1.2±0.2	25.0±5.2
Ah	40-49	6.5±0.3	2.0±0.4	0	0.12±0.01	3.25±0.15	0.159±0.008	11.9±0.5	0.9±0.2	18.0±1.3
Bhk1	49-70	6.9±0.2	1.0±0.4	0	-	2.53±0.14	-	-	-	-
Bhk2	70-91	7.6±0.1	-	8.9±3.6	-	1.51±0.04	-	-	-	-
BCk1	91-110	7.7±0.1	-	22.0±4.9	-	0.91±0.07	-	-	-	-
BCk2	110-140	7.8±0.1	-	24.6±4.7	-	0.68±0.07	-	-	-	-
Ck	140-160	8.0±0.1	-	28.6±5.1	0.10	0.46±0.03	-	-	-	-
Former arable land, 30 years under the fallow										
Ahpt1	0-12	6.8±0.4	2.0±0.7	0	0.17±0.01	5.02±0.43	0.228±0.014	12.8±0.4	2.7±0.4	48.4±8.4
Ahpt2	12-30	7.0±0.4	1.5±0.7	0	0.13±0.01	4.43±0.49	0.204±0.017	12.3±0.4	2.2±0.4	30.4±1.9
Ahp3	30-50	7.0±0.3	1.1±0.4	0	0.12±0.01	4.03±0.32	0.194±0.012	12.0±0.2	1.7±0.5	15.6±0.9
Bhk1	50-71	7.5±0.4	0.7	0	-	2.88±0.21	-	-	-	-
Bhk2	71-94	8.0±0.3	-	6.3±3.5	-	1.78±0.31	-	-	-	-
BCk1	94-117	8.2±0.3	-	15.5±4.2	-	0.95±0.07	-	-	-	-
BCk2	117-170	8.2	-	22.0	-	0.91	-	-	-	-
Ck	170-200	8.2	-	24.5	0.10	0.69	-	-	-	-
Fallow land										
Aht1	0-12	6.5±0.4	1.9±0.7	0	0.17±0.01	6.86±0.57	0.296±0.027	13.5±0.4	2.4±0.6	44.4±4.7
Aht2	12-30	6.7±0.3	1.6±0.6	0	0.14±0.01	5.53±0.70	0.248±0.037	12.9±0.4	1.4±0.4	34.6±5.2
Ah	30-48	6.9±0.2	1.0±0.5	0	0.13±0.01	4.61±0.67	0.213±0.035	12.6±0.3	1.0±0.2	23.8±0.8
Bh1	48-68	7.0±0.2	0.3	0	-	3.54±0.58	-	-	-	-
Bhk2	68-88	7.2±0.4	-	8.0	-	1.83±0.11	-	-	-	-
BCk1	88-109	7.5±0.6	-	19.5	-	0.78±0.09	-	-	-	-
BCk2	109-120	8.6	-	23.0	-	0.35	-	-	-	-
Ck	120-200	9.2	-	15.7	0.10	0.12	-	-	-	-

CONCLUSIONS

It was established that the main negative changes of arable typical chernozem occurred in their arable layer. As a result of anthropic activity, there take place processes of humus loss, soil compaction and structure loss. Thus, typical arable chernozem lost about 35 percent of the initial content of humus from 0-25 cm layer. It was detected a trend of depletion of nutrients reserves in comparison with their content in fallow soils.

Chernozems under the fallow for 30 years recovered their initial characteristics by about 80-90 percent only in 0-30 cm layer. The next soil layer (30-50 cm) is characterized by mainly prismatic structure and high bulk density.

Thus, our research confirms the possibility of restoring the quality of cernozems by influence of steppe vegetation that once formed it.

We have to emphasize that the use of land under the fallow for a long time is impossible, but obviously, it is necessary to include grasses in crop rotation to improve the soil condition.

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EROSION - MAJOR PROBLEM IN THE EFFICIENT USE OF SLOPING LANDS

Olesea COJOCARU[1], Esmeralda CHIORESCU[2]

[1]Institute of Pedology, Agrochemistry and Soil Protection ”N. Dimo”,
MD-2070, Chisinau, Republic of Moldova
[2],,Ion Ionescu de la Brad,, University of Agricultural Sciences and Veterinary Medicine,
700490, Iasi, Romania

Corresponding author email: olesea.cojocaru@bk.ru

Abstract

The rational use of soil, the main means of production in agriculture today represents for most countries a problem of the first order. In this paper we demonstrate that erosion is a major problem known fact that usually leads to worsening soil properties affecting them, washing them, thus contributing significantly to reducing agricultural production. For this purpose for the detection and assessment of soil erosion in hilly region of the Middle Prut a lot of research is necessary. Observations on liquid leakage and erosion study were made using specially arranged parcels. For achieving this goal it is necessary to establish the most effective measures for erosion control the extent research data recording. On the territory the researched object of Negrea village, Hincesti district biggest danger presents it of course - soil erosion.

Key words*: plain Middle Prut, erosion, soil, liquid leaks, sloping lands.*

INTRODUCTION

In order to obtain better results in the economic exploitation of the sloping lands it is necessary to know the degree of erosion and apply the whole system of erosion control measures. (Nour and Balteanschi, 2004).
Taking into account that the main problems that have sloping lands related to the retention and evacuation directed to storm water and restoring productive potential of eroded soils, it is necessary that measures are introduced should be adequate, with maximum efficiency and to take account all factors which determine the erosion.
Therefore, knowledge of the characteristics of this phenomenon, of the evolution and the factors which it determines constitutes an important element in establishing and appreciation of leaks on the slopes, to recommend the most effective measures erosion control (Cerbari, 2010).
On the village territory Negrea, Hincesti district biggest danger presents it of course - soil erosion. Whereas the area Plain Middle Prut was recorded in the relief fragmented and often lack of water in the soil (Ursu et al., 2005) due to the texture thereof clay loam, a very important problem on sloping lands is represented by retention in the soil of certain higher quantities of water from heavy rains, thus reducing liquids leakage and the erosion.
At the same time, increase the agricultural production of these soils. A good soil is the fundamental component in ensuring the sustainable development of agriculture and society. Conservation of soil and fertility are as important as obtaining agricultural production. (Cerbari, 2010; Boincean et al., 2012).
So the research that is carried out in the Middle Prut Plain ultimately aiming to minimize the erosion of the sloping lands, to raise agricultural production almost to the level of those obtained of not eroded lands. Thus, it needs to influence all factors of vegetation, so that by harmonizing them to obtain the best results. Approximative distance from the Negrea community to the main sites is the following: Hincesti – 23 km, Chisinau – 60 km.

MATERIALS AND METHODS

The fact that more than half the agricultural area of the village territory Negrea are on sloping lands, therefore in permanent degradation potential danger, under the action

of the destructive process of erosion. In ensemble of factors acting on the land cover, erosion is a major a modelling agent who contributes to continuous change the general appearance of the land surface. The intensity of erosion processes is conditioned by the degree of inclination and length of slopes, soil texture, arable farming and in soil tillage (Ursu, 2006).
The more the degree of soil erosion is higher, with that less erosion control resistance and more intensive erosion process (Cerbari, 2010).
The research was conducted on an ordinary chernozem clay loam with varying degrees of erosion in a reception basin typical for hilly area of the Middle Prut, from Hincesti district.
Observations on liquids leakage and erosion study were made using specially arranged parcels located on different segments of the slope with varying degrees of soil erosion.
Organized experiences were placed by known methods. The parcels had rectangular shape with an area of 3 m^2. In part of the downstream was installed a metal trough and scored vessel for reception leakages (Figure 1).

Figure 1. The experimental parcels

For the calculation the water losses and soil after each simulated artificial rain with device portable sprinkler irrigation was determined volume the resulting mixture. The amount of eroded soil was calculated after the samples of the resulting mixture was decanted, dried and weighed.

RESULTS AND DISCUSSIONS

Research conducted the parcels to control the leakage of lands sloping from the village Negrea, shows that increasing the volume of fluid leakage (Table 1) from the soil poorly eroded to the strong eroded are due to the decrease hidrostability of the structure, increasing the degree of compaction, reducing permeability for water in the soil (Nour and Balteanschi, 2004).

Table 1. The influence of the degree of soil erosion on leakage

Degree of erosion	Volume of leakage (mm)	Runoff coefficient	The speed of infiltration, mm/min	Turbidity, g/l
poorly	24.6	0.06...0.39	1.88...1.18	50.82...33.44
moderately	27.5	0.08...0.46	1.85...1.08	55.02...43.48
strong	31.0	0.12...0.52	1.77...0.97	80.54...67.88

The intensity of surface runoff appreciates the considerable analysis for the duration of artificial rain (Motoc, 1975).
According to data obtained to poorly eroded soil, runoff coefficient increased from 0.06 at the beginning of observations to 0.39 at the end thereof, the average being 0.21.
The moderately eroded soil those indicators make up the respectively 0.08-0.46 and strongly eroded at 0.12-0.52.
From the data obtained it follows that between the values of runoff coefficient and the speed of infiltration of rainwater there is inverse correlation.
Thus, with the increase in runoff coefficient, the speed of infiltration decreases in the degree of erosion of 1.77-1.88 mm/min at the beginning of the rain to 0.97-1.18 mm/min it's finishing.
Reception basin soils with varying degrees of erosion are distinguished essentially after turbidity leakage.
From the data presented show that middle turbidity to poorly eroded soil was 41.22 g/l to moderately eroded soil with 48.47 g/l and strongly eroded at 73.28 g/l (Figure 2).

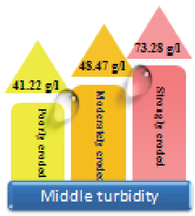

Figure 2. The middle turbidity of the degree of soil erosion

The main feature of soil cover of fields is a predominance of cernozems (black soils) ordinary in its structure (Cerbari, 2010). In conditions of Moldova important natural factor in the formation of stable harvests and treble are atmospheric precipitations. In the area village Negrea the amount of precipitation in a multiannual cycle is 505 mm (www.meteo.md).
It is worth mentioning that leakage turbidity values essential diminishes to time, irrespective of the degree of soil erosion. The biggest charging of leakages with washed earth material shall be recorded at the initial stage. Toward the end of artificial rain the turbidity leakages is reduced in the middle by about 24%.
It has been demonstrated, that the largest losses of soil are produced always at rapid precipitation, because of thereof maximum intensity corresponds to the lowest capacity of the infiltration of the soil, which is already wet.
So in addition to others known factors as topography, vegetation and others, it is apparent that both the number and intensity of torrential rains as well as time thereof directly helps to trigger and amplification erosion phenomenon.
Is apparent that water leakage on sloping land represents reserves which for agricultural are lost and do not contribute to soil and plants supplying with water required (Motoc, 1975).
The effect of degrading in soil erosion is not just limited to the removal of fertile layers, but at the deteriorating of physical, chemical, hydric and biological properties of thereof.
From the above analysis emerge a conclusion and the need to undertake a complex of measures amelioration and erosion control for reducing liquids eventual leakages from the slopes (Boiangiu, 1961).
Organizing of erosion control will present the first condition and the first component of measurement systems drafted for each separate agricultural land.
Each measure, erosion control process and technology has certain possibilities retaining and adjusting of superficial leakages (Ursu, 2001; Ursu, 2006).
Measuring systems will be placed in the field crop rotations in the agronomic cycle that include perennial grasses, alfalfa, vetch, rye grass and sainfoin.
The density agrotechnical measures depend on the inclination and slope length agricultural crop, texture and degree of soil erosion.
The data recorded in the research results, shows that erosion processes are very active and an accelerated evolution in the hilly area of the Middle Prut (Ursu et al., 2005). Less evident on typical and molic delluvial soils, inversely through the fact of deposit of the alluvial material (Soil Science Dictionary, 1977).
The main task of pedological investigations on slope agricultural land, is the conservation and enhancement their effective fertility to obtain foreseen harvests (Boincean, 2013).

CONCLUSIONS

The values of liquid and solid leakages are determined by the degree of soil erosion. The weak eroded soil runoff coefficient was 0.21 in the middle at 0.27 eroded soil moderately and strongly eroded at 0.33.
The measures and procedures for the protection of soil in the reception basin from the area of the Middle Prut must be applied in a differentiated way and correlated with the intensity of erosion.
It has been demonstrated; that the biggest losses of soil always are produced to rapid precipitation because of their maximum intensity corresponds to the lowest capacity of the infiltration of the soil, which is already wet.
Of surface erosion process is irreversible and eroded soils practically cannot restored. If the degree of soil erosion is greater resistance erosion smallest and the erosion process more intense.
The direct consequence of worsening soil properties affecting them the erosion is the reduction in agricultural production more so as the process is more advanced. Erosion on the territory of test/demonstrative fields provokes every year the loss of big quantities of fertile soil and nutritious elements and lead to the reduction of soil fertility and their bonitation points.

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STUDY OF THE BIOLOGICAL NITROGEN FIXATION PROCESS TO COMBINATION OF SOME BLUE-GREEN ALGAE FROM THE GENUS *NOSTOC*

Sergiu DOBROJAN, Victor ȘALARU, Irina STRATULAT, Galina DOBROJAN

State University of Moldova, Laboratory of "Phycology", str. A. Mateevici 60, Chisinau, Republic of Moldova

Corresponding author email: sergiudobrojan84@yahoo.com

Abstract

This article exposes the results of studying the process of biological fixation of nitrogen to a combination of nitrogen-fixing algae species belonging to the genus Nostoc. For the achievement of research have been applied the differential method of studying biological fixation of nitrogen. The experimental results showed that combined application of species of nitrogen-fixing blue-green algae, which belong to the genus Nostoc is effective, helping to increase the quantitative amounts of fixed nitrogen, eliminating significant amounts of nitrogen and nitrogen content self-regulation in nutrient medium. Thus, we recommend applying nitrogen-fixing algae combinations that belong to the genus Nostoc in future research in the field.

Key words*: *blue-green algae, combination, genus Nostoc, nitrogen fixation.

INTRODUCTION

Biological nitrogen fixation is an important global process carried out by microorganisms that less reactive nitrogen, one of the most abundant components of the Earth's atmosphere, passes in inorganic compounds of nitrogen (Șalaru et al., 2013). Biological nitrogen fixation is carried on symbiotic and non-symbiotic way. Non-symbiotic nitrogen fixation is an important source of nitrogen, especially in ecosystems with a small number of plants capable of association with microorganisms for a symbiotic fixation (Samuel, 2007; Madjar and Davidescu, 2009). The nitrogen fixing blue-green algae are part of non-symbiotic group of organisms.

Many species of blue-green algae are able to fix atmospheric nitrogen, which places these algae among the most complete living organisms (Șalaru et al., 2013). Because of this property, the blue-green algae are widely used as bio-fertilizers in many regions of the world. Using the algal bio-fertilizers on the soils in Tundra region have as the result fixation up to 115 kg N/ha/year, in soils in Norway region - 1-2.5 kg N/ha/year, in Antarctica - 24 kg N/ha/year, in temperate region up to 49 kg N/year, and in tropical region to 90 kg N/ha/year (Grimm and Petrone, 1997).

In addition, application of algal bio-fertilizers contribute to improving the mechanical structure and physico-chemical properties of the soil, increasing the capacity of maintaining of soil water (Громов, 1996; Федоров, 1955), reducing concentrations of toxic elements, such as iron (II) and sulfur (with 16.82 to 24.6%), oxidable organic matter, Al_2O, the increase of organic carbon concentration (1.15 times) and increase crop productivity (Venkataraman, 1981). Algal bio-fertilizers application is of interest and for quantitative reduction of greenhouse gas concentration (such as N_2O).

One of blue-green algae taxon, as a major practical importance is the genus *Nostoc*. Species of genus *Nostoc* have morphological and physiological characteristics that advantage in their practical application as bio-fertilizers. These features are substantiated by the following advantages: the ability of heterocysts forming responsible for nitrogen fixation, filamentous forms of talus, vegetative cells undifferentiated functional, mode of reproduction by hormogones and spores which at times stemming from heterocysts, formation of macroscopic colony or less microscopic embedded in gelatinous mass, low humidity and light resistance, the ability to easily accommodate at the different types of soil (Dembitsky and Ezanka, 2005; Еленкин, 1949, Зенова and Штина, 1990), as well as other increased resistance to adverse environmental conditions. In addition, the algae species from genus *Nostoc* are cosmopolitan, widespread in the regions tropical, temperate and polar terrestrial ecosystems (Potts, 2000). Many species of nitrogen-fixing algae, from genus *Nostoc* form symbiotic relationships with fungi, lichens and many phylogenetic groups of higher plants (Meeks, 1998; Rai et al., 2000), and gelatinous mucilage serves as a living place of many bacteria and unicellular algae (Зенова and Штина, 1990).

An important part in implementing the algae as bio-fertilizer is the selection of administrated species. Our previous research showed that the lots combined administration of several species of blue-green algae from genera *Nostoc*, *Cylindrospermum*, *Anabaena* and *Anabaenopsis* in quality of bio-fertilizers in the cultivation of cucumbers, we obtained a larger amount of nitrogen accumulated in the soil and increase harvest vegetables compared to the control where the algalization of soil was achieved only one species (Доброжан et al., 2014).

Selection the species of algal bio-fertilizers that will be combined must be done rationally and well scientifically proven to get the best results in practical application. Therefore, the first researches for combining the species of algae, selected as bio-fertilizers, must been carried out under laboratory conditions on liquid nutrient media.

The research purpose is to study biological nitrogen fixation process in laboratory conditions, at combined administration of algal species of the genus Nostoc.

MATERIALS AND METHODS

The experimented algae - were used three species of the genus *Nostoc* from the collection of laboratory of "Phycology", State University of Moldova.

The experiments were carried out under laboratory conditions at 27-29°C, for a period of 15 days of continuous illumination (120 watts/0.64 m^2). The genus *Nostoc* algae were grown after periodic method on liquid nutrient medium Drew, preventive sterilized using the ultraviolet lamp (Dobrojan et al., 2016). Inoculum consisting of an equal combination to three nitrogen-fixing species and was administered at a dose of 003 g/l recalculated at absolutely dry biomass (BAU).

The process of biological nitrogen fixation was been studied by determining NH_4^+, NO_3^-, total N in algal biomass, fixed atmospheric nitrogen, total nitrogen and nitrogen removed in the nutrient medium. Total nitrogen in algae cells, ammonia and nitrate was been determined by the spectrophotometric method (Воскресенская et al., 2006; Sandu et al., 2010).

Total nitrogen was calculated by summing the total N from biomass (mg, N * algal biomass, g) + N-NH_4^++N-NO_3^-+N-NO_2- (from nutrient medium). Removed nitrogen was calculated by applying the formula: N. el (%) = (N tm * 100) / (Nt-N0), where: N tm – total nitrogen in nutrient medium, Nt - total nitrogen (N algal cel. + N tm); No- total nitrogen of inoculum. Fixed atmospheric nitrogen was determined according to the formula: Nf = (N tb+N tm)-N0, where: Ntb - total nitrogen in algal biomass; Ntm - total nitrogen in the nutrient medium; No - total nitrogen of inoculant cells.

Mathematical processing of results - Results were processed using mathematical computer program "Microsoft Office Excel 2013", determining the arithmetic mean X and standard error x.

RESULTS AND DISCUSSIONS

One of the forms of accessible nitrogen for higher plants and many microorganisms is ammonium ions. It is been considered that ammonium ions are the form of nitrogen resulting from the biological fixation of atmospheric nitrogen conducted by algae. Therefore, this indicator should have be monitored to assess how the implementation process of biological nitrogen fixation.

Table 1. Changes of ammonia nitrogen (N-NH_4^+) in the nutrient medium for cultivation of algae from genus *Nostoc*, mg/l

Days of analysis	Concentration N- NH_4^+, mg/l (X±x)
1	0
3	1.39±0.12
6	1.20±0.06
9	0.57±0.06
12	1.65±0.12
15	2.08±0.05

As we can see from the presented data in Table 1, ammoniacal nitrogen concentration varies depending on the day of analysis. On the 3rd day showed an increase of ammonia, and then reduce until the 9th day, followed by an increase to the 15th day. This indicates that the algae fix nitrogen up to a limit, after which produce the consumption, the process is continuously repeated.

Ammonium ions from biological nitrogen fixation result oxidizes and turns into nitrates, according to the reaction: $NH_4 + 2O_2 \rightarrow NO_3^- + 2H^+ + H_2O$ + Energy. As is well known, oxidation of 1 g of N-NH_4 consumed 4.6 g of O_2 and excessive production of acids (1 mole of N-NH_4 forms 2 moles of H^+) (Belingher and Chimerel, 2011). Doing a theoretical calculation, appears that the genus *Nostoc* species produced quantities of oxygen required to reduce the amount of ammonium ions detected in nutrient medium, ranging from 2.62 to 9,57 mg/l, which shows yet another argument for the practical implementation algal bio-fertilizers - to increase the quantity of oxygen in the soil.

Table 2. Changes of N - NO3 in nutrient medium at the cultivation *Nostoc* species, mg/l

Days of analysis	Concentration N - NO_3^-, mg/l (X±x)
1	0
3	0.01±0.001
6	0
9	0
12	0.68±0.03
15	0.40±0.04

As we can see, the concentration of nitrate ions is not in strict dependence on the ammonium ions. The largest quantities of nitrates is been observed during the period when the amount of ammonium is high. Some days of analysis (6'th and 9'th) were not detected nitrates in nutrient medium (Table 2). This can be caused by consumption of nitrate by vegetative cells of algae which can consume both forms of ammonium and nitrates ones.

As we can see, the amount fixed atmospheric nitrogen has the tendency of increasing followed by decrease but the biomass grow exponentially. The highest amount of atmospheric nitrogen fixed by algae attesting at the 9th day reaching 34.67±1.12 mg/l BAU, where biomass increased by 2.5 times (compared to the results obtained from third day of measurement).

This amount of nitrogen at the 9'th day has allowed its consumption by vegetative cells and increase biomass algal until the 12th day, after which insufficient amount of nitrogen and increased demand for nitrogen of vegetative cells had stimulated the initiating process of fixing nitrogen (Figure 1). This allows us to conclude that algae of genus *Nostoc* possesses the property of fixing atmospheric nitrogen but also to consume it for the increase of algal biomass, thus creating a balance of nitrogen concentration in the nutrient medium. Is worth noting that results at combining species of the genus *Nostoc* are higher than using separate specie of *Nostoc flagelliforme*, where the total amount of fixed nitrogen reached maximum 11.52 mg/l (Dobrojan et al., 2014).

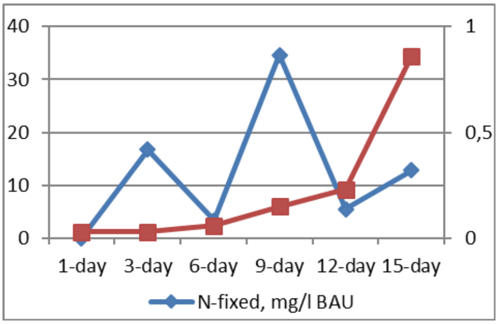

Figure 1. Fixed atmospheric nitrogen and the biomass growth of blue-green algae from genus *Nostoc*

Eliminating activity of nitrogen in nutrient medium, as well as nitrogen fixation, have tends to increase followed by decrease. Nitrogen eliminating occurs when nitrogen fixation activity is lower (at 6'th and 12'th day) (Figure 2), which shows that after nitrogen fixation following the elimination of in nutrient medium. Combined administration of algae from genus *Nostoc* has the effect of eliminating a higher amount of nitrogen (up 42.16%) than the separate administration of *Nostoc gelatinosum* specie (up 12.5%) (Dobrojan et al. 2014).

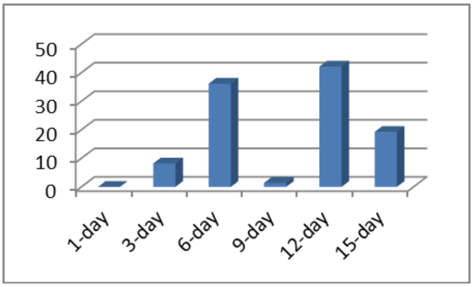

Figure 2. Eliminated nitrogen in nutrient medium for cultivation the algae from genus *Nostoc*, %

CONCLUSIONS

Combined administration of algal species from the genus *Nostoc* contribute to the accumulation of significant amounts of ammonia nitrogen in the nutrient medium and effectively fixes atmospheric nitrogen (34.67 ± 1.12 to mg N/l BAU). The fixed nitrogen is removed in nutrient medium at the algae cultivation, then the process is stopped, and the eliminated nitrogen is used by the vegetative cells growth and increase the biomass, after that the process is initiated again. This indicates that biological nitrogen fixation performed by combinations of algae from genus *Nostoc* is a self-regulating process. We found that conducted research by combinations of algae from the genus *Nostoc* can be applied in future field research.

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CONTRIBUTION OF GREEN MANURE, RHIZOBIUM AND HUMIC + FULVIC ACID ON RECOVERING SOIL BIOLOGIC ACTIVITY OF OLIVE MILL WASTEWATER CONTAMINATED SOIL

Kemal DOGAN[1], Ali SARIOGLU[2] Ali COSKAN[3]

[1,2]Mustafa Kemal University, Faculty of Agriculture, Department of Soil Science & Plant Nutrition, 3100 Hatay, Turkey
[3]Suleyman Demirel University, Faculty of Agriculture, Department of Soil Science & Plant Nutrition 32260 Isparta, Turkey

Corresponding author email: kdogan@mku.edu.tr

Abstract

Olive trees cultivation is one of the important agricultural product in especially Mediterranean, Aegean and Marmara regions of Turkey. There are about 750 million productive olive trees worldwide whereas 98% of them located in the Mediterranean region. Three major olive oil producers worldwide are Spain, Italy, and Greece, followed by Turkey. Olive Oil Mill Wastewater (OMWW) is one of the waste products of olive oil process that contains different harmful substances such as polyphenols and long-chain fatty acids which risky for soil and plants. These harmful materials are environmentally not safe, while they cause economic and ecological problems. Due to the considerable amount of OMWW occur every year, a number of approaches tested by the researchers to overcome this issue. In this study the effect of OMWW alone and combination with green manure, rhizobium and humic acid on soil microbial activity evaluated. Results gathered revealed that OMWW was reduced determined microbial activity parameters as soil respiration (CO_2 production), dehydrogenase enzyme activity and microbial biomass carbon content. All applications were effective on restoring CO_2 production that diminished due to OMWW; however, humic acid and green manure+humic acid applications yielded the highest benefit. Dehydrogenase activity did not differ strongly by OMWW applications. Microbial biomass carbon (MBC) values decreased rapidly by OMWW incorporation, but green manure and bacteria application together restored MBC, even higher values determined in that variant.

Key words: *olive oil mill wastewater, soil microbial activity, bioremediation*.

INTRODUCTION

Olive Oil extraction facilities are producing large amount of wastewater, which contain undesired toxins. Three-phase and two-phase centrifugation systems are used in olive oil industry, more or less, both of them produce these toxins containing wastes. In general three-phase systems produce more wastewater or sludge comparing to two-phase systems. Thus, two-phase centrifugation systems were commonly referred by olive oil producers, recently. The environmental impact of olive oil production is considerable, mainly due to the utilization of large amounts of water and the production of large amounts of either wastewater or sludge. Pressure and three-phase centrifugation systems produce substantially more olive mill wastewater (OMWW) than two-phase centrifugation, which significantly reduces liquid waste yet produces large amounts of semi-solid or slurry waste commonly referred to as two-phase pomace or alperujo in Spanish (Alburquerque et al., 2004; Niaounakis and Halvadakis, 2006). But according to some researcher, the two-phase-system has not penetrated significantly into the other olive oil-producing countries, mainly due to difficulty in handling the sludge for this reason most countries continue to make use of the three phase centrifugation system (Kotronarou and Mendez, 2003).
OMWW has very high organic load and also contains high levels of phytotoxic and microbially inhibitory compounds, such as phenolics and long-chain fatty acids (Niaounakis and Halvadakis, 2006; Thomsom, 1964; Fountoulakis et al., 2002). Phenolic compounds are present in wastes from several industrial processes, likewise, olive oil mill wastewater (OMW) is an effluent containing many of these compounds which are

responsible for its black color, and its phytotoxic and antimicrobial (mainly antibacterial) properties (Martinez et al., 1986; Martinez-Garcia, et al., 2007; Tsioulpas et al., 2002). This wastewater constitutes a serious problem with severe negative impact on soil and water quality, and thus on agriculture, environment and health (Parades et al., 1999; Khoufi et al., 2007).
Vast majority of olive oil production occurs in the Mediterranean region, utilizing a tremendous volume of water in an area of the world in which water resources are limited. Treatment and refuse of olive mill wastewater (OMWW) presents significant challenges both due to the nature of olive oil production and due to the characteristics of the wastewater (high chemical oxygen demand, high phenolic content, and dark color). Christopher et al. (2007) use bioremediation technic to solve the OMWW problem. They have tested number of different microorganisms (Archaea, Bacteria and fungi) and processes (aerobic or anaerobic bioreactors, composting) to treat OMWW. According to their results, biological processes provide some of the most viable options for the treatment of OMWW. Effective application of these techniques, yielding significant reductions in high chemical oxygen demand, phenols, and colour, will allow safe and economical disposal of OMWW.
Tsioulpas et al. (2002) studied at Phenolic removal in olive oil mill wastewater by strains of *Pleurotus spp*. in respect to their phenol oxidase (laccase) activity. They used several *Pleurotus spp*. strains to remove phenolic compounds from an olive oil mill wastewater. Martinez-Garcia et al. (2007) investigated Two-stage biological treatment of olive mill wastewater with whey as co-substrate. Their results show that fifty-four percent of the phenol was biodegraded during the aerobic treatment stage, and biogas with between 68% and 75% methane was produced during anaerobic digestion.
Roig et al. (2005) studied on overview on olive mill wastes and their valorization methods. According to these researchers olive mill wastes represent an important environmental problem in Mediterranean areas where they are generated in huge quantities in short periods of time. Their high phenol, lipid and organic acid concentrations turn them into phytotoxic materials, but these wastes also contain valuable resources such as a large proportion of organic matter and a wide range of nutrients that could be recycled.
In this research, the effects of OMWW on some biologic parameters of soil was evaluated while useful part of this substance considered as indicated Roig et al., (2005). To support microorganisms to denature toxic ingredient of OMWW, green manure, rhizobium and humic+fulvic acid were applied.

MATERIALS AND METHODS

An incubator experiment was carried out at Mustafa Kemal University, Faculty of Agriculture; Soil Sci. & Plant Nutrition Department. OMWW was obtained from any olive oil factory in Hatay, where located Southeast of Turkey, in Mediterranean region (Figure 1).

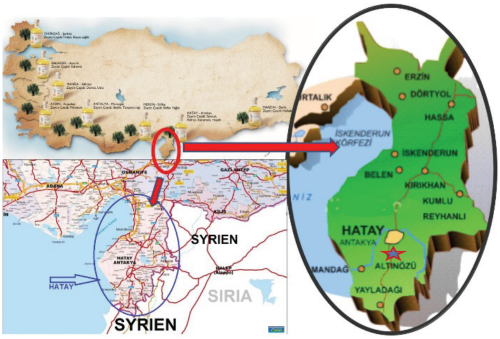

Figure 1. Geographic location of research Area

Olive cultivation's proportion of Hatay is around 10% of Turkey. There are 85 olive oil factories available that using two or three-phase centrifugation systems. The total processing capacity of these companies is approximately 22 thousand tons. Soils used in the experiment were collected from Mustafa Kemal University research and implementation area. Some soil properties are provided in Table 1. Explanation of abbreviation used in the tables provided in Table 2.

Table 1. Some soil properties of experimental soil

pH	Salt (%)	$CaCO_3$ (%)	Corg (%)	Texture class
8.35	0.22	17	1.15	CL

Sieved 200 g of soils was placed to open lid jar and alone or combination of the practices provided in Table 2 realized. Afterwards samples were incubated for one month at 28^{o}C. Soil moisture controlled at regular interval and sustain at field capacity.

Table 2. Explanation of practices

Abbreviations	Explanations
BE	Before experiment – natural situation
OMWW	Olive Oil Mill Wastewater: 10 ml of OMWW homogenized to 200 g of soil.
GM	Green manure: Doses adjusted according to 20 tons of green manure to one hectare
HA	Humic and fulvic acid: Doses adjusted according to 50 liter to one hectare.
Br	Bacteria: Bacteria suspension containing 4 x 10^9 cells applied to 200 g of soil.

An organic matter content of humic+fulvic acid was 5% where pH was 11-13. At the end of the experiment samples removed out of the incubator and analyses started immediately. CO_2 analyses were done by titration method which CO_2 was captured by $Ba(OH)_2$ and remaining BaOH titrated by HCl (Isermayer, 1952). Dehydrogenase enzyme activity (DHA) was determined according to Thalman (1956). Microbial biomass carbon (MBC) content was determined by fumigation-extraction method (Ohlinger, 1993). Completely randomized design was used, obtained results were statistically analysed via MSTAT-C pocket software and ranged with Duncan multiple range test.

RESULTS AND DISCUSSIONS

The effect of OMWW, green manure, humic+fulvic acid, *rhizobium* bacteria and all of randomized combination of this application on CO_2 production presented in Figure 2 and Table 3. All applications significantly influenced CO_2 production of soils, whereas, OMWW application diminished CO_2 production rapidly. Only 0.75 mg CO_2-C from 100 gram of dry soil at 24 h which the highest value among the applications was 12 mg at both OMWW+HA and OMWW+GM+HA variants. These two was followed by OMWW+GM+HA+Br and OMWW+GM+Br with 11.50 and 10.75 mg CO_2, respectively. Considering overall results it seems to be Br and HA more effective to contribute soil on recovering harmful effects of toxic substances added by OMWW.

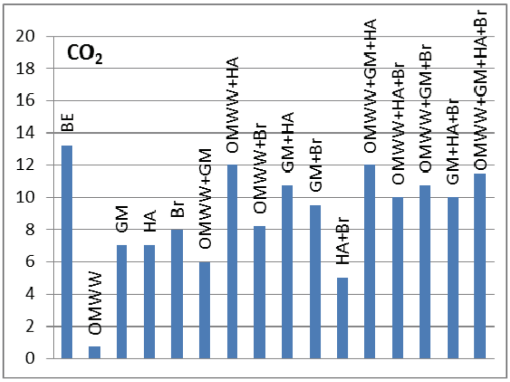

Figure 2. CO_2 production (mg CO_2-C 100 gds^{-1} 24 h^{-1})

Determined dehydrogenase (DHA) values are presented in Figure 3 and Table 3. There was no similarity between CO_2 production and DHA activity, which DHA was not effected from OMWW application considerably. Even so-called safe substrates reduced dehydrogenase activity more than OMWW. The lower DHA values were determined in OMWW, OMWW+HA, GM+HA, HA+Br and OMWW+HA+Br as 307, 262, 236, 276, 259 g TPF at 10 gram of dry.soil for 24h, respectively.

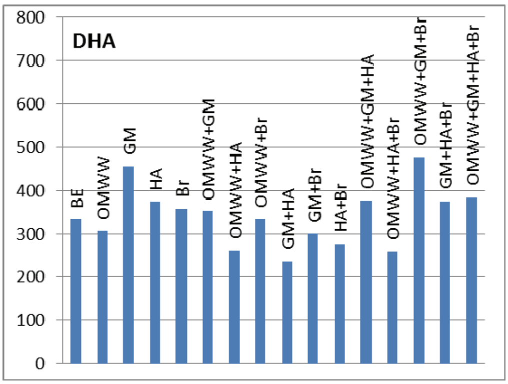

Figure 3. DHA (g TPF 10 gds^{-1} 24 h^{-1})

The highest DHA values determined in OMWW+GM+Br variants as 478 □g TPF 10 gds $^{-1}$ 24h^{-1} which approximately 55% higher than OMWW applied soils.

Microbial biomass carbon values which effected from OMWW, green manure, humic+fulvic acid, *rhizobium* and their combination are presented in both Figure 4 and Table 3.

The lowest MBC values are determined in OMWW+Br and OMWW+GM as 2.1 and 2.5 µg MBC in one gram of soil. The negative effect of OMWW become more dramatic when applied with GM or Br in term of MBC. However, surprisingly when GM and Br incorporated together with OMWW, the highest MBC value was achieved as 95.4 µg C g dry soil^{-1}.

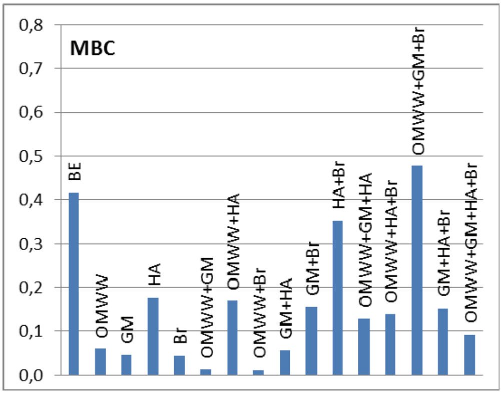

Figure 4. MBC Content (mg MBC gds^{-1})

Table 3. Statistically results of values

Applications	CO_2 (mg CO_2-C 100 gds^{-1} 24 h^{-1})		DHA (µg TPF 10 gds^{-1} 24 h^{-1})		MBC (mg MBC in gds)	
BE	13.25		335		0.0833	
OMWW	0.75	h	307	ef	0.0118	e
GM	7.00	ef	456	a	0.0089	e
HA	7.00	ef	374	bc	0.0354	b
Br	8.00	cd	358	b-d	0.0086	e
OMWW+GM	6.00	b	353	b-d	0.0025	f
OMWW+HA	12.00	a	262	gh	0.0339	b
OMWW+Br	8.25	cd	334	de	0.0021	f
GM+HA	10.75	b	236	h	0.0111	e
GM+Br	9.50	bc	301	ef	0.0311	bc
HA+Br	5.00	g	276	fg	0.0700	cd
OMWW+GM+HA	12.00	a	376	b	0.0254	d
OMWW+HA+Br	10.00	b	259	gh	0.0275	cd
OMWW+GM+Br	10.75	b	478	a	0.0954	a
GM+HA+Br	10.00	b	374	bc	0.0300	b-d
OMWW+GM+HA+Br	11.50	ab	383	ab	0.0182	de

gds: gram dry soil, data obtained before experiment conducted was not included to statistical analyses.

CONCLUSIONS

Olive Oil Mill Wastewater (OMWW) is a huge pollution problem for some countries which produce oil olive especially in cities around Mediterranean Sea. Because of the oil extraction process has both two-phase and three-phase centrifugation systems which are unfortunately producing plenty amount of water that containing several toxic waste matters. These toxics are mainly consisted on phenolic matters and long-chain fatty acids that are strong phytotoxic and microbial inhibitory compounds. Addition to such as phenolic and long-chain fatty acids OMWW also contains very high organic load (Halvadakis, 2006; Christopher et al., 2008). OMWW is known as black water in olive grown region in Turkey.

OMWW is growing concern for Turkey, yet no feasible, economic and uncomplicated solution developed; although a number of researches carried out already. According to Martinez-Garcia et al., (2007) several OMWW purification systems and approaches have been reported including evaporation basins (Saez et al.,1992), physico-chemical treatments (Flouri et al., 1996), filtration processes (Almirante and Carlo, 1991), aerobic treatment (Benitez et al., 1997) and anaerobic digestion (Rozzi et al., 1989). However, recommendation must be done considering environmental concern and utilization opportunities. The aim of this study was determining the effects of some organic and ecological material such as green manure, *rhizobium* and humic+fulvic acid on recovering soils from hazardous effects of OMWW. It is well known, contamination of so-called “black water” diminishes microbial activity parameters such as CO_2 production, DHA activity and MBC contents that evaluated once more in this this research. CO_2 production values in all variants were determined higher than solely OMWW applied soil, whereas the lowest CO_2 production value is observed in OMWW soil as 0.75 mg CO_2-C 100 g.dry.soil^{-1} 24 h^{-1}. Other values are changed between 6-12 mg CO_2-C 100 g.dry.soil^{-1} 24 h^{-1}. Soil respiration consists of CO_2 produced from biochemical processes associated with root activities (autotrophic respiration), and microbial organic matter decomposition (heterotrophic respiration) (Saiz et al. 2006; Boone et al., 1998; Buchmann, 2000).

DHA value of OMWW soil was 307 μg TPF 10 g dry soil^{-1} 24 h^{-1} and the other values are changed between 236-478 μg TPF 10 g dry soil^{-1} 24 h^{-1}. According to DHA results treatments and their combinations improved DHA activity, but the differences between the values were not as evident in CO_2. Moreover, humic+fulvic acid and OMWW combination was caused decrease on determined DHA values. According to several researchers, soil quality defined as “the capacity to function within an ecosystem and sustain biological productivity, maintain environmental quality and promote plant, animal and human health”. In natural conditions, soils tend towards maintaining an equilibrium between pedogenetic properties and the natural vegetation (Parr and Papendick, 1997; Pascual, 2000).

MBC value in OMWW soils is find as 0.0118 mg. dry. soil^{-1}. Some of application Some MBC values were higher than OMWW whereas some others were higher. Conversely DHA activity results, microbial biomass carbon (MBC) content increased in OMWW+humic+fulvic acid applied variant. The highest value of MBC is determined in OMWW+GM+Br soils as 0.03 mg MBC in gram of dry soil.

Generation of OMWW in the Mediterranean region has a significant environmental impact. Overall, the incorporation of biological processes provides some of the most viable options for the treatment of OMWW (Christopher et al., 2008). Based on the results gathered, OMWW applications decreased to soil microbial activity. However if some ecological material such as green manure, soil organisms and humic+fulvic acid use with this waste, it can reduce to toxic effect of OMWW.

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EFFECT OF HUMIC+FULVIC ACID APPLICATION AT DIFFERENT DOSES ON BIOLOGICAL ACTIVITY OF DIFFERENT REGION SOILS

Hande EROL, Ali COSKAN

Suleyman Demirel University, Faculty of Agriculture,
Department of Soil Science & Plant Nutrition, 32260 Isparta, Turkey

Corresponding author email: alicoskan@sdu.edu.tr

Abstract

An organic matter content of soil is one of the major parameter representing soil quality. A pot experiment carried out to determine the effect of humic+fulvic acid (HFA) is considered to be the most effective part of the organic matter on biological activity of different region soils. In this study, HFA doses of 0, 500, 1000, 2000 ppm were applied to soil collected from 7 different regions of Turkey and corn seeds were sown. Following the harvest, the colony forming units of microorganisms, CO_2 production, dehydrogenase enzyme activity (DHA) and microbial biomass carbon (MBC) were analysed to evaluate biological activity of soils. The results obtained revealed that the HFA was effective in terms of parameters determined but, the effectiveness was variable in terms of the region studied. The lower values were observed in the soil taken from Konya region according to the biological activity parameters of CO_2 production, DHA and MBC. The higher values were determined in soil taken from Antalya or Samsun. According to HFA doses, increment until 1000 ppm resulted in significantly higher values of biological activity parameters whereas, increment from 1000 to 2000 ppm was not effective on the parameters mentioned above, even decline was observed in some cases.

Key words: *maize, biological activity, humic and fulvic acid.*

INTRODUCTION

Organic matter improves soil physical, chemical and biological properties of the soil (Shirani et al., 2002); however, soil organic matter contents of Turkey generally is low (Eyupoglu, 1998; Gezgin et al., 1999). Thus, any practice targeted to increase organic matter contents of soil has great importance in Turkey to ameliorate aggregate stability, water-air balance, resistance to erosion as well as plant nutrition. Influence of humic substance on plant nutrition occurs indirectly via increasing water holding capacity, aeration and availability of nutrients or directly via stimulating root development, chelating the metals and changing the uptake metabolism (Lobartini et al., 1997). Humic and fulvic acids (HFA) also have a challenge on soil reclamation, bioremediation and odor prevention (Gunes, 2007). Seker and Ersoy (2005) pointed that dual applications of mineral fertilizer and humic substance increased N, P, K, Fe, Zn, and Mn contents of the *Zea mays*. Effects of humic substances are related to many factors. Leventoglu and Erdal (2014) reported close relation between soil type and humic substance applications on dry weight, N, Mg, and Cu concentrations of the corn. Sozudogru et al. (1996) reported positive effects of humic acids on N and P uptake whereas no effects on K, Ca, Na and Cu. Furthermore, Erdal et al. (2014) reported negative effects on Fe uptake which is one of the problematic elements on plant uptake in Turkey. Soil biologic characteristic is also affected by humic substance applications. Visser (1985) reported 200 times more microorganism number in case of 30 mg L^{-1} HFA applications. Turgay et al. (2004) reported higher CO_2 formation in leonardite application which has a considerable amount of humic substances. The aim of this research was to evaluate humic substances on soil biologic activity with respect to different region soils.

MATERIALS AND METHODS

This research was carried out as a pot experiment at Suleyman Demirel University, Soil Sci. & Plant Nutrition Dept. Soils are collected from 7 different regions of Turkey, whose brief properties are provided in Table 1. Dracme corn variety was used as a test plant.
Humic+fulvic acid extracted from leonardite

using KOH. Doses were 0, 500, 1000, and 2000 mg kg^{-1} soil and they were mixed thoroughly afterwards placed to pots containing 1500 g soil. Basic fertilization was performed as 300 mg kg^{-1} N, 200 mg kg^{-1} P, and 200 mg kg^{-1} K using NH_4NO_3, TSP, K_2SO_4 and diammonium phosphate. At the end of the experiment, soils were analyzed to determine their CO_2 production (Isermayer, 1952), microbial biomass carbon contents (Ohlinger, 1993), dehydrogenase activity (Beyer et al., 1993) and number of microorganism (Ottow, 1984). All results statistically were analyzed via MSTAT-C pocket software.

Table 1. Some properties of the soil used

Properties of soil	Diyarbakir	Konya	Urfa	Samsun	Kutahya	Eskisehir	Antalya
Sand (%)	39.8	37.7	28.0	57.5	65.2	41.5	21.7
Silt (%)	22.0	25.5	20.0	14.1	21.4	12.2	25.9
Clay (%)	38.2	36.8	52.0	28.4	13.4	46.3	52.4
Tex.class	C	CL	SCL	SCL	C	SC	SCL
Corg (%)	1.64	0.54	1.56	1.27	1.29	0.88	2.46
$CaCO_3$(%)	34.4	22.8	41.3	8.3	28.5	27.4	22.3
pH	8.3	8.3	8.5	7.4	8.1	8.1	7.9
Salt (%)	0.36	0.16	0.61	0.09	0.30	0.31	0.10

RESULTS AND DISCUSSIONS

The effects of humic+fulvic acid (HFA) applications to different regions of soils on CO_2 production presented in Table 2.

According to dose averages, all applications increased CO_2 production of the soils, where the statistically the lowest value was observed in the control. No statistical differences were determined between doses. Averages of regions represent considerable differences; Diyarbakir gave nearly two times higher value than that of Konya soils. The highest and the lowest values in dose x region interaction were in Samsun soil with 2000 mg kg^{-1} HFA application and control variant of Konya soil, respectively. Dehydrogenase activities (DHA) of soils are given in Table 3.

Comparing to CO_2 production, DHA was not as effective at the lower doses of HFA. The highest value was observed in middle dose, the highest dose even diminished for the DHA comparing to control. Region-average data revealed that the highest DHA was in Antalya and the lowest were in Konya and Kutahya soils. The highest dose x region interaction was also in Antalya and more than 30 times higher than the lowest value which was observed in control variant of Konya. Control soil of Konya yielded the lowest value in both CO_2 production and DHA; however the highest values were determined from different regions. Similarly CO_2 production and DHA, Microbial Biomass Carbon (MBC) were greatly influenced from HFA applications (Table 4).

Table 2. CO_2 production (µg CO_2-C g_dry_soil^{-1} 24 h^{-1})

	Doses				
Regions	0 (control)	500 mg kg^{-1}	1000 mg kg^{-1}	2000 mg kg^{-1}	Average
Diyarbakir	26.1 e-i	34.2 a-c	37.2 a	33.1 a-e	32.6 A
Konya	8.8 m	16.8 j-l	25.5 f-i	14.7 k-m	16.5 D
Urfa	25.5 f-i	26.6 d-i	32.6 a-f	13.2 lm	24.5 C
Samsun	22.8 h-j	28.4 c-h	22.1 h-j	37.4 a	27.7 B
Kutahya	22.1 h-j	31.7 a-f	31.0 a-g	35.8 ab	30.1 AB
Eskisehir	22.2 h-j	24.3 g-i	20.6 i-k	29.0 b-h	24.0 C
Antalya	28.4 b-h	33.6 a-d	29.2 b-h	29.3 b-h	30.1 AB
Average	22.3 B	27.9 A	28.3 A	27.5 A	

Table 3. Dehydrogenase activity (µg TPF 10 g_dry_soil^{-1} 24 h^{-1})

	Doses				
Regions	0 (control)	500 mg kg^{-1}	1000 mg kg^{-1}	2000 mg kg^{-1}	Average
Diyarbakir	163.1 f-k	178.7 f-j	136.6 g-m	208.3 fg	171.7 D
Konya	35.0 m	93.8 i-m	70.1 k-m	57.2 l-m	64.0 E
Urfa	184.1 f-i	197.4 f-h	212.9 fg	141.7 g-l	184.0 D
Samsun	456.3 d	458.2 d	354.7 e	372.6 de	410.4 B
Kutahya	96.9 h-m	80.2 g-m	77.1 j-m	87.2 i-m	85.4 E
Eskisehir	204.4 fg	257.3 f	239.8 fg	223.5 fg	231.2 C
Antalya	1013.3 b	914.1 c	1182.7 a	846.3 c	989.1 A
Average	307.6 AB	311.4 AB	324.8 A	276.7 B	

Table 4. Microbial Biomass Carbon-MBC (µg MBC g_dry_soil[-1])

	Doses				
Regions	0 (control)	500 mg kg^{-1}	1000 mg kg^{-1}	2000 mg kg^{-1}	Average
Diyarbakir	198.3 ab	122.6 b-e	176.7 a-c	108.2 c-f	151,4 B
Konya	25.2 fg	86.5 d-g	97.3 c-g	137.0 b-d	86,5 CD
Urfa	43.3 e-g	54.1 d-g	108.2 c-f	68.5 d-g	68,5 D
Samsun	230.8 a	238.0 a	248.8 a	245.2 ab	240,7 A
Kutahya	82.9 d-g	39.7 e-g	21.6 g	39.7 e-g	46,0 D
Eskisehir	104.6 c-g	22.4 g	115.4 c-e	113.7 c-e	89,0 CD
Antalya	93.7 c-g	111.8 c-e	194.7 ab	122.6 b-e	130,7 BC
Average	111.3 AB	96.4 B	137.5 A	119.3 AB	

MBC as a parameter of microbial organism presence of soil revealed that the middle dose was more effective than higher and lower doses. According to dose-average values, lower doses even reduced MBC comparing to control. Samsun showed the highest region-average value whereas the highest region x doses interaction value also was determined in that region. Similar to CO_2 production and DHA, the lowest MBC value was determined in Konya once again. This data had a great importance to represent natural situation of Konya soils, which had quite low biological activity. For all region sampled, soil bacteria, fungi and actinomycetes numbers were determined and the results are presented in Figure 1, 2, 3 respectively.

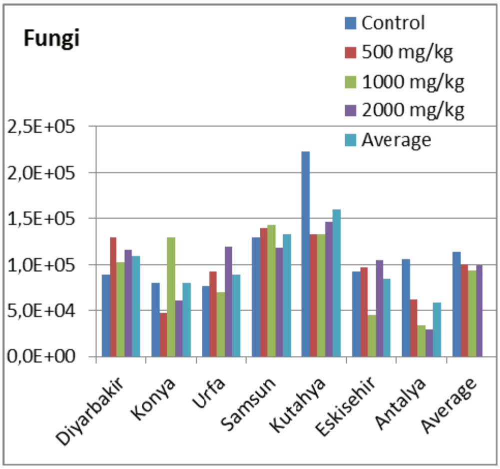

Figure 2. The number of fungi in one g of soil

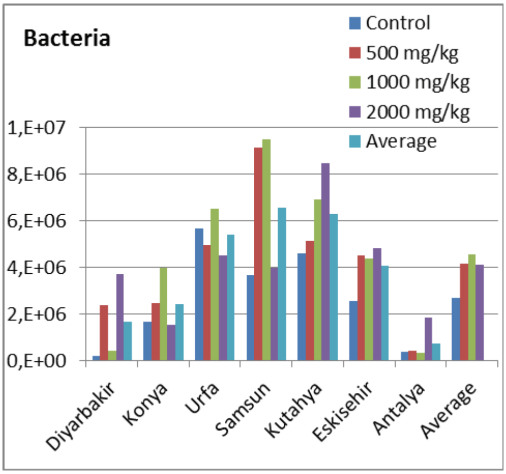

Figure 1. The number of bacteria in one g of soil

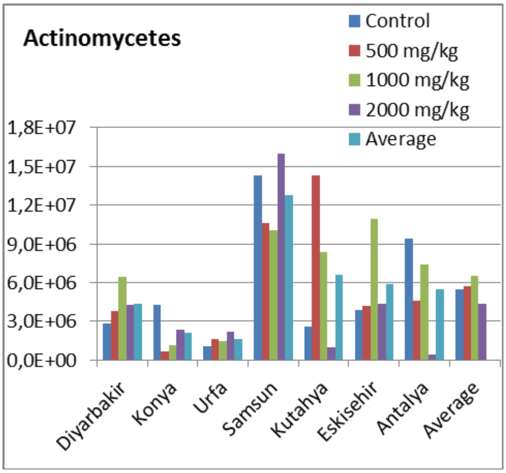

Figure 3. The number of actinomycetes in one g of soil

As clearly seen in Figure 1, higher colony forming unit (cfu) of bacteria was observed in Samsun soil. Antalya gave the lowest values in general. Dose-average values revealed that all doses increased bacteria abundance; however, 1000 mg kg^{-1} dose was more effective among the doses. Fungi cfu (Figure 2) was not in accordance with bacteria based on dose-averages. All doses reduced fungi abundance. The highest fungi was determined in Samsun and Kutahya whereas the lowest was found in Antalya. Diminishing effect of HFA application was more prominent in Antalya soils. Similar to fungi results, cfu of actinomycetes was the highest in Samsun and Kutahya whereas the lowest were in Konya and Urfa. In general quite much fluctuation was determined in soil microorganism's abundance. To compare the natural situation of the regions, data observed in control is represented in one table (Table 5).

Table 5. Natural situation of the regions in term of biological parameters

Regions	CO_2 (µg CO_2-C gds^{-1} 24 h^{-1})	DHA (µg TPF 10gds $24h^{-1}$)	MBC (µg MBC gds^{-1})	Fungi cfu x 10^4/gds	Bacteria cfu x 10^5/gds	Actinomycete cfu x 10^6/gds
Diyarbakır	26.1	163.1	198.3	9.0	1.7	2.8
Konya	8.8	35.0	25.2	8.0	16.6	4.3
Urfa	25.5	184.1	43.3	7.7	56.7	1.1
Samsun	22.8	456.3	230.8	13.0	36.9	14.3
Kütahya	22.1	96.9	82.9	22.3	46.0	2.6
Eskişehir	22.2	204.4	104.6	9.3	25.4	3.9
Antalya	28.4	1013.3	93.7	10.7	3.6	9.4

(gds: gram dry soil; cfu: colony forming unit)

The lowest CO_2 production, DHA and MBC values, which are the predominant parameters of biological activity, were determined in Konya soil. Konya is located nearly in the middle of Turkey with less precipitation accompanying relatively colder climate region. This would be the reason of less biologic activity in Konya. Supporting this idea, Antalya, which has higher precipitation and warmer climate, gave higher CO_2 and DHA. Among the regions, the highest precipitation occurred in Samsun, which the highest MBC recorded. Table 5 clearly indicated the great biological differences in the region; therefore, the effect of HFA varied in quite wide range.

The correlations between the parameters are presented in Table 6.

Table 6. Correlations between parameters determined

	CO_2	DHA	MBC	Fungi	Bacteria
DHA	0.2401 *				
MBC	0.1274	0.3068 **			
Fungi	0.1154	-0.2794 *	0.0554		
Bacteria	0.0669	-0.2821 *	-0.0222	0.3626 ***	
Actinomycete	0.1736	0.1881	0.3426 **	0.1859	0.0889

*: $p<0.05$ **: $p<0.01$ ***$p<0.001$

As seen from Table 6, there was a positive correlation between DHA and CO_2 production at $p<0.05$ level. No more significant correlation with CO_2 production was observed. DHA is an enzyme that has a role on respiration; therefore, correlation between them is not extraordinary, even higher correlation coefficient was expected. There was a significant positive correlation ($p<0.01$) between soil MBC indicating the total amount of microorganisms and DHA activity whereas DHA gave negative correlation with fungi and bacteria. The strongest correlation was determined between fungi and bacteria at $p<0.001$ level. Actinomycete was only correlated by MBC with $p<0.01$. Actinomycetes are more resistant to heat and drought stress, thus in all regions actinomycete abundance was relatively high. In normal cases most available group of microorganisms consisted by bacteria, this is the evidence of the stress condition of the some areas studied.

CONCLUSIONS

Humic+fulvic acid is a part of organic matter which recently became very popular in Turkey. There are a number of associations and research centres all over the world to evaluate complex structure of the humic substances. Although HFA is a part of organic matter, considering recommended dose, it does not have potential to improve soil organic matter contents. However, when applied in even small quantities, it is still effective due to its hormone-like effect. On the other hand, optimum dose for every type of soil is yet not known. Therefore this research was carried out to evaluate relation between application doses and different soils from different regions.

Results revealed that different soils react considerably different up to HFA doses. As an example, effect of HFA application on CO_2 production was much more effective in Konya soil comparing to all others. Even the lowest dose of HFA increased CO_2 formation as double in this region. Determined CO_2 production of untreated Konya soil provided only 1/3 of the other region indicating insufficient biological productivity of soils which means HFA has a great importance in that areas.

In general, HFA is defined as a potential agent to improve soil biologic parameters based of the data obtained in this research. Optimum doses were 500 mg kg^{-1} for Antalya, 2000 mg kg^{-1} for Samsun, Kutahya and Eskisehir, and 1000 mg kg^{-1} for rest of the region studied. Although higher doses above 2000 mg kg^{-1} were not tested, changes on CO_2 production by increasing doses indicated that the higher doses had a potential to decrease marginal CO_2, thereby biological activity. DHA values also gave similar results to the CO_2; however, the highest value on CO_2 production was in Samsun while the highest DHA was in Antalya. As mentioned earlier, DHA had a role on respiration, thus close relations are expected between CO_2 production and DHA which it was week in this research. However, Beck (1984) reported extraordinary circumstances controlled by many factors that preventing close relation between CO_2 and DHA. In accordance with CO_2 and DHA, the lowest MBC value is also determined in Konya soil. This situation is most probably related by low organic matter contents as well as cold climate and drought condition in that region. Proving this idea, the highest MBC determined in Samsun soil having uniform precipitation throughout the year provided water requirement of soil microorganisms and led to organic matter accumulation. CO_2 production data was also confirmed with MBC values for Samsun. Close relation between MBC and soil organic carbon contents reported many times in the literature (Schnurer el al., 1985; Sparling et al., 1986; Franzluebbers et al., 1995; Okur et al., 2006). Moreover Hasebe et al. (1985) reported the highest MBC in organically fertilized soils. Organic fertilizer and green manure applications increased soil C, N and MBC contents as well as CO_2 production DHA and mineralization (Frazer et al., 1988; Bhardjaw and Datt, 1995). Results obtained from this research also represented that the HFA application as a part of organic matter increase CO_2, DHA and MBC.

Based on the results gathered, no doubt, HFA applications increased soil biological activity; however excessive doses diminishing soil biological parameters. Therefore, regional dose determination researches should be carried out to prevent unwanted circumstances caused by high rate HFA applications.

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RESEARCH ON THE IMPACT OF THE MORPHOLOGICAL VARIATION OF MINERAL FRAGMENTS ON SOIL HYDRAULIC PROPERTIES

Viorel FILER[1], Florian STĂTESCU[1], Madalin BODEA[1], Daniela RUSU[2], Florica DOROFTEI [2]

[1]"Gheorghe Asachi" Technical University, Mangeron Dumitru Str. 63, 770800, Iasi, Romania
[2]Institute of Macromolecular Chemistry "Petru Poni" Iasi, Romania

Corresponding author email: stef_vio2000@yahoo.com

Abstract

This paper aims to highlight the relationship between soil particles morphological (shape, size and surface area) and hydraulic properties (hydraulic conductivity - saturated and unsaturated and soil suction). Determination of morphological characteristics of soil particles was achieved by: a) size analysis and b) SEM microscopic analysis type. Determination of soil hydraulic properties was performed by laboratory methods for hydraulic conductivity was used the constant-head method (ks) and the falling head method (kθ), suction was determined using experimental plant which comprises sandbox, sand/kaolin box and pressure membrane apparatus.

Key words: *hydraulic conductivity, suction, particle size analysis, microscopic analysis.*

INTRODUCTION

According to classical literature soil can be defined as being a porous medium characterized by the existence of a very complicated system of grooves, paths and storages that allow transit and storage of different types of fluids. This description can help us in achieving an overview on how water and various chemicals move. This movement is due to the existence of two types of phases: the solid one (soil matrix) and the liquid one (soil solution) that is moving through the pores of the soil.

In most cases when leaching process occurs - highlighted by penetration of water into soil, soil permeability ranges. In a first stage the transport capacity is high and then begins to decline relatively rapidly until the soil or medium in which the movement of the water reaches saturation.

Since then the amount of water that is entering the soil and throughput certain section under a hydraulic gradient becomes constant.

The ingress of water when the soil is saturated is defined by filtration process and if the soil is unsaturated by infiltration action. These processes are governed by some properties of the two media characterized by their nature and composition. When referring to this aspect only the solid part of soil represented by soil matrix is taken into account. The matrix can be composed of mineral fragments with different morphological traits (size, shape and surface area).

Study on the impact of particle morphology variation on soil hydraulic proprieties plays a very important role when you want to highlight how the transport of water and various substances takes place. This is important in a lot of applications: hydrology, pedology, geotechnical etc. In the context of the issues mentioned above we can shed light on purpose of this paper represented by highlighting the relationship between variation in morphological characteristics of the mineral particles of the soil (size, surface area and typology of the porosity from the particle surface) and hydraulic properties (hydraulic conductivity - saturated and unsaturated and soil suction). The result of this study realized on soil samples collected from various depths between 0-80 cm (0-20 cm, 20-40 cm, 40-60 cm and 60-80 cm) from the research area Dancu - Iași (Figure 1.a) can provide some information about the hydrological regime of soil types that have different textures displayed on all four depths study.

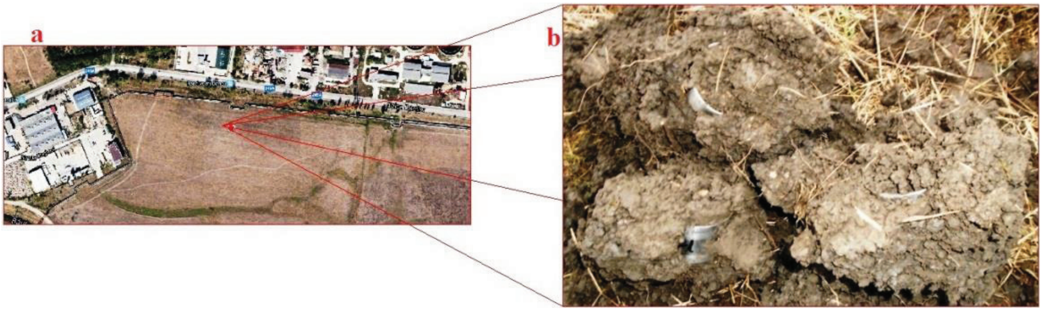

Figure 1. Presentation of the location study: a - zone of sampling soil; b - samples harvested

MATERIALS AND METHODS

All research was conducted on soil samples disturbed (stored in labeled bags) and undisturbed harvested (collected by the method of metallic cylinders with a volume of 100 cm^3) shown in Figure 1.b).

Highlighting soil particles morphology was achieved by: a) size analysis (Figure 2.1a) and SEM (Scanning Electron Microscope) microscopic type (Figure 2.1b).

Microscopic research was performed using scanning electron microscope Quanta 200, manufactured by FEI Company. All samples were analyzed in Low Vacuum, approximately 60 Pa to 20 Kv shown in Figure 2.1b).

The analysis of hydraulic characteristics of soil samples was achieved by the laboratory methods for hydraulic conductivity was the constant-head method (K_s) (Lungu, 2013) give us in Figure 2.2d and the falling head method (K_θ) (Stanciu and Lungu, 2006) presented in Figure 2.2e. Suction was determined on a value range between pF 0 and pF 4.2 using experimental plant comprising: sandbox (pF 0 - pF 1.8) remarked in Figure 2.2a, sand/kaolin box (pF 2 - pF 2.7) shown in Figure 2.2b and the pressure membrane apparatus (pF 3 - pF 4.2) noticed in Figure 2.2c (Dumitru, 2009).

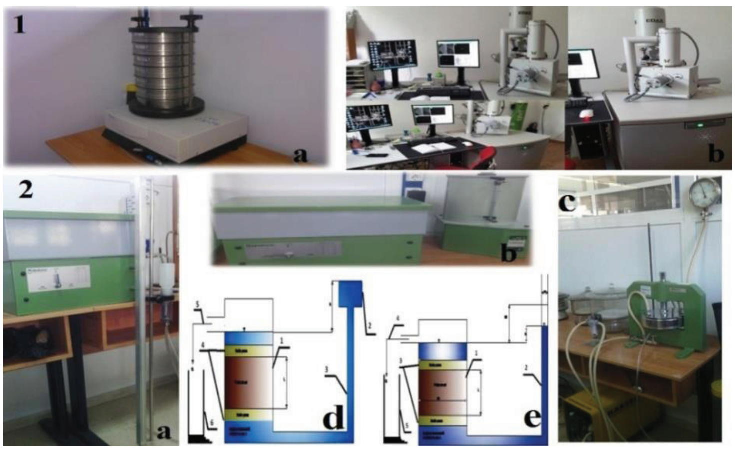

Figure 2. The apparatus used in research: 1: equipment used to analyze the morphology of mineral particles: a: shaker electromagnetic; b: equipment used in microscopic analysis SEM; 2: all equipment used in the study of hydraulic properties a: sandbox; b: sand/ kaolin box; c: pressure membrane apparatus; d: constant-head method; e: falling head method

CALCULATION PROCESS

Hydraulic conductivity Ks on vertical direction of the water flow is calculated from the relationship:

$$K = \frac{V * L}{T * A * h} \quad (1)$$

where:

V- volume of water collected;
L - length of the soil sample;
T - time for the collection volume of water (the excess);
A -cross-sectional area of the sample.

Unsaturated hydraulic conductivity values were enteritis with relation:

$$K = \frac{a * L}{T * A} * \ln\left(\frac{h_1}{h_2}\right) \quad (2)$$

where:

a - the cross -section of graduated tube;

L - length of the soil sample;
T - time for the collection volume of water (the excess);
A - cross-sectional area of the sample;
h_1 and h_2 - height of water column after a time T.

The dates of water retention curve in the soil were obtained using the relations 5:

$$W = \frac{\text{weight of soil water} \cdot 100\%}{\text{weight of soil}} \quad (3)$$

$$\rho_d = \frac{\text{dry soil weight (without ring,canvas)}}{\text{weight of soil}} \quad (4)$$

$$\theta = W \,.\, \rho_d \quad (5)$$

where:

θ - volumetric water content;
W - soil humidity;
ρ_d - bulk soil density.

RESULTS AND DISCUSSIONS

The results from the research have been pooled and stored in tables and figures.

Table 1 shows the values of the unsaturated hydraulic conductivity and in the 1 give us the values of two types of essential characteristics of our study. Thus in the first part of the table are presented morphological values that were studied by the methods mentioned in the previous section. In the second part of Table 2 are mentioned the values of satured hydraulic conductivity. SEM analysis results will be presented in Figure 3, which will be highlighted in the morphological characteristics of two soil mineral fragments for example: 1 mm and < 63 μm to 0-20 cm depth - the shape of fragment, the size and the particle surface area (done with AutoCAD 2007).

Table 1. Unsaturated hydraulic conductivity values

Kθ D 0-20 cm at 15 °C		Kθ D 20-40 cm at 15 °C		Kθ D 40-60 cm at 15 °C		Kθ D 60-80 cm at 15 °C	
ΔT	Kt (cm/s)	ΔT	Kt (cm/s)	ΔT (sec)	Kt (cm/s)	ΔT (sec)	Kt (cm/s)
2	0.139435	2	0.139435	2	0.139435	20	0.013943
11	0.026962	6	0.049431	9	0.032954	128	0.006105
16	0.019827	11	0.028840	15	0.021149	147	0.002408
22	0.015490	16	0.021299	19	0.017936	170	0.002256
27	0.013631	21	0.017526	24	0.015335	212	0.003032
33	0.012127	25	0.016008	30	0.013340	234	0.002071
38	0.011537	30	0.014614	36	0.012178	280	0.001302
43	0.011538	36	0.013461	40	0.012115	327	0.003139
49	0.011057	41	0.013214	48	0.011287		
55	0.011163	46	0.013348	53	0.011585		
62	0.011432	51	0.013898	59	0.012014		
67	0.012517	57	0.014713	66	0.012707		
74	0.013871	63	0.016292	73	0.014061		
The average	0.023891	The average	0.028621	The average	0.025084	The average	0.004282

Table 2. Results of the morphological analysis and hydraulic analyzsis

The study area	Depth harvest	Morphological properties				Hydraulic properties			
		Size composition		The surface area of the particle (mm^2)	The particle dimension P.D. (mm)	Suction (θ %)		Saturated hydraulic conductivity Ks (cm/s)	
		p (%)	µm			θ	pF	ΔT (sec)	Ks (cm/s) at 20 °C
		100	1000	8.023	3.3	52.21	0	2	0.139435
		44	500	5.286	2.43	51.32	0.4	8	0.037073
		15	250	0.143	0.507	50.44	1	13	0.024403
		9.5	125	0.244	0.192	48.67	1.5	21	0.016228
		4.5	63	0.0077	0.107	47.36	1.8	26	0.014155
		2	< 63	0.0012	0.04	46.9	2	32	0.012506
Dancu	0-20 cm					46.49	2.3	49	0.011537
						44.73	2.7	51	0.010769
						37.57	3	59	0.010406
						30.13	3.4	66	0.010739
						15.39	4.2		
								Average	0.027079
		100	1000	11.389	4.15	45.16	0	2	0.139435
		45.5	500	5.544	2.85	43.68	0.4	9	0.032954
		12	250	0.0711	0.343	43.54	1	14	0.022660
		7	125	0.015	0.161	41.93	1.5	18	0.018933
		3.5	63	0.0058	0.104	41.12	1.8	23	0.016002
		1	< 63	0.0019	0.47	39.51	2	27	0.014822
Dancu	20-40 cm					36.14	2.3	33	0.013285
						33.77	2.7	39	0.012425
						33.59	3	44	0.012313
						32.81	3.4	58	0.010586
						31.25	4.2	69	0.010272
								Average	0.027608
		100	1000	8.442	3.46	48.33	0	2	0.139435
		36	500	6.147	3.29	47.5	0.4	6	0.032954
		18	250	0.086	0.483	45.83	1	12	0.021149
		11	125	0.026	0.219	45	1.5	17	0.017936
		5	63	0.011	0.205	42.5	1.8	22	0.015335
Dancu	40-60 cm	2	< 63	0.0031	0.08	35.86	2	28	0.013340
						27.9	2.3	34	0.012178
						26.11	2.7	38	0.012115
						25.37	3	45	0.011287
						23.88	3.4	51	0.011585
						12.22	4.2	57	0.012014
								Average	0.139435
		100	1000	13.292	4.27	42.7	0	600	0.000464
		42	500	2.151	1.84	40.6	0.4	1080	0.000723
		35	250	0.061	0.303	37.5	1	2520	0.000723
		10	125	0.034	0.227	35.41	1.5	3240	0.000118
		8	63	0.0096	0.113	33.33	1.8	3720	0.000172
		5	< 63	0.0011	0.042	30.33	2	4500	0.000107
Dancu	60-80 cm					27.42	2.3	5640	0.000148
						24.78	2.7	6720	0.000152
						20.05	3		
						16.59	3.4		
						8.45	4.2		
								Average	0.000326

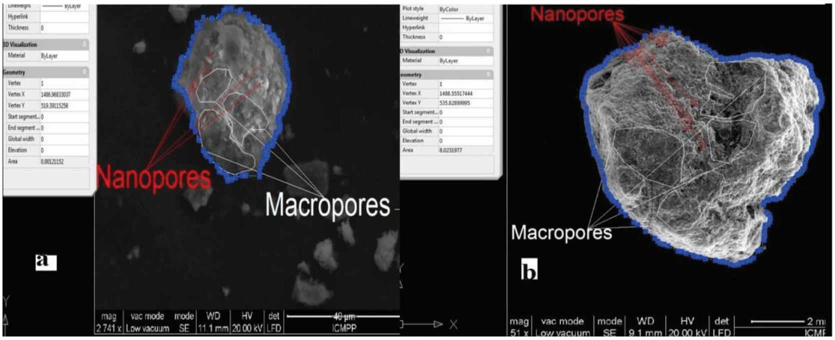

Figure 3. SEM image at 2741 and 51 x - morphological particularities of mineral fragments from Dancu 0-20 cm a: particle < 63 µm - specific surface area and particle size and distribution of soil particle pore surface. b) particle 1 mm - specific surface area and particle size and distribution of soil particle pore surface

In determining the change of soil hydraulic properties in the Dancu area only maximum and minimum of two types of pores were taken into acount: maximum macropores surface and minimum surface of nanopores. To determine the relationship between morphological characteristics associated to different sizes of particles that are in direct relation with pore system and saturated hydraulic conductivity, only nanopores characteristics were taken into account because they have a smaller carrying capacity. Macropores were used to calculate unsaturated hydraulic conductivity because they own a bigger transportation capacity.

This relationship is shown in Figures 4 and 5. In analyzing ties between the morphological characteristics associated particles of different fractions directly related to pore system that lies across the surface of their ability to note the water of mineral particles to focus only on two categories of pores (macropores and nanopores). Suction lowest (pF 0 - pF 2.0) thresholds were associated with macropores because they can store a higher amount compared to nanopores that can retain water volume much smaller at higher pF values (pF 2.3 - pF 4.2). This relationship between morphological characteristic of particle with different grains dimension (size) and soil suction is presented in Figures 6 and 7.

The values of morphological characteristics are shown in Tables 3 and 4 (done with AutoCAD 2007).

Table 3. Results of the morphological analysis for particles of different size fractions with macropores system

Dancu 0 - 80 cm	Fraction size	The surface area of the particles S.A of part. (mm^2)	The type of pores	The pore surface (max) P.S. (mm^2)	The pore dimension P.D. (mm)
D 0-20 cm	1 mm	8.023	Macropores	0.642	1.19
D 0-20 cm	500 µm	5.286	Macropores	0.156	0.547
D 0-20 cm	250 µm	0.143	Macropores	0.144	0.155
D 0-20 cm	125 µm	0.244	Macropores	0.00013	0.049
D 0-20 cm	63 µm	0.0077	Macropores	0.00033	0.026
D 0-20 cm	< 63 µm	0.0012	Macropores	0.00018	0.023
D 20-40 cm	1 mm	11.389	Macropores	1.037	1.551
D 20-40 cm	500 µm	5.544	Macropores	0.251	0.628
D 20-40 cm	250 µm	0.0711	Macropores	0.008	0.136
D 20-40 cm	125 µm	0.015	Macropores	0.0011	0.053
D 20-40 cm	63 µm	0.0058	Macropores	0.00028	0.024
D 20-40 cm	< 63 µm	0.0019	Macropores	0.00009	0.018
D 40-60 cm	1 mm	8.442	Macropores	0.762	1..29
D 40-60 cm	500 µm	6.147	Macropores	0.738	1..40
D 40-60 cm	250 µm	0.086	Macropores	0.346	0.984
D 40-60 cm	125 µm	0.026	Macropores	0.0014	0.060
D 40-60 cm	63 µm	0.011	Macropores	0.00058	0.042
D 40-60 cm	< 63 µm	0.0031	Macropores	0.00026	0.023
D 60-80 cm	1 mm	13.292	Macropores	1.068	2.057
D 60-80 cm	500 µm	2.151	Macropores	0.160	0.597
D 60-80 cm	250 µm	0.061	Macropores	0.0038	0.111
D 60-80 cm	125 µm	0.034	Macropores	0.0022	0.071
D 60-80 cm	63 µm	0.0096	Macropores	0.0014	0.060
D 60-80 cm	< 63 µm	0.0011	Macropores	0.0001	0.015

Table 4. Results of the morphological analysis for particles of different size fractions with nanopores system

Dancu 0 - 80 cm	Fraction size	The surface area of the particles S.A (mm^2)	The type of pores	The pore surface (min) P.S. (mm^2)	The pore dimension P.D. (mm)
D 0-20 cm	1 mm	8.023	Nanopores	0.00028	0.022
D 0-20 cm	500 µm	5.286	Nanopores	0.0002	0.019
D 0-20 cm	250 µm	0.143	Nanopores	0.000007	0.002
D 0-20 cm	125 µm	0.244	Nanopores	0.0000003	0.0009
D 0-20 cm	63 µm	0.0077	Nanopores	0.00000067	0.001
D 20-40 cm	1 mm	0.0012	Nanopores	0.0008	0.003
D 20-40 cm	500 µm	11.389	Nanopores	0.0005	0.028
D 20-40 cm	250 µm	5.544	Nanopores	0.0000052	0.003
D 20-40 cm	125 µm	0.0711	Nanopores	0.0000010	0.0014
D 20-40 cm	63 µm	0.015	Nanopores	0.00000073	0.001
D 40-60 cm	1 mm	0.0058	Nanopores	0.00007	0.014
D 40-60 cm	500 µm	0.0019	Nanopores	0.00004	0.014
D 40-60 cm	250 µm	8.442	Nanopores	0.00007	0.012
D 40-60 cm	125 µm	6.147	Nanopores	0.0000026	0.001
D 40-60 cm	63 µm	0.086	Nanopores	0.0000022	0.002
D 60-80 cm	1 mm	0.026	Nanopores	0.00012	0.017
D 60-80 cm	500 µm	0.011	Nanopores	0.00002	0.008
D 60-80 cm	250 µm	0.0031	Nanopores	0.000003	0.0031
D 60-80 cm	125 µm	13.292	Nanopores	0.0000019	0.0024
D 60-80 cm	63 µm	2.151	Nanopores	0.0000006	0.001

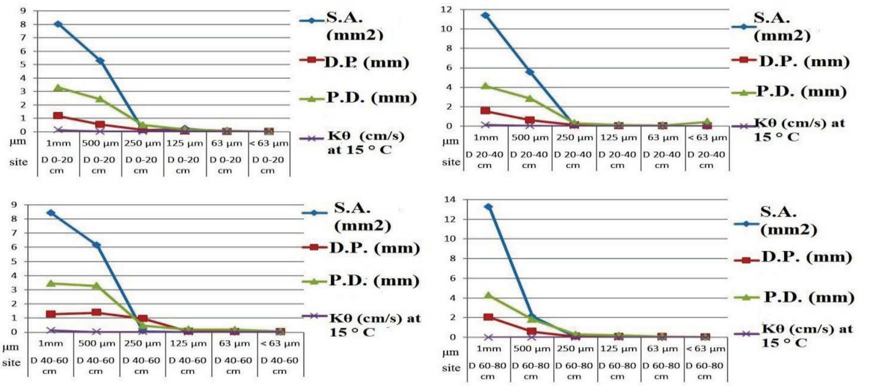

Figure 4. The relationship between morphological characteristics associated particle with different sizes and unsaturated hydraulic conductivity

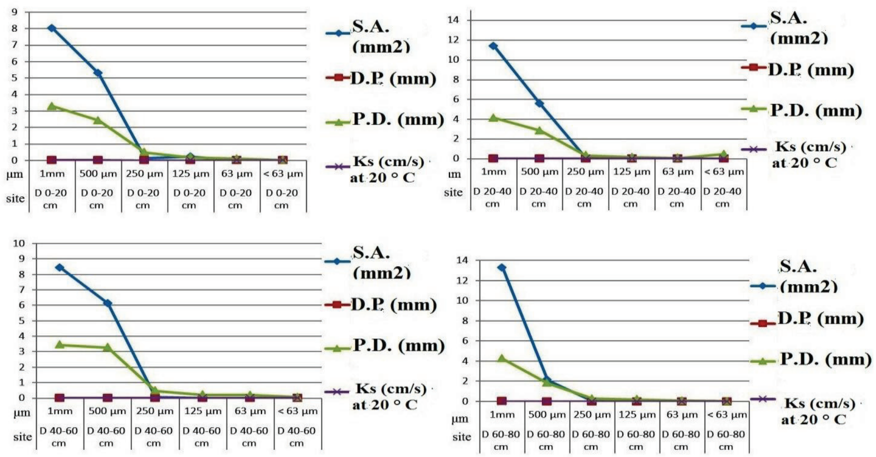

Figure 5. The relationship between morphological characteristics associated particle with different sizes and saturated hydraulic conductivity

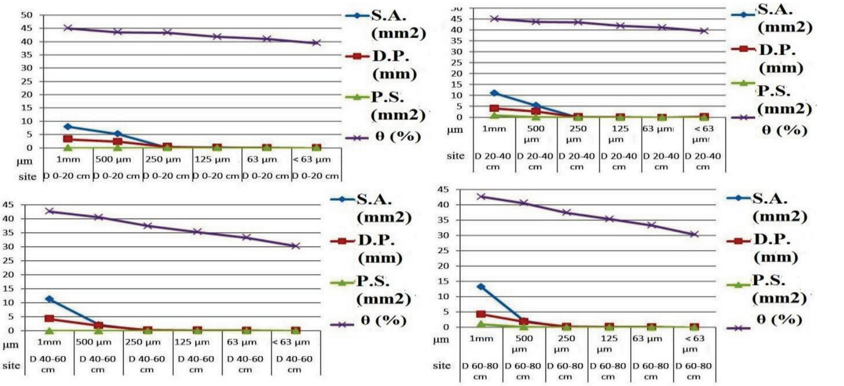

Figure 6. The relationship between morphological characteristic of particle with different sizes and soil suction (macropores)

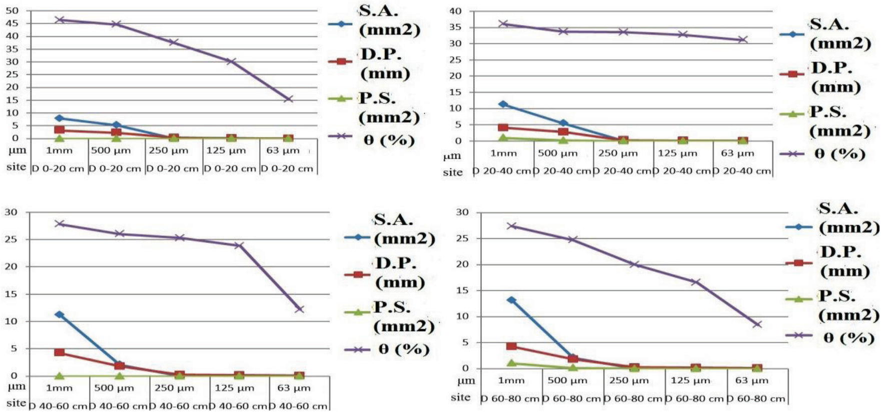

Figure 7. The relationship between morphological characteristic of particle with different sizes and soil suction (nanopores)

RESULTS INTERPRETATION

The results of size analysis can highlight a variation of the percentages corresponding to each particle size fractions in direct proportion with increasing depth of soil sampling analysis. Following the analysis of SEM type, we can achieve an overview on the morphological characteristics of soil particles for each particle size. The morphological characteristics of soil particles ranged in depth from six different particle sizes. If the surface of soil particles, it has changed depending on the size of granule fraction, decreasing in direct proportion to their size and the other features taken into account (pore size and pore surface).

One of the hydraulic properties - unsaturated hydraulic conductivity varied significantly from one depth to another. Saturated hydraulic conductivity recorded the lowest values in the case of D 60-80 cm depth compared to the other three. In the case of 0-20 cm and 20-40 cm depths the values have been differed very little. This difference can be attributed to relatively significant variation the contents of sand, dust and clay.

Unsaturated hydraulic conductivity was higher than those observed for saturated hydraulic conductivity evidenced in the comparative analysis of average values for the two types of conductivity. Thus for D 0-20 cm Kθ was slightly higher than D 40-60 cm, the same variation was observed for D 20-40 cm and D 60-80 cm latter being 80% lower than previous case where the percentage was much lower.

The suction soil analysis results showed a survey taken in distribution of water the contents was varieted from a harvest depths to another depths. As examples D 40-60 cm was higher in comparation with D 60-80 cm.

One difference was recorded for D 0-20 cm where the content has not decreased but increased. This change can be justified by a higher content of clay and silt found at 0-20 cm depth. The relationship between morphological characteristics of soil particles at different sizes and hydraulic properties of soil samples collected from the Dancu study area presented a real situation characterized by a change in water regime governed by a morphological variation (size, particle surface, pore size and pore surface) of mineral fragments that goes into the soil analyzed. Relating to all the above we can mention a similarity between D 20-40 cm and D 60-80 cm. The difference between D 0-20 cm and D 40-60 cm in this case is determined by the relationship between the morphological characteristics of the soil particles with different sizes and unsaturated hydraulic conductivity - shown in Figure 4. When you looked at the relationship between morphological characteristics of the soil particles at various dimensions and soil suction was considered, as in the case of hydraulic conductivity, only two kinds of pores (macropores and nanopores).

If it notices a decrease in the macropores water contents with decreasing values of morphological characteristics of mineral fragments.

Regarding the situation nanopores, it could highlight a change in the form of suction of curves for the four depths. The curve shapes change according to the size of each particle fraction retention, different size and surface.

Water contents fell as the two types of pore surface began to decrease depending on size fraction. As with hydraulic conductivity this relationship has changed from a depth to another.

CONCLUSIONS

The percentages variation of sand, silt and clay has exerted considerable changes in terms of ground water regime for Dancu harvested area, as evidenced in the case of each depths.

The results of SEM analysis type have been a dominant factor in determination of the relationship between morphological characteristics of soil particles with different sizes and analyzed soil hydraulic properties.

We emphasize that the relationship between morphological characteristics of soil particles with different sizes and hydraulic properties of soil samples collected from the Dancu study area presented a real situation, characterized by a change in water regime governed by morphological characteristics variation (size surface particles, pore size and pore surface) of mineral fragments that goes into the soil analyzed.

This study respect the conference theme in question through careful research of the main characteristics of the soil in the study, and the opportunity to highlight their influence on the regime of transport of various fluids regardless of the type and concentration, which can have a high impact on the speed leaching study characterized by a significant concentration and composition of various chemicals and their ability to be stored in the saturated and unsaturated soil - considereat as being a living environment without which our existence is not justified.

Regarding the influence of variation of soil hydraulic properties have studied according to the physical changes, in this case the distribution of sand content, silt and clay on the entire section analyzed (0-80 cm) can greatly influence on the soil by providing an development of the activities with favorable conditions for agriculture (Stătescu and Pavel, 2011).

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THE PEDOFUNCTIONAL FRAMEWORK FOR ENSURING ADAPTIVE-LANDSCAPE-AMELIORATIVE TECHNOLOGIES

Gheorghe JIGAU, Elena TOFAN

Moldova State University, 65 A, M. Kogalniceanu, Chisinau, Republic of Moldova, MD-2009

Corresponding author email: gheorghe.jigau@gmail.com

Abstract

The evolutionary trends of arable chernozems are determined as result of series of integrated agrogen processes with natural processes and typogenetic, and exodynamic (destructive) processes. In contrast to the natural processes, the agrogen does not bear a temporary character – cyclic, reversible but are unidirectional progressive over time. As consequences their intensification minimized the weight of natural processes, which leads to equilibrium disturbance between the components of agrolandscapes. Under these conditions establishing the natural trend of soil ecosystem functioning in its basic quality as agrolandscape can be achieved only within a new advanced type, adaptive-landscape-ameliorative agricultural systems.

Key words*: arable chernozems, agrogen processes, agrolandscape, natural trend.*

INTRODUCTION

According to recent evaluation over 80 per cent of arable chernozems are affected by 2-3 anthropogenic processes including destructuring, compaction, decreasing in humus content. Rapidly are extended surfaces affected by secondary over wetting in some periods of year. Practically all soil resources are affected by energetic and biologic degradation. Therefore, experienced effects in over cultivation chernozems materialized in reduction to minimum capacity of self-reproduction and self-regulation of soil ecosystem with involvement of aridization-desertification elements. Soils affected by specified processes practically are no longer responsive to agrotechnical and agrochemical applied measures. At the same time, it is only partially exploited agroclimatic potential of the landscape and the capacity of agroecosystems adaptation to drought and extreme temperatures. To the contrary increased vulnerability degree of agroecosystem to climate instability, for that crop remain fully dependent on climatic conditions.

Taking into consideration the mentioned, we can conclude that despite the material and financial efforts submitted, agricultural systems applied not only do not ensured enhancing of soil fertility, as was stated during the last 50-60 years but also have led to deregulation stability of landscape with damage to environment components. This implies the need to promote and implement new agricultural systems based on the harmonious combination of society's interest and laws of development.

MATERIALS AND METHODS

Methodological framework of some integrated technologies in the functioning mechanisms of landscape (ecosystems) is provided by the concept of sustainable agriculture that is based on sustaining the natural process of soil as the basis of landscape. From this perspective of ideas the sustainable use of soil resources is not conceivable without properly addressing landscape-ecological complex process of territorial organization to agricultural production and its management. The agricultural systems should be developed based on the legalities and fundamental principles of landscape functioning and are called to ensure the exclusion of disturbing risks of state and equilibrium of natural systems used in agriculture. This situation can be provided by adaptive-landscape agricultural systems. However, where quasi-equilibrium state is deregulated, should be practiced agricultural systems able to provide rehabilitation. Starting from the real state of soil resources used in agriculture, we consider that the concept of landscape adaptation is outdated.

The object of restoring the natural trend of soil ecosystem functioning in his basic quality as agrolandscape, can be achieved under a new more advanced type adaptive-landscape-ameliorative agricultural systems.

In accordance with the exhibited objectives which focus on the priority directions of sustainable management for soil resources are the:

- Rational correlation of objectives for the use of soil resources, including investment programs, with potential and capacity to sustain the natural capital (principle of adaptation);
- Anticipation of climate change effects and development of action plans for crisis generated by natural phenomena and anthropic.
- Ensuring food security, food safety and economic prosperity through harnessing the benefits of soil resources in Republic of Moldova, without compromising the need to maintain soil fertility, biodiversity conservation and environmental protection.

In developing the present paper have been used own research results and also materials obtained under soils evaluation investment for the purpose of implementation of adaptive-landscape-ameliorative technologies.

RESULTS AND DISCUSSIONS

The bioclimatic conditions of Republic of Moldova favors as priority achievement three typogenetic regional processes: the formation and accumulation of humus, structure and accumulation of carbonates. The contrasting characters determine the temperature regime at regional level, the argillic alteration which ensures the stability of soil particle size composition. Combining efficiently these processes in strict accordance with specific landscape conditions ensuring stability and enlarged reproduction, over time (at pedological scale) of the chernozem type pedogenesis. The large diversity of climatic and geomorphological conditions determines three levels of fertility and respectively, chernozems functioning under region (Tables 1, 2, and 3).

Along with natural typogenetic processes in the contemporary evolution of chernozems in region, these also are influenced by a series of agrogen and degradative processes (Table 4).

Synchronized development of natural processes with agrogen and degradative lead to diversification of pedogenetic regional process with involvement of several natural and anthropic evolution forms (Jigau, 2008; Lesanu and Jigau, 2012).

Table 1. The parameters of agrophysic structural-functional model of chernozems in the space between Prut and Nistru

Fertility factors	Normative for fertility levels		
	Reduced	Moderated	Increased
Aggregate composition:			
- Physic clay content (< 0.01 mm), %	15-30	30-45	45-60
- Fine clay content (< 0.001 mm), %	12-18	20-30	30-40
Microaggregate composition:			
- microaggregate content > 0.01 mm, %	65-70	70-82	>82
- clay peptizer content (< 0.001 mm), %	3-4	2-3	1-2
Structural composition:			
- aggregate composition 10-0.25 mm, %	65-70	70-80	>80
- aggregate stability (hydrostable aggregates > 0.25 mm), %	<40	40-60	>60
The coeficient of dispersion, %	25-40	15-25	<15
Degree of aggregation, %	50-65	65-80	>80
Coefficient of structure	<0.67	0.67-1.5	>1,5
Bulk density, g/cm^3	<1,0	1.0-1.1	1.1-1.3
Resistance to penetration, kg/cm^2	>50	26-50	<25

Table 2. The parameters of hydrophysic structural-functional model of chernozems in the space between Prut and Nistru

Fertility factors	Normative for fertility levels		
	Reduced	Moderated	Increased
The average permeability for 6 hours, mm/hour	<25	25-35	35-40
Field capacity for water, %, g/g	<25	25-30	<30
Total porosity, %	<50	50-55	55-65
Capacity for air, %	12-15	15-20	20-25
Conductive pore of moisture, % of total porosity	<40	40-55	55-65
Inaccessible water content, %, g/g	>13	11-13	<11
Reserves of productive water, layer 0-100 cm, mm	<180	180-200	>200

Table 3. The parameters of physic-chemical structural-functional model of chernozems in the space between Prut and Nistru

Fertility factors	Normative for fertility levels		
	Reduced	Moderated	Increased
Humus content in the horizon Am, %	<4	4-6	>6
Layer thickness of humus generating horizon (A+AB), cm	<60	60-80	>80
The reserve of humus t/ha, layer 0-100 cm	<350	350-500	>500
Ratio C:N in composition of humus	>13:1	10-13:1	10:1
Ratio Ca:Mg adsorbed in radicular layer	<10:1	10-13:1	13-14:1
Cacium content adsorbed, % of the cation exchange capacity	<70	70-80	>80
Degree of base saturation, %	<80	80-95	≈100
Content of mobile phosphorus, mg/100 g soil (annual crops)	1.6-3.0 (2.1-3.5)	3.1-4.5 (3.6-5.0)	4.1-5.0 (4.6-6.0)
Content of mobile phosphorus, mg/100 g soil (vineyards plantations)	3.1-4.5	4.6-6.0	6.1-8.0
Content of mobile phosphorus, mg/100 g soil (fruit plantation)	<3.0	3.0-4.0	>4.0
Exchangeable potassiun content, mg/100 g soil (annual crops)	10.1-20.0	20.1-30.1	30.1-40.0
Exchangeable potassiun content, mg/100 g soil (vineyards plantations)	8,1-12,0	12.1-18.0	18.1-25.0
Exchangeable potassiun content, mg/100 g soil (fruit plantation)	10.0-20.0	20.1-30.0	>30
Content type of mobile zinc, mg/kg	0.31-0.9	0.91-1.5	1.51-4.5
Content type of mobile copper, mg/kg	0.11-0.3	0.31-0.7	0.71-2.1
Content type of mobile manganese, mg/kg	15-25	25-40	40-80
Content type of boron manganese,, mg/kg	0.31-0.9	0.91-1.2	1.21-3.6
Adsorbed sodium content, % of total capacity of the cation exchange capacity	5-10	3-5	<3.0
pH	>7-8	7.2-7.8	6.8-7.2

Table 4. Contemporary evolutionary processes of chernozems in the Carpato-Danubiano-Pontic space

Class	Group	Elementary processes
Natural	Bioclimatic (typogenetic)	Formation and accumulation of humus Structuring Migration of carbonates
	Sinevolutionary	Eluvial, levigation, debasification, argilization
	Functional	Decomposition and synthesis of organic substances Decomposition and synthesis of minerals Biologic accumulation of biofile elements Differentiation of substances Haploidization
Agrogene	Morphoturbational	Stratification, compaction, destructuring, plagenization and slitization
	Turbational regime	Crusting, peptization, siltization (clogging), over wetting, aridization
	Functional turbational	Dehumification, depletion, exhuastion, overcultivation, pollution reduction / degradation of soil biota biodiversity
Degradative	Abrazional	Erosion Deflation (wind erosion)
	Destructive	Landslide and land subsidence Flooding Pedolit accumulation

Modifications specified are materialized in the noticeable morphologic modifications and morphogenetic as opposite to natural processes, the anthropogenic does not bear temporary character – cyclic reversible but are unidirectional progressive over time remaining effects are cumulated. In the early stages these are localized in the upper segment of profile. Thereafter extending in the lower horizons and certified across the active pedogenetic segment.

Therefore in agroecosystems (agrolandscapes) the pedogenetic ambiance is determined by the ratio between the impact of natural and anthropogenic factors. Last are materialized in processes (destructuring, compaction, crusting and clogging) leading to imbalance ratio between biotic and abiotic factors, respectively deregulation of structural-functional organization resulted in the formation of new types of functional profiles that do not have natural analogues (Table 5).

Table 5

Types of agrophysic profiles of chernozems in the anthropogenic pedogenesis

Types of agrophysic profiles	Depth, cm	Bulk density		Apparent porosity		Aeration prosity	
		g/cm^3	specification	%	specification	%	specification
Excessive	0-10	0.87	Unsatisfactory	76	Excessive	43	Excessive
loosening	10-20	0.91	Unsatisfactory	73	Excessive	39	Excessive
	20-30	1.02	Optimal	60	Excellent	31	Excessive
	30-40	1.07	Optimal	58	Excellent	28	Admissible
	50-60	1.14	Optimal	57	Excellent	24	Optimal
Loosening	0-10	1.02	Optimal	60	Excellent	30	Admissible
	10-20	1.07	Optimal	59	Excellent	30	Admissible
	20-30	1.03	Optimal	59	Excellent	29	Admissible
	30-40	1.17	Optimal	55	Excellent	23	Optimal
	50-60	1.14	Optimal	57	Excellent	23	Optimal
Epicompacted	0-10	1.52	Siltic	40	Extreme	14	Insufficient
(crust)	10-20	1.46	Consolidated		insufficient	13	Insufficient
	20-30	1.34	Critique	43	Insufficient	13	Insufficient
	30-40	1.21	Optimal	48	Insufficient	15	Sufficient
	50-60	1.15	Optimal	47	Insufficient	17	Sufficient
				56	Excellent		
Proxycompacted	0-10	1.24	Optimal	51	Sufficient	23	Optimal
	10-20	1.50	Slitic	41	Insufficient	13	Insufficient
	20-30	1.43	Unfavorable	44	Insufficient	13	Insufficient
	30-40	1.47	Consolidated	43	Insufficient	11	Insufficient
	50-60	1.19	Optimal	54	Sufficient	17	Insufficient
Mezocompacted	0-10	1.27	Optimal	51	Sufficient	20	Optimal
	10-20	1.27	Optimal	41	Sufficient	20	Optimal
	20-30	1.55	Slitic	40	Extreme	13	Insufficient
	30-40	1.21	Optimal		insufficient	16	Sufficient
	50-60	1.40	Critique	54	Sufficient	15	Sufficient
				47	Insufficient		
Baticompacted	0-10	1.08	Optimal	58	Excellent	37	Excessive
	10-20	1.22	Optimal	53	Sufficient	28	Admissible
	20-30	1.20	Optimal	54	Sufficient	26	Admissible
	30-40	1.24	Optimal	53	Sufficient	25	Optimal
	50-60	1.50	Slitic	43	Insufficient	14	Insufficient
	70-80	1.50	Slitic	40	Extreme	12	Insufficient
					insufficient		

In the excessively loosening profile are created favorable conditions for water storage. At the same time, excessive aeration porosity in 0-30 cm layer causing low capacity for useful water in the soil. As result in these soils with agrophysics profile the water scarcity and pedological drought under pedogenetic active layer is attested in the years with the natural atmospheric precipitation regime. Soils with agrophysics profile, epicompacted and proxycomapcted have low and very low water permeability. Consequently this store only about 40 % of precipitation that is why here is attested unsatisfactory water reserves (< 80 mm in the 0-100 cm) even at the beginning of vegetation period. However, in these conditions is forming poorly developed radicular systems.

Soils with mezocompact profile favor the development of a well-developed radicular system. The presence of slitic layer at the depth 20-30 cm causes the concentration of water, nutrients and plant roots in the first 20-30 cm. Thus in years with normal precipitation harvest are limited to the capacities of 0-30 cm segment. In dry years the pedologic drought in soils already occurs in June. In the soils with baticompacted agrophysics profile the edaphic volume is good. In the 0-50 cm layer is created normal conditions for radicular system development. However, excessive aeration porosity causes the losing party of the water reserves to physical evaporation. At the same time the presence of slitic layer in the middle segment of profile (50-60 cm) does not allow the water reserves and nutrients exploitation in the medium and lower segment of profile.

Table 6. Criteria for evaluating the degree of resistance

Nr.	Criteria for evaluating the agrolandscape			Specification
1.	BH ≥ 0 H ≥ 5 % GCN = 100% GCP = 100 % GCK = 100% Nm – raised K_2O ≥ 30 mg/100g P_2O_5 ≥ 4 mg/100g	CSC ≥ 30 me/100g pH – neutral, weakly basic Ca:Mg 9-10:1 Na me/100 g < 1 SA < 0.15-0.25 %	AAV>80 % DA = 1.1-1.38 g/cm^3 Ɛt = 55-65 % Ɛair = 15-25 % Ɛagr = 55-65 % Kstr > 1.5 AHS > 60 %	Anthropogenic pressures correspond to reproductive capacity of landscape. The agrolandscape stability constitutes about 100 %. Conservation measures are needed for landscape.
2.	BH < 0 H =4-5 % GCN ≥ 90% GCP ≥ 95 % GCK ≥ 80% K_2O = 25- 30 mg/100 g P_2O_5 = 3.3-3,4 mg/100g	Nm – moderated pH – weakly basic, basic Ca:Mg 7-9:1 Na me/100 g < 1 SA < 0.15-0.25 %	AAV=60-80 % DA = 1.3-1.4 g/cm^3 Ɛt = 50-55 % Ɛair = 25-30 % Ɛagr = 20-25 % Kstr = 1.0-1.5 AHS =50-60 %	Compliance degree of anthropogenic pressures and landscape capacity constitutes 90 %. Measures are needed to enhance soil organic matter content and system recovery of organic substances.
3.	BH < 0 H =3-4 % GCN ≥ 70% GCP ≥ 90 % GCK ≥ 70% K_2O = 15- 20 mg/100g P_2O_5 = 3-2.5 mg/100g	Nm – low CSC =20-25 me/100g pH – basic Ca:Mg 6-8:1 Na me/100 g < 1 SA < 0.3 %	AAV=50-60 % DA = 1.3-1.4 g/cm^3 Ɛt = 40-50 % Ɛair > 30 % Ɛagr < 20 % Kstr = 1.0-0.7 AHS =40-50 %	Compliance degree of anthropogenic pressures and landscape capacity constitutes 70 %. Measures are needed to enhance soil organic matter content and optimization of physics parameters.
4.	BH < 0 H =2-3 % GCN ≥ 70% GCP ≥ 80 % GCN ≥ 70% K_2O < 15 mg/100g P_2O_5<2 mg/100g	Nm – low CSC < 20 me pH ≥ 8,2 Ca:Mg =6:1 Na me/100 g < 1 SA < 0.3 %	AAV=30-40 % DA > 1.4-1.6 g/cm^3 Ɛt < 40 % Ɛair < 40 % Ɛagr < 20 % Kstr < 0.7 AHS =30-40 %	Evolutionary trend carries degradative character. Crop rotations are mandatory measure to ensure stability of agrolandscape.

BH – balance of humus, H – humus content in arable layer, %, GCN, GCP, GCK – compensation degree of nitrogen content (N), phosphorus content (P), potassium (K) in soil, K_2O – exchangeable potassium content in soil, mg/100 g soil, P_2O_5, - phosphorus content mg/100 g soil, CSC – cation exchange capacity, mg/100 g soil, Ca:Mg – ratio of the cations Ca and Mg in soil adsorbtive complex, pH – soil reaction, Na – sodium content in the soil adsorbtiv complex, me/100 g soil, SA – salt content slightly soluble, %; AAV – valuable agronomic aggregate content (0,25-10,0 mm), %, DA – bulk density, g/cm^3, Ɛt – total porosity, %; Ɛair – aeration porosity, %; Ɛagr – aggregate porosity, %; Kst – structuring coefficient; AHS – hydrostable aggregate content, %, Nm – mineralized nitrogen

Based on the above we find that practically all arable soils require improvement measures for their physic features and functionality in relation to environmental components through adaptation of adaptive-landscape-ameliorative technologies.

The concept involves two basic categories: adaptation potential for landscape and adaptive capacity of plants. The adaptation potential for landscape is the expression of relation soil ↔ environmental components materialized in fertility factors, chemical, physic-chemical, agrochemical and biological.

Adaptive capacity of crops involves their ability to model adaptation potential of landscape in accordance with their potential. In this regard adaptive-landscape-ameliorative agricultural technologies involve the identification of technological elements and crops capable not only to ensure yields in quantities and required quality but also ensure improvement relation of soil with environmental components under which is provided enlarged reproduction of bioproductive soil function.

Through this prism of ideas adaptive-landscape-ameliorative agricultural systems include:

- Complex evaluation of soil fertility factors, relief conditions, geological structure and microclimate for each fields separately. Identification of priorities and risk factors, and technological elements respectively.
- Selecting crops and their location in specific landscape condition.
- Differentiation of crop rotation in accordance with their ability to provide improvement of adaptive potential of landscape (Table 6).
- Crop rotation with minimal cultures (5) will be admitted only when the stability degree of agrolandscape constitutes more than 90% and that pressure from outside correspond to fully capacity of self-reproduction and self-regulation of landscape. In the second and third group agrolandscapes, number of crops included in the rotation will increase as the degree of stability is reduced below 70% of ameliorative crop rotations.
- Promotion of leguminous plants within all crop rotations recommended for specific landscape conditions
- Using the most suitable technologies economically and environmentally, introduction of criteria pedo and ecoefficiency in all agricultural activities
- Limiting to a minimum degradation processes. Emphases will be placed primarily on the exclusion of physical processes and erosion.

CONCLUSIONS

Sustainable management of soil resources under evolutionary trend, natural and anthropogenic conditions involves the need for a new paradigm of integrated processes and their management. Within this emphasis following to be placed on restoring equilibrium between agrolandscape components responsible for enlarged reproduction of soil as the basis of landscape. Achieving this objective involves promoting and implementing adaptive-landscape-ameliorative technologies.

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THE BASIC FRAMEWORK FOR CONCEPTUAL-METHODICAL BIOENERGY RESOURCES OF CHERNOZEMS

Gheorghe JIGAU, Ana BARSAN, Elena TOFAN

Moldova State University, 65 A, M. Kogalniceanu, Chisinau, Republic of Moldova, MD-2009

Corresponding author email: gheorghe.jigau@gmail.com

Abstract

Anthropization of chernozems pedogenesis process involved a stable trend of bioenergetic degradation in chernozems. Through the renaturation concept, self-restauration and self-regeneration processes of biorutinar systems, restauration of bioenergetic resources of chernozems involves a new paradigm for soil resources management in the integrated process of agricultural production.

***Key words**: chernozems, biorutinar systems, bioenergetic resources, soil resources management.*

INTRODUCTION

Through the concept of “biorutinar system of soil” organic matter provides the bridge between the living substance and abiotic and is materialized in biological functions and physical which ensuring optimal eco-pedogenetic ambience for the living organism in the soil. Management of soil resources is facing two major problems: climate change and bioenergetic soil degradation.

Climate changes involve modification of interaction between the pedogenetic, biologic and geomorphologic factors. Under circumstances when geological factor (parent rock) is not affected by climate change, the modification received only pedogenetic factor where is affected the active layer that involving the modification of direction and intensity of the pedogenesis processes. In natural regime specified implications are attenuated as the biological factor, due to adaptive capacity is more inert to these changes, a way as genetic-functional modification are slow and to a smaller extent are reflected on the functionality and stability of landscape.

Under anthropogenic pedogenesis the role of biologic factor in the landscape functioning is significantly reduced. This is reflected in the first line on typogentic processes: the formation and accumulation of humus, biogenic accumulation of chemical elements, especially those biofile, and structuring. These are materialized in the bioenergetic degradation of soil which involves dehumification, depletion and soil exhaustion, restructuring and degradation of pore space. In these conditions, the system losses accelerated the biorutinar ability to self-organization and self-restoration. Integrated index of these changes are the bioenergy resources.

Instead, in the anthropogenic pedogenesis significantly increases the role of geomorphological factor. As a result anthropogenic pedogenesis is controlled by the geomorphological and climatic factor. It is realized in the intensification of water and wind erosion, accelerated increasing of over-wetted surfaces in some periods of the year, aridization and intensification of pedogenetic active layer. All of this engage degradative trend to contemporary pedogenesis.

Under specified conditions the bioenergy resources of soil ecosystem are determined by a number of factors including:

- Drastic reduction in the quantity of organic debris framed in the pedogenesis processes as a result of biocenosis substitution with agrocenosis.
- Reducing to a minimum of the amount of biologically nitrogen available for framing in the process of humification, following the exclusion of leguminous in the crop structure and its replacement by mineral nitrogen.

- The intensification of the humus mineralization.

The last two processes are favored by the modification of airhydric regimes and oxidation-reduction through systematic performance of the agricultural work in the arable layer where lies organic debris, and the decomposition-transformation processes.

- Increasing processes of humus loss with water and wind erosion.
- Humus decomposition and biodegradation under the influence of mineral fertilizers and activation of microflora from the account of applied fertilizers.
- Reducing intensity of the formation processes and humus accumulation as a result of physical degradation of soils.

As a result in the soils of the region there is a stable trend of humus content reduction (Tables 1 and 2).

From Table 1 we noticed that decreasing humus content lead to stable increase of soil areas with a very low degree of humus assurance from the account of areas with high degree of assurance and relatively optimal. This leads to homogenization deterioration of agro-landscape soil functionality and reduced their bioproductivity.

Table 1. Surface dynamics with varying degrees of humus assurance within some pedogeographic district (% of district)

No. district	Predominant soils	Evaluation period	Degree of humus assurance				
			Very low	Low	Moderated	Optimal	High
1.	Gray soils, clay illuviated and levigated chernozems	I	0.5	23.3	63.6	10.1	2.5
		II	1.0	18.7	57.6	17.2	5.4
		III	1.6	14.1	51.6	24.3	8.4
		IV	1.8	13.3	41.2	35.6	1.1
		V	-	17.0	37.3	44.7	1.0
2.	Typical moderated humus chernozems	I	0.4	15.3	55.7	28.6	-
		II	1.5	13.4	47.6	40.3	7.2
		III	2.3	11.5	39.5	43.2	3.2
		IV	1.6	15.8	45.5	34.5	2.6
		V	1.6	11.0	46.5	38.9	2.0
10.	Typical moderated humus chernozems and levigated	I	-	18.8	54.6	26.6	-
		II	2.6	21.8	50.0	15.6	-
		III	4.6	24.9	55.4	15.1	-
		IV	10.2	40.2	41.8	4.8	-
		V	16.9	43.4	36.5	3.2	-
5.	Typical moderated humus chernozems and levigated	I	-	19.4	62.7	17.9	-
		II	8.3	29.1	50.1	12.5	-
		III	9.4	38.9	43.7	7.1	-
		IV	12.5	44.8	38.1	4.5	-
		V	13.6	34.9	47.6	3.9	-
9.	Levigated chernozems and clay illuviated and gray soils	I	-	22.7	55.8	21.5	-
		II	4.3	28.6	50.3	16.8	-
		III	9.0	35.0	43.9	12.1	-
		IV	8.5	36.2	45.3	9.8	-
		V	11.0	43.0	46.7	9.3	-
Sub district 11 a	Typical low humus chernozems	I	1.4	18.7	58.5	20.3	0.6
		II	4.2	19.3	53.2	21.9	1.3
		III	6.0	19.8	46.0	23.0	5.2
		IV	8.9	35.1	52.0	3.3	0.8
		V	8.1	30.9	56.5	4.5	-
Sub district 13 b	Carbonated chernozems	I	5.0	41.5	45.1	6.6	1.8
		II	20.0	42.0	30.1	6.3	1.6
		III	22.9	42.9	27.1	5.5	1.8
		IV	18.8	44.0	29.7	5.6	0.9
		V	19.4	51.5	28.0	1.0	-

Table 2. State and dynamics of humus content in the soils of agro-landscapes, % of period 1965-2013

Agricultural unit	No. flield	Predominant soils	Evalution period					
			I	II	III	IV	V	VI
AGROSFERA-BM (Parlita, Ungheni)	1	Typical siltic-clay chernozems	4.9	4.5	4.5	4.2	4.1	4.1
	2	Typical clay-siltic chernozems	5.1	4.7	4.6	4.4	4.1	4.1
	3	Typical siltic-clay chernozems with solonetzs areas	4.9	4.6	4.3	4.5	4.3	4.0
	4	Typical clay-siltic chernozems with eroded areas	3.8	3.4	3.0	3.1	3.0	2.9
	5	Typical siltic-clay chernozems with eroded areas	4.1	3.8	3.6	3.2	3.0	2.9
Vindex-Agro (Malaieşti, Orhei)	1	Typical siltic-clay chernozems	5.3	4.9	4.6	4.3	4.2	4.0
	2	Typical clayey chernozems	5.1	4.7	4.6	4.4	4.2	4.0
	3	Typical clayey chernozems	4.9	4.6	4.3	4.6	4.3	4.0
Podgoreni (Lingura, Cantemir)	1	Typical low humus chernozems low moderated eroded	3.6	3.3	2.9	3.1	3.0	2.9
	2	Typical low humus chernozems low eroded	3.9	3.6	3.4	3.1	3.0	3.0
	3	Typical low humus chernozems moderated eroded	2.8	2.4	2.1	2.0	1.9	1.9
	4	Typical low humus chernozems low moderated eroded	3.7	3.4	3.1	3.1	3.0	2.9
MAVIL-AGRO (Rujnita, Ocnita)	1	Typical chernozems clay-siltic	5.7	5.3	5.1	4.7	4.5	4.4
	2	Levigated chernozems siltic-clay	5.9	5.5	5.2	5.0	5.0	4.7
	3	Typical chernozems clay-siltic low moderated eroded	5.3	4.6	4.5	4.2	3.9	3.8

In this respect the data presented in Table 2 presents that even within agricultural units in which is practiced an efficient management of soil resources, humus content have reached the critical threshold (14 %) and in some cases present values below it.

The current state of soil cover and evolution trend involves the conclusion that agricultural systems practiced are not able to ensure the conservation and reproduction of bioenergy resources of soil although this objective it has been permanently targeted by agricultural policies and decision makers.

This implies the need for a new paradigm of soil resources management in the agricultural practices which involves reproduction of bioenergetics resources in the framework of integrated production process by supporting natural processes.

For the purpose of this paradigm in the framework of agricultural systems reproductive-resource emphasis is placed on the optimization of agro-landscape functionality (Figure 1).

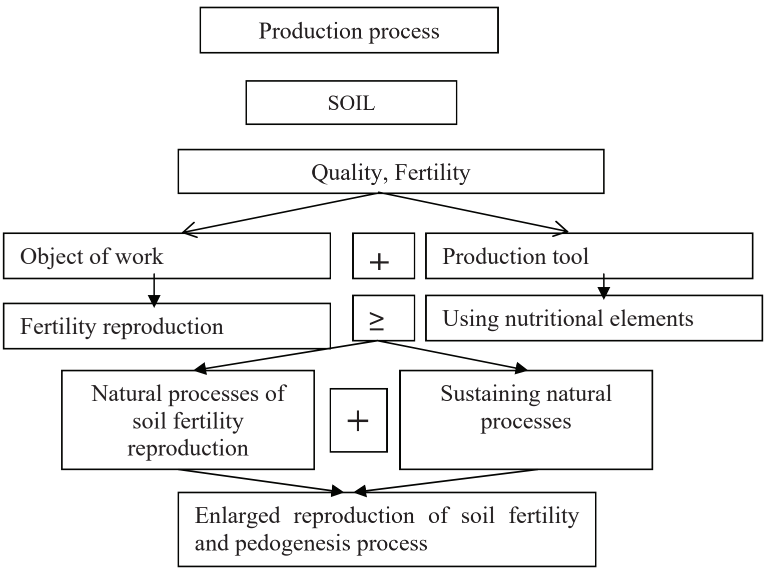

Figure 1. Paradigm of the soil fertility reproduction in the production process

Achieving the proposed objectives of the new paradigm involves:

- Measures oriented on accelerated accumulation of organic matter in soil.
- Measures focus on ensuring an optimal airhydric ambience and hydrothermal to conduct at formation processes and migration of humus.
- Ensure source of nitrogen necessary for the formation process of humus by framing mandatory legumes in cropping patterns.

At the present stage for development of the food market is appropriate that surface to compose about 30 % of the area with technical cultures and optimization of physical characteristics and regimes of agrogen layer in arable soils. For the purpose of technological components specified an essential element of resource-reproductive agricultural systems is their adaptation to the landscape conditions. The latest involves creating a report as close to natural quantity of crop residues deposited on the soil surface and deposited in the profile.

To achieve this objective it is very important to know the mechanism of the agro-landscape in each part and the structural adjustment of cultures and deposited in the profile.

MATERIALS AND METHODS

The conceptual methodological framework of this study is provided by adaptation and development of the renaturation concept and disturbed geosystems by stimulating the self-capacity and self-restoring capacity of biorutinar systems (Goleusov, 2012; Ursu, 2011; Burlacu, 2000).

Through this prism of ideas in its capacity as biorutinar system, soil is a special type of natural formation formed as a result of the interaction of biotic systems (biologic factor which represents an integrated system of external and internal biocenoses (soil biota)) and abiotic (climate, parent rock and relief) over time. In this respect biorutinar systems are natural-history formations formed in concrete conditions of landscape and include energetic-informational and physical structure.

Energetic-informational structure is the information carrier, concerning the conditions in which was formed and was performed development and evolution of biorutinar system. The physical structure implies a certain form of soil substance organization (structural-functional organization) in accordance with the concrete condition of landscape. In the biorutinar system structural-functional organization is the product of soil matter modeling (abiotic substance) by the biologic factor in accordance with own needs. Therefore structural-functional organization of biorutinar system corresponds to actual conditions but bears and footprint, features relict, materialized in previous stages. This implies the conclusion that certain energetic-functional structure carries the program of self-organization and self-restoration of biorutinar system.

Energetic-functional structure of soil ecosystem interaction is analog to neighboring structures changing with their modification and opposite influencing them. Modification of energetic-informational program in the development of soil biorutiar system can be determined by internal changes (pedofunctionl regimes) and external factors.

Thank to this fact in the pedogenetic rotation (cyclic) of biorutinar systems do not return to its initial state. For them is characteristic progression development. Through this prism of ideas anthropogenic modification is a response to the program's bioenergy deregulation of the biorutinar system by substituting biocenosis with agrocenosis and soil biota degradation.

Anthropogenesis in this regard represents transfer processes of biorutinar system from a structural-functional form to another. Its restoration in stability conditions through abiotic factor (mineral component) is possible only by restoring the bioenergetic component.

RESULTS AND DISCUSSIONS

The objective of the evolutionary renaturation process of soil biorutinar system is based on the "sustainable concept", concept which requires supporting natural processes and mechanisms of soil ecosystem functioning for the purpose to extend its reproduction, maintaining soil fertility at a high level and rigorous control for pest, pathology, weeds with moderate energy expenses, while maintaining a high level without disturbing the environment.

In this regard in a spirit of sustainable development concept of sustainable agriculture system include organic agriculture, biological agriculture and ecological agriculture systems. Among them preferentially in Moldova are used ecological systems, biological and integrated.

The dynamics monitoring of humus content in arable layer shows that in the period 2009-2015 there has been a slight tendency for increasing humus content.

In this regard, more pertinent are biological system which requires incorporation into soil organic debris, treating them with biological preparation which represents the fraction of labile humic substances resulting from the biohumus production and annual administration of 800 kg/ha. Under this system more efficient work system is superficial incorporation of organic matter to a depth 10-14 cm.

Furthermore superficial tillage system is the most effective and into other agricultural system monitored (Table 3). Notable perspectives offers and integrated agricultural system where the emphasis is placed on the reduction mechanical pressures on soil, management of water reserves and organic reserves. Under ecological system effects are mitigated as a consequence of the larger share of weeding in the crop structure.

Table 3. Dynamics of humus content in the 0-30 cm layer under various agro-technologies (typical moderated humus chernozems clay-siltic)

Agro-technologies	Tillage system	Humus content, %					
		2009		2012		2015	
		At the beginning of vegetation	At the end of vegetation	At the beginning of vegetation	At the end of vegetation	At the beginning of vegetation	At the end of vegetation
Conventional (control) (Cosnita, Dubasari)	Differential	4.18	4.09	4.15	4.09	4.16	4.07
	Deep loosening	4.10	4.02	4.07	4.03	4.11	4.06
	Plowing	4.08	4.01	4.04	4.00	4.10	4.02
	Superficial	4.21	4.11	4.17	4.12	4.17	4.13
Ecological (Cosernita, Criuleni)	Differential	4.20	4.16	4.17	4.14	4.21	4.13
	Deep loosening	4.12	4.09	4.13	4.06	4.13	4.04
	Plowing	4.18	4.12	4.17	4.14	4.20	4.11
	Superficial	4.23	4.18	4.20	4.16	4.21	4.16
Biological (Iurievca, Cimişlia)	Differential	4.36	4.32	4.38	4.35	4.40	4.35
	Deep loosening	4.20	4.03	4.18	4.04	4.20	4.08
	Plowing	4.21	4.00	4.18	4.02	4.16	4.00
	Superficial	4.53	4.49	4.47	4.38	4.56	4.47
Integrated (Parlita, Ungheni)	Differential	4.28	4.24	4.23	4.25	4.31	4.24
	Deep loosening	4.16	4.06	4.17	4.05	4.16	4.06
	Plowing	4.19	4.06	4.18	4.08	4.18	4.02
	Superficial	4.40	4.28	4.34	4.27	4.38	4.32

Monitoring the evolution process of bioenergy resources of typical moderated humus chernozem under various management technologies of soil and vegetal residues showed that in all variants in the first 4 years additions of organic matter were insignificant and were no big differences between the versions. Increasing organic matter reserves and their differentiation through the practiced system practically starts from the second crop rotation (after 4-5 years).

It draws attention the fact that organic matter content increases in the agricultural system practiced, first in the 0-30 cm layer, a phenomena probably caused by the concentration of crop plants root system in the first 0-30 cm from the surface (Table 4).

Accelerated restoration of organic matter reserves is supported entirely by increased reserves of fresh organic matter in soil in great extent by creating more favorable conditions for decomposition – transformation of organic substances accompanied by formation and accumulation of humus.

Table 4. Content and reserves of organic matter in typical moderated humus chernozem under different agricultural systems (average data) (SRL Civea-Agro, Edinet)

Tillage system	Soil layer, mm	Organic matter content, %	% reported to plowing version	Organic matter reserves t/ha
Plowing at various depths	0-10	3.81 ± 0.06	0	40.0
	10-20	3.74 ± 0.04	0	38.3
	20-30	3.71 ± 0.03	0	36.4
	30-40	3.63 ± 0.02	0	35.4
	40-50	3.31 ± 0.02	0	34.0
Mini-Till system reduced (9 year)	0-10	3.93 ± 0.06	+ 0.12	42.7
	10-20	3.87 ± 0.04	+ 0.13	41.3
	20-30	3.81 ± 0.04	+ 0.10	40.0
	30-40	3.65 ± 0.03	+ 0.02	35.8
	40-50	3.31 ± 0.02	0	34.0
Mini-Till system resource-conservative (9 year)	0-10	4.11 ± 0.13	+ 0.30	46.4
	10-20	4.07 ± 0.01	+ 0.33	44.8
	20-30	3.95 ± 0.06	+ 0.24	43.3
	30-40	3.62 ± 0.02	- 0.01	41.4
	40-50	3.31 ± 0.02	0	34.0
Mini-Till system resource-conservative (9 year)	0-10	4.60 ± 0.09	+ 0.79	50.9
	10-20	4.28 ± 0.09	+ 0.54	50.6
	20-30	4.26 ± 0.06	+ 0.55	50.4
	30-40	3.93 ± 0.06	+ 0.30	47.8
	40-50	3.68 ± 0.07	+ 0.37	44.2

Our research showed that evolution of indices of humus state synchronized with evolution of settlement indices (bulk density, total porosity) and soil regimes, expressed by water reserves and differential porosity. At the same time was established that the conditions of humus formation optimized with the following purposes: plowing < MiniTill resource-reproductive (adaptive – landscape – ameliorative technologies).

Within practiced technologies management of vegetal debris can be described through Figure 2 and Table 5 and 6. Through this prism of ideas impact of organic debris can be approved with the impact of livestock manure, this one being reduced only to arable layer.

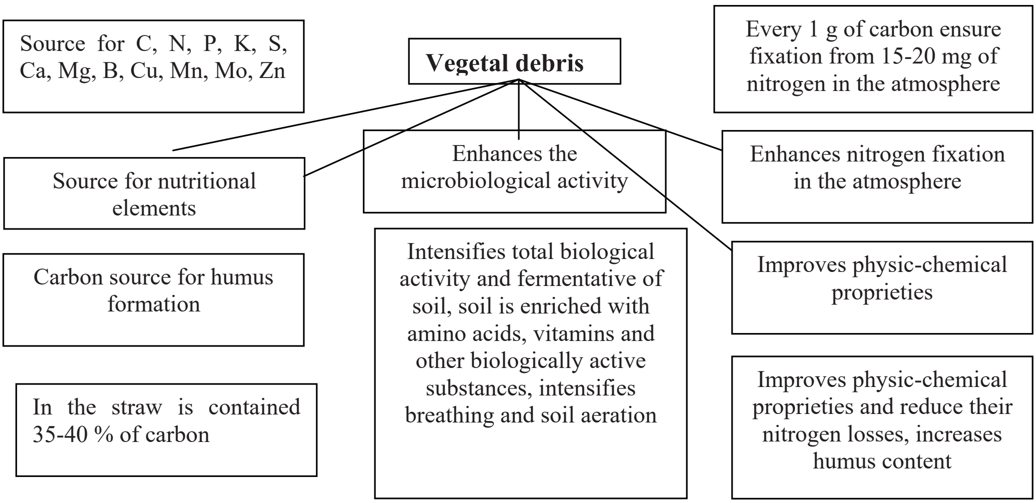

Figure 2. Management of organic waste into agricultural resource- reproductive practices

Table 5. Development stages of organic substances and soil biorutinar system in agricultural practices

Initial stage	Transition stage	Constitution stage	Stabilization stage
Reestablishment of structural aggregates	Enhancing soil bulk density	The large quantity of organic waste	Accelerated accumulation of organic debris
Low organic matter content	Increasing organic debris content	Increased coefficient of carbon content	Continuous variability of carbon and nitrogen content
Restoring biomass, soil microbiota	Enhancing phosphorus content	Increased coefficient of carbon content	Optimization of mobility degree and accessibility of water
Enhancing nitrogen content	Immobilization of nitrogen mineralization	Nitrogen immobilization, mineralization reduction, increased biological cycle of chemical elements, optimization and increase its volume	Circuit scale of nutritional substances, reducing nitrogen and phosphorus content
Time, year			
0 – 5	5 – 10	10 – 20	> 20

Table 6. Restoration stages of biorutinar system in agricultural practices and resource-reproductive

Nr.	Restoration elements	Restoration effect of biorutinar system
1.	Enhancing organic matter content in soil	Reestablishment and enhancing of biological diversity of soil biota, reestablishment of transformation processes and decomposition of organic waste, restoring biogeochemical substances in the pedogenesis, restoring organic matter in soil and ecological reconstruction of pedogenetic processes, a better exploitation, retention and conservation of water in the soil, reducing vulnerability to drought.
2.	Restoration of biogeocenotic functions and development of biodiversity	Porous space optimization, increasing number of animals, plants and microorganism, maintaining a healthy soil and soil fauna, formation processes intensification and humus accumulation, enhancing volume of biogeochemical circuits, processes intensification and biogenic accumulation of biofile elements, restoration capacity of soil biota.
3.	Restoration of ecological functions of soil ecosystem, greening the production process.	Restoration of physical, biological and chemical functions of organic substances system of soil, restoration of soil biogeocenotic functions, pedofunctional optimization of regimes (pedogenetic regimes), optimization of health state of agroecosystems (reducing the revegetation, reduction of risks and vulnerability to pest and diseases), enlarged reproduction of chernozems pedogenesis process.

In the reproductive resources practices which entails the establishment of bioenergy resources of the soil is important to ensure the system operation of organic substances throughout the profile. This requires restoration of soil biorutinar system of the entire thickness of the active pedogenetic layer which providing a humus profile progressive accumulative.

Achieving this goal is possible by providing free migration of mobile humic substances in similar hydro-physical activities but imply the rotation of root system. This implies the inclusion of crops with deep root system (rapeseed, sunflower and maize) in the structure of crop and field occupied that include perennial grasses, intercropping and crop intermediate depending on the concrete landscape condition.

CONCLUSIONS

In conditions of synchronized evolution of pedogenetic factors and the internal functioning of soil biorutinar system, the objective of enlarged reproduction of bioenergy resources of it and restoration capacity of self-regulation and self-organization, required a new paradigm of soil management resources within agricultural resource-reproductive systems.

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THE INFLUENCE OF SOIL TILLAGE ON THE TEXTURE OF CHERNOZEM CAMBIC FROM MOLDOVA

Corina LEAH

Institute of Soil Science, Agrochemistry and Soil Protection “Nicolae Dimo”,
100 Ialoveni str, 2070 Chisinau

Corresponding author email: leah.corina@gmail.com

Abstract

The paper aimed to present the some aspects on changing the pedomorphological and physical indicators of upper profile of cambic chernozem under soil tillage in a period of 60 years. Soil tillage have directly influence on the size composition of it’s, both arable layer and in the immediate vicinity layer. Content of 1.0-0.05 mm fraction in the horizon A of fallow soil is 2.2 times higher, in horizon B - 2.5 times higher, than in arable soil. Cambic chernozem from forest belt in the fallow condition has remediated the original textural properties within a period of 60 years. Using in the arable the tillage of chernozem cambic led to argillisation of upper layer. Content of fraction <0.01 mm constitutes in the horizon A - 60.2%, in horizon B - 59.7%. Soil texture is a quality virtually unchanged, so agricultural and reclamation technologies must adapt to the textural specifics of soils. Role of the soil texture is apparent from the characterization of particle size fractions.

***Key words**: arable, cambic chernozems, follow, physical properties, tillage.*

INTRODUCTION

Intensive farming of the land results in land degradation and reduction of soil production capacity. Soil tillage has the greatest influence on its physical properties. Tillage applied to the soil causing mechanical damage of soil structure and priority of macro-aggregates, which leads to changing in the volume of solid faze and porous space, which involves changing in the water and heat systems and finally on their chemical and biological properties (Budoi and Penescu, 1996).
In Republic of Moldova the soil tillage conventional system based on annual ploughing had the effect of decreasing the content and reserves of humus, through intensification of organic matter mineralization, due to increasing macro porosity of soil arable layer, reducing hydro stability of structural aggregates, increasing vulnerability to degradation by soil compaction, erosion etc. (Cerbari, 2011).

MATERIALS AND METHODS

The research was conducted on experimental fields of Institute of Soil Science, Agrochemistry and Soil Protection "Nicolae Dimo", located within the village Ivancea, district Orhei, Central zone of Moldova.
The study objects: chernozems cambic (leachate): I - fallow soil for 60 years (forest strip); II - arable soil, used under field crops.
In performing the research were used approved methods for conducting study in the field and laboratory. Description of soil profiles were made based on the pedomorphological indicators approved by methodology of pedological studies.

RESULTS AND DISCUSSIONS

Cambic chernozems from central part of Moldova are polygenetic soils of origin. Arable cambic chernozems were formed by the following pedogenesis phases: under forest vegetation → under steppe vegetation during the great migrations of people → under ploughing since 1850. In the soil forming phase under forest vegetation the combination of eluvial-illuvial process of clay migration with alteration process *"in situ"* of mineral part of these soils, led to the textural differentiation of their profile (Cerbari, 2010).
Contemporary arable cambic chernozems of Central Moldova inherited from the pedogenesis stage influenced by forest

vegetation a textural differentiated profile, with high content of fine clay with predominantly colloidal fraction. In terms of the existing system of agriculture these soils have undergone to intensive dehumification and accelerated destructuration of arable layer.

High content of clay, humus content reduction and structure deterioration have accelerated the secondary compaction of arable layer. Non fertilization of cambic chernozems with organic fertilizers, inadequate use of fertilizers, strong secondary compaction of arable layer leads to decreasing in their production capacity.

In order to study comparative physical properties of cambic chernozem fallow and arable were placed two soil profiles. Period of 60 years is sufficient to restore the initial parameters of chernozems properties under steppe vegetation in the forest belts in terms of not using of grassy vegetation air mass (Cerbari, Balan, 2010).

Profile I. Cambic Chernozem clay-loamy, fallow. At the foundation of forest strips the soil was sloppy. The horizons Ahb1 and Ahb2 were formed on the basis of soil material of former arable layer, buried by sloppy at the depth of 25-60 cm. Soil performed on loess clay-loamy deposits of alluvial Pliocene-Pleistocene rocks deeper than 130 cm. Carbonates is leached from soil profile until BCk horizon, depth of 95 cm. Cambic chernozem clay-loamy, fallow 60 years, has the type of profile: Ahţ1→Ahţ2→Ahb1→Ahb2 →Bhw1→Bhw2→ BCk1→BCk2→Ck.

Profile II. Cambic Chernozem loamy-clay, arable. Profile of arable chernozem was located on the experimental field. In the 2014 on the field was sown winter wheat. After harvesting the soil was performed stubble disking at the 8-12 cm depth (agronomic operation to perform stubble-turning). Cambic arable chernozem is characterized by the profile type: Ahp1→Ahp2 →Ahb1 → Bhb2 → Bhw1 → Bhw2→BCk1→ BCk2→C. The thickness of the genetic horizons of the studied profiles is shown in Figure 1.

Soil texture. Findings of the structure is made taking into account the structural aggregates shape, their size and the structuring degree of the soil mass. Structure formation process is long and complex and is going under the action of various factors, and de-structuring process takes place under the anthropogenic influence.

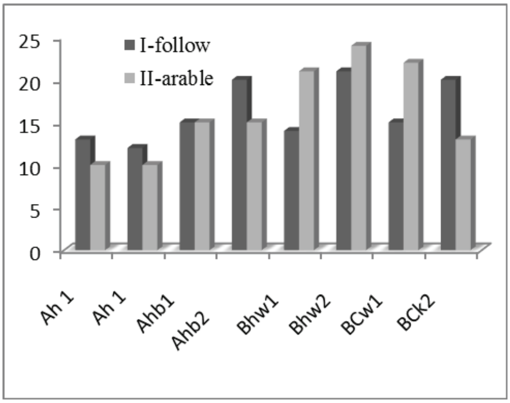

Figure 1. The thickness of the soil genetic horizons

Fallow cambic chernozem is characterized with clay-loamy texture throughout the whole profile and cambic process pronunciation in the horizons Bhw1 and Bhw2. The content of the physical clay on the soil profile ranges from 51% in the fallow layer, up to 55% in the cambic horizons and clay content at the same time - from 35% to 38%.

As a result of soil sloppy 60 years ago to the founding of forest belt, the horizon Ahp of former arable soil was buried at 25-40 cm depth, and at the land surface was removed horizon Bhw, weakly humiferous, brown colour and nuts-prismatic structure. Soil being fallow over a period of 60 years, under the influence of herbaceous vegetation has evolved in the direction of restoring the state's initial grubbing according to texture.

Arable cambic chernozems have a loamy-clay texture, the physical clay content in the humiferous profile - 60-61%, in the BC and C horizons - 56-58%. The clay content in the horizons A and B ranges between 39-40%, in BC and C - within 56-57% (Table 1).

Argillisation is a translocation process, which consists of enriching the horizon with clay formed "*in situ*" by altering the silicates primary and formation the secondary silicates or clay minerals. This process is characteristic of soils formed in the sylvo-steppe zone or forest area. From this process forms the cambic horizon, noted B.

Clay has the main role in the formation of a significant number of physical and chemical properties of soil. First, the clay content, plus the humus depends on water adsorption, cation exchange and nutrients, adhesion, plasticity, shrinkage and swelling.

Coefficient of argillisation of soil is the ratio of physical clay (<0,001) content in genetic horizons and parental rock (Крупеников, Скрябина, 1976). The coefficient of argillisation is presented in the Figure 2.

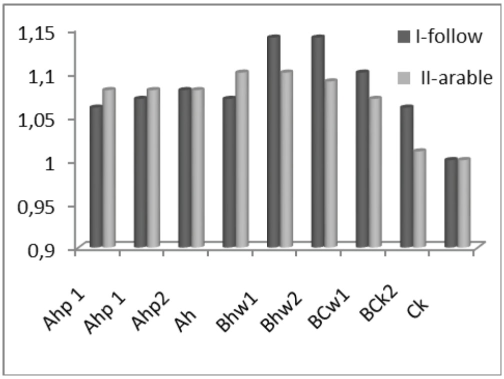

Figure 2. Coefficient of argillisation of soils

Argillisation of the upper part of these profiles is due to changes of hydrothermal regime of soils after grubbing and agricultural using in the arable land.

Texture as the main physical feature of soil plays an important role in determining of the most physical and chemical properties (Canarache, 1999). The production capacity depends on the size composition of the soil's characteristics, agronomic and ameliorative properties, and higher recovery technology. Soil texture is a quality virtually unchanged, so agricultural and ameliorative technologies will be must adapt to the textural specifics of soil. Role of texture is apparent from the characterization of particle size fractions (Canarache, 1990).

Investigated chernozems, as mentioned, are characterized by high content of fine clay which, under the processes of dehumification and destructuration of their arable layer is arranged to strong secondary compaction. Cambic chernozem compaction is a process caused by anthropogenic causes, after which greatly increases the apparent density, the total porosity and respiration indicator falls below normal values (Cerbari, 2010).

Table 1. Texture of cambic chernozems, fallow and arable

Horizon and depth, cm	Size fractions, mm; content, % g/g						
	1.0-0.25	1.0-0.05	0.05-0.01	0.01-0.005	0.005-0.001	<0.001	<0.01
Profile I. Chernozem cambic clay-loamy, fallow							
Ahţ 1 0-13	0.4	13.4	35.6	4.9	10.5	35.2	50.6
Ahţ 2 13-25	0.6	14.6	33.2	5.3	10.8	35.5	51.6
Ahb1 25-40	0.6	14.5	32.4	6.5	10.4	35.6	52.5
Ahb2 40-60	0.5	14.2	32.2	6.8	10.3	35.5	52.6
Bhw1 60-74	0.4	14.4	30.9	6.4	10.1	37.8	54.3
Bhw2 74-95	0.4	12.3	32.1	7.1	10.3	37.8	55.2
BCk1 95-110	0.5	11.9	32.5	7.7	10.9	36.5	56.1
BCk2 110-130	0.3	11.6	32.0	7.3	13.6	35.2	56.1
Ck 130-150	0.4	12.4	32.2	6.3	15.6	33.1	55.0
Profile II. Chernozem cambic loamy-clay, arable							
Ahp 1 0-10	0.7	5.1	34.0	7.5	13.5	39.2	60.2
Ahp 2 10-20	0.7	6.9	32.2	7.6	13.6	39.0	60.2
Ahp1 20-35	0.8	6.8	32.0	7.8	13.4	39.2	60.4
Ahp2 35-50	0.5	6.7	32.8	7.1	13.2	39.7	60.0
Bhw1 50-71	0.4	7.4	32.1	8.4	11.9	39.8	60.1
Bhw2 71-95	0.6	5.6	33.6	8.3	12.4	39.5	60.2
BCk1 95-117	0.5	5.1	36.0	7.7	12.0	38.7	58.4
BCk2 117-130	0.5	5.0	38.1	7.4	12.4	36.6	56.4
Ck 130-150	0.5	5.1	38.3	7.5	12.5	36.1	56.1

The main cause of the decrease the resistance to compaction of arable layer of investigated cambic chernozem is insufficiently flow of organic matter in the soil. Along 25 years in agricultural soils the organic fertilizers have not been applied. The quantities of chemical fertilizers used to fertilize crops, are small and do not provide a equilibrated balance of nutrients in the soils. Secondary production from harvesting crops usually not incorporated into the soil or used for other purposes and burned on the fields.

The clay-loamy and clay soils is characterized by large and very large amounts of inaccessible water, mechanical and thermal properties less favorable, have great capacity for swelling and shrinkage, but have favorable chemical properties (cationic exchange capacity, high buffering and humus content). Other features of these soils vary considerably depending on their structural status.

The production capacity of soils with fine textures, depending on the circumstances described above, varies generally, from medium to small. These soils must be worked in optimal epoch, which is short, are generally receptive to deep tillage, seedbed required quality is achieved with greater difficulty than other soils. Hence, that arable cambic chernozems researched are a means of production in agriculture fairly difficulties.

A long-term favorable state of the physical quality of the soil arable layer can be created by a permanent flow of organic matter in degraded soils and creating a system of minimal tillage.

CONCLUSIONS

The degradation process of soil structure affects mainly the upper horizon, the one used for agricultural cultivation. Degradation occurs mechanically by tillage, influencing some morphological and physical properties. The tillage layer 0-35 cm of arable cambic chernozem on the experimental field, under the action of the soil tillage and other human activity has degraded over a period of 60 years; the structure was destroyed, the resistance for compaction was lost.

The measures that can be taken regarding degradation properties of soils counteract the negative effects of different agricultural practices. The most used measures to improve the soil texture are agricultural tillage at optimal humidity, remediation of degraded physical properties, and application of mineral and organic fertilizers, combating degradation processes of arable soils.

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GRASSLANDS OF MOLDOVA: QUALITY STATUS, VULNERABILITY TO ANTHROPOGENIC FACTORS AND ADAPTATION MEASURES

Tamara LEAH

"Nicolae Dimo" Institute of Soil Science, Agrochemistry and Soil Protection,
100 Ialoveni Str., MD-2070, Chisinau, Republic of Moldova

Corresponding author email: tamaraleah09@gmail.com

Abstract

The paper aimed to present the evolution and quality state of grasslands, pastures and hayfields in Republic of Moldova. Pastures and hayfields are considered the most vulnerable ecosystems to climatic conditions and anthropogenic factors. Their share is 10% of the country territory. Quality status of grasslands is unsatisfactory, being influenced by anthropogenic factors: overgrazing, erosion and landslides, salinization and waterlogging. During 2000-2015 the surface hayfields decreased by 1.6 thousand hectares, which are plowing. Pasture areas tends to increase, thus increasing the expense of uncultivated and abandoned land. The main cause that led to pasture degradation is the way to use - now they are not privatized, not have a stable surface, the animal grazing is not regulated. Vulnerability is directly proportional to soil degradation factors and natural conditions. Existing adaptive measures are concentrated in combating erosion processes and increasing soils fertility, therefore, planning and implementation of adaptation measures in the agricultural sector must be addressed and while referring to grasslands and pastures.

Key words: *grassland, pastures, hayfields, degradation, Republic of Moldova.*

INTRODUCTION

The grasslands are agricultural areas of pastures and hayfields, natural or cultured, used for the grass production or other herbaceous forage that have not been included for at least five years in the system of crop rotation and used for grazing and feed production, in compliance with good agricultural and environmental conditions. The grasslands, pastures and hayfields are considered natural ecosystems and dominant elements of the rural environment with greater biodiversity than cultivated areas, especially if they are as natural ecosystem (Dumitrescu, 1996).

In the past, grasslands occupied 80% of the current territory of Moldova. The grubbing-up of areas occupied by grasslands was performed gradually, but very accelerated after 1822. Towards 1861 the steppes and water-meadows area was reduced to 61% of the territory (890 thousand ha), over 26 years - in 1887 the area covered with perennial herbaceous vegetation amounted 444 thousand ha (Postolache, 1995). In Moldova, these ecosystems are currently a small percentage - 10% of the territory or 384 thousand ha (Cadastrul Funciar, 2015). This is due to anthropogenic factors of land degradation and climate change condition that affecting the most vulnerable ecosystems.

The main forms of land degradation used as grasslands are erosion processes, overgrazing, excessive humidity, landslides, salinization, and alkalization etc.

Climate change has a serious impact on pastures and meadows, manifested by changes in the environment (soil quality and herbs productivity, biodiversity of pastoral vegetation and animals); by changes in livestock (feed resources and areas of vegetation spread, reducing forage yields and vegetation period, reducing animals nutrition and productivity); by changes on the socio-economic sector (production and food security, changes driven productivity, changes in land use, water availability and quality, reduction of recreation land and quality of agricultural land etc.).

MATERIALS AND METHODS

In order to characterize the evolution of grasslands surface and degree of degradation, the following indicators were used: surface in different period, quantity of feed productivity, most anthropogenic factors influence their quality, adaptation measures. The data have been analyzed and interpreted in this work.

RESULTS AND DISCUSSIONS

The grasslands, pastures and hayfields in Moldova are considered vulnerable areas on whose territory systematic indicators are exceeded environmental quality versus standardized rules, causing serious damage to the state's environment with consequences. Worldwide permanent grassland occupies an area of 2 times the arable land. In the Republic of Moldova the surface of grasslands is approximately 5 times lower than plowing area, their share is 10% of the country territory (Figure 1).

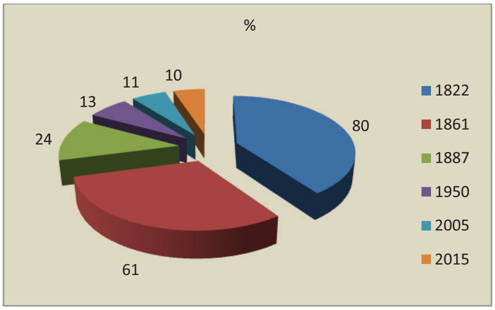

Figure 1. The share of grasslands in Moldova

In the last 25 years the area of grasslands has increased at the expense of arable land left as fallow or abandoned plots (Figure 2).

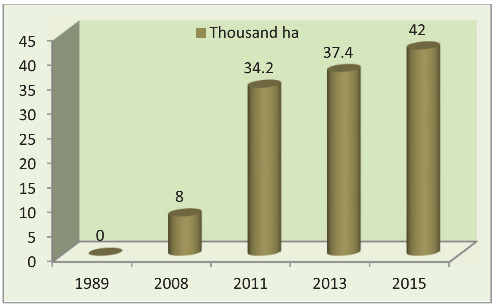

Figure 2. The surface of areas set aside in Moldova

Up to now, in Moldova have been preserved 1200 natural grassland areas. Surface sectors ranges between 0.3 ha and 300 ha. These are hayfields on the strongly abrupt slopes, where cannot be worked with agricultural machines, as well as those on the low lands with excessive water regime, caused by flood or superficial level of groundwater (Rusu, 2003).

Throughout the exploitation period, just as today, on the natural grasslands not apply even the most basic maintenance measures. The grasslands are used from early spring to late autumn with a large number of animals, in good and bad weather. As a result, the productivity of grasslands decreases from year to year, the vegetation degradation occurs. The species with high nutritional value and high productivity progressively evolves species with low feed value that less is required of animals. On the slopes during dry periods is completed with a pronounced soil moisture deficit and those with heavy rain - with erosion damage to vegetation and soil cover (Program, 2001).

Yields of grasslands on the slopes are small and of poor quality and consists 400-600 kg/ha of hay. Productivity of meadows is higher - 2000-2600 kg/ha of hay. But considering the high fertility of floodplain soils and good water plant supply, it is considered that the productive potential of meadows is about 20,000 kg/ha of hay. So the actual conditions of exploitation of this potential capacity use are only 10% of hay.

The natural grasslands in Moldova give only about 5% of the quantity of forage needed for the maintenance of the country's livestock. The US provides 33% of the forage grasslands and Romania over 50% (Rusu, 2003).

As a result of ignoring the role of natural grasslands in Moldova the mostly fodder produced on the arable land which now occupies more than 170 thousand hectares or 10% of arable land. But annual forage crops, due lack of more fully possible use of ground water reserves, forming 20-40% lower yields than perennial grasses (Rusu, 2003).

Thus, forage annual plants cannot serve as alternative perennial grasses. It is necessary to revisit attitude toward rational grasslands and use their high production potential, due to the long period of vast biological activity and plasticity to the climatic conditions.

Good agricultural practice, with economic and environmental reasons is the development of controlled grazing animals in summer the henhouse and providing wintering in their farms, with natural multiflora herbs (hay) as basic food (Simota, 2014).

The area of pastures and hayfields is growing (Figures 3 and 4) while arable land and permanent crops decreases.

This increase resulted in particular by failing to growing of arable land under agrarian reform after 1990.
Another cause, leading to changes in grassland areas is type of ownership. Pastures are not privatized, they are in public ownership. In countries where grasslands are privatized they have a stable surface and regulated grazed. If in 1995 the pasture area in privately owned made up 58.3 thousand ha, in 2004 - 2.1 thousand ha, i.e. they decreased by 27 times, in 2014 - consist about 4.6 thousand ha.

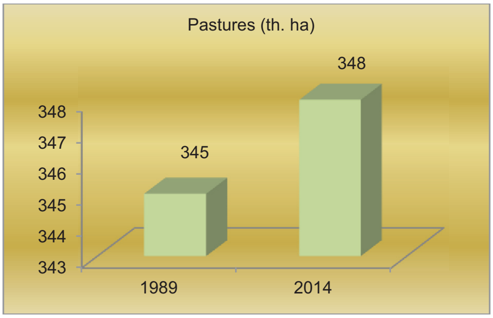

Figure 3. Comparative pastures area in Moldova

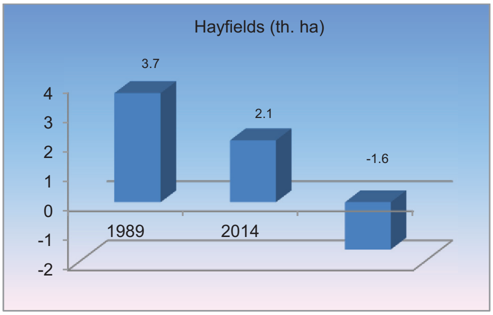

Figure 4. Comparative hayfields area in Moldova

In Moldova the surface of *natural hayfields* decreased considerably. If in 1960 the hayfields extending over 30 thousand ha, in 1966 their area constituted 10 thousand ha, in 1978 - only 2.4 thousand ha. Evaluation of hayfields areas during the years 1995-2005 demonstrates a minimum stability compared with grassland areas. In 1995 the hayfields areas made up 1.5 thousand ha, in 2004 - they increased to 2.3 thousand ha, reaching level of 1978, in 2014 - 2.2 thousand ha (Cadastrul Funciar, 2015).
Due to low productivity, part of hayfields has been plowing and included in aside and elsewhere - turned into grasslands. Currently hayfields are located on steep slopes and in large and small river meadows and their surface is not taken into account.
The hayfields on the slops have a vegetable coating consisting from xerophytes plants that are consumed by animals only in early spring. During summer and autumn period these plants are dried and give low yields. In dry periods, occurs abundant growth of weed species harmful for sheep, goats and other species of animals. This type of hay is very vulnerable to climate change, especially to long drought.
Floodplain meadows have a vegetal cover composed from mesophilic and hydrophilic plants with a much higher forage value. In the composition of plant species predominate perennial grasses with a high resistance to flooding, salinity and drought (Ionel, 1999; Rusu, 2003).
Land reform and changes in land relations characteristic of this reform led to the degradation of pastures and hayfields. Erosion processes continues, occurs secondary compacting of arable layer, salinization, alkalization, excessive humidity and the formation of marshy meadows, expanding humidity areas on the slopes, reduction of humus reserves in soil layer and other nutrients, degradation of pastures and hayfields.
It creates a situation when addressing any social problems requires coordination with measures to protect the biosphere and its main component - the soil.
Pastures and hayfields distribution analysis shows that these are spread over different types of soil: chernozems - 6.5% of the total area, that makes up 15.1% or 280.122 ha; hydromorphic soils - 6.2%; other soils (gray soils, dilluvial, compacted, damaged, deformed, landslides) - 2.5% (Figure 5).

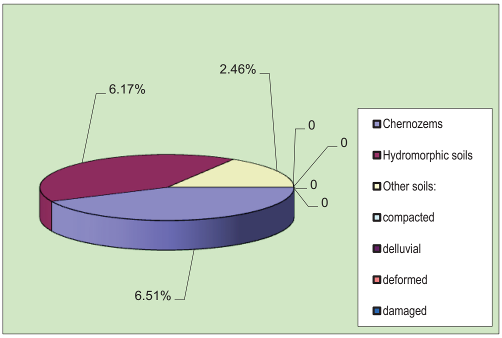

Figure 5. Distribution of pasture areas depending on the type of soil

Considering that most pastures are located on the chernozems and hydromorphic and semi-hydromorphic soils (soils of meadows) is required to orient adaptation measures system towards increasing the fertility of these soils and combat their degradation (Program, 2004). Moldova's pastures suffer most from over-charging of animals. Research has revealed the existence of areas with intense critical exploration environment. These are land from river meadows, on the slopes, near the forests, fallow land, landslides (Photo 1).

Photo 1. Natural pastures in Orhei district, Moldova

Currently in Moldova the total area of pastures is 384 thousand ha, 99% of them are used as grassland for animals (Cadastrul Funciar, 2015).

Free grazing is an extensive system of exploitation, in that the grasslands are used in early spring to late autumn, without taking into account grass production and the need to allow for plant recovery periods after they have been consumed by animals. The number of animals does not correlate with production capacity of pastures and occurs the livestock overload. In Moldova free grazing is practiced extensively and traditionally (Photo 2).

Photo 2. Free grazing of animals in the Răut river meadow in Orhei district, Moldova

Parceled grazing or rational is a modern system of pastures use, which removes the drawbacks of free grazing, but unfortunately not used in Republic of Moldova. Grazing plots involves applying a series of measures that relate to the determination of pasture production, establishing capacity and density, grazing pasture parcels division.

Vulnerability is the degree to which a community, population, species, ecosystem, region, agricultural system or other entity is sensitive or is unable to cope with the adverse effects of climate change. The vulnerability comprises a set of conditions and processes related to physical, social, economic and environmental conditions that increase the susceptibility of different sectors from the impact of climate change (Florea, 2003).

The vulnerability highlights exposures of grasslands, pastures and hayfields to various environmental changes. Vulnerability of grasslands, pastures and hayfields is directly proportional to the degree of manifestation of soil degradation factors (erosion, salinization, excessive humidity) and natural conditions.

The positive factors that increase the ability of vegetation and animals to adapt and effective resist to climate action is called *adaptive capacity*.

Adaptation measures relates mainly to processes of decrease vulnerability of natural grasslands to climate change. Existing adaptive measures are concentrated to combating erosion and increasing soil fertility, therefore, planning and implementation of adaptation measures in the agricultural sector must be addressed and while referring to pastures and hayfields (Program, 2004).

A much greater attention must be given to measures required to adapt (Program, 2001):

- *Long-lasting actions* (combating erosion, chemical amelioration of salty soils, landslides stabilization);
- *The average temporary actions* (land leveling, over seeding, deforestation of woody vegetation);
- *Annually performing actions* (fertilization, weed control, cleaning of garbage).

Adapting the pastures to conditions and climate change phenomena are carried out by measures to improve grasslands without replacing existing vegetation (Jones, 1989; Rusu, 2003):

- cleaning grasslands by the unfavorable
- vegetation, mounds, garbage and stones;
- combating erosion processes;
- correct nutrition regimes;
- over seeding grasslands.

Measures above mentioned have the highest effect if performed in complex and after a comprising preventive plan to care the pastures. Given Moldova stand out as the most essential and absolutely necessary, care grasslands measures (Program, 2001):

- removing water excess from meadows;
- combating erosion;
- eradication of weeds and worthless plants;
- fertilization and grasslands over seeding.

To achieve the development programs of herbs production, impact and risk reduction an important role is establishing the *models of grasslands rational use.* This requires grouping the lands. The models are developed on climatic zones and regional soils (Grâneanu, 1973; Rusu, 2003).

Grouping land for grazing is carried out based on the suitability of their degree of slope, erosion, landslides, depth of the ground water level, the degree and depth of gleyzation, salinity, alkalinity, content of stones, texture of upper horizon (Program, 2004).

The models of crop rotation and recovery technologies proposed crop rotations with perennial grasses in crop protection for all climatic zones of Moldova. Choosing the right crop rotation is determined not only by biological and ecological factors, but also by a number of other economic factors. Thus, developing models of rational use of land resources, including grasslands is a creative work, ready-made recipes are not, given the diversity of natural and economic conditions. Cultivation of perennial grasses technology is known and applied in crop rotations more often in recent years. Anti-erosion field-cropping model for different climatic and farmland conditions are very useful in areas with fragmented relief, where are spread meadows and pastures (Jones, 1989).

The *models works on land improvement* depending on the form and degree of degradation have as their object marshes that are spread to all districts. They cover compact areas, well outlined, with sizes ranging from 2-4 ha to 70-80 ha. Marshes have a pronounced microrelief, hydrological and lithology specific conditions, by vegetal cover, characteristic to wetlands. In normal regime marshes often become weeds outbreaks. Regarding these soils are often applied the models on drained soils without salting potential drained (Șecun, 1972).

Protection models of grasslands depending on the erosion degree of the slope. These models are implemented only in land erosion control planning. Their implementation is less efficient separate.

In the cumulative meadow landscapes soils affected by salinity or salinization occupies 80% of the salting areas. For differentiated implementation of complex ameliorative measures for recovery and exploitation salinity soils are also proposed appropriate groups. According to the group is developed operating model (Metodologia, 1999).

Models for improvement and recovery are developed for natural grasslands and soils with low fertility. Grasslands occupy, usually soils affected by factors make it impossible to growth the field plant: strong erosion, landslides, covered with silt, salty, with excess humidity - 90-99% of the total area of grassland used as pasture.

Radical restoring less productive grasslands and grassing eroded soils, taken out of field crops rotation is a method applied more frequently in recent years. On the meadows where vegetation cover is degraded, rarity, invaded by weeds, thorns, where improve works by surface measures are not effective, the grubbing and seeding need arises. Over seeding grassland and arable soils strongly eroded not require large capital investments and complies with existing technique in the farms. Expenses recovered in 2-3 years. Create sown grassland provides a production increase of at least 3 times compared to the natural ones.

Planning and implementation of adaptation measures must be addressed significantly in other areas, land used for grazing. Currently, adaptation to climate change is subject to a series of challenges.

These challenges include:

• improving climate models and scenarios at detailed regional level, especially in terms of extreme weather events, to reduce the high degree of uncertainty; application of these models on fields, sectors, grasslands etc.;

• registration the progress in the understanding of ”best practice” in adaptation measures through exchange of information on the feasibility, costs and benefits;

• involve public and private sector and the general public both locally and nationally level;

• to improving coordination and collaboration at national and international level, to ensure coherence of adaptation measures with other policy objectives and the allocation of adequate resources (Program, 2001).

Good agricultural practices, with economic and environmental benefits, it is rational exploitation grazing by animals and organic fertilization. It needs to be aware that these ecosystems are particularly sensitive and fragile. Good practices, with economic and environmental reasons is the development of grazing animals in summer at the sheepfold and assurance in the winter season within their own farms, having as basic nutrition the natural multiflora hay.

CONCLUSIONS

Grasslands of Moldova is currently only on the slopes affected by erosion and landslides, salinization and in the valleys degraded by excess moisture. In the category of meadows remained only those lands that were not currently plowing and are in poor condition. On the slopes coverage of soil with vegetation is 5-70%. Production of grass in the meadows does not exceed 10% of the soil biopotential.

In Moldova natural grasslands provide only 5% of the feed. To increase the amount of forage production and improve soil fertility is necessary to increase production of existing natural grass of meadows and create pastures on the eroded soils. Only through over seeding and organic fertilization the grassland production will increase 4-5 times. The sown grassland of meadows increases crops by at least 2 times the natural ones.

In Moldova the greatest difficulty in creation and improvement the pastures is lack of herbage seed basis. It is necessary to create the basis of herb seeds as: Vetch, Fescue, Ryegrass, Alfalfa, Sainfoin, and other grasses adaptation for our climate conditions. It is also necessary enlarged existing ones - Sainfoin and Alfalfa. This should motivate the expansion of sectors with meadows, compensation by the State a part of the seed cost and other advantages.

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COMPARATIVE EVALUATION OF PLASTICITY AND MICROAGGREGATES CONTENT OF CARBONATE CHERNOZEM UNDER DIFFERENT ANTHROPIC-IMPACT LEVELS

Lucia MACRII

State Agrarian University of Moldova, 44 Mircesti Str., Chisinau, Moldova

Corresponding author email: luciamacrii@yahoo.com

Abstract

Information about soil properties changes under different anthropic-impact levels is necessary for selecting appropriate sustainable soil management practices. The aim of this work was to evaluate the plasticity and water-stable microaggregates content (<0.25 mm) of soil in various agroecosystems and to show the correlations established between them. These soil properties sensitize very well biochemical and physical soil changes and can be used as diagnostical indexes. The study was conducted on carbonate chernozem at the Didactic Station "Chetrosu" of the State Agrarian University of Moldova, including long-term crop rotation agroecosystems, single-crop systems (55 years) - fallow, alfalfa, weed-free fallow and single-maize-crop system (29 years).
The researches has shown that, with anthropic-impact amplification, soil plasticity is decreasing and powder fraction (<0.25 mm) content is increasing. The best physic and physic-mechanical soil properties (water-stable microaggregates content (<0.25 mm), plasticity) were established at fallow (55 years) and the worst at weed-free-fallow (55 years), the other studied agroecosystems takes an intermediate position between these two extremes. There were established strong and medium correlations between plasticity (liquid and plastic limits) and water-stable microaggregates content (<0.25 mm) of carbonate chernozem managed under different anthropic-impact levels. Correlation coefficients and trend lines between plasticity and the water-stable microaggregates content (<0.25 mm) revealed a negative tendency because the soil plasticity decrease at the same time with the powder fraction content increasing.

Key words*: anthropic-impact level, microaggregates content, soil plasticity.*

INTRODUCTION

Accelerated soil degradation is a major ecological problem of the world. The source of this problem is closely linked to agriculture and society. The anthropic-impact level on soils is more visible and right evaluated if parallel are studding soils formed under natural conditions. Based on these researches we can see the gradual soil properties changes at a management practice to another, and implement measures that will reduce soil degradation.

Longstanding research of physic-mechanical properties of soil from Republic of Moldova, in different biogeographical zones, types of ecosystems and agroecosystems, level of human impact, including degraded and undegraded agrophysic soils, soils with various degrees of erosion, allowed the proposal to use some of physic-mechanical properties of soil (plasticity and adherence) as diagnostical indexes of complex soils degradation trends (Andriuca and Macrii, 2015). At the same time, studying aggregate stability, it is possible to quantify whether or not the management is ameliorating the natural soil properties and the land capability for agriculture. Knowing the soil structure, as an essential element of soil fertility, has a great importance because it influences not only the physical conditions aeration and food regime but also the accessibility of nutrient for plant, degradation of organically material in soil and microbiological activity (Țopa and Jităreanu, 2007).

MATERIALS AND METHODS

The investigations was carried out at the Didactic Station "Chetrosu" of the State Agrarian University of Moldova, located in the South-East side of the Central Moldavian Plateau (46^o $92^'$ N latitude, 29^o $04^'$ E longitude and 51 m altitude above sea level) on carbonate chernozem with loamy texture. The researches included agroecosystems with different anthropic impact levels: long-term crop rotation agroecosystems – maize, alfalfa – 1st year use; single-crop systems (55 years) - fallow, alfalfa, weed-free fallow and single-maize-crop system (29 years).

The article prezents correlations between soil plasticity (plastic and liquid limits) and water-stable microaggregates content (<0.25 mm), % g/g obteined at the soil aggregate hydrostability determination.

Soil plasticity (plastic and liquid limits) were determined by Vasiliev A. method, the soil aggregate hydrostability by Savvinov wet-sieving method, both according to conventional methods used in soil science and geology (Вадюнина and Корчагина, 1986; Canarache, 1990).

The soil samples were taken from the arable and subarable layer - 0-60 cm at each 10 cm.

RESULTS AND DISCUSSIONS

The carbonate chernozem humus content of researched agroecosystems deviate in surface layer from 3.41% (in fallow) to 2.75% (in weed-free fallow), pH varies in arable and subarable layer beetwen neutral and alkaline (6.9-8.2), the sum of Ca^{++} and Mg^{++} falls within the range of 19.7-28.8 me/100 g soil. The weed-free fallow soil is highlighted with lower content of Ca^{++} and Mg^{++} (19,7-24,7 me/100g soil) compared with the other studied agroecosystems (25.4-28.8 me/100g soil).

The soil plasticity of researched objects is described by liquid and plastic limits and correspond loam variety (Table 1).

From agrotechnical aspect, the plastic limit represents the most important soil characteristics, because it simultaneously represents the upper limit of the moisture of soil physical suitability for machine tillage. Therefore, the knowledge of this plasticity limit is very important for correct and well-timed soil tillage. If at approximately equal colloid clay fraction content plastic limit values are higher, the interval of moisture suitable for tillage is wider, together with the time interval favourable for good tillage with less resistance and energy waste (Gajiè, 2005).

Soil plasticity studies revealed the highest values for liquid (38.8%) and plastic (22.4%) limits in fallow (55 years), which represent a background variant.

The soil liquid and plastic limits researches in arable and subarable layers of various agroecosystems show, that plasticity deviate more significant, among variants, in arable layer, because this one, receive the direct consequences of anthropic-impact, especially those relating to the soil tillage. With anthropic-impact amplification, the soil liquid and plastic limits is decreasing. Compare with fallow (55 years) soil plasticity, the weed-free fallow (55 years), in arable layer (0-30 cm), deviate at liquid limit with 5-9% and at plastic limit with 2-5%, other studied variants – single-alfalfa-system (55 years), single-maize-system (29 years) and crop-rotation agroecosystems (maize, alfalfa 1st year use) are placed between these extremes (fallow and weed-free fallow), so remarked deviation in arable layer (compared to fallow) do not exseed 3,6% at the liquid limit and 2.9% at the plastic limit, however a worsening trend of these indexes are notified in single-alfalfa-system (55 years). The liquid and plastic soil limits indexes of single-maize-system (29 years) compared with the crop-rotation agroecosystems soil plasticity values are higher (statistically significant), this is explained by the higher content of organic matter.

In subarable layer, liquid and plastic limit is characterized with smaller differences among researched variants, and yet, a decrease of plasticity is observed at weed-free fallow (up to 3.8% at liquid limit and up to 1.2% at plastic limit, compared with fallow). The crop rotation agroecosystems and single-maize-system, in subarable layers, recorded significant higher values (with 1.9-3.3% increase) at liquid limit, compared with fallow.

If we compare the soil plasticity between arable and subarable layer, at liquid limit, then it can be noted a slightly decrease with depth (up to 3%) in fallow and slightly increase (up to 2%) in crop-rotation agroecosystems and single-maize-system. Weed-free fallow soil show more significant increase of liquid limit (up to 5%) in subarable layer compared with arable, because of degradation. The greater the degradation of soil in arable layer the greater it differs by the soil of underlying layer.

Table 1. The influence of anthropic-impact level on soil plasticity

Plasticity, %	Layer, cm		Single-crop agroecosystems				Crop rotation agroecosystems	
			Fallow (55 years)	Alfalfa (55 years)	Weed-free fallow (55 years)	Maize (29 years)	Maize	Alfalfa 1st year use
Liquid limit	0-30	min	34.9	32.8	29.5	34.7	34.3	33.8
		max	38.8	35.2	30.3	36.4	35.4	35.8
	30-60	min	34.3	35.0	30.5	37.6	37.3	36.2
		max	35.6	35.4	35.1	38.3	38.2	37.4
$DL_{0.05} = 0.3$								
Plastic limit	0-30	min	19.5	18.8	17.6	19.5	19.0	19.0
		max	22.4	19.6	17.8	19.7	19.6	19.5
	30-60	min	19.1	18.6	17.9	19.4	19.7	19.0
		max	20.3	18.8	19.3	19.7	19.8	19.6
$DL_{0.05} = 0.6$								

Soil plastic limit of studied objects, show the same tendency between moistures in arable and subarable layers, only differences are smaller.

The soil changes at diverse management practices may be pointed out and by studying aggregate stability. Therea are shown the microaggregates content (<0.25 mm) obtained at wet-sieving (Figure 1). The chart analysis show a perfect view of slowly increase of microaggregates content (<0.25 mm) in fallow (55 years) from above (27.3%) to beneath layers (58.0% at 50-60 cm deph). This natural microaggregates content distribution it is reversed in agroecosystems. The weed-free fallow (55 year) is a system with the most dispersed soil phase – the content of microaggregates (<0.25 mm) at wet-sieving corisponde to 92.5% at 0-20 cm depth and 89.9% at 20-40 cm depth, and only at 50-60 cm depth the content of microaggregates decrease to 60.9%.

The intensive soil tillage without organic matter incorporation and lack of any vegetation leads to extremal degradation with complete destruction of soil solid phase.

The crop rotation-agroecosystems and single-maize-system (29 years) don't differ among them by the microaggregates content, that it's placed between 64.4-72.3% in arable layer and 51-7-64.1% in subarable layer.

The single-alfalfa-system (55 years) doesn't contribute completly at the building of stabile aggregates, having the same position as crop-rotation agroecosystems. It was noticed that at 50-60 cm depth, regardless of anthropic-impact level, the content of microaggregates don't differ significantly among variants (51.7-64.1%).

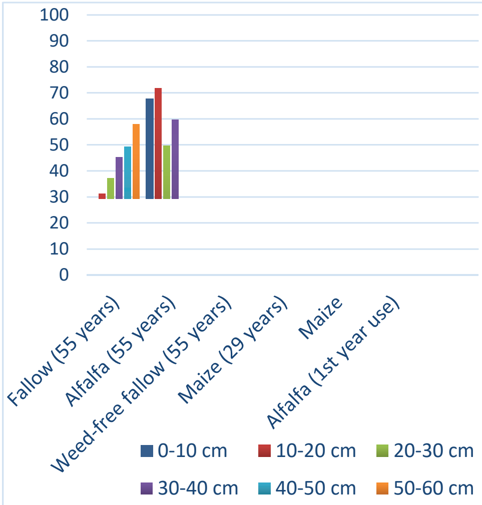

Figure 1. The influence of anthropic-impact level on the soil' microaggregates content (<0.25 mm), % g/g (wet-sieving)

There were established correlations between limits of soil plasticity and microaggregates content (<0.25 mm) for soil managed under single-crop-systems (55 years) and crop-rotation agroecosystems plus single-maize-system (29 years) (Figures 2, 3, 4, and 5). The analysis of trend lines found that soil plasticity diminishes with microaggregates content increasing. The both properties are related to soil particles behaviour in contact with water, what explain in complex physic-chemical soil state. The r - coefficient values show that were established strong correlations, with exception of medium one-between plastic limit and water-stable microaggregates content (<0.25 mm) of soil used under crop rotation agroecosystems and single-maize-system, but statistically authentic.

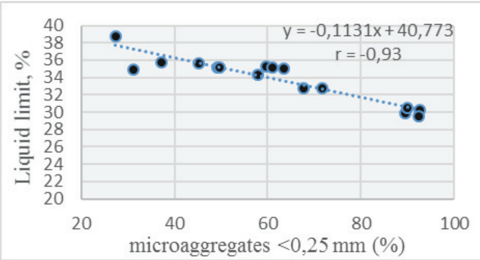

Figure 2. Correlations between soil liquid limit and microaggregates content (wet sieving) under single-crop-systems (55 years)

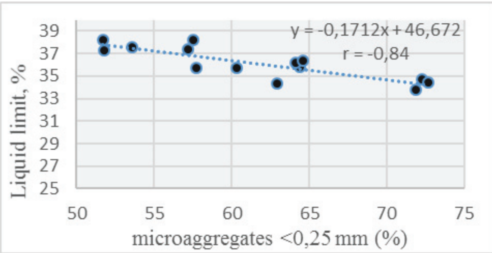

Figure 3. Correlations between soil liquid limit and microaggregates content (wet sieving) under crop-rotation agroecosystems and single-maize-system (29 years)

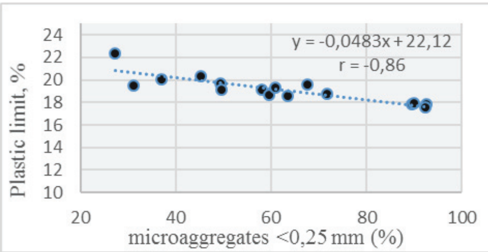

Figure 4. Correlations between soil plastic limit and microaggregates content (wet sieving) under single-crop-systems (55 years)

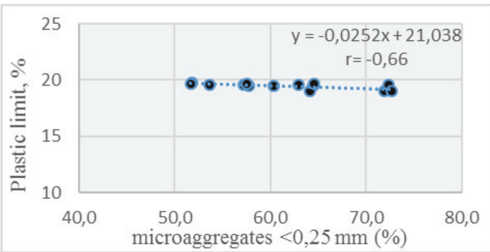

Figure 5. Correlations between soil plastic limit and microaggregates content (wet sieving) under crop-rotation agroecosystems and single-maize-system (29 years)

CONCLUSIONS

The anthropic-impact level on soils is more visible and right evaluated if parallel are studding soils formed under natural conditions.

The best physic and physic-mechanical soil properties (water-stable microaggregates content (<0.25 mm), plasticity) were established at fallow (55 years) and the worst at weed-free-fallow (55 years), the other agroecosystems takes an intermediate position between these two extremes.

With anthropic-impact amplification soil plasticity is decreasing and powder fraction (<0.25 mm) content is increasing more significantly in arable layer.

There were established strong and medium correlations between plasticity (liquid and plastic limits) and water-stable microaggregates content (<0.25 mm) of carbonate chernozem managed under different anthropic-impact levels.

Correlation coefficients and trend lines between plasticity (liquid and plastic limits) and the water-stable microaggregates content (<0,25 mm) revealed a negative tendency, because the soil plasticity decrease at the same time with the powder fraction content increasing.

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RATIONAL METHODS OF SOILS MAINTENANCE IN ORCHARDS

Tatiana NAGACEVSCHI[1], Sava GRIȚCAN[2]

[1]Moldova State University, 65 A, Mihail Kogalniceanu, Chisinau, Republic of Moldova, MD-2009
[2]Scientific and Practical Institute of Horticulture and Food Technology, 59 Vierului, Codru, Chisinau, Republic of Moldova, MD-2011

Corresponding author email: lola8459@mail.ru

Abstract

The study of different maintenance methods of sloppy soils used under orchards through their influence on the physical and chemical soils proprieties, with the purposes of assessing the state, should be completed taking into account the factors that determine their degree of stability. Not least should be monitored soil-plant relationship and the final product exposed through quality and quantity of fruit harvested on different types of soil maintenance. In order to propose the most optimal maintenance methods of sloppy soil in the fruit plantations and even maintaining and improving the soil physical parameters were monitored several methods of soil maintenance in the orchard. As witness served the arable soil, most often used in orchards in Moldova, other maintenance methods investigated that were used is soil maintained in the row: 1. Grassed; 2. under pellicle; 3. the use of herbicides; 4. Herbicides + mulching. The results obtained demonstrate that the improvement and maintenance of soil physical and chemical parameters and quality and quantity of harvested fruit corresponds to variant 1 and 2.

***Key words**: sloppy soils, arable soil, orchards, soils proprieties, soil maintenance.*

INTRODUCTION

Sustainable development of the Moldova's economy broadly is conditioned by the efficient use and protection of soil resources. The relatively favorable climatic conditions and high productivity potential of soils offer the possibility of consequential development of the different braches of agriculture. However sustainable development requires ecological balance, a particular report between natural and human ecosystems. Such equilibrium is extremely important in the steppe area, which is characterized by an almost permanent moisture deficit.

Resistance to drought of trees is high enough in comparison with other agricultural plants.

The influence of soil water and air reduces the growth of shoots and leaves, amount and fruit quality, slows differentiation of fruit bud. As consequences only periodically fructifies and premature aging.

Soil work for a long time in orchards contribute to the worsening of the soil physical characteristics which ultimately influences negatively on growth and fruitfulness of fruit trees. Harvest losses due to the degradation of the soil physical properties through its compaction, is equal to increases in production due to irrigation and almost equal to those obtained from the use of fertilizers.

MATERIALS AND METHODS

The research aimed to highlight changes of agrophysics soil characteristics of orchards in bearing on long term and proposing new soil maintenance methods that does not lead to its degradation: the control variant for all the experiences has served black field maintained clean of weeds by mechanical works between the rows and manual hoeing in rows. Depending on the moisture conditions and soil state were used a disc harrow, cutter or grower. There have been carried out 4-5 works during the period of the vegetation, as needed. The experience included 4 versions: 1. Temporary revegetation with perennial grasses, 2. Polyethylene foil, 3. Herbicidal-mulch, 4. Herbicides on the strip along the row width of 1.0 m. Alternation in time and space of these methods minimizes the expenses and ensure environmental protection.

Research was conducted in plum trees plantations 5 years, on the typical chernozems weakly humus, silty sloppy, which belongs to pedological-geographic district Forest Hills Codri. In order to characterize the soil cover and development status of the trees and harvest on the experimental polygons were placed main profiles from which samples were collected on the genetic horizons and corresponding measure of the vegetable development and harvest.

RESULTS AND DISCUSSIONS

Settlement state of soil is generally determined by bulk density, which substantially influences the growth process and development of agricultural crops, whereas its values depend on aeration and hydric regimes, and various chemical and microbiological processes. The porosity depends on the capacity to retain water, the permeability and aeration. For its part it depends on the texture, structure and bulk density. In the moderate loosened soils the properties of the total porosity component are favorable, simultaneously, ensuring better condition for water retention accessible to plants, aeration and rapid movement of the water excess.

The compacted soils, except of certain coarse textures, the ratio of total porosity components is often less favorable (Canarache, 1990).

In the founding processes of industrial plantations for vineyards and orchards is performed soil stripping (deep plowing depth 50-60 cm). As a result the stripping disturbs the natural order of genetic horizons and brings to the terrestrial surface the soil underlying horizons with weak humus and high carbonate content. This leads to degradation of fertility layer 0-30 cm of the sloppy soil, the processes extremely pronounced in the case of stripping the soil moderately and strongly eroded (Ursu, 2000).

Every year is required to study the sloppy soils which form a group of anthropogenic soils. Therefore, we should be careful at the physical characteristics, for on time to detect the changes taking place in the soil as a results of the work.

In fruit growing space of arable layer and in 20-30 cm layer occur differentiations of total porosity parameters according to the increase of bulk density.

The data obtained (Table 1) show that the upper layers of soil (0-20 cm and 20-30 cm), as in the witness and in the four variants of soil maintenance bulk density parameters varies which indicates that conditions of soil maintenance in the orchards influencing bulk density parameters: in the case of witness where the soil is maintained as a black field at 20-40 cm is highlighted an increase in bulk density in comparison with 0-20 cm layer, reaching values form 1.46-1.49 g/cm^3, corresponding also in case of the variant with herbicides from 1.51-1.53 g/cm^3. These values characterize the typical chernozem silty as weak compacted soil.

At the grassy variant covered with polyethylene foil and herbicide mulch, this compaction is not particularly highlighted, for bulk density parameters corresponding values varies from 1.24-1.34 g/cm^3, characterizing the soil as moderate weak loosened.

The porosity depends on the capacity to retain water, the permeability, aeration. In its turn it depends on the texture, structure and bulk density. In the soils moderate loose the properties of total porosity components are favorable, simultaneously providing better water retention conditions accessible to the plants, aeration and the rapid movement of water excess. In compacted he soil with the exception of coarse texture, the ratio of total porosity components it is often less favorable. In the fruit growing space of 0-20 cm layer on the surface and in the 20-30 cm occur a differentiation of total porosity values corresponding to the increase of bulk density. The total porosity of 0-10 cm layer at witness is 52%, corresponding to the herbicide variant what characterize it a good and low porosity in the 20-40 cm layer. The other variants are characterized with good porosity. Characterizing the soil structure (Table 2) of the variants with different forms of maintenance of the orchards: is observed presence of moderately lumping, in the witness and the variant with herbicide at maintained covered by grass soil and in the polyethylene foil, and herbicides and the mulch variants soil is characterized by small lumps. The amount of meso-aggregates (10-25) also named as the agronomical valuable aggregates have the highest weight at variant where soil is maintained covered by grass, herbicide-mulch variant and under polyethylene foil.

Table 1. Bulk density and total porosity

Variant	Depth (cm)	Bulk density (g/cm^3)	Total porosity (%)
Witness	0-10	1.25	52
	10-20	1.49	46
	20-30	1.46	47
	30-40	1.41	48
Temporary revegetation	0-10	1.36	49
	10-20	1.26	52
	20-30	1.24	53
	30-40	1.31	51
Polyethylene foil	0-10	1.19	56
	10-20	1.31	51
	20-30	1.32	51
	30-40	1.26	53
Herbicidal-mulch	0-10	1.09	59
	10-20	1.27	52
	20-30	1.34	50
	30-40	1.27	53
Herbicide	0-10	1.31	51
	10-20	1.30	52
	20-30	1.51	44
	30-40	1.53	43

An appreciation of the structure and the amount of hydrostable aggregates with a diameter >0.25 which characterize a good structure in the case when containing more than 40%, what is observed at soil and in the variants: covered by grass, herbicides-mulch and in the polyethylene foil. In conclusion it can be stated that the soil in variants: covered by grass, herbicides-mulch and under polyethylene foil have a tendency for the rehabilitation of structure of the upper part of sloppy layer.

From the data presented (Table 3) is observed that the content of all nutrients is higher in the 0-20 cm layer and 20-40 cm. In the 0-60 cm layer is observed that soil maintenance methods in the strip across the row of trees not negatively influenced on the nutrition trees with nitrogen, except for covered version with polyethylene foil, where is observed insignificant decrease. High nitrogen content is highlighted in herbicides variants and vegetable mulch. Concerning the phosphorus content is not observed essential decrease and its quantity is within the optimal limits.

The content of potassium in the soil has increased in revegetation and herbicides-mulch variants, namely there were processed cutting the grass and mulching with vegetable mass (weeds), which affected both the mobilization of potassium as well as the increasing content in the soil of it, ranging from 2.9-1.7 mg.

The analysis of data presented (Table 4) revealed that witness variant where weed control took place through mechanical work and in herbicides variant were applied systemic herbicides in the layer 0-60 cm soil moisture is lower than the witness variant, polyethylene foil and herbicides-mulch.

The quantity of moisture in the case of temporary grassing, polyethylene foil and herbicides-mulch is higher, respectively 0.47, 1.18 and 1.14%. At these variants the soil was into different measures covered which allowed minimizing water evaporation from the soil. In the case of the soil cover, the soil moisture is 1.8% higher and variable in herbicides-mulch 1.14% due to organic mulch layer from the surface. Temporary grassing retains moisture in the soil with 0.47% higher than at the witness.

Table 2. Structure (*dry sieving, **wet sieving)

Variant	Depth (cm)	The aggregates diameter (cm)		
		>10	10-0.25	< 0.25
Witness	0-10	*39.60	52.70	7.70
		**-	39.29	60.74
	10-20	31.40	61.60	7.00
		-	36.06	63.94
	20-30	30.50	65.70	3.80
		-	43.51	56.49
	30-40	36.60	61.50	2.00
		-	55.21	45.85
Temporary revegetation	0-10	30.10	65.00	4.90
		-	48.80	51.20
	10-20	20.40	71.50	8.10
			43.17	56.83
	20-30	28.20	65.90	5.90
		-	49.64	50.36
	30-40	26.60	68.20	5.20
		-	45.02	64.29
Polyethylene foil	0-10	30.60	55.40	14.00
		-	38.25	61.75
	10-20	30.80	65.00	4.20
		-	44.54	55.46
	20-30	25.90	67.30	6.80
		-	48.03	51.97
	30-40	23.00	73.40	3.60
		-	54.97	45.03
Herbicidal-mulch	0-10	18.00	70.60	24.40
		-	48.32	51.68
	10-20	16.60	74.80	8.60
		-	44.54	55.46
	20-30	23.80	70.80	5.40
		-	48.03	51.97
	30-40	30.20	66.10	3.70
		-	55.00	45.03
Herbicide	0-10	38.90	52.50	8.60
		-	18.80	81.20
	10-20	30.50	64.70	4.50
		-	33.17	66.83
	20-30	34.40	62.30	3.30
		-	39.64	60.36
	30-40	30.80	66.00	4.20
		-	45.02	54.98

Table 3. Action of maintenance methods of the soil on the content of nitrogen, phosphorus and potassium in the soil layer (mg/100 g dry soil)

Depth (cm) / Variant	Witness (black field)	Temporary grassing	Polyethylene foil	Herbicide-mulch	Herbicide
Nitrogen content (NO_3)					
0-20	2.36	1.96	2.11	1.89	2.17
20-40	1.87	2.28	1.85	2.00	1.92
40-60	0.68	0.78	0.84	0.97	0.81
0-60	1.97	1.67	1.60	1.98	1.66
Phosphorus (P_2O_5)					
0-20	2.13	2.66	1.98	2.42	2.01
20-40	1.32	1.44	1.39	1.28	1.47
40-60	0.68	0.67	0.58	0.66	0.61
0-60	1.38	1.59	1.32	1.46	1.36
Potassium (K_2O)					
0-20	24.3	26.9	25.4	22.6	24.7
20-40	20.7	25.7	23.9	23.4	21.2
40-60	17.5	18.1	18.0	17.1	17.9
0-60	20.7	23.6	22.4	20.0	21.3

Table 4. Dynamics of soil moisture at different maintenance methods (%)

Depth (cm) / Variant	Witness (black field)	Temporary grassing	Polyethylene foil	Herbicide-mulch	Herbicide
0-20	19.36	19.26	20.14	19.81	19.54
20-40	20.49	20.27	20.40	21.44	19.69
40-60	15.93	17.11	18.91	17.,90	16.41
60-80	15.12	16.14	16.17	16.31	15.49
Mean 0-80 cm	17.72	18.19	18.90	18.86	17.78
Difference compared to the witness	0	+0.47	+1.18	+1.14	+0.06

The versions studied demonstrate (Tables 5 and 6) that they have not acted significantly on the average fruit weight and production at a tree and per hectare is higher in variants with polyethylene 26.5% and herbicides-mulch 28%, which proves the fact that in these variants the soil moisture remained stable over a longer period.

Table 5. Average mass of the fruit and prune production

Variant / Year	Number of fruit per tree (piece)	Average mass of a fruit (g)	Harvest		% to witness
			At a tree (kg)	t/ha	
2013					
Witness (black field)	345	43.0	17.0	11.3	100
Temporary grassing	385	44.8	17.5	11.7	103
Polyethylene foil	450	43.7	18.5	12.3	109
Herbicide	358	42.5	18.0	12.0	106
Herbicide-mulch	400	44	20.0	13.3	118
2014					
Witness (black field)	218	46.9	10.2	6.8	100
Temporary grassing	261	46.4	12.1	8.1	119
Polyethylene foil	292	50.2	14.7	9.8	144
Herbicide	268	45.0	12.1	8.1	119
Herbicide-mulch	222	42.4	12.0	9.4	138

Table 6. Average mass of the fruit and prune production (average years 2013-2014)

Variant	Number of fruit per tree (piece)	Average mass of a fruit (g)	Harvest		% to witness
			At a tree (kg)	t/ha	
Witness (black field)	281	44.8	13.6	9.05	100
Temporary grassing	323	45.1	14.8	9.9	111
Polyethylene foil	371	46.9	16.6	11.05	126.5
Herbicide	313	43.7	15.0	10.05	112.5
Herbicide-mulch	311	43.2	16.0	11.35	128

CONCLUSIONS

By using various maintenance methods of sloppy soil from orchards aimed to stop the degradation of physical and chemical parameters. It can be stated: sloppy soils are subjected easily to compaction and degradation of physical parameters (structure degradation, compaction, reducing porosity and permeability); revegetation is one of the best maintenance methods in terms of physical rehabilitation of sloppy soil; the use of pellicle in row solves the problem of moisture; soil cover in the strips across the row of trees with polyethylene foil and herbicide-mulch with phytomass resulting from mowing grass in the intervals between rows demonstrates the positive results in many aspects (moisture, food and production); in no versions have been observed any depressive aspect of trees. It has been found that during the years 2013-2014 average production is higher in versions with polyethylene and herbicidal mulching (26.5-28%).

Temporary grassing and herbicides versions occupy an average position between witness and mulching versions.

In order to rehabilitate and maintain the optimal physical properties of the soil, and increasing the physiological state of the fruit trees, as well to maintain soil from orchards are needed temporary alternative methods: covering by grass, polyethylene and herbicides-mulching.

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DIVERSITY, DISTRIBUTION AND ECOLOGY OF THE FRESHWATER NATURAL HABITATS FROM SOUTHERN OF OLTENIA, ROMANIA

Mariana NICULESCU

University of Craiova, Faculty of Agronomy, Departament of Botany, 19 Libertatii Street, 200583, Craiova, Romania

Corresponding author email: mniculescum@yahoo.com

Abstract

In this paper we made a general presentation of the most important freshwater natural habitats from the Danube and Jiu floodplains, part of Southern of Oltenia, Romania. In the researched area there are the following Natura 2000 habitats: 3130 - Oligotrophic to mesotropic standing waters with vegetation of the Littorelletea uniflorae and/or Isoëto-Nanojuncetea, 3140-Hard oligomesotrophic waters with benthic vegetation of Chara spp., 3150- Natural eutrophic lakes with Magnopotamion or Hydrocharition-type vegetation, 3160- Natural Dystrophic Lakes and Ponds, 3260-Watercourses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation, 3270-Rivers with muddy banks with Chenopodion rubri p.p. and Bidention p.p. vegetation. Six types of freshwater natural habitats of conservative interest have been identified on the Southern of Oltenia, in the Danube and Jiu floodplains (D. Gafta, O. Mountford coord., 2008). These natural habitats are represented by hydrophilous, hygrophylous and meso-hygrophylous plant communities. The plant communities that edify the freshwater natural habitats from this area have been analyzed and characterized from the chorological, ecological point of views. They were also examined according to their floristic composition and physiognomy, after the conservation status and human impact. Of the rare and vulnerable species we can mention: Vallisneria spiralis, Utricularia minor, Nymphaea alba, Azolla filiculoides, Typha minima. The phytodiversity of the freshwater natural habitats from Sotheren of Oltenia is endangered because the human impact is very high, although this area it is included in the important protected areas from Romania.

Key words: *freshwater, habitats, plant communities, Oltenia.*

INTRODUCTION

When referring to Oltenia, one can notice that the floristic patrimony of this part of the region is very well represented. Because of the very varied pedoclimatic and orographic conditions existing in Oltenia, there are approximately 2,200 species of cormophytes on its lands, which represent 2/3 of our country's vascular flora. The main wetlands in the southern of Oltenia which are found the freshwater natural habitats are the following:

- Poiana Mare, Ciupercenii Noi, Ciupercenii Vechi, Desa, Rast Vechi, Rast - part of the protected aria ROSCI 0039 Ciuperceni- Desa;
- Horezu-Poienari, Sadova, Piscul Sadovei, Grindeni, Bistret, Zaval, Badosi, Bratovoiești, Gingiova, Comosteni, Ostroveni - part of the protected aria ROSCI0045Coridorul Jiului;
- Corabia - part of the protected aria ROSCI0044 Corabia - Turnu Magurele Hunia, Salcia, Vrata - part of the protected aria ROSCI0299 Danube at Gârla Mare – Maglavit (Figure 1).

Due to the diversity of flora and vegetation from the Southern of Oltenia, and to the little scientifical research in the last 30 years regarding the freshwater natural habitats, we considered necessay achievement for these studies.

The biotic conditions on this part of Romania allow the existance of some specific natural habitats, specific plant communities. The natural habitats present a intersting structure and numerous rare plant species registered into Romanian Red Lists Săvulescu, T. (ed.)., 1952-1976; Tutin et al , 1964-1980, 1993). Inventory of this natural capital and establishing coherent management measures in this area which have already suffered huge transformations due to the eco-climat changes, will lead to a better management and preservation of the area.

MATERIALS AND METHODS

The studies on the field involved a good bibliographic documentation regarding the physical-geographical frame: the relief, the geology-lithology, the hydrographic network, the soils and the general and local climate. The plant species nomenclature follows the Flora Europaea and Flora of Romania. The plant communities that edify the freshwater natural habitats from this area have been described by personal observations and on the base of the synthesis book Coenotic structure and ecological characterization of the phytocoenosis of Romania (V. Sanda et al 2001). As for the classification of the vegetal associations, we have used synthesis papers by J.S. Rodwell, J.H.J. Schaminée, L. Mucina, S. Pignatti, J. Dring, D. Moss. To identify the habitats we used the Romanian Manual for interpretation of Eu habitats and Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, Annex I (Habitats Directive).

We gave a special attention to the calculation of the Bray-Curtis dissimilarity index, used to construct Group average (UPGMA) dendrograms and Jaccard coefficient (for binary data) used to construct Simple average (WPGMA) dendrograms (Podani, 2001).

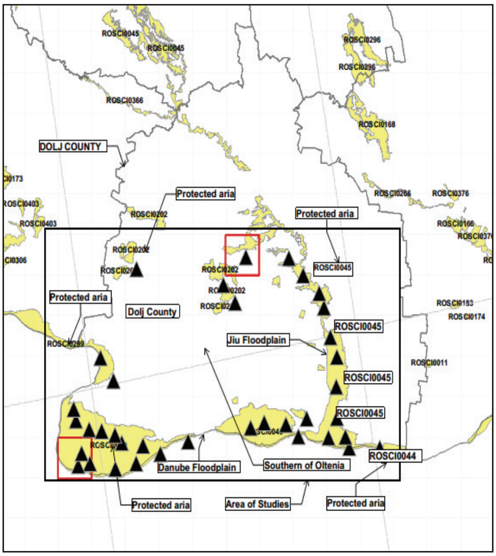

Figure 1. The Map of thematic area

RESULTS AND DISCUSSIONS

As a result of our study, 6 freshwater types of habitats of conservative interest have been observed in the Southern of Oltenia, in the Danube and Jiu floodplains (Table 1).

3130 - Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*

Chorology: Ciupercenii Noi in the Danube floodplain, Horezu-Poienari in the Jiu foodplain, Badosi, Piscu Sadovei – Zacatoarea Lake, at altitudes ranging between 30 m and 70 m, developed on alluvial soil, reaching a coverage of up to 95%.

Typical plant communities of this habitat identified in Southern of Oltenia: *Cyperetum flavescentis* Koch ex Aichinger 1933. The characteristic and dominant species: *Cyperus flavescens, Juncus articulatus, Alopecurus aequalis, Juncus bufonius, Polygonum hydropiper, Rorippa sylvestris, Agrostis stolonifera, Echinochloa crus-gallis* (Niculescu et al, 2014).

In the UPGMA dendrogram of the *Cyperetum flavescentis,* there are pointed out also 2 distinct clusters. In the first sub-cluster there are grouped relevées 1, 2, 3, 4, 5, 6, 7, 9 and 10, especially due to *floristic*. The latter clusters' surveys are grouped surveying 8 - on high dominant values, due to the abundance of *Pulicaria vulgaris* (abundance-dominant (AD) 2). Given this dendrogram, the values of the quantitative index, *Bray-Curtis* varies, reflecting the heterogeneity of the floristic structure of the phytocoenoses of this pant community (Figure 2).

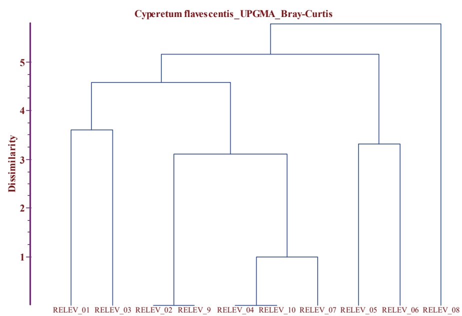

Figure 2

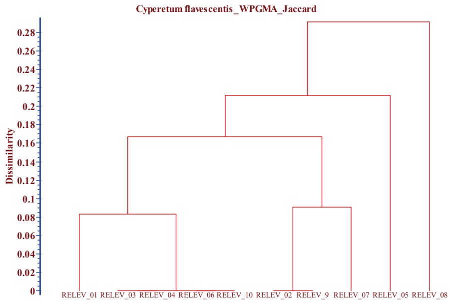

Figure 3

After an analysis of the dendrogram of this plant community, used WPGMA method and Jaccard coefficient, there can be noticed also the separation of the 8th relevées, from the rest of the surveys, which are grouped in a cluster. This cluster is separated in two sub-clusters: the former groups the surveys 1, 2, 3, 4, 5, 6, 7, 9, 10 and the latter, surveying 1 (Figure 3).

3140- Hard oligomesotrophic waters with benthic vegetation of *Chara* spp.

This natural habitat are poorly represented in the Southern of Oltenia.

Chorology: Ciupercenii Noi, Ciupercenii Vechi, Balta Păsărica, Danube floodplain, Corabia, Comosteni, Gingiova, Ostroveni, Horezu-Poienari, Jiu floodplain, at altitudes ranging between 20 m and 60 m, developed on alluvial soil.

Typical plant communities of this habitat identified: *Charetum fragilis* Corillion 1957 (Sanda et al.,2001). This plant community is found on a small surface (0,10ha) and have a smaller phytodiversity:*Chara fragilis, Lemna minor, Ceratophyllum demersum, Myriophyllum spicatum, Alisma plantago-aquatica, Utricularia minor, Vallisneria spiralis.*

3150-Natural eutrophic lakes with Magnopotamion or Hydrocharition-type vegetation

This natural habitat are well-represented in the Southern of Oltenia. The total area for this natural habitat is 408,53 ha.

Chorology: Corabia, Danube floodplain, Ostroveni, Topila Lake, Sadova, Piscul Sadovei, Sadova Lake, Dobreşti, Rast, Rastu Vechi, Badosi, Grindeni, Bistret, Vrata, Arcerului Lake; Bratovoiesti, Desa.

Typical plant communities: *Lemnetum minoris* Soó 1927; *Lemnetum trisulcae* Knapp et Stoffers 1962; *Lemno – Azolletum filiculoides* Br.-Bl. 1952; *Lemno – Salvinietum natantis* Miyawaki et J. Tx. 1960; *Ceratophylletum demersi* Soó1927 nom.nud; *Polygonetum amphibii (natantis)* Soó 1927; *Hydrocharitetum morsus-ranae* van Langendonck 1935; *Potamogetonetum crispi* Soó 1927; *Potamogetonetum nodosi* (Soó 1960) Segal 1964.

In the floristic composition of the ptytocoenoses of this natural habitat meet numerous hygrophile and hydrophile species. These phytocoeonoses have a special composition, being characterised by the dominance of the species: *Lemna minor, Lemna trisulca, Azolla filiculoides, Elodea nuttallii, Salvinia natans, Potamogeton crispus, Sparganium erectum, Butomus umbellatus, Ceratophyllum demersum, Alisma plantago-aquatica, Glyceria aquatica, Sagittaria sagittifolia, Nymphoides peltata, Hydrochari morsus-ranae, Myriophyllum spicatum, Schoenoplectus lacustris, Glyceria maxima, Phragmites australis, Stachys palustris, Mentha aquatica, Utricularia vulgaris, Spirodela polyrrhiza, Juncus buffonius, Cyperus fuscus, Typha angustifolia.* The plant communities at altitudes ranging between 20 m and 70 m, developed on alluvial soil and limnosoil, reaching a coverage of up to 100%.

3160-Natural dystrophic lakes and ponds

Chorology: Ostroveni, Pasarica Lake, Hunia, Salcia, Calafat, Bistret, Calugareni Lake, Corabia, Poiana Mare, Bratovoiesti, at altitudes ranging between 20 m and 60 m, developed on alluvial soil, reaching a coverage of up to 90%.

Typical plant communities of this habitat identified in Southern of Oltenia: *Myriophyllo verticillati-Nupharetum luteae* Koch 1926; *Nymphoidetum peltatae* (Allorge 1922) Bellot 1951 (Rodwell, J, 2002; Sanda et al, 2001). The characteristic and dominant species: *Nuphar luteum, Nymphaea alba, Nymphoides peltata, Myriophyllum spicatum, Utricularia vulgaris, Spirodela polyrrhiza, Potamogeton pectinatus, Potamogeton crispus, Myriophyllum verticillatum, Ceratophyllum demersum, Scirpus lacustris, Sparganium erectum.* After the analysis of the Gropup average (UPGMA) dendrogram of the *Nymphoidetum peltatae* (Allorge 1922) Bellot 1951 plant community, there can be noticed that relevés are grouped in two clusters. For the former sub-cluster, there can be noticed that grouping the surveys 2, 7, 6 and 10 can be explained by the absence of *Potamogeton nodosus*.The latter cluster only groups surveys 1, 3, 5, 4, 8, 9. The branches of the dendrogram are well individualized. The quantitative values of the *Bray-Curtis* species indicating developed floristic heterogeneity (Figure 4).

We gave a special attention to the calculation of the index Jaccard index (for binary data) and to performing the dendograms, by using the method -Simple average (WPGMA) (Figure 5).

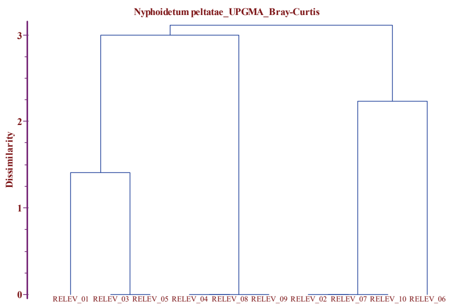

Figure 4

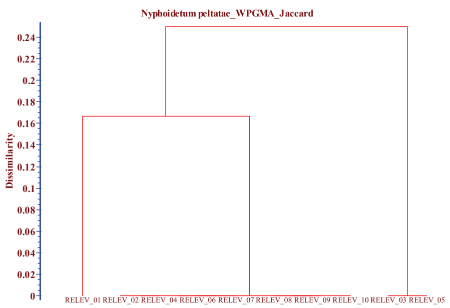

Figure 5

3260-Watercourses of plain to montanelevels with the *Ranunculion fluitantis* and *Callitricho-Batrachion vegetation*

This natural habitat are poorly represented in the Southern of Oltenia.

Chorology: Poiana Mare, Corabia, Ostroveni, Sadova, Bratovoiesti, Desa.

Typical plant communities: *Ranunculetum aquatilis* (Sauer 1947) Géhu 1961. In the floristic composition of the ptytocoenoses of this natural habitat meet numerous hygrophile and hydrophile species. Also, these phytocoeonoses have a special composition, being characterised by the dominance of the species: *Ranunculus aquatilis, Lemna minor, Lemna trisulca, Azolla filiculoides, Elodea nuttallii, Salvinia natans, Potamogeton crispus, Ranunculus trichophyllus, Ceratophyllum demersum, Myriophyllum spicatum, Potamogeton pectinatus, Potamogeton crispus, Myriophyllum verticillatum.* The plant communities at altitudes ranging between 20 m and 70 m, developed on alluvial soil and limnosoil, reaching a coverage of up to 90%.

3270-Rivers with muddybanks with Chenopodion rubri and Bidention p.p. vegetation

This natural habitat also are well-represented in the Southern of Oltenia.

Chorology: Corabia, Ostroveni, Topila Lake, Ciupercenii Noi, Sadova, Piscul Sadovei, Badosi, Grindeni, Bistret, Vrata, Arcerului Lake, Bratovoiesti, Desa. Typical plant communities:*Bidenti-Polygonetumhydropiperis* Lohm. in Tüxen 1950; *Polygono lapathifolii-Bidentetum* Klika 1935; *Echinochloo–Polygonetum lapathifolii* Soó & Csűrös 1974; *Bidentetum cernui* (Kobenza 1948) Slavnić 1951.

The phytocoeonoses have a special composition, being characterised by the dominance of the species: *Bidens tripartita, Echinochloa crus-galli, Bidens cernua, Polygonum lapathifolium, Polygonum hydropiperis, Glyceria maxima, Phragmites australis, Lycopus europaeus, Stachys palustris, Mentha aquatica, Juncus buffonius, Typha angustifolia, Typha minima, Veronica beccabunga, Lythrum salicaria, Juncus buffonius, Cyperus fuscus, Typha angustifolia, Rorippa sylvestris, Sparganium erectum, Veronica beccabunga, Ranunculus sceleratus, Butomus umbellatus, Agrostis stolonifera, Alisma plantago-aquatica, Epilobium hirsutum.* The plant communities developed on alluvial soil, reaching a coverage of up to 100%.

After an analysis of the dendrogram of the *Echinochloo–Polygonetum lapathifolii* Soó & Csűrös 1974 plant community, there can be noticed the separation of the 2^{th} surveying, from the rest of the relevées, which are grouped in a cluster. This cluster is separated in two sub-clusters: the former groups the relevées 1, 3, 4, 5, 6, 7, 8, 9, 10 and the latter, surveying 2.

The surveys of the former cluster are grouped due to the presence of the species *Butomus umbellatus* (AD=2) and Sparganium erectum (AD=1). The branches of the dendrogram are very well individualized, for the quantitative index of *Bray-Curtis*. This reflects the heterogeneity of floristic composition of the phytocoenoses of this association (Figure 6).

In the dendrogram of the *Echinochloo–Polygonetum lapathifolii* Soó & Csűrös 1974, used the WPGMA method and Jaccard index, there are pointed out also 2 distinct clusters. In the first sub-cluster there are grouped relevées 1, 2, 3, 5, 6, 8, 9 and 10 especially due to *Polygonum lapathifolium*, which abundance-dominant (AD) is 4. The latter clusters' surveys are grouped in two relevées:4 and 7. Given this dendrogram, the values of the Jaccard index, varies, reflecting the heterogeneity of the floristic structure of the phytocoenoses of this pant community (Figure 7).

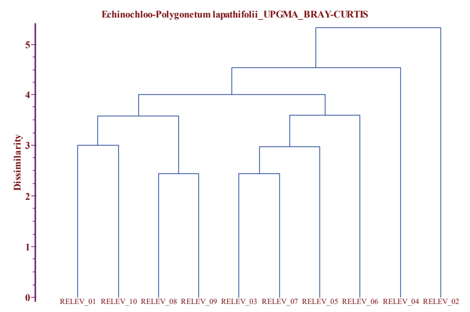

Figure 6

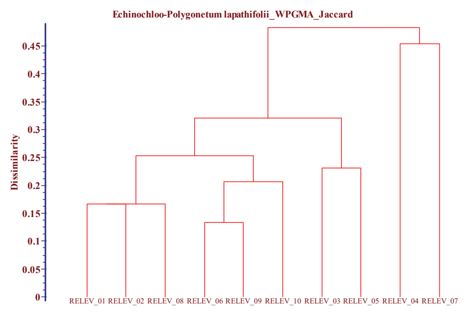

Figure 7

Conservation status and human impact

In the investigated area this habitats is characterized by the following data on the conservation status and human impact:

Conservation status: from favorable up to unfavorably-inappropriate.

Development trend of habitat: from stable up to decreasing.

Human impact and current pressures: G05.07- missing or wrongly directed conservation measures; D.06- Other forms of transportation and communication; F02.01. - Professional passive fishing; F02.03.02- pole fishing; H05.01- garbage and solid waste; F04.02.02- hand collection; E03.01- disposal of household/recreational facility wast; A.06.01.02- non- intensive annual crops for food production; D.06- Other forms of transportation and communication; H05.01- garbage and solid waste; H01.09- diffuse pollution to surface waters due to other sources not listed; E01.01- continuous urbanization.

Future threats: H01.09- diffuse pollution to surface waters due to other sources not listed; E03.01- disposal of household / recreational facility wast; E01.01- continuous urbanization; F02.03.02- pole fishing; Future threats: F02.01. - Professional passive fishing; D.06- Other forms of transportation and communication; F.03.02.09 - other forms of taking animals; H05.01- garbage and solid waste; H01.09- diffuse pollution to surface waters due to other sources not listed; F02.01.-Professional passive fishing; E01.01- continuous urbanization.

CONCLUSIONS

Six types of freshwater natural habitats of conservative interest have been identified on the Southern of Oltenia, in the Danube and Jiu floodplains.

These natural habitats are represented by hydrophilous, hygrophylous and meso-hygrophylous plant communities. Of the rare and vulnerable species we can mention: *Vallisneria spiralis, Utricularia minor, Nymphaea alba, Azolla filiculoides, Typha minima.* The phytodiversity of the freshwater natural habitats from Sotheren of Oltenia is endangered because the human impact is very high, although this area it is included in the important protected areas from Romania.

Table 1. Habitats of European interest in the studied area from Southern of Oltenia

No	***Natural habitats***	***Natura 2000 code***	***Palearctic Hab. code***
1.	Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*	3130	22.12 x (22.31 or 22.32)
2.	Hard oligomesotrophic waters with benthic vegetation of *Chara* spp.	3140	(22.12 or 22.15) x 22.44
3.	Natural eutrophic lakes with Magnopotamion or Hydrocharition-type vegetation	3150	22.13 x (22.41 or 22.421)
4.	Natural Dystrophic Lakes and Ponds, 3260 Watercourses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation	3160	22.14
5.	Watercourses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation	3260	24.4
6.	Rivers with muddy banks with Chenopodion rubri p.p. and Bidention p.p. vegetation	3270	24.52

Figure 8. Freshwater natural habitats Ostroveni (Dolj County)

Figure 9. *Nynphoidetum peltatae* – Ostroveni

Figure 10. Freshwater natural habitats Bisteț (Dolj County)

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*** Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, Annex I (Habitats Directive).

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NITRATES AND DRINKING WATER

Claudia Mariana ODOROG

University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd., District 1, Bucharest, Romania

Corresponding author email: odorogclaudia@yahoo.com

Abstract

The presence of nitrates in surface water and groundwater is a problem for many countries from European Union. The Directive 91/676/EEC establishes measures to be followed by agricultural sector to reduce nitrate pollution from nitrate and to prevent further pollution of this type. Measurements of nitrates concentrations in water wells from Sohatu village, Calarasi county, in May 2014 and July 2014, showed higher values than the maximum allowed nitrate concentration of 50 mg/l in some of the samples analyzed. The higher values were registered for ammonium. The presence of nitrates in drinking water is a problem because, in Sohatu, for many people, this is the only source of water. Drinking water with high concentration of nitrates affects the human health. The lack of a sewage system, the distance from well to latrine or stable that it is small, the use of fertilizers in large quantities than normally, the applied fertilizers without observing the periods of prohibition from code of good agricultural practice, the wells which are not covered and where not complied with conditions of hygienic and sanitary, these are some of the causes of high concentrations of nitrates. To reduce the concentration of nitrates in water wells and to prevent a new pollution, it is necessary to stablish some measures.

Key words: *nitrates, pollution, water.*

INTRODUCTION

Nitrates (NO^{3-}) and nitrites (NO^{2-}) are nitrogen compounds there are naturally in the environment. They occur by nitrification of ammonium ions, which is present in soil and water. The ammonium is oxidized, in the presence of bacteria of the genus *Nitrosomonas*, and formed nitrites. Nitrites are oxidized and formed nitrates in the presence of bacteria of the genus *Nitrobacter* (Institut National de Sante Publique du Quebec, 2003). These dynamic processes are presented in Figure 1 (Prakasa Rao, 2002).

Nitrates play a role in the growth of plants and they are used as a means of increasing the fertility of the soil. When fertilizers are used in quantities exceeding the need of plants, it increases the risk of water pollution. Nitrogen compounds can enter surface waters through the discharge of wastewater, as a result of precipitation, by deposition of dust particles, through fixation from atmosphere by bacteria from the nodes of plants (U.S. Environmental Protection Agency, 1993). Nitrogen compounds from soil come to the decomposition of organic materials of plant or animal origin, and from application of fertilizers based on nitrogen. If these compounds are not used by plants in growth process, they get into groundwater.

The Directive 91/676/EEC is one of the programs designed to reduce the water pollution, pollution caused or induced by nitrates formed from agricultural sources. The Directive defines the measured which must be followed in agriculture and there are limitations on the amounts of mineral and organic fertilizers which can be applied per unit area. To achieve this goal were defined the areas vulnerable to pollution with nitrates, the codes of good agriculture practices were developed as the programs of action for the protection of waters from pollution caused by nitrates formed from agricultural sources. The Directive has established the amount of nitrogen that can be applied per unit area of 170 kg N (Directive 91/676/EEC).

Any excess of nitrogen compounds in the soil can leaching in groundwater and can increase the concentration of nitrates in drinking water for the maximum permissible value of 50 mg/l.

Drinking water with high concentration of nitrates affects the human health. The studies indicate that 70% in the total contribution of nitrates come from fruits and vegetables, 21%

from water and the rest from meat. To avoid the adverse effects on human health, daily it is indicated to not consume nitrates over 3.7 mg/kg - body/day (Scăețeanu and Pele, 2014).

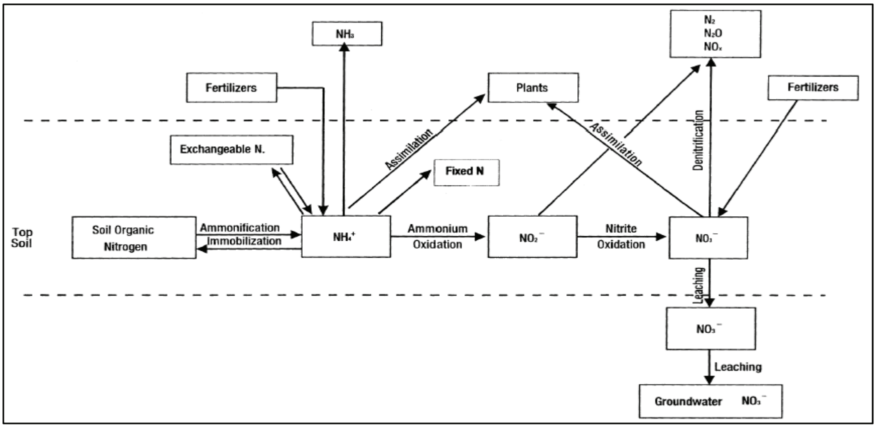

Figure 1. Nitrogen transformations in soil

To children nitrates cause the disease called methemoglobinemia: nitrates metabolize hemoglobin, the oxygen carrying component of red blood cells, into methemoglobin which is incapable of oxygen transportation. Due to the consequential color of the skin, this affection is known as Blue Baby Syndrome and mostly affects children less than six months of age.

MATERIALS AND METHODS

The water samples used in the study were seized from the countryside, located in the South-Eastern of Romania. The types of soil - chernozem (black earth) and the little slopes - allow the practice of agriculture and the cultivation of grain crops (ICPA Bucharest).
In 2013, in the same village, were measured the water quality parameters and were registered the concentrations of nitrates more than the maximum value allowed, for many of the samples analyzed.
To trace the dynamics of nitrate concentrations, in 2014 were analyzed, in May and July, samples of water obtained from the well of residents and street well.
The wells have a depth of 6 to 60 m. For analysis was used a multiparameter test well that offered data on the concentration of nitrates water analyzed, temperatures, carbon species, dissolved oxygen, chlorophyll, pH, ammonium, geographic coordinates, water depth. The system of pumping the water in the well does not always allow the introduction of test well. In this case used a container - a bucket - where to put water and insert the test well to measure.
In May 2014 were measured the water quality parameters in 7 well. The well number 2 and 3 are in the street, they are not system of pumping the water, it is not used a bucket to read the water quality parameters. The well number 1, 4, 5, 6 and 7 are in households, they have systems of pumping the water and, to read the water quality parameters, we used a bucket and put water.
In July 2014 were measured the water quality parameters in 7 wells. The well number 7 from July 2014 it is not the same with the well number 7 from May 2014. In July 2014, the well number 7 is a street well.
The analysis of water quality parameters was made in accordance with the applicable provisions (Law 458/2002; Law 311/2004).

RESULTS AND DISCUSSIONS

Table 1 reproduces the recorded values for the nitrates and ammonium concentration, in the water samples analyzed in May 2014.
After the degree of pollution caused by nitrates, water samples are analyzed and can be categorized: no pollution waters - nitrate concentration from 0 to 25 mg/l, low pollution

waters - nitrate concentration from 25 to 40 mg/l, water with the risk of pollution - nitrate concentration from 40 to 50 mg/l, water highly polluted - nitrate concentration from 50 to 100 mg/l, water very polluted - nitrate concentration more than 100 mg/l.

Table 1. Nitrate and ammonium concentration in water samples - Sohatu, May 2014

No. well	Recorded values with test well	
	Nitrates NO_3^- (maximum accepted concentration 50 mg/l)	Ammonium NH_4^+ (maximum accepted concentration 0.50 mg/l)
1	38.47	0.44
2	57.50	0.18
3	22.48	2.34
4	5.67	0.46
5	38.17	0.63
6	22.80	0.16
7	3.31	1.92

The dates from Table 1 show: 4 samples have values of nitrate concentration under 25 mg/l - the wells number 3, 4, 6 and 7 and the water is not polluted, the samples from wells 1 and 5 have values of nitrate concentration from 25 to 40 mg/l and the water is low polluted, the sample from well 2 has value of nitrates concentration from 50 to 100 mg/l and is a water highly polluted. In this well number 2, the value of nitrate concentration is more than value maximum accepted from 50 mg/l.
The results show great values for ammonium in samples from wells 3, 5 and 7.
In July 2014, the measurement of water quality parameters shows concentrations of nitrates as in Table 2.

Table 2. Nitrate and ammonium concentration in water samples - Sohatu, July 2014

No. well	Recorded values with test well	
	Nitrates NO_3^- (maximum accepted concentration 50 mg/l)	Ammonium NH_4^+ (maximum accepted concentration 0.50 mg/l)
1	21.22	0.13
2	21.53	0.16
3	15.29	0.08
4	0.54	5.25
5	23.77	4.92
6	9.35	0.96
7	21.51	0.18

The analysis of water samples from wells shows values of nitrate concentration from 0 to 25 mg/l. The water of wells is not polluted.
A comparison of the values registered for the nitrate concentration in the 6 wells analyzed in May and July 2014, shows a decrease in the value of nitrate concentration (Figure 2). The heavy rainfall can explain the low concentration of nitrate - the water was diluted and the concentration of nitrate was decreased.
According to statistics on rainfall, the years 2011-2012 are dry years and 2013-2014 are rainy years (Sandu, 2015). It is known that, in dry years, nitrates accumulate in the area from the root layer and groundwater layer. If, after dry years, succeed rainy years, nitrates, compounds of nitrogen soluble in water, penetrate into groundwater - called the piston effect.
The May 2014 was the most rainy month from 1961-2014, and July 2014 the fourth most rainy month from 1961-2014 (Sandu, 2015). The 2013, a rainy year, was succeeded by 2014, another rainy year, cause decrease of nitrate concentration as a result of dilution of water. This explains the little values of nitrate concentration in samples in May 2014, and less in July 2014. We can say that rainfall from 2013-2014 affects values registered for nitrate concentration in water samples analyzed in 2014.
The results in July 2014, show great values for ammonium in samples from well 4, 5 and 6. The presence of ammonium ions in water of well, may indicate o recent contamination with products of cellular decomposition from manure or waste water. The presence of one of nitrogen compounds in environment depends on the presence or absence of oxygen. In environment with low oxygen concentration, there are ammonium and nitrite; in environment with great oxygen concentration there is nitrate.
The studies indicate four main sources of pollution with nitrate: nitrates from the process of mineralization of waste and household waste, nitrates from waste or wastewater fermentation in the livestock sector, fermentation that is not controlled or is poorly conducted, nitrates from fertilizers, nitrates from mineralization of humus (ICPA

Bucharest, Ord. 1182/1270/2005). The order in which were given to the classes reflects the order as pollutants. The presence of nitrates in wells may be due: the natural composition of the soil, the use of chemical fertilizers with nitrogen, wells which are not covered and where not complied with conditions of hygienic and sanitary, the accumulation of nitrates in the area from root layer and groundwater layer, and penetrate into groundwater in dry years.

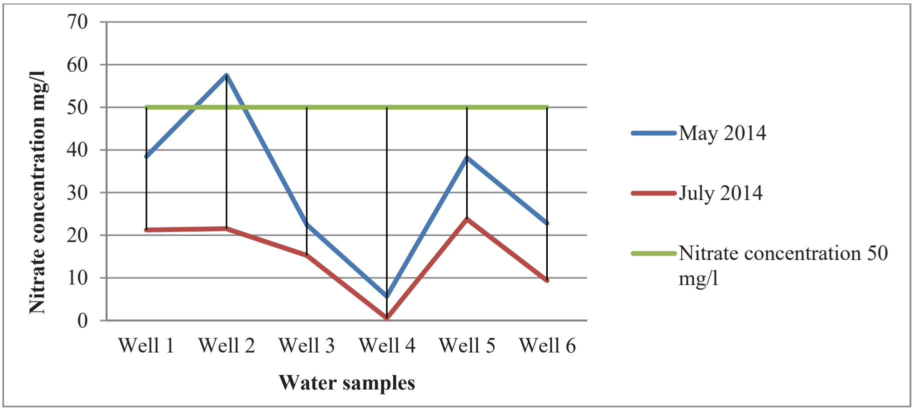

Figure 2. Nitrate concentration in wells, Sohatu, May-July 2014

The analysis of values registered for nitrate concentration in wells from Sohatu village, showed the following issues: in the wells from people that have animals (well 1, May 2014) or vegetables (well 6, May 2016) were registered great nitrate concentrations; great concentration were registered for street wells (wells 2, 3 and 7 - only July 2014). Low nitrate concentrations were found in wells that are deep - over 60 m. In addition, the street wells are not covered and not complied with conditions of hygienic and sanitary, the casings of the wells are fissured or deteriorated and the water from rain can infiltrate, the paving around the wells is missing or is fissured.

CONCLUSIONS

In this paper is present a study about monitoring of groundwater quality from Sohatu village, Călărași county. Water samples analyzed were from street wells or household wells.

In samples from street wells, elevated concentration of nitrates due to the fact that wells are not covered, hygienic and sanitary conditions are not good enough, the casings of the wells are fissured or deteriorated, the water infiltrated and get into the groundwater.

In samples from household wells, elevated concentration of nitrates due to the fact that sewage system is missing and wastewaters are discharged into the soil; the septic tanks do not have waterproofed walls and nitrate can get into the soil.

Wells are placed near latrine or stable.

Platforms for manure are missing and with rain, the liquid from manure get into the soil and into the groundwater and nitrate concentration increase.

Nitrates from fertilizers are accumulated, in dry years - 2011-2012, in the area from the root layer and groundwater layer; in the rainy years - 2013-2014, nitrates, compounds of nitrogen soluble in water, get into groundwater - increase nitrate concentration.

2013 and 2014 are rainy years and decrease the nitrate concentration as a result of dilution of water.

The presence of ammonium in water indicate a recent contamination with products of cellular decomposition from manure or wastewater.

For the protection of waters against pollution caused by nitrates from agricultural sources and for the prevention a new pollution, it is necessary to respect provisions from code of good agricultural practice and hygienic and sanitary conditions in order to place the wells.

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EFFECT OF DIFFERENT PLASTIC COVER MATERIALS AND BIOFUMIGATION TO SOIL ORGANIC MATTER DECOMPOSITION IN GREENHOUSE SOLARIZATION

Hasan ÖZ[1], Ali COŞKAN[2], Atılgan ATILGAN[1]

[1]University of Suleyman Demirel Agricultural Faculty, Agricultural Structures and Irrigation Department, Çünür, Isparta, Turkey
[2] University of Suleyman Demirel Agricultural Faculty, Soil Science and Plant Nutrition Department, Çünür, Isparta, Turkey

Corresponding author email: atilganatilgan@sdu.edu.tr

Abstract

Solarization is a hydrothermal process which brings about thermal and other physical, chemical, and biological changes the moist soil during, and even after, mulching. Organic matter, the soil is the most important component, emerges as an important parameter in the solarization applications, because it contains many changes and events. The experimental site was located at the University of Suleyman Demirel Research Center in Isparta. Greenhouse experiments were conducted during 2011-2012 in the 60 day period (July-August). The experiments were arranged as a randomized block design, with three replications per treatment, based on a plot size of 2m x 2m. Four soil treatments and control (non-sol) were applied: solarization, biofumigation, bubble solarization and bubble-water solarization. After the experiment, samples of treated soil were taken from 15 and 30 cm depths from the center of each tested plot, immediately after termination of solarization and then soil was tested organic matter. The high organic matter content is determined in Sol treatment according to data from the year 2011. According to these results, it can be said that Sol treatment was the lowest mineralization in applications. Similarly to the first year, in 2012, while amount of organic matter decreased with depth, it was determined that only an increase in BSol treatment. Based on these results, it was concluded that soil organic matter with solarization application convert available nutrition form to plants with decomposition it.

***Key words**: biofumigation, decomposition, greenhouse, organic matter, soil solarisation.*

INTRODUCTION

Soil solarization refers to covering the soil with transparent plastic sheeting during the appropriate period. The plastic sheeting is the modern tool for capturing solar energy to heat the soil in the open field or a greenhouse (Katan and De Vay, 1991). Solarization is a hydrothermal process which brings about thermal and other physical, chemical, and biological changes the moist soil during, and even after, mulching (Stapleton et al., 1985).

The method is sample, safe, and effective, leaves no toxic residues, and can be easily used on a small or large scale. Soil solarization has the long-term benefits of increased nutritional status, and decreased microbial, nematode and weed population of the soil, which finally leads to better plant vigor (Sofi et al., 2014).

Soil solarization with polyethylene film mulch alone may not be consistently effective for the control of soil borne pathogens and therefore combinations with organic or inorganic soil amendments have been used to enhance the effectiveness of solarization (Ramirez-Villapudua and Munnecke, 1987; Komariah et al., 2011). Solarization may cause an increased growth response in plants not only due to reductions in soil pathogens but also due to changes in chemical or physical properties of the soil (Seman-Varner et al., 2008). Soil solarization improves soil structures and increases the availability of nitrogen and other essential plant nutrients (Elmore et al., 1997).

Although the heat generated in soil by solar radiation and the resultant death of plant pathogens and pests encompass the mayor principles of soil solarization, the increase in available plant nutrients and relative increase in populations of rhizosphere competent bacteria (Stapleton and DeVay, 1984). One of common results of soil heating is an increase in concentration of certain soluble mineral nutrients. When soil is heated, much of resident microbiata is killed and degraded, thus liberating the mineral nutrients (Stapleton, 1990). Organic matter, the soil is the most important component emerges as an important parameter in the solarization applications, because it contains many changes and events.

The main objective of this research was to determine the effect of traditional solarization cover material with testing new different covering materials and bio-fumigation treatments to soil organic matter decomposition.

MATERIALS AND METHODS

The experimental site was located at the University of Suleyman Demirel Research Center in Isparta. Greenhouse experiments were conducted during 2011-2012 in the 60 day period (July-August). The soil at the study site was range alluvial profile, mild and moderate alkaline character. Measured soil texture was 46 % clay, 35 % silt and 19 % sand.

The experiments were arranged as a randomized block design, with three replications per treatment, based on a plot size of 2m x 2m. Four soil treatments and control (non-sol) were applied: solarization (Sol), biofumigation (BioSol), bubble solarization (BSol) and bubble-water solarization (BWSol). In the research, two different cover materials were used. For the soil used for solarization and biofumigation treatments were covered with a 0.04mm transparent polyethylene film. For bubble solarization and bubble-water solarization treatments were covered with 30 mm in diameter, 12.5 mm in height bubble transparent polyethylene film.

In the biofumigation (BioSol) treatment, wet poultry manure of 1.5 kg m^{-2} was added to each parcel in order to increase temperature even further by virtue of bio-fumigation Barbour et al. (2002).

In the third application (BSol), double-layered bubble cover material with air between layers, recommended by Bainbridge (2010), was implemented. The air between the two layers of polyethylene on this material was expected to ensure temperature isolation between the soil and air, therefore, to attain higher temperatures compared to control group. The fourth application (BWSol) includes the bubble water solarization study that is tried for the first time for solarization process and that constitutes the main element of hereby research. In this test, the cover material consists of cover material obtained by filling water into the bubble wrap in BSol application.

After the experiment, samples of treated soil were taken from 15 and 30 cm depths from the center of each tested plot, immediately after termination of solarization and then soil was tested organic matter according to Schlichting and Blume (1966).

All data were subjected to one way analysis of variance with the MSTAT-C software (Version 1.2; Crop and Soil Department Michigan State University). Classification was applied to Duncan test described by Bek (1983). Variance analysis was prepared using a randomized complete block experimental design model.

RESULTS AND DISCUSSIONS

The results for the organic matter content defined in the study are given in Table 1. The high organic matter content is determined in Sol treatment according to data from the year 2011. According to these results, it can be said that Sol treatment was the lowest mineralization in applications. It was determined that the amount of organic matter decreased with depth. The difference between the mean of the values were not statistically significant ($P<0.05$).

Table 1. Change of organic matter content at the treatments (%)

	Years	Depth	Sol	BSol	BWSol	BioSol	Non-Sol
Organic Matter[1] (%)	2011	0-15 cm	1.92a	1.85ab	1.87ab	1.77ab	1.86ab
		15-30 cm	1.36b	1.57ab	1.41ab	1.49ab	2.11a
	2012	0-15 cm	1.60b	1.88ab	1.65b	1.69b	1.77ab
		15-30 cm	1.55b	2.28a	1.50b	1.65b	1.59b

[1]Different small letters indicate significant differences for $P<0.05$ in the column for each year

The second year, the highest amount of organic matter is determined in the 15-30 cm soil depth BSol treatment. Similarly to the first year, in 2012, while amount of organic matter decreased with depth, it was determined that only an increase in BSol treatment. Every each year in terms of the overall average, the difference was not statistically significant between treatments ($P<0.05$).

Soil solarization, which is a moderate heating treatment, did not result in significant changes in total soil organic matter (Katan, 1991).

Ozeres-Hampton et al (2004) and Seman-Varner et al. (2008) showed that organic matter decomposition was not affected by solarization. Organic matter values determined in study by the depth and mean per year is given in Figure 1 and Figure 2.

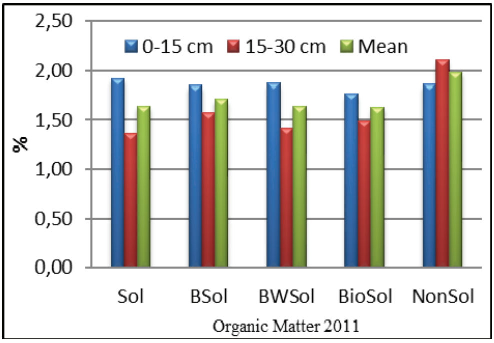

Figure 1. Organic matter values in 2011

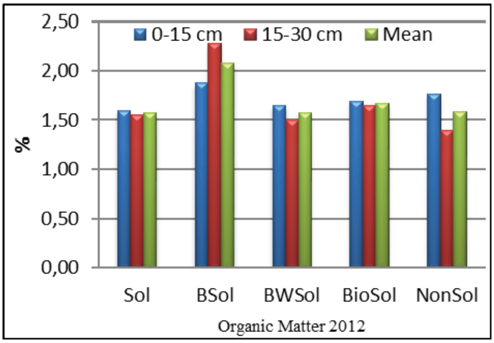

Figure 2. Organic matter values in 2012

Solarization prepares favorable environment for plants, changing the soil physical and chemical structure. In particular, plays an important role decomposition of organic matter in transforming such as plant nutrient elements N, Ca^+, Mg^+, K^+ available plant nutrition form for the plants (Elmore et al., 1997).

CONCLUSIONS

Analyzed results obtained in this study, compared to control parcel, organic matter content in treatments decreased in both depth only except BSol treatment in 2012. Based on these results, it was concluded that soil organic matter with solarization application convert available nutrition form to plants with decomposition it.

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SOIL CHARACTERIZATION FROM OSOI - MORENI AREA, IAȘI, BY ANALYZING CERTAIN INDICATORS OF SALINITY

Maria Cătălina PASTIA, Florian STĂTESCU, Adriana Nicoleta STAN

"Gheorghe Asachi" Tehnical University of Iasi, Faculty of Hydrotehnical Engineering, Geodesy and Environmental Engineering, 65 Prof. dr. docent Dimitrie Mangeron Blvd., 700050, Romania

Corresponding author email: mariapastia@yahoo.com

Abstract

Saline soils are characterized by an excess amount of soluble salts and sodium, which can be changed in the soil water. This excess of salt changes the physical and chemical properties of soil, creating an environment that inhibits crops. Therefore, the accumulation of salts in the soil is one of the main reasons for a low level of agricultural production. At this point, one of the most pressing issues worldwide is overpopulation, which highlights further the issue of sustainable food production.

As a result, in recent years, more emphasis has been placed on research and soils affected by salinity on finding ways to improve them. To effectively address this problem it is necessary to research in terms of the physical properties of these soils chemical and microbiologycal and the effective implementation of scientific discoveries and the sustainable management. This paper investigates some indicators of salinity and the correlation between them, to characterize the soils affected by salinity and to show that it creates problems in agriculture, and presenting some plant species tolerant to salt.

Key words*: saline soils, salt tolerance, crop.*

INTRODUCTION

Salinity is a process where we have accumulation in soil with excessive quantities of sodium salts, calcium, magnesium, potassium, particularly accumulations of chlorides, sulphates, carbonates and bicarbonates, which give us a negative fertility soil (Eckelman et al., 2006).

This accumulation of salts, especially sodium salts, it is the first physiological threat when we speak about ecosystem.

Salinity related land degradation is becoming a serious challenge for food and nutritional security in the developing world. As per FAO/UNESCO soil map of the world, a total of 953 million ha covering about 8 percent of the land surface is suffering from salinity / sodicity (Szabolcs I., 1971).

Salt-affected soils are reported to comprise 42.3 percent of the land area of Australia, 21.0 percent of Asia, 7.6 percent of South America, 4.6 percent of Europe, 3.5 percent of Africa, 0.9 percent of North America and 0.7 percent of Central America (El-Mowellhey N., 1998). Excess of salts in a soil can bring drastic changes in some of the soils physical and chemical properties resulting in the development of an environment unsuitable for growth of most crops.

Soils having salts in the solution phase and/or sodium ions (Na^+) on the cation exchange sites exceeding the specified limits are called salt-affected soils. Major captions in salt-affected soils are sodium (Na^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), and to a lesser extent potassium (K^+).

The major anions are chloride (Cl^-), sulphate (SO_4^{2-}), bicarbonate (${HCO_3}^-$), carbonate (${CO_3}^{2-}$), and nitrate (${NO_3}^-$). These soils are generally divided into three broad categories: saline, sodic and saline-sodic.

MATERIALS AND METHODS

Description of the research perimeter (Site)

<u>*Study area*</u>

The area in which the research took place and the soil samples were taken, (Figure 1) is part of Iaşi County, Prisacani village, common meadow Prut and Jijia. The village is located in the eastern part of the county.

Common meadow Prut and Jijia rivers consists of alluvial deposits with sandy-clayey facies or sandy loam, tens meters of thick argillized surface, instead of the old river bed or lake bottoms, these layers are deposited on a bed of marl.

Figure 1. Locating the research base perimeter of Osoi-Moreni, Prisacani village

According to the literature (Nițu et al., 1985), the soils from the common meadow Jijia and Prut rivers, occur as alluvial, calcareous and saline marshy grounds.

Alluvial soils are clayey, fallow, or becoming fallow, some evolved, other less developed, with morphological differentiation and clear texture. In the formation of these soils an important role has been the influence of groundwater, located at depths of 1-2 m and its mineralization till 5 g/l.

Laboratory tests

To describe some soil physical and chemical properties i.e. grain size and texture, pH, electrical conductivity and measurements on the ion content of (Na^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), SAR (Sodium Absorption Ratio) and soil ESP (Exchangeable Sodium Percentage) of the soil samples were using laboratory tests as described by Chemical and microbiological analysis methods of National Institute of Research and Development for Soil Science, Agrochemical and Environmental Protection of Bucharest and Geotehnica - laboratory tests (Stanciu and Lungu, 2013; ICPA Bucharest, 1987).

For the classification into classes and subclasses of texture use the methodology presented in Soil Assessment Study (ICPA Bucharest, 1987).

Soil density (D) has been determined by the pycnometric method, and the results had expressed in g/cm^3.

Bulk density (DA) has been determined by the metal cylinder of known volume (100 cm^3) momentary soil moisture, expressed in g/cm^3.

$$DA = \frac{m_2 - m_1}{V_t} \quad (1)$$

Total porosity (PT) has been determined by mathematical calculation according to formula:

$$PT = \left(1 - \frac{DA}{D}\right)100 \quad (2)$$

and the results has been expressed in % by volume (% v/v).

The degree of humidity (Sr): the initial degree of moisture is defined as the ratio between the volume of water contained in soil pores and the total volume of the pores in that soil, and it has been determined during the endometrium test.

$$S_r = \frac{\rho_s}{e_0 \rho_w} \cdot \frac{w}{100} \quad (3)$$

where:

ρ_s - skelett density;

e_0 - the index of the initial pore;

ρ_w - the density of water;

w - humidity of the soil sample in their natural state.

Four different criteria are currently recognized in the scientific literature as indicators of salinity. These are denoted by the electrical conductivity (ECe), which describes the salinity of the aqueous extract at 25 °C; the sodium absorption rate (SAR), which is the ratio of sodium cations to the soil compared to the combined concentration of calcium cations (Ca^{2+}) and magnesium (Mg^{2+}) in the soil; exchangeable sodium percentage (ESP) is used to determine the level of sodium in the soil and the pH of the soil.

Two of these criteria are defined in equations (4) and (5) (Sumner, 1993; Rengasamy, 1999; Quirk, 2001):

$$SAR = \frac{Na^{+}}{\sqrt{(Ca^{2+} + Mg^{2+})/2}} \quad (4)$$

were:

SAR - Sodium Absorption Ratio, $(cmol\ kg^{-1})^{0.5}$

Na^{+}, Ca^{2+}, Mg^{2+} - Mesured exchangeable Na^{+}, Ca^{2+}, Mg^{2+}, respectively, $cmol\ kg^{-1}$

$$ESP = (Na^{+} / CEC)100 \quad (5)$$

were:

ESP - Exchangeable Sodium Percentage, %

Na^{+} - Mesured exchangeable Na^{+}, $cmol\ kg^{-1}$

CEC - Cation Exchange Capacity, $cmol\ kg^{-1}$

An ESP of 15 (SAR<13) is generally considered the threshold below which soils are classified as non-sodic, and above which soils are dispersive and suffer serious physical problems when water is applied (http://www.soils.org/sssagloss/, 2006).

However, considerable data exist on infiltration rates and hydraulic conductivities that show that sodic soil behaviour may occur at ESP values of less than 5 if ECe is lower than 4 dSm^{-1} (Sumner and al., 1998).

Therefore, the principal factor determining the extent of the adverse effects of Na^{+} on soil properties is the ambient electrolyte concentration in the soil solution, with low concentrations exacerbating the harmful effects of exchangeable Na^{+}. The SAR has been widely used as a proxy for ESP within the range 0-40 (the ESP range which is most common in agricultural soils).

Therefore a soil having electrical conductivity of the saturated paste extract (ECe) ≥ 4 dS m^{-1} and sodium adsorption ratio (SAR) < 13 is called a saline soil. Soils having (ECe) < 4 dS m^{-1} and sodium adsorption ratio (SAR) ≥ 13 is are designated as sodic soils. If a soil has (ECe) ≥ 4 dS m^{-1} and sodium adsorption ratio (SAR) > 13 it is categorized as a saline-sodic soil (Table 1). Saline-sodic and sodic soils are generally treated together because of similar amelioration practices are used for these soils.

Table 1. Classes depending on the variation salinity indicators SAR, ESP, pH and ECe

Type of soil	The property of soil			
	SAR	ESP	pH	ECe (mS/m1)
Non-saline, non-sodic	< 13	< 15	< 8.5	< 4
Saline	< 13	< 15	< 8.5	≥ 4
Sodic	≥ 13	> 15	> 8.5	< 4
Salin-sodic	> 13	> 15	> 8.5	≥ 4

RESULTS AND DISCUSSIONS

The results obtained by the laboratory analyzes and mathematical calculations, give us the possibility to define the soil studied in terms of: texture, total porosity, the degree of humidity, pH, ECe, Na^{+}, Ca^{2+}, Mg^{2+}, Na^{+}, SAR, ESP. These results are showed in Table 2.

Table 2. Analytical data on the physical and chemical properties of soils in the studied area

	UM	(0-25 cm)	(25-50 cm)	(50-75 cm)	(75-100 cm)
Gravel (>2 mm)	%	-	-	-	-
Coarse sand (0.5 mm<d<2 mm)	%	-	-	-	-
Medium sand (0.25 mm<d<0.5 mm)	%	-	-	-	-
Fine sand (0.05 mm<d<0.25 mm)	%	4.25	2.60	4.25	4.25
Silt (0.005 mm<d<0.05 mm)		39.20	63.34	26.23	30.04
Clay (0.002 mm<d<0.005 mm)	%	41.19	26.81	23.11	25.48
Fine clay (<0.002 mm)	%	15.36	7.25	46.41	40.23
Textural class	-	Clay	Silty - clay	Loamy clay	Loamy clay
Bulk density	g/cm^3	1.79	1.81	1.89	1.84
Total porosity	%	49.79	44.88	42.06	42.89
Content of moisture	%	32.12	21.79	20.73	19.02
The degree of humidity	%	0.87	0.72	0.77	0.68
pH	unit. pH	6.83	6.9	6.92	6.99
ECe	dS/m^{-1}	93.3	85.,4	103.3	110.7
Na^{+}	m.e/100 g	25.96	25.34	0.81	3.22
$Ca^{2+} + Mg^{2+}$	m.e/100 g	7.12	8.78	8.01	9.46
SAR	m.e/100 g	13.57	11.44	12.87	11.88
ESP	%	63.08	59.66	63.92	60.94

After analyzing the size particle, the soil has been classified as belonging to the textural clay and clay-loam classes (www.soils.org, 2006).
The soil is characterized by a content of clay between 56 and 69.2%. The resulting data are in agreement with the specialty literature, which describes broadly, the soils of common meadow the Prut and Jijia rivers as fine textured soils.
Bulk density values range between 1.79 to 1.89 for the soil. It was observed that the density values increase with the depth.
The soil with porosity values of less than 50%, large values of density and a fine texture, will negatively affect the retention capacity of the water, the permeability, aeration and the ratio drainage / water infiltration (Tanji, 1990). The porosity values of the soil are small. The soils with a high clay swells strongly in the presence of water, which reduces the water permeability. The low permeability leads to stagnation of water in the soil and at the soil surface. This is accompanied by a number of processes and transformations under anaerobic conditions (Maas and Hoffman, 1977). The results obtained regarding the soil moisture and soil degree of humidity, confirms this assertion. Exchangeable of sodium percentage quantifying the relative abundance of sodium (mainly) as compared to the complex of divalent cations in exchange cation and provides a means of assessing the risk of structural instability of the soil vulnerable in this conditions. The electrical conductivity of the solution is correlated with the degree of soil salinization. So, the data resulting from the analysis performed in the laboratory shows that the soil has a high degree of salinity, which can be grown only with plants of highly tolerance to salinity.
These characteristics are useful to improve the saline / alkali soils, the irrigation, sewage and waste water.

Problems created in agriculture

Crops on this saline soils are characterized by small plants. "Dwarf" plant is the first visible effect of the action of soluble salts in agriculture.
Some of physical characteristics of saline soils, the classification as clay textural classes and clay-loam, bulk density with high values, the porosity values below 50% will adversely affect water retention capacity, permeability, aeration and report leakage / seepage water.
Other features such as high content of clay, which will swell strongly in the presence of water reduces their permeability for the water. Low permeability leads to stagnation of water in soil and soil surface, which is accompanied by a number of processes and transformations under anaerobic conditions. All these features makes it difficult for the cultivation of these soils and shortens the period in which you can perform agricultural work.
The high concentration in salt contents disrupts the quality of water and nutrients, plant metabolism, and the absorption by plants and soil biota. The water which contains a large amount of salt dissolved brought into contact with the plant cells, with protoplasmic mucous membrane, leads to reducing, shrivelling and the loss of the cell viability. Plant physiology research is required for tolerant salinity plants, for achieve the best results in the desalination of soil, remediation, preservation of these characteristics and for economic optimization.
Plant tolerance to salinity is their ability to resist on the effects of concentrated soluble salts in the root.
Salinity tolerant plants have a strongly ameliorative character. Through their ability to extract large amounts of soluble salts, especially Na^+ and Cl^- or $NaCl_2$ and to accumulate in the leaves. These plants contribute along with the other specific measures to improve salinity with the condition to remove the whole mass of the vegetation.
The lower limit of saturation extract electrical conductivity (ECe) of these soils is conventionally set at 4 dS m^{-1} (at 25^oC). Actually, sensitive plants are affected at half this salinity and highly tolerant ones at about twice this salinity.
The salt tolerance of a crop is not an exact value. It reflects the ability of a crop to resist the adverse, non-specific effects of excessive root zone salinity. Although the capacity of a crop to endure salinity cannot be stated in absolute terms, the relative crop responses to known salinities under certain conditions can be predicted.
The tolerances of crops to salinity are generally divided into four classes i.e. sensitive,

moderately-sensitive, moderately-tolerant and tolerant (Akhtar et al., 1994). Generally, the threshold and linear slope for a crop remain within one class. Where the linear curve for a crop crosses division boundaries, the crop was classified based on the tolerance at lower levels at which yield was commercially acceptable.

Bean (*Phaseolus vulgaris* L.), strawberry (*Fragaria x ananassa* Duch.), peas (*Pisum sativum* L.), lentil (*Lens culinaris*) are sensitive tolerance to salinity.

Soya (*Glycine max*), peanuts (*Apios americana*), onion (*Allium cepa*), millet (*Pennisetum glaucum*), flax (*Linum usitatissimum*), garlic (*Allium sativum*) are moderately-sensitive tolerance to salinity.

Indian mustard (*Brassica juncea*), wheat (*Triticum aestivum*), sunflower (*Helianthus annuus*), barley (*Hordeum vulgare*) rise (*Oryza sativa*) and cotton (*Gossypium hirsutum*) are moderately-tolerant to salinity.

Canola (*Brassica napus* L.), sugar beet (*Beta vulgaris* L.), Rhodes grass (*Cynodon gayana*), Kallar grass (*Leptochloa fusca*), Bermuda grass (*Cynodon dactylon*), are tolerant to salinity.

Various approaches have been taken to improve the salt tolerance of these crops by introducing genes for salt tolerance into adapted cultivars, including screening of large international collections, extensive testing of selected cultivars under field conditions, conventional breeding methods and unconventional crosses with the crop-specific relatives. The aim has been to exploit variation in salt tolerance within a particular crop and its progenitors or close relatives to produce new cultivars with more tolerance than the existing cultivars.

Another issue in cultivating soils affected by the salinity, is the choice of crops used as an amelioration tool, to resist the absence of oxygen when excessive irrigations are applied to leach salts from top soil to lower depths. Root zone salinity in conjunction with oxygen deficiency greatly increases salt uptake compared with saline non-waterlogged conditions (Maas and Hoffman, 1977). This effect may cause failure in active transport and exclusion processes in the root membrane (Drew, 1983; West and Taylor, 1984; Dagar et al., 2004).

There seems to be a need to evaluate salt tolerant crops for their resistance again hypoxia. The genotypes showing greater tolerances against the combined effects of salinity and hypoxia may be a better choice for soil amelioration. Thus genotypes of increased tolerances to salinity and hypoxia should be investigate or developed through genetics and bioengineering processes. Use of suitable rotations of the salinity-hypoxia-tolerant crops during soil amelioration may help promote lowering of the water table-leaching of salts and soil aggregation.

CONCLUSIONS

The analysis of the results obtained from conducted research, allow us to take the following conclusions:

According to the analysis of particle size, the soil present fine texture.

The soils presents high values of bulk density, lower value of porosity, with high degree of compaction, these qualities printing a low water permeability of soils.

Soils are characterized by a high degree of humidity, water stagnation at the surface and inside the soil horizons.

The results of this study support the conceptual model of aggregate turnover developed by Six et al. (1999): tillage practices disrupt large macroaggregates.

SAR values above 13 correlated with saturation in sodium (ESP) greater than 15% (of T) on a minimum thickness of 10 cm, it identifies a Natric horizon. SAR values between 4 and 13 correlated with saturation in exchangeable sodium (ESP) 5-15% (of T) on a minimum thickness of 10 cm, identify us a hiponatric horizon.

Corroborating these dates allow us to characterize these soils from the physical features point of view. Same dates are used in the calculation of the water stocks, choosing the agrotechnical applications and the calculation of the amendments.

Crop diversification and production systems based on plant species resistant to salinity, are likely to be the key to the future agriculture and economic.

This is relevant for arid and semi-arid countries less developed, where most farmers cultivate salt-affected land and the resources are poor and the communities experiencing severely unemployment, poverty and male population migration.

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BIOTA'S EVOLUTION OF GRAY FOREST SOILS IN THE CENTRAL ZONE OF THE REPUBLIC OF MOLDOVA

Irina SENICOVSCAIA

"Nicolae Dimo" Institute of Soil Science, Agrochemistry and Soil Protection,
100 Ialoveni Str., MD-2070, Chisinau, Republic of Moldova

Corresponding author email: irina_sen@mail.ru

Abstract

The biota status of virgin and arable gray forest soils in the central zone of the Republic of Moldova has been investigated statistically. Sampling was carried out in profiles per soil horizons and from 0-30 cm layer separately. Database of invertebrates, microorganisms and enzymatic activities has been formed. The current status of biota of the old-arable gray forest soil is characterized by the significant reduction in comparison with the level of the 1960s and with soil's standards that are in conditions of natural ecosystems. The highest values of biota's abundance were registered in virgin soils in the forest with the exception of humus-mineralizing microorganisms. Number of invertebrates was 169.3-222.3 ex m^{-2}, Lumbricidae family - 63.6-102.4 ex m^{-2} and microbial biomass - 686.9-1065.1 μ g C g^{-1} soil respectively. Biological indices in soil profiles decreased with the depth and depended of the form of farming system. The negative effects on biota and humus status have been observed as a result of the long-term land management practices without organic fertilizers. The growth of humus-mineralizing microorganisms has been noticed. Annual losses due to mineralization processes account for 0.01%. Trends and regression equations describing the growth of humus-mineralizing microorganisms and the fall of humus content in old-arable gray forest soils have been calculated.

Key words*: biota, humus, gray forest soil, mineralization process, land management.*

INTRODUCTION

Soil biota should be considered as a component of the integrated management of natural resources. Microbial soil quality indicators are widely used in the ecological management of Europe's forests (Raubuch and Beese, 1995). In Canada, the forest certification process in environmentally sustainable forest management is associated with applying of microbial soil quality indicators (Staddon et al., 1999). Database of soil biota-standards is essential for determination of the mechanism of biota's natural resistance to changes of the fluctuation of climatic conditions and research of different aspects of biodiversity, degradation processes diagnostics and ecological certification of soils (Senicovscaia et al., 2012). Soil biological indicators contain the information about the landscape stability and environmental benefits for the agricultural politics at the national level. The use of soil bio-indication as an integrated monitoring tool for soil degradation might serve as a prospect solution (Ananieva et al., 2002).

The process of destruction of natural ecosystems and intensification the biological degradation of soils are interrelated. Investigations of soil biota in conditions of natural standard sites that are in equilibrium, preserving all basic parameters and have not lost their ecological and genetic links with components of the landscape are very important. At that point, the ideal research object is biota of gray forest soils (grayzems) located in the central zone of the Republic of Moldova. Evolution of the biota of these soils is interesting also from the point of view of the national soil quality standards.

The purpose of the research was to determine the influence of different land management practices on soil biota's state in gray forest soils aiming to develop the scale parameters of their stability for the national soil quality standards.

MATERIALS AND METHODS

The experimental site is located in the central zone of the Republic of Moldova, in the wooded steppe of the central - Moldovan forest province, in the district No. 8 of gray forest soils and leached chernozems of the wooded steppe of hilly Kodru Forests, in the Ivancha village, Orhei region (Figure 1). Biota's state in the gray forest soil in the condition of long-term arable has been investigated in comparison with virgin soils in the old-growth (primary) forest in conditions of natural ecosystems. The soil is a gray forest soil.

Sampling for microbiological and enzymatic indicators was carried out in 2 profiles per soil horizons to a depth of 140 cm in 2005 and from 0-30 cm layer separately during 1988-1998 and 2005-2010. Additionally, some microbiological indicators were compared with the level of the 1960s. Invertebrates sampling was carried out from 14 soil semi-profiles to a depth of 60 cm in 2009 and 2010. Furthermore the database of invertebrates for the period 1991-2006 has been used (Demchenko, 2006). Thus, the database of soil biological indicators covers the period between 1958 and 2010.

Figure 1. Fragments of natural and agricultural landscapes located in the central zone of the Republic of Moldova

Status of invertebrates was identified from test cuts by manually sampling the soil layers to the depth of soil fauna occurrence (Gilyarov, 1965). Diversity at the family level and classification according to feeding habits were categorised according to Gilyarov and Striganova (1987).

Microbiological properties. The microbial biomass carbon (C) was measured by the rehydration method (the difference between C extracted with 0.5M K_2SO_4 from fresh soil samples and from soil dried at 65-70^oC for 24h (Blagodatsky et al., 1987). Reserves of MB have been calculated taking into account the carbon content of the microbial cell and the bulk density of soils. Counts of culturable microorganisms (heterotrophic bacteria, humus-mineralizing microorganisms, actinomycetes, bacteria from the family of the *Azotobacter* and fungi) were obtained on agar plates (Zvyagintsev, 1991).

Enzymatic activity. The potential enzymatic activity was determined in samples of the air-dry soil. The urease activity was measured by estimating the ammonium released on incubation of soil with buffered urea solution by colorimetrical procedure (Haziev, 2005). The catalase activity was determined by the volumetric method by the rate of hydrogen peroxide's decomposition during its interaction with the soil and by the volume of released oxygen (Galstyan, 1978). The dehydrogenase activity was determined by the colorimetric technique on the basis of triphenylformazan (TPF) presence from TTC (2,3,5-triphenyltetrazolium chloride) added to soil (Haziev, 2005). The polyphenoloxidase and peroxidase activities were determined by the colorimetric technique using hydroquinone as a substrate (Karyagina and Mikhailovskaya, 1986).

Soil chemical properties. Organic carbon was determined by dichromate oxidation; the humus content was estimated using the coefficient 1.724 (Arinushkina, 1970).

Soil biological indices were evaluated by analysis of variance and correlation. Statistical parameters of soil invertebrates were calculated taking into account the depth of soil fauna occurrence, microorganisms and enzymes - for the layer of 0-30 cm.

RESULTS AND DISCUSSIONS

Comparison of biota in virgin and arable gray forest soils. The number of invertebrates in the virgin gray forest soil amounts to 169.3-222.3 ex m^{-2}, *Lumbricidae* family - to 63.6-102.4 ex m^{-2}, and its biomass - to 29.1-64.7 and 23.9-59.1 g m^{-2} accordingly (Table 1). The number of saprophagous constitutes of 90.4-127.8 ex m^{-2} that is 53.4-57.5% of the total number of invertebrates. The share of earthworms in the total abundance of invertebrates in the soil of natural ecosystems constitutes of 37.6-46.1% and their biomass - 82.1-91.3%. The average weight of one exemplar of *Lumbricidae* family in the virgin gray forest soil constitutes 0.5 g. Indices of invertebrates' number and biomass in the virgin soil are characterized by the medium and considerable variability (27-67%). Virgin soils are characterized by a high diversity of invertebrates. In addition to the *Lumbricidae* family species from the families of *Formicidae*, *Enchytraeidae*, *Elateridae*, *Carabidae, Scarabaeidae, Araneae, Apidae, Pieridae, Cerambycidae, Scutelleridae, Tenebrionidae, Coccinellidae* and other have been found in the virgin soil.

Table 1. Statistical parameters of biota in the gray forest soil under different land management in the Central zone of the Republic of Moldova

Index	Virgin gray forest soil						Arable gray forest soil					
	min	max	mean value	V,%	confidence interval ($P \leq 0.05$)	n	min	max	mean value	V,%	confidence interval ($P \leq 0.05$)	n
Invertebrates												
Number of invertebrates, ex m^{-2}	96.0	248.0	195.8	27	169.3-222.3	12	25.0	192.0	63.8	74	46.6-81.0	22
Biomass of invertebrates, g m^{-2}	16.4	100.8	46.9	60	29.1-64.7	12	4.5	9.8	7.6	27	6.5-8.6	12
Number of *Lumbricidae* fam., ex m^{-2}	40.0	144.0	83.0	37	63.6-102.4	12	14.0	104.0	43.2	71	32.0-54.4	22
Biomass of *Lumbricidae* fam., g m^{-2}	7.4	90.8	41.5	67	23.9-59.1	12	4.3	9.6	6.8	27	5.8-7.7	12
Microorganisms (0-30 cm)												
Microbial biomass, μ g C g^{-1} soil	529.0	1105.5	876.0	26	686.9-1065.1	8	119.6	331.2	244.3	28	209.9-278.7	18
Heterotrophic bacteria, CFU g^{-1}soil*10^6	4.1	9.9	5.9	36	4.8-8.0	15	2.3	4.8	3.3	10	3.3-3.4	33
Humus-mineralizing microorganisms, CFU g^{-1} soil*10^6	1.2	3.6	1.9	46	1.1-2.8	15	5.0	11.4	8.9	15	8.6-9.2	33
Actinomycetes, CFU g^{-1} soil*10^6	0.9	4.3	2.5	42	1.4-3.6	15	0.9	3.1	2.4	10	2.38-2.42	33
Fungi, CFUg^{-1} soil*10^3	92.0	130.0	110.0	11	98.1-121.9	15	24.0	70.0	40.5	30	33.5-47.6	33
Azotobacter gen., CFUg^{-1} soil	0	0	0	0	0	15	0	52.0	8.1	26	1.6-14.5	33
Enzyme activity (0-30 cm)												
Urease, mg NH_3 10 g $^{-1}$soil 24 h^{-1}	6.2	9.9	8.1	18	5.4-9.7	6	0.3	2.5	1.4	51	0.9-1.9	10
Catalase,	2.1	5.8	3.9	36	3.1-4.7	14	0.8	3.5	2.2	39	1.8-2.6	22
Dehydrogenase, mg TPF 10g^{-1} soil 24h^{-1}	2.00	2.76	2.40	11	2.13-2.67	6	0.25	1.50	0.74	42	0.59-0.89	20
Polyphenoloxidase, mg 1,4-p-benzoquinone 10 g^{-1} soil 30 min^{-1}	1.5	8.5	4.1	70	1.1-7.1	6	1.0	4.5	2.3	41	1.9-2.7	22
Peroxidase, mg 1,4-p-benzoquinone 10 g^{-1} soil 30 min^{-1}	22.5	32.5	27.8	15	23.4-32.2	6	14.0	31.0	25.7	20	23.4-28.0	22

The soil in conditions of natural ecosystems contains 12 families of invertebrates. About 15 species of invertebrates have been identified in the virgin gray forest soil. The following species have been detected in the virgin gray forest soil: *Lumbricus terrestris, Apporectodea roseus, Glomeris marginata, Diplopoda De Blainville, Dorcadion fulvum, Eurygaster maura, Bombus terrestris, Carabus convexus, Scolopendra cingulata, Coccinella septempunctata, Galeruca tanaceti, Blaps mucronata, Formica rufa* et al. Saprophagous prevail in the composition of the edaphic fauna in the virgin soil. They comprise 88.6% of the total number of invertebrates in the virgin gray forest soil.

The total biomass of microorganisms in the soil under forest ranges from 529.0 to 1105.5 μ g C g^{-1} soil in the 0-30 cm layer. It is much greater than its abundance in arable soils. A similar trend has been noticed in the number of the heterotrophic bacteria and fungi. But the number of the humus-mineralizing microorganisms and actinomycetes in most cases is much lower than in the arable soil. *Azotobacter* genus in the gray forest soil is found out occasionally in conditions of the arable management.

The current status of the biota in the arable gray forest soil is characterized by the significant reduction in the abundance, biomass and activity in comparison with soil's standards that are in conditions of natural ecosystems (Table 1). Indices of the number and biomass of invertebrates and earthworms decreased in the arable soil by 3.1-6.2 and 1.9-6.1 times respectively in comparison with the virgin soil. Arable gray forest soil contains only 2-5 families of invertebrates. Species from the *Lumbricidae, Scarabaeidae, Diplopoda* and *Araneae* families prevail in the faunal samples.

Maintaining the functioning of microorganisms and their biomass's reserves in soils of agro ecosystems is determined by amounts of crop residues from the crop rotation, entering into the soil in conditions of arable land. The total number of fungi and heterotrophic bacteria in the gray forest soil under arable land is significantly lower than in the virgin soil, including extinct groups typical for litter. Bacteria are dominated in the structure of the microbial community; the share of fungi is reduced. *Penicillium, Mucor, Trichoderma* and *Fusarium* genus are predominated among the fungi.

The total microbial biomass content decreased on average from 876.0 to 244.3 μ g C g^{-1} soil as a result of the long-term arable land management without the application of organic fertilizers. The content of the microbial carbon in soils affected by the long-term arable use, is lower in 3.6 times compared with the soil-standard. This regularity is observed on the mean values of indicators as well as on their confidence intervals.

The characteristic feature of microbial communities of arable gray forest soils is the high content of the humus-mineralizing microorganisms and the low enzyme activity. In the most cases, there is a high variability of microbiological and enzymatic indices, the reason is that soil is characterized by the heterogeneity of habitats and the patchy distribution of microorganisms in the soil.

More intensive land-use involving soil tillage stimulates the microbial decomposition of organic matter and tends to result in a decrease in the humus content in the arable soil. The soil layer of 0-10 cm is exposed by the highest mineralization. The humus content in the 0-30 cm layer constitutes in average 3.61% in the virgin soil and 2.32% in the arable soil (Table 2).

Table 2. Humus content* in the gray forest soil under different land management (%)

Depth, cm	Virgin land	Arable land
0-10	6.83	2.28
10-20	2.38	2.37
20-30	1.62	2.31
0-30	3.61	2.32

*mean values (n=10 for each layer)

Strong positive correlation links were found between the abundance of invertebrates and humus content in the 0-30 cm layer. The correlation coefficient (R^2) between the total number of invertebrates and humus content constitutes R^2 = 0.76; between the total biomass of invertebrates and humus content - R^2 = 0.85; between the biomass of *Lumbricidae* family and humus content - R^2 = 0.70 respectively.

Profile distribution of biota in the gray forest soil. A characteristic feature of virgin gray forest soils is the high concentration of invertebrates (91.8%) and *Lumbricidae* family (78.7%) in the upper layers of soils and in the litter (Figure 2). The migration of invertebrates into the underlying layers it is typical for the arable soils which were used for a long time under arable. Layer from 0 to 10 cm practically does not contain invertebrates.

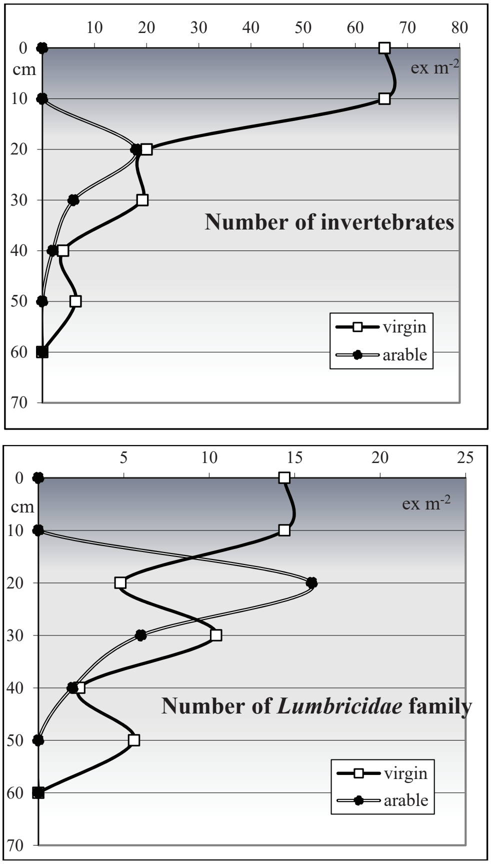

Figure 2. The profile distribution of invertebrates and *Lumbricidae* family in virgin and arable gray forest soils (mean values, data base of 2008-2009)

The highest level of the microbial biomass has been determined in the A_1 horizon of the virgin soils and whereas the lowest - in the BC and C horizons of both profiles (Figure 3). Microorganisms in virgin gray forest soils are concentrated in the 0-50 cm layer (81.8%), the biomass index decreases sharply in the soil profile to a depth of 30-50 cm. The concentration of microorganisms in the top layer reaches 1631.1 μ C g^{-1} soil. The reserves of the microbial biomass in 0-100 cm layer of virgin gray forest soil constitute 12.7 t dry matter ha^{-1}.

In arable soils the base mass of microbes is concentrated in the 0-30 cm layer. Arable soils are characterized by the gradual decrease of the biomass with the depth as compared to soils of natural ecosystems.

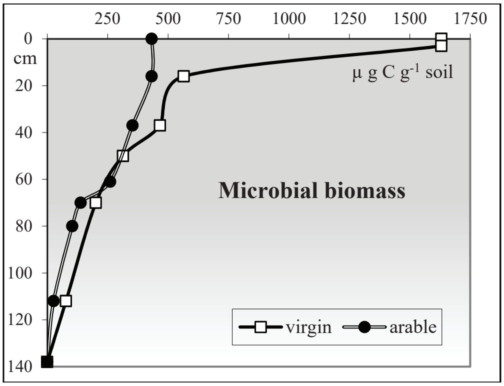

Figure 3. The profile distribution of microbial biomass in virgin and arable gray forest soils

The long-term use of plowing leads to the decrease of the content and reserves of microbial biomass in arable soils as in the upper horizons, and as a whole in the soil profile. A profile of the soil is covered by the degradation process as a whole. The reserves of the microbial biomass in the 0-100 cm layer of the arable gray forest soils is declined to the level of 7.9 t dry matter ha^{-1}.

The highest level of enzyme activities has been determined in the upper layers of virgin soil and whereas the lowest - at the depth of 60-120 cm in both profiles (Figure 4).

The activity of urease reaches in the virgin gray forest soil to 19.7 mg NH_3 10 g^{-1} soil 24 h^{-1}. The similar trend has been determined also for catalase and dehydrogenase activities. Arable soils are characterized by the gradual decrease in the enzymes activity with the depth as compared to virgin soils.

So, the profile distribution of soil biota in virgin soil is a classic phenomenon, when a major amount of biota is concentrated in the top layer. This is the result of the fact that the main mass of leaf litter is concentrated in the upper soil layers.

The distribution of the biota in the profile of old-arable soil is more uniform. This agrees with the fact that first three horizons of arable forest soils were mixed in one as a result of use in agriculture (Lungu, 2015).

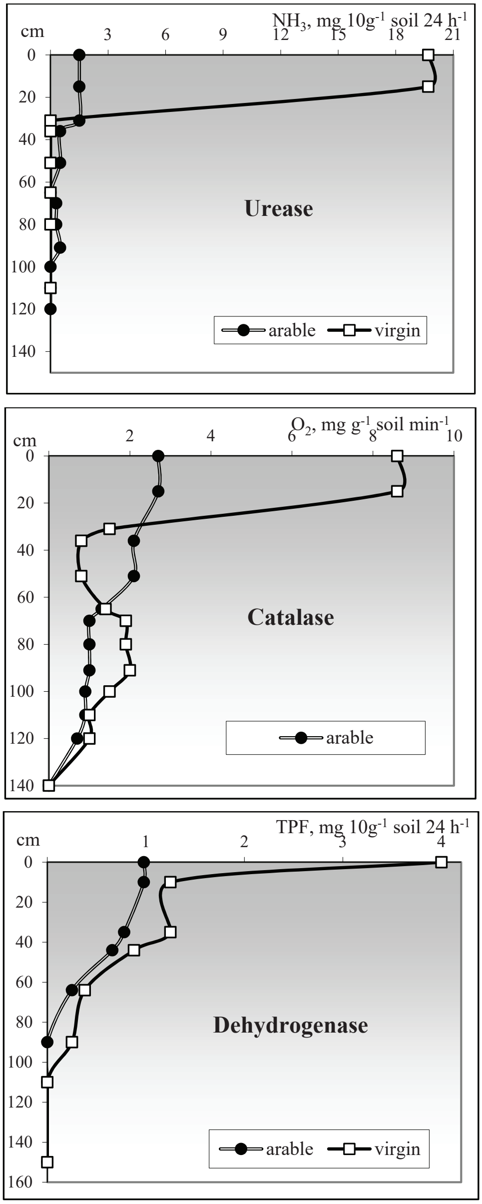

Figure 4. The profile distribution of enzymes in virgin and arable gray forest soils

Evolution of the biota and humus status in arable gray forest soils. The current state of biota of arable gray forest soils in the conditions of agricultural ecosystems of the Republic of Moldova is characterized by a decline of biota's abundance and activity compared to the level registered in 1960s (Senicovscaia, 2015). The biological degradation of arable soils is interconnected with the dehumification processes, compaction and destruction of the soil structure. A major reason for the deterioration of soil biological properties and for the decline of humus content under arable agriculture is annual tillage, which aerates the soil and breaks up aggregates where microbes are living. The selection process of species that can survive in conditions of a lower organic matter content and deterioration of physicochemical parameters of soil systems is taking place among the microorganisms.

A characteristic feature of long-term dynamics of arable gray forest soils is a significant decrease in the number of fungi (Figure 5). The time trend of the fungi is described by the polynomial function and reveals the strong link ($R^2 = 0.87$). Statistically significant changes in the number of heterotrophic bacteria have not been fixed.

During the 52 years of the utilization of arable soils the humus content decreased on average by 20-25% from its initial level. Annual losses due to mineralization processes account for 0.01%. Mineralization processes are dominated in soils, degraded as a result of long-term arable use. The growth of humus-mineralizing microorganisms has been noticed (Figure 6).

The database of humus-mineralizing microorganisms and the humus content was processed separately by the correlation and regression analysis during periods of observations (Figure 6). Regression equations with the highest correlation coefficients were chosen from all of the regression equations. Humus-mineralizing microorganisms' trend is described by the power function. Trend has the high correlation coefficients: 0.69.

Trend of the humus content is described by the polynomial function. Correlation coefficient constitutes 0.89. These results indicate that the humus content was closely linked to the content of humus-mineralizing microorganisms in soil.

The intensification of mineralization processes in arable gray forest soils leads to a steady decline in the humus content and reserves.

The temporary long-term variability of the enzymatic complex of arable gray forest soils managed to trace to the catalase activity (Figure7). Soil has lost about 50% of their catalase activity in comparison with the initial level as a result of 52 years of arable use.

It was found that catalase activity is characterized by a trend of decreasing activity described by the polynomial equation. Trend has the high correlation coefficients: 0.63.

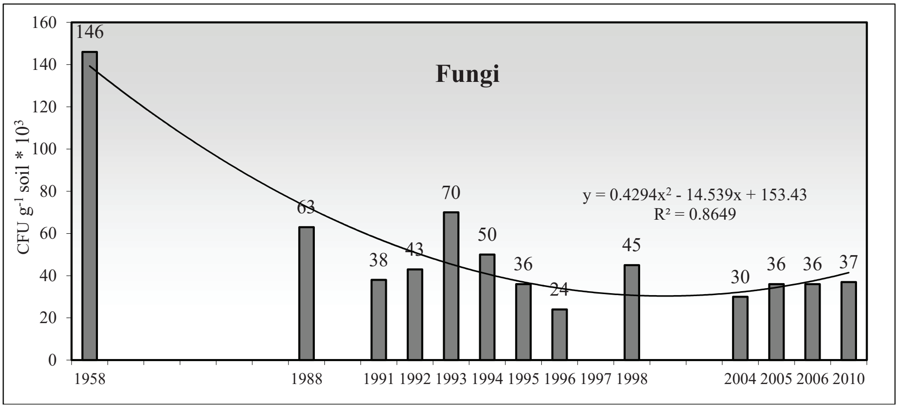

Figure 5. Dynamics of the fungi's content in arable gray forest soils

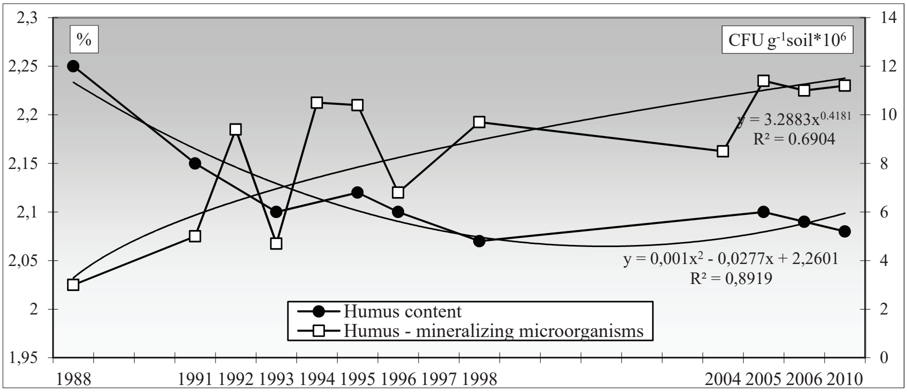

Figure 6. Dynamics of the humus and humus-mineralizing microorganisms' content in arable gray forest soils

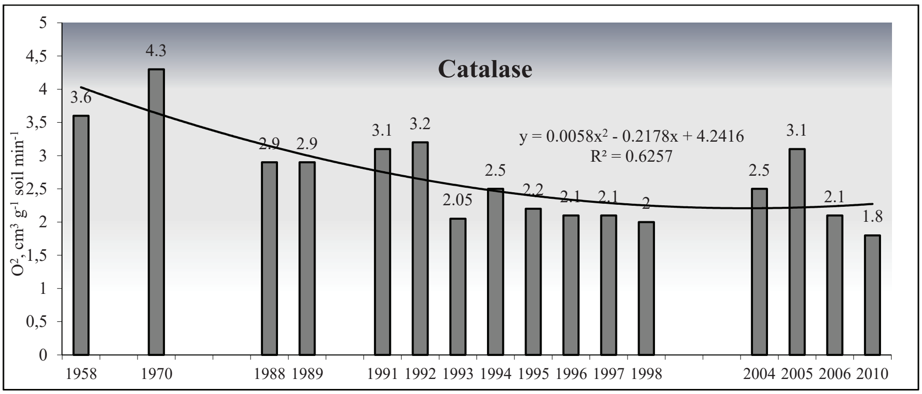

Figure 7. Dynamics of the catalase activity in arable gray forest soils

CONCLUSIONS

Virgin gray forest soils are ideal standards in regard to the composition, biomass and activity of the biota. The soil biota's composition in natural ecosystems is complex and diverse. Forests are habitat and source of conservation and reproduction of the edaphic fauna and soil microorganisms.

Biological indices in soil profiles decreased with the depth and depended of the form of farming system. The highest values of biota's abundance were registered in the A_1 horizon of virgin soils with the exception of humus-mineralizing microorganisms. Number of invertebrates was 169.3-222.3 ex m^{-2}, *Lumbricidae* family - 63.6-102.4 ex m^{-2} and microbial biomass - 686.9-1065.1 μ g C g^{-1} soil respectively. The topsoil is a unique locus with a high enzymatic activity.

The agricultural management without application of organic fertilizers leads to soil degradation. This reflects in deterioration of soil biological properties and in reduction of humus content in soil. In the arable soil humus-mineralizing microorganisms dominate.

The evolution of biota in the old-arable gray forest soil is characterized by the significant reduction in the number, biomass, activity and diversity in comparison with the level of the 1960s and with soil's standards that are in conditions of natural ecosystems. Time trends are described by the power and polynomial function with high correlation coefficients.

Statistical parameters of the biota's state of virgin and arable gray forest soils have a practical importance for the operative estimation of effectiveness the degradation processes and agricultural practices for the conservation of soil quality.

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INFLUENCE OF SOIL TILLAGE UPON THE YIELD OF SEVERAL SEMI-LATE MAIZE HYBRIDS GROWN AT MOARA DOMNEASCĂ – ILFOV

Ionuţ Cosmin SFETCU, Doru Ioan MARIN, Elena Loredana SFETCU

University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, Bucharest, Romania

Corresponding author email: sfetcuionut08@yahoo.com

Abstract

The concept of sustainable agriculture system includes numerous types of tillage, but in all cases the chosen variant takes into account the following: the climatic and edaphic conditions, the ecological particularities and the characteristics of the crop, and the technical level, so that crop production could be close to or even exceed the results achieved in the traditional system.
The technological tillage systems have developed significantly over the past decades, in concept and the extension of conservative tillage methods, both worldwide and in Romania. Given the complex mechanization based on a variety of machinery and agricultural machinery, modern agriculture creates numerous possibilities for reducing interventions on the soil, thus increasing the profitability of agricultural production (Guş Petru, Rusu Teodor, 2008).
This paper presents the results of the research carried out on the reddish preluvosoil of the Teaching Farm belonging to USAMV Bucharest and located at Moara Domnească, Ilfov County, in 2014.
The biological material consisted in semi-late maize hybrids and the Romanian hybrid OLT – (FAO 400) as control. The experimental variants were: plough 20 cm (control), chisel 20 cm, chisel 40 cm, disk 10 cm, disk/plough 20 cm, disk/chisel 40 cm.
In all tillage variants (Both traditional and minimal), the hybrid P0216 was the most productive, with the highest yield of 7595.3 kg/ha.

Key words*: Zea mays* L.*, yield, soil tillage, bulk density.*

INTRODUCTION

Soil is the most important natural resource of mankind. The existence and development of human society depend vitally on soil quantity and quality, and by its production capacity.
The soil tillage system can change the morphological, physical, chemical and biological features of the soil (Canarache A., 1978, 1986, Nedeff V., 1995, Pintilie C. and collab., 1979, Dick R.P., 1992, Dexter A.R., 2004, Munkholm L.J. and collab., 2005).
In time, the long-term use of the conventional soil tillage system can alter soil fertility, increasing evaporation; at the same time, the surface soil layers turn into dust, thus becoming susceptible to wind and water erosion (Lal, R., A.A. Mahboubi and Faussey, N.R.,1994).
Maize (*Zea mays* L.) is grown on large areas of the Romanian Plain as it is one of the most important crop plants. Traditional soil tillage is the most used in this area. To reduce soil degradation and to increase water retention of the area, it is recommended to use conservation tillage and to maintain the plant waste (Picu, 2005). Over the past few years, the No-tillage and Minimum tillage systems have become popular among the soil conservation measures taken in Romania. The implementation of these two systems are perceived as effective on soil compaction, i.e. provide higher resistance to penetration, compared with the traditional system, which results in better soil moisture and temperature (Moraru P. I., Rusu T., 2013).
The research carried out on the reddish preluvosoil of Moara Domnească, Ilfov, showed that soil structure and other soil features are favourably influenced by the minimum tillage system (Marin D.I. and collab., 2005).

MATERIALS AND METHODS

Research was performed on reddish prelouvosoil, at the experimental field of the Teaching Farm located at Moara Domnească, Ilfov.
The test included the following factors:

Factor A – the soil tillage system, with the following variants: a_1-plough at 20 cm in depth (control), a_2-chisel 20 cm, a_3-chisel 40 cm, a_4-disk 10 cm, a_5-disk/plough 20 cm, a_6-disk/chisel 40 cm, disk/chisel 40 cm and disk/arat 20 cm in the previous crop (winter wheat).

Factor B – maize hybrids: Olt (FAO 400), P0216 (FAO 510), Sumbra (FAO 500).

Basic tillage was carried out in the last decade of September.

Sowing was performed in the second decade of April by using the sower SPC 6.

For weed control, we applied herbicides (Dual Gold at a rate of 1.4 l/ha (s-metholachlorine 960 g/l) - preemergent and Dicopur Top 1.0 l/ha (344 g/l acid 2.4 D + 120 g/l dicamba) + Titus 25DF, 50g/ha (25% rimsulfuron methil) - postemergent).

Two mechanical hoeings were also carried out.

$N_{120}P_{60}K_{60}$ kg s.a./ha fertilization was also performed, using the NPK 15:15:15 complex fertilizer and urea.

During the experiment we performed observations and measurements that included: the seedling emergence date, height growth rate, leaf formation rate, fruition rate, biomass acumulation rate, numer of grains per cob, TGW, HM. We also measured the weeding level depending on the soil tillage type.

The influence of tillage on the features of the reddish preluvosoil was emphasized by measurements performed after the soil tillage, before crop start and after harvest.

We measured bulk density (B.D.) of the soil by using the method of cylinders with a constant volume of 100 cm^3; the results were interpreted after N. Stângă, 1978.

- very light < 0.94 g/cm^3;
- light 0.95-1.07 g/cm^3;
- unhardened 1.08-1.20 g/cm^3;
- slightly hardened 1.21-1.34 g/cm^3;
- moderately hardened 1.35-1.47 g/cm^3;
- very hardened > 1.48 g/cm^3.

Harvesting was performed between 15-20 September.

Climate conditions were a highly influential factor on crop production and soil features. We used the data recorded by the Găneasa Weahter Station to determine the climate conditions.

From the climatic viewpoint, 2014 was characterized by annual average temperatures and rainfalls above the standards for the respective area (Table 1). During the maize growth period (April-August), the average temperature was 19.9ºC, i.e. 1.7ºC over the standard, while the sum of rainfalls was 381.2 mm, i.e. 65.5 mm over the multiannual average values; however, the values were lower in July and August.

Table 1. Climatic conditions of Moara Domnească, Ilfov County (2013-2014)

Nr. crt.	Month	Average temperature (ºC)		Average monthly rainfalls (mm)	
		2013-2014	Normal	2013-2014	Normal
1	Oct.	14.0	**11.0**	81.7	**35.8**
2	Nov.	8.3	**5.3**	17.6	**40.6**
3	Dec.	-0.2	**0.4**	1.2	**36.7**
4	Jan.	-0.5	**-3.0**	33.2	**30.0**
5	Feb.	1.2	**-0.9**	7.6	**32.1**
6	Mar.	8.9	**4.4**	37.3	**31.6**
7	Apr.	13.4	**11.2**	116.0	**48.1**
8	May	19.3	**16.5**	88.0	**67.7**
9	Jun.	19.9	**20.2**	113.0	**86.3**
10	Jul.	22.8	**22.1**	38.0	**63.1**
11	Aug.	24.1	**21.1**	26.2	**50.5**
Average/Sum Apr-Aug		***19.9***	***18.2***	***381.2***	***315.7***
Average/Sum		***11.9***	***9.8***	***559.8***	***522.5***

RESULTS AND DISCUSSIONS

Influence of soil tillage on bulk density - B.D. (g/cm^3)

Research carried out in the 2013-2014 agricultural year showed that B.D. varied in spring for 0-10 cm in depth, depending on the soil tillage type, between 0.95-1.10 g/cm^3. The values were classified according to N. Stângă, 1978, as follows: light (variant plough 20 cm), unhardened (variant disk 10 cm) (Table 2). At 10-20 cm in depth, the values of B.D. varied between 1.11 g/cm^3 in the plough 20 cm and disk/plough 20 cm variants, unhardened soil, and 1.46 g/cm^3 (variant disk 10 cm), moderately hardened soil. For the 20-30 cm interval, the lowest value was recorded in the variant chisel 40 cm (1.35 g/cm^3) and the highest in the variant disk 10 cm (1.50 g/cm^3). Bulk density for 30-40 cm varied between 1.44 g/cm^3 in the variant chisel 40 cm and 1.56 g/cm^3 in disk 10 cm, very hardened soil.

For 0-40 cm in depth, depending on soil tillage, B.D. varied between 1.23 g/cm^3 (the variant plough 20 cm) and 1.40 g/cm^3 (the variant disk 10 cm).

Table 2. Influence of basic tillage on bulk density of reddish preluvosoil (g/cm^3) in maize crop, Moara Domnească-Ilfov, March 2014

Variant	Depth (cm)				Average (g/cm^3) 0-40
	0-10	10-20	20-30	30-40	
Plough 20	0.95	1.11	1.38	1.48	1.23
Chisel 20	1.05	1.25	1.45	1.48	1.30
Chisel 40	1.08	1.27	1.35	1.44	1.28
Disk 10	1.10	1.46	1.50	1.56	1.40
D/A20	0.97	1.13	1.40	1.49	1.24
D/C40	1.10	1.28	1.38	1.45	1.30

Influence of soil tillage on grain production in maize crop

The results regarding the influence of basic tillage on the maize grain production are presented in Table 3.

In the hybrid Olt, the highest production resulted from the variant of traditional tillage after disk (disk/plough 20 cm), i.e. 2% (135.4 kg/ha) higher than the control, plough 20 cm.

In the same hybrid, the lowest production was recorded by the disk variant (5960.8 kg/ha), i.e. 1014 kg/ha lower than the control, which was significantly negative. The production resulted from the hybrid P0216 varied between 7595.3 kg (traditional tillage after disk (the variant disk/plough 20 cm), i.e. 2% higher than the control, and 6246.0 kg/ha (the variant disk 10 cm), i.e. 84% of the control production.

In the hybrid Sumbra, the highest production was recorded by the variant alternating traditional tillage and disk/plough 20 cm (6959.3 kg/ha). The lowest production was recorded by the variant disk 10 cm (5703.2 kg/ha), which was significantly negative, compared with the control.

The application of the minimum tillage system resulted in productions closer to the control in the variants chisel 40 cm and disk/chisel 40 cm (7149.5-7245.8 kg/ha).

Influence of the hybrid on grain production in different tillage variants

The comparative analysis of the maize hybrids (Table 4) shows that, compared with the hybrid Olt (the control), the hybrid P0216 recorded very significantly positive productions in all tillage variants. Thus, we recorded 6% production increase (484.7 kg/ha) in the variants plough 20 cm and disk/plough 20 cm (484.4 kg/ha). The hybrid Sumbra recorded lower grain productions than the hybrids Olt and P0216, with statistically assured differences in the variants chisel 40 cm (-182.6 kg), disk 10 cm (-257.6 kg) and disk/plough 20 cm (-151.6 kg/ha).

Table 3. Influence of basic soil tillage on grain production in a maize hybrid assortment, Moara Domnească - Ilfov, 2014

Hybrids/ Variant	OLT			P0216			SUMBRA			Average		
	2014 Kg/ha	%	Dif. Kg/ha	2014 Kg/ha	%	Dif. Kg/ha	2014 Kg/ha	%	Dif. Kg/ha	2014 Kg/ha	%	Dif. Kg/ha
A20	6975.5	100	Mt	7460.2	100	Mt	6888.5	100	Mt	7108.0	100	Mt
C20	6593.9	94	-381.6	6869.2	92	-591.0	6544.6	95	-343.9	6669.2	93.6	-438.8
C40	6868.5	98	-107.0	7149.5	96	-310.7	6685.9	97	-202.6	6901.3	97	-206.7
Disk	5960.8	85	-1014.7	6246.0	84	-1214.2	5703.2	83	-1185.3	5970.0	84	-1138.0
D/A20	7110.9	102	135.4	7595.3	102	135.1	6959.3	101	70.8	7221.8	101.6	113.7
D/C40	6845.6	98	-129.9	7245.8	97	-214.4	6776.0	98	-112.5	6955.8	97.6	-152.2

$DL_{5\%}$ = 320.5kg/ha $DL_{1\%}$ = 429.4 kg/ha $DL_{0.1\%}$ = 566.8 kg/ha

Table 4. Influence of hybrid on grain production in different soil tillage variants, Moara Domnească - Ilfov, 2014

Hybrids/ Variant	OLT (Control)			P0216			SUMBRA		
	Production 2014 Kg/ha	%	Dif. Kg/ha	Production 2014 Kg/ha	%	Dif. Kg/ha	Production 2014 Kg/ha	%	Dif. Kg/ha
A20	6975.5	100	Ct	7460.2	106	484.7	6888.5	98	-87
C20	6593.9	100	Ct	6869.2	104	275.3	6544.6	99	-49.3
C40	6868.5	100	Ct	7149.5	104	281.0	6685.9	97	-182.6
Disk	5960.8	100	Ct	6246.0	104	285.2	5703.2	95	-257.6
D/A20	7110.9	100	Ct	7595.3	106	484.4	6959.3	98	-151.6
D/C40	6845.6	100	Ct	7245.8	105	400.2	6776.0	99	-69.6

$DL_{5\%}$ = 124.8 Kg/ha $DL_{1\%}$ = 177.5 Kg/ha $DL_{0.1\%}$ = 257.0 Kg/ha

Influence of soil tillage on some production indicators – TGW, HM

Tables 5 and 6 present the values of productivity elements (TGW, HM) in the three maize hybrids, under the conditions of traditional and minimum tillage. In the hybrid Olt, the thousand grain weight varied between 269.5 g (the variant disk 10 cm) and 280.2 g (the variant disk/plough 20 cm). In P0216, the thousand grain weight varied between 272.6-280.8 g in disk 10 cm and plough 20 cm – control, respectively.

Table 5. Influence of basic tillage on thousand grain weight (TGW) in a maize hybrid assortment, Moara Domnească – Ilfov, 2014

Hybrids/ Variant	OLT TGW (gr)			P0216 TGW (gr)			SUMBRA TGW (gr)		
	2014	%	Dif. (gr)	2014	%	Dif. (gr)	2014	%	Dif. (gr)
A20	278.1	100	Mt	280.8	100	Mt	277.0	100	Mt
C20	273.9	98	-4.2	274.1	97	-6.7	271.3	98	-5.7
C40	276.3	99	-1.8	277.0	98	-3.8	275.1	99	-1.9
Disk	269.5	97	-8.6	272.6	97	-8.2	269.0	97	-8.0
D/A20	280.2	101	2.1	279.7	99	-1.1	278.4	101	1.4
D/C40	276.8	99	-1.3	277.5	98	-3.3	275.2	99	-1.8

Table 6. Influence of basic tillage on hectolitre mass (HM) in a maize hybrid assortment, Moara Domnească – Ilfov, 2014

Hybrids/ Variant	OLT HM (kg/100 l)			P0216 HM (kg/100 l)			SUMBRA HM (kg/100 l)		
	2014	%	Dif. (kg/100 l)	2014	%	Dif. (kg/100 l)	2014	%	Dif. (kg/100 l)
A20	72.0	100	Mt	72.8	100	Mt	71.8	100	Mt
C20	69.1	96	-2.9	69.2	95	-3.6	68.9	96	-2.9
C40	70.9	98	-1.1	71.6	98	-1.2	70.5	98	-1.3
Disk	69.0	96	-3.0	69.6	95	-3.2	69.0	96	-2.8
D/A20	72.8	101	0.8	73.0	100	0.2	72.2	100	0.4
D/C40	71.6	99	-0.4	71.8	98	-1.0	71.9	100	0.1

In the hybrid Sumbra, the thousand grain weight varied between 269.0 g (the variant disk 10 cm) and 278.4 g (the variant disk/plough 20 cm). Compared with the control (the variant plough 20 cm), the hybrids Olt and Sumbra recorded a positive increase of TGW in the variant disk/plough 20 cm.

Regarding the hectolitre mass of the three hybrids, the lowest values were recorded by the variant disk 10 cm (69.0 kg/100 l in the hybrid Olt) and chisel 20 cm in the hybrids P0216 (69.2 kg/100 l) and Sumbra (68.9 kg/100 l). The highest values were recorded in the variant disk/plough 20 cm (72.8 kg/100 l in the hybrid Olt, 73.0 kg/100 l in the hybrid P0216 and 72.2 kg/100 l in the hybrid Sumbra).

CONCLUSIONS

Bulk density before the crop start showed that the soil tillage system resulted in valued varying beyween 0.95 g/cm^3 (0-10 cm in depth, variant plough 20 cm) and 1.49 g/cm^3 (30-40 cm in depth, the variant alternating traditional tillage and disk/plough 20 cm) in the conventional system, and 1.05 g/cm^3 (0-10 cm in depth, variant chisel 20 cm) and 1.56 g/cm^3 (30-40 cm in depth, variant disk 10 cm) in the non-conventional system.

The highest grain productions of the three maize hybrids were recorded in the variant alternating traditional tillage and disking (disk/plough 20 cm), with 2% increase in production (the hybrid Olt – 135.4 kg/ha, the hybrid P0216 – 135.1 kg/ha) and 1% increase in production (the hybrid Sumbra – 70.8 kg/ha) compared with the control.

In 2014, the hybrid P0216 recorded the highest production in all soil tillage variants, i.e. 7595 kg/ha in the variant alternating traditional tillage and disking (disk/plough 20 cm).

Annual chiselling at 40 cm in depth or the alternative disking/chiselling at 40 cm in depth recorded almost similar results as in the case of traditional tillage, as the production of the three maize hybrids represented 96-98% of the control production.

Minimum tillage on reddish preluvosoil can be an alternative to the traditional system (ploughing).

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RESEARCH REGARDING THE USE OF GRAIN MASH AS SOIL FERTILIZER

Andrei SIURIS, Tatiana CIOLACU

"Nicolae Dimo" Institute of Soil Scince, Agrochemistry and Soil Protection, 100 Ialoveni Str., MD-2070, Chisinau, Republic of Moldova

Corresponding author email: siurisandrei@mail.ru

Abstract

The work presents research results regarding the use as fertilizer of grain mash, a waste from alcohol production industry. Annually there are produced up to 55 thousand m^3 of grain mash in the Republic of Moldova, which need to be used without adversely affecting the environment. Grain mash contains about 93% of water, 5% of organic matter. One cubic meter of grain mash contains on average 2.8 kg of total nitrogen, 1.2 kg of phosphorus and 1.1 kg of potassium. It was established that grain mash used as fertilizer increases productivity of field crops by 40-50%. In conclusion, grain mash should be used as fertilizer.

***Key words**: grain mash, fertilization, agrochemical indices, fertilizer, yield.*

INTRODUCTION

Grain mash (of wheat, barley or maize), potato mash and molasses are by-products of factories of ethyl alcohol production. Annually in the Republic of Moldova, from 20 enterprises existent in the country accumulates about 45 thousand tons of this wastes (Statistical Yearbook of the Republic of Moldova). Until the agrarian reform in '90 years, grain mash was used as animal feed at the animal farms. With the dissolution of large farms and reduction of livestock, in generally, that possibility disappeared and nowadays alcohol producers are facing daily serious problems related with wastes disposal and environmental legislation. Grain mash, in the most of cases, is thrown into the environment, somewhere near the fabrics, thus causing pollutant impacts especially on soil and surface waters. At the same time, grain mash contains basic elements so necessary for plant growth, nutrition and soil fertility maintenance. In this context, alcohol producers of our country face a huge issue related with disposal of wastes, that must solved urgently - the issue of using this wastes. International researches in this domain are not so many (Korceaghina, 2012; Nicolic and Petresca, 2006; Nenaidenko et al., 1988) and in the Republic of Moldova in generally were not made until recent time. We consider that the use of grain mash as soil fertilizer will partially solve the three social and economic problems: partial recovery of soil fertility, increase of plants productivity and protecting the environment from pollution with wastes. The purpose of this paper is to appreciate fertilizing potential of grain mashes resulted from the production of ethyl alcohol.

MATERIALS AND METHODS

As study material of our research served waste from the production of ethyl alcohol - grain mash. Research and observations, for the appreciation of potential of grain mash as fertilizer, were conducted during 2011-2014 years at technological-experimental Station "Codru". Grain mash incorporated into the soil contained on average 0.25% N, 0.10% P_2O_5 and 0.08% K_2O.

The studied soil was slightly eroded leached chernozem of clay-loamy texture, moderate humus content of 3.52%; P_2O_5 - 3.12 mg/100 g soil; K_2O - 30 mg/100 g soil (by Machighin method); pH - 6.8; hydrolytic acidity - 2.71 me/100 g soil. Experience scheme is presented in Table 3. The experience was founded in four repetitions (Figure 1).

The area of each experimental plot was 120 m^2 (6 m x 20 m). Chemical and physico-chemical analyses of grain mash, soil and plants were made according to approved or adopted standards in the Republic of Moldova. Statistical analysis was performed by the method of dispersion and correlation with the use of MS Excel program.

Figure 1. Foundation of the experience

RESULTS AND DISCUSSIONS

Research shown that grain mash from alcohol production is characterized by a water content of 93.4% and 6.63% dry matter (Table 1).
The average pH value is 3.7 units. They contain a huge amount of organic matter (5.1%) and a varied content of primary elements: 0.21 to 0.33% total nitrogen, total phosphorus 0.06-0.19% and potassium total 0.09-0.13%. The amount of nutrients (NPK) that are contained in a cubic meter of waste is an average of 5.1 kg. The ratio of carbon:nitrogen is 9:1.
The three-year average data have shown that fertilization of leached chernozem with grain mash contributed to a significant increase in organic matter content and mobile forms of nutrients (Table 2). In the arable layer, compared to the control (2.93%) humus content value increased by 0.15-0.25% on fertilized variants or by 3.8 to 6.3 t/ha.
There was a significant increase in mobile phosphorus content by 0.21-0.46 mg/100 g soil or 0.5-1.0 t/ha and in exchangeable potassium by 3-6 mg/100 g soil or 0.7-1.4 t/ha.
Our research showed that grain mash applied as fertilizer act beneficially on the productivity of field crops (Table 3).
Mash grains applied annually at a dose of 47 and 94 m^3/ha (equivalent to N_{120} and N_{240}) resulted in the average yield increase in three years of 1221 and 1597 kg/ha grain units respectively, or 50-65% in comparison with unfertilized variant (Figures 2, 3 and 4).

Figure 2. Sunflower fertilized with grain mash

Figure 3. Winter wheat fertilized with grain mash

In harvest of field crops on variants fertilized with grain mash in doses 47 and 94 m^3/ha (equivalent to N_{120} and N_{240}) annually, it was established a higher protein content (Table 4). Application of grain mash not only increased concentration of substances in filed crops but favoured yield increase itself. It was noticed that weight of harvested protein and fat was significantly increased compared to the witness. The weight of the collected protein in three years was higher in comparison with the reference plants by 577-650 kg/ha or 86-97%.
Fertilization with grain mash conducted to growth of wet gluten content and crude protein content in wheat by 6.7-7.0% and 2.1-3.3% respectively in comparison with unfertilized control plot. At the same time nitrogen content grow by 0.36-0.58%. There were no statistical modification in phosphorus and potassium content of wheat grains.

Table 1. Chemical composition of grain mash from the production of alcohol (n = 10)

Water content, %	Organic matter, %	Total forms, %			kg/m^3			Sum NPK, kg/m^3	Ratio C:N
		N	P_2O_5	K_2O	N	P_2O_5	K_2O		
93.4	5.1	0.28	0.12	0.11	2.8	1.2	1.1	5.1	9:1

Table 2. Influence of fertilization with grain mash on agrochemical indicators in arable layer of leached chernozem

Variant of the experience	Organic matter, %			P_2O_5, mg/100 g sol			K_2O, mg/100 g sol		
	Mean	Increase compared to control		Mean	Increase compared to control		Mean	Increase compared to control	
		%	t/ha		mg/100 g	t/ha		mg/100 g	t/ha
1.Witness	2.93	-	-	2.31	-	-	26	-	-
2.Grain mash, 47 m^3/ha per year	3.,08	0.15	3.8	2.52	0.21	0.5	29	3.0	0.,7
3.Grain mash, 94 m^3/ha per year	3.18	0.25	6.3	2.77	0.46	1.0	32	6.0	1.4

Table 3. Effects of fertilization with grain mash on field crops productivity, kg/ha

Variant of the experiment	Grape harvest on the years			On average, grain units		
	2012, sunflower	2013, winter wheat	2014, sunflower	Crop	Crop increase compared to witness	
					kg	%
1.Witness	1230	3818	1170	2449	-	-
2.Grain mash, 47 m^3/ha per year	1840	5673	1790	3670	1221	50
3.Grain mash, 94 m^3/ha per year	2070	6183	1980	4046	1597	65
$DL_{0.5\%}$	223	520	172			

Table 4. Quality indices of main production formed under the action of grain mash

Indices and units	Variant of the experiment		
	1.Witness	2.Grain mash (N_{120}), 47 m^3/ha per year	3.Grain mash (N_{240}), 94 m^3/ha per year
Year 2012, sunflower			
Protein content, %	16.2	16.3	16.2
Quantity of protein, kg/ha	199	300	335
Increase of protein, kg/ha	-	101	136
Fat content, %	43.7	42.7	42.6
Quantity of fat, kg/ha	538	786	882
Increase of fat, kg/ha	-	248	344
Year 2013, winter wheat			
Protein content, %	7.9	11.2	10.0
Quantity of protein, kg/ha	302	635	618
Increase of protein, kg/ha	-	333	316
Fat content, %	22.9	29.6	29.9
Quantity of fat, kg/ha	874	1679	1848
Increase of fat, kg/ha	-	805	974
Year 2014, sunflower			
Protein content, %	14.2	17.3	18.4
Quantity of protein, kg/ha	166	309	364
Increase of protein, kg/ha	-	143	198
Fat content, %	51.8	48.7	48.7
Quantity of fat, kg/ha	606	872	964
Increase of fat, kg/ha	-	266	358
Total protein increase in three years:			
kg/ha	-	577	650
%	-	86	97

CONCLUSIONS

In a cubic meter of grain mash from production of alcohol contained in average: 2.8 kg of nitrogen, 1.2 kg of total phosphorus and 1.1 kg of total potassium, in sum they make 5.1 kg/m^3.

Application of grain mash on leached chernozem led to an increase in organic matter content of 0.15-0.25% (3.8 to 6.3 t/ha). There was a significant increase in mobile phosphorus from 0.21 to 0.46 mg/100 g (0.5-1.0 t/ha) and exchangeable potassium 3-6 mg/100 g soil (0.7-1.4 t/ha).

Fertilization with gain mash resulted in average yield increase in three years of 1200-1600 kg/ha of grain units or 50-65% compared to the unfertilized control. The mass of the collected protein in three years increased compared to the witness by 570-650 kg/ha or 86-97%.

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A COMPARISON OF THE GRAVIMETRIC AND TDR METHODS IN TERMS OF DETERMINING THE SOIL WATER CONTENT OF THE CORN PLANT

Cagatay TANRIVERDI[1], Hasan DEGIRMENCI[1], Engin GONEN[1], Sedat BOYACI[2]

[1]Kahramanmaras Sutcu Imam University, Faculty of Agriculture, Biosystem Engineering Department, Kahramanmaras, Turkey
[2]Ahi Evran University, Faculty of Agirculture, Biosystem Engineering Department, Kirsehir, Turkey

Corresponding author email: ctanriverdi@ksu.edu.tr

Abstract

This study, conducted in Kahramanmaras province with a view to watering the corn plant on a timely basis so as to avoid the plant going through water stress, aims to establish the relationship between the direct (Gravimetric) and indirect -namely the Time Domain Reflectometry (TDR) measurement methods and present the advantages and disadvantages of the said methods. In both methods, the results have been presented based on the calibration curves that have been found to determine the soil water content in 15, 45 and 70 cm deep soil (for 15 cm depth R^2=0.91, for 45 cm depth R^2=0.98, and for 70 cm depth R^2=0.84). As a result of the statistical analysis the relationship between the gravimetric and TDR measurement methods was found to be significant ($p<0.05$). According to this result, it was established that there was a strong relationship between the measurements and that the TDR equipment yielded very good results in determining the soil water content and the difference between the measurements performed by gravimetric and TDR equipment s was found to be statistically very significant in terms of reducing labor and time ($p<0.01$). According to the analysis result, the TDR measurement method was found to have saved a significant amount of time and labor as compared to the gravimetric measurement method. In the end, the effectiveness of using TDR as an indirect method for minimizing water consumption in the agricultural areas and thereby yielding more crops by preventing soil salinity has been established. It was concluded that the use of TDR will contribute positively, in many respects, to the national agricultural economy and the Turkish farmer thanks to the minimization of the labor and water costs and the more productive use of the water resources.

Key words: *soil water content, TDR (Time Domain Reflectometry), gravimetric method.*

INTRODUCTION

Today, the technological developments are considered as important in increasing efficiency as such indispensable elements as labor, capital and natural resources. Technological developments result from scientific works and studies (Uçan, 2001; Tolk et al., 2015). The methods employed in determining the soil water content are divided into groups, namely the direct methods that rely on the principle of determining the body of water and the indirect methods that rely on the principle of measuring any soil property that depends on the soil water content (Muñoz-Carpena, 2006; Uytun et al., 2013).
The direct method is that of the gravimetric method whereby the water inside the soil is evaporated from a soil sample and taken away from the soil through washing and chemical reactions and the amount thus taken away is determined. The biggest disadvantage of the direct method is the destruction brought about on the trial parcels and soil profiles due to the impossibility of taking more than one sample from each spot. Taking multiple samples from the same spot may lead to the creation of macro pores on the soil which, in turn, result in the change in the soil humidity regime. Another disadvantage of the said method is that the differences in the humidity contents of the soil samples taken at different times reflect both the variation in the soil water and the variation resulting from the heterogeneous quality of the soil. Moreover, the fact that the result obtained through this method will not be able to be assessed in a real timeframe, but it will take time to carry out the measurement is considered as another drawback of this method. The most important feature of the gravimetric method is

that it is a standard method applied for the calibration of indirect methods (Kutilek and Nielsen, 1994; Zazueta and Xin, 1994; Demiralay, 1977; Gardner, 1986; Tanrıverdi, 2005; Uytun et. al., 2013; Zhou et. al., 2014; Çapar and Uçan, 2015).

In indirect methods, the change in certain physical and physiochemical properties of the soil depending on the amount of water available is taken as the basis. In most of those methods, the soil humidity is easily determined either through the sensors that have been permanently placed in the soil or the sensors that have been placed in specially opened pockets in the soil at the time of the reading. The most important feature of the indirect methods is that once the equipment is installed in the soil, they facilitate frequent and constant measurements in the same spot in real time and in a conveniently accessible manner without allowing any deterioration in the soil property and having to spend long periods of time. Moreover, the soil water content will have been determined once the sensor is read. Among the indirect methods, electrical conductivity method, thermal conductivity method, neutron method, gamma ray weight loss method and the recently popularized TDR (Time Domain Reflectometry) method are regarded as important methods.

TDR equipment determines the soil water content by performing dielectric measurement through its probes (Quaknin et al., 2015). The studies conducted by various researchers for the purpose of measuring the soil water content in various different soil textures report that the use of TDR equipment is an acceptable method in measuring the soil water content as it yields reliable and accurate results (Hart et al., 1994; Van Clooster et al., 1995; Frueh and Hopmans, 1997; Hart and Lowery, 1998; Nissen et al., 1998; Irmak et al., 1999; Noborio et al. 1999; Huisman and Bouten, 1999; Robinson et al., 1999; Thomsen et al., 2000; Tanrıverdi, 2005; Tülün, 2005; Küp, 2009; Zhou et al., 2014; Quaknin et al., 2015; Chung et al., 2016; Schwartz et al., 2016).

This study aims to determine the utilization of TDR as a reliable method by determining the calibration curve of the TDR equipment, which is used as an indirect method in determining the soil humidity content, and present the advantages and disadvantages of preferring this particular method by comparing it to the gravimetric method.

MATERIALS AND METHODS

Measurements were conducted in a corn field located in Kahramanmaras central county consisting of 18 parcels of 420 m^2 surface area for the purpose of determining the irrigation water requirement by using gravimetric and TDR methods in the spots of the said field, each representing 18 parcels. Measurements were taken from the 15, 45 and 70 cm deep soil before and after the irrigation and conducting checks.

For the gravimetric method, a total of 54 soil samples were taken from 3 different depths using augerhole hand brace, and the humidity content of the samples taken was identified in the laboratory. On the other hand, uncouted probes were used for the purpose of performing measurements with the TDR equipment. The probes were left in the parcel until the end of the trial in order to avoid the formation of macro gaps in the parcels and making measurements in the same spots, and in such a way as to represent each and every parcel.

The samples taken from the parcels using augerhole hand brace for the gravimetric method were taken into a spoiled soil sampling container so as to avoid losing its humidity content and the container was firmly sealed around the lid by a band. The samples brought to the laboratory from the field were weighed by precision scales and the wet weight of each sample was determined. After having identified their we weight, the samples were dried in the soil drying ovens at 105^{o}C for 24 hours until their weight became stable, and the weight found by the end of the drying process was designated as the dry mass of the soil this method, the reduction in the weight of the soil sample is that of the mass of the water which is lost through evaporation during the drying process. The soil water content based on weight (mass) is;

$$Pw = \frac{YA - KA}{KA} x100$$

In this equation;

Pw; represents the soil water content based on weight (mass),

YA; represents the wet weight of the soil sample,
KA; represents the dry weight of the sample.
According to this equation, the amount of water contained in the soil mass/gram is determined in mass/gram (Kırda and Sarıyev, 2002).
The working principle of the TDR method was identified as follows (Topp et al., 1980; Jones et al, 2002);

$$\varepsilon = \left(\frac{ct}{2L} \right)^2$$

Here:
ε represents dielectric constant,
c represents the velocity of light in space ($3x10^8$ ms^{-1}),
t represents the travel time of the pulse within the media,
L represents the length of the electrode.
As can be understood from the formula above, the basic principle of the measurement is explained through the change in the soil dielectric constant (ε) depending on the soil water content. The relationship between the dielectric constant and volumetric water content is determined as (θ=f[ε]; 3^{rd} degree polynomial).

RESULTS AND DISCUSSIONS

Advantages and disadvantages of the gravimetric method

The findings of this study drew similarities to the study conducted by Zazueta and Xin 1994 in terms of the advantages and disadvantages of the gravimetric method. As a direct measurement method, the gravimetric method has advantages in that it measures accurately, is not affected by the soil type and salinity and is easily calculable.
The most significant disadvantage of the method is that it requires the soil sample to be kept for 1 full day until it is dried out completely at 105^oC degrees and before it weighed, and thus taking nearly 2 days to determine the humidity content of the soil sample in addition to the time elapsed in collecting the soil samples.
Moreover, the labor required in gathering the 54 soil samples from 18 different parcels before and after the irrigation and for control purposes was also found to be significantly costly.
Another disadvantage of the gravimetric method is the increase in the number of macro gaps resulting collecting soil samples. Such gaps are highly important in terms of being replaced, depending on the agricultural awareness of the worker taking the soil sample, preserving the soil structure and avoiding soil loss.

Advantages and disadvantages of the TDR (Time Domain Reflectometry) method

This method was tried out by various researches in different soil textures, and the equipment was found to be conveniently usable in determining the humidity content of the soil. The advantages of the TDR equipment include less destruction of the macropores in the soil compared to the gravimetric method, easier transportation in the field, saving time and labor costs, allowing measurements at the required depths thanks to convenient handling of the equipment by the farmer and easier determination of the water requirement of the plants. One of the major advantages of the TDR equipment over the gravimetric method is that the water content of the soil is calculated instantly without having to wait for 24 hours as in the case of gravimetric method.
In addition to being costlier than the gravimetric method, the disadvantage of the system includes the necessity to prepare different calibration curves for different soil textures. Moreover, the increase in the percentage of clay and organic substances in the soil also contribute to the errors in the measurements performed by the TDR equipment.
As a result of this study, the advantages and disadvantages of the TDR method were found to be similar to those found by various other researchers (Zazueta ve Xin., 1994; Irmak et al., 1999; Tanrıverdi, 2005; Tülün, 2005; Küp, 2009).

Determining the calibration curve

Although the gravimetric method has negative aspects in terms of time and labor costs as compared to the TDR method, the method applied in TDR calibration is a standard one as in the case of all indirect methods. For this reason, in order to achieve more reliable results in the TDR method, the TDR calibration of the gravimetric method should also be used as well (Tanrıverdi, 2005; Uytun et al., 2013; Zhou et al., 2014; Capar and Ucan, 2015). In this study, the values measured in the 15, 45 and 70 cm deep soil layers through gravimetric and TDR methods are represented in the Figures 1, 2 and 3 below.

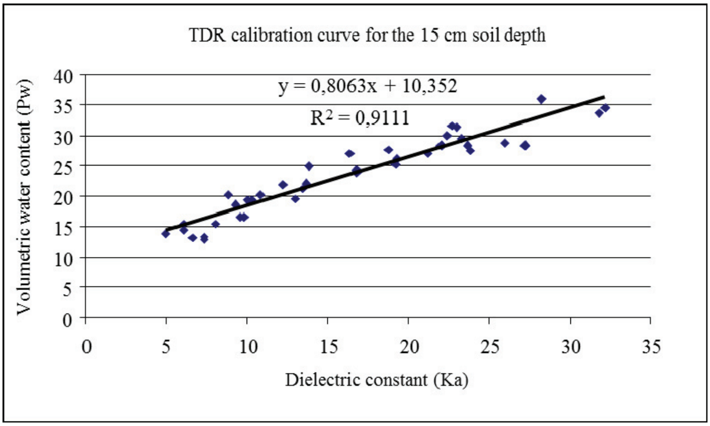

Figure 1. TDR calibration curve for the 15 cm soil depth

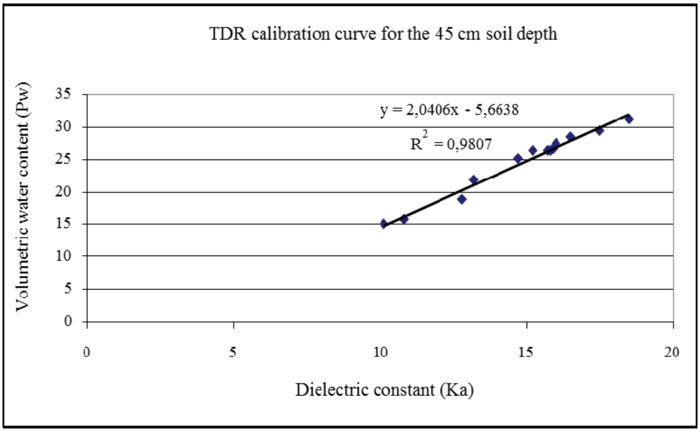

Figure 2. TDR calibration curve for the 45 cm soil depth

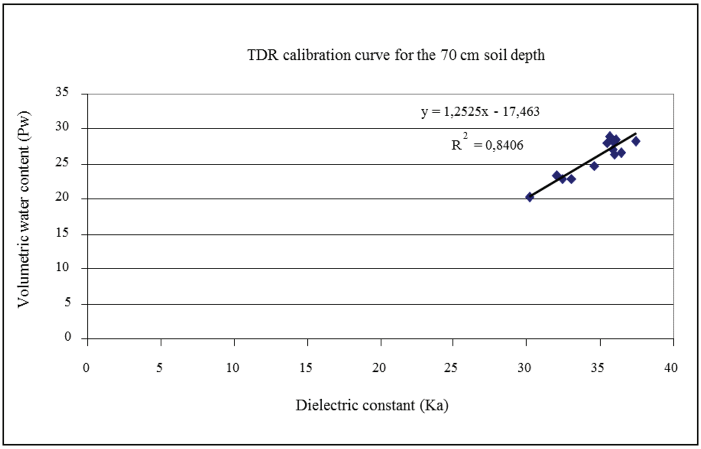

Figure 3. TDR calibration curve for the 70 cm soil depth

The fact that the correlation coefficient between the volumetric water content and dielectric constant was found to be higher in this study suggests that the TDR equipment can be very easily used for these kinds of soils.
As a result of the statistical analysis, the relationship between the gravimetric method and the TDR measurements were found to be significant ($p<0.05$). The result of the analysis suggested that there was a strong relationship between the measurements and that the findings of the present study bore similarities to the studies conducted by Tanrıverdi, 2005; Tülün, 2005; Küp, 2009.

Saving labor costs

The amount of time spent in collecting samples in 15, 45 and 70 cm deep soil in gravimetric method takes no longer than 5 minutes. This length of time is also related to the experience on the part of the person collecting the sample, the likelihood of hitting the hand brace to a stone in the underground, the time spent in wrapping up the lids of the sample containers in an effort to avoid the evaporation of the moisture of the soil sample therein, which contribute to the extension of the overall measurement time. In the TDR method, however, the measurements take about 1 minute for the 3 soil depths.
Since the amount of labor spent in the study cannot be included in the units of measurements, it was measured by way of verbal dialogs. According to the verbal dialogs, the difference between the gravimetric method and the TDR measurement methods were considerably big. As a result of the statistical analysis, the difference between the measurements performed by the gravimetric measurement and TDR equipment were found to be statistically very significant ($p<0.01$).

CONCLUSION

The studies that aim to preserve our domestic soil and water resources are conducted on a continuous basis by all the national institutions, yet they fail to relate to the level of the Turkish farmer. Although the studies thus far conducted with a view to extending the agricultural technological developments in our country and yielding more crops from a unit area are found to be encouraging, it is our view that the failure of such studies to relate to the level of the farmer is one of the major reasons why the efficiency in agricultural terms has not yet lived up to the expectations.
In this study where the direct and indirect measurement methods have been compared in order to determine the amount of water to be provided to the plants by the farmers on a timely basis so as to avoid the plant going through water stress;
It was established that the gravimetric measurement method despite being time consuming and costly in terms of labor- was essential, as a direct measurement method, in terms of calibrating the indirect methods.
On the other hand, the TDR measurement method, as an indirect measurement method, was found to have a number of advantages, in addition to saving time and labor costs, such as
- Enabling direct measurement in the field,
- Being mobile, lightweight and easily transportable,
- Capable of being used in different soil textures,
- Reducing the number of macropores in the soil,
- But it was also found to have a drawback in that extreme care should be taken when used in soils with high percentages of clay and organic substances.

As suggested by a number of researchers, the use of calibrated TDR will make significant contributions to the domestic farmer in terms of efficiency, time and labor cost saving thanks to it's a for ementioned advantages (Irmak et. al., 1999; Tanrıverdi, 2005; Küp, 2009; Quaknin et. al., 2015; Satriani et. al., 2015; Chung et. al., 2016).

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POTENTIAL OF THE LAND IN ARCHAR VILLAGE FOR CREATION OF VINES FOR QUALITY WINE GRAPE VARIETIES. CLIMATIC AND GEOGRAPHIC SPECIALITY OF THE TERROIR

Krasimir TRENDAFILOV, Violeta VALCHEVA, Mladen ALMALIEV

Agricultural University, 12 Mendeleev Blvd., 4000 Plovdiv, Bulgaria

Corresponding author email: mladenalmaliev@abv.bg

Abstract

The most important factors, defining the concept of "terroir" for a great wine are soil and climate. The climate allows the vine to adapt to the given location and under specific conditions. In this sense, interest in our study was part of land in Archar village in North terroir "Danubian Plain", characterized by its specific climate. The influence of the light over the vine plant estimate by the values of the helios-thermos coefficient. The average value for the base station was 4.22 and in terms of the brightness determined the studied object as suitable for the cultivation of all vine varieties. The radiation conditions in the studied area were suitable for growth of vine and did not impose restrictions on the choice of formations, planting distance and orientation of the rows of the plantation. The data for the average monthly air temperature for the warmest month of the year shown, that the area was suitable for the production of vine intended for relatively large set of guidelines for realization - for champagne wine, white and red quality wines, white and red table wine, dessert wines, as well as for the production of dessert grapes. During the period of grapes ripening - August and September were found relatively high values of the average temperature amplitudes. The stated values ensure optimal conditions for the process of photosynthesis and respiration and provides a normal and harmonious accumulation of sugars and acids in the grapes. The vegetation period was 200 days. The stated value was sufficient and provides a normal vegetation period for most varieties.

Key words: *vine, terroir, wine, grape.*

INTRODUCTION

The most important factors, defining the concept of "terroir" for a great wine are soil and climate. The climate allows the vine to adapt to the given location and under specific conditions (Falcetti, 1994). In this sense, interest in our study was part of land in Archar village in Northern terroir "Danubian Plain", characterized by its specific climate.

The influence of the climatic elements - temperature, humidity and solar radiation are the main factors of which depend the vital functions of the vine. In certain values they promote the growth, the regular fruit-bearing and the obtain of quality grape production. One of the most important forms for determination of the climatic conditions are agro-climatic resources of the territory (Wilson, 1998). In terms of climate conditions the region of Northern Bulgaria is characterized by humid continental climate.

MATERIALS AND METHODS

The object of the study is located in Archar village, Dimovo municipality, Vidin region, "Long Meadow" place. For the properly solve of a number of production problems in the creation of vineyards is necessary to know the physiographic special features of the area, where located the soil-climatic and in many cases the microclimatic conditions of the terrains, determining the different development, growth and specific qualities of the grape production.

Dealing with indicators such as: average monthly temperatures during the vegetation period, average dates of sustainable establishment of average day air temperatures above or below a certain limit, temperature amounts for the period with average air temperatures above a certain limit, duration of these periods and the period without frost, indicators for characterization the conditions of moisture and others, would contribute for the proper and timely implementation of various

agronomic practices, providing production efficiency (Leeuwen et al., 2004).
The presented in this study results were an attempt to provide guidelines for the creation of new vineyards and the choice of wine grape varieties.

RESULTS AND DISCUSSIONS

General climatic characteristic

In climatic attitude the studied terrain for creation of new vineyard in Archar village belongs to European-continental climatic region, humid continental climatic sub region and North climatic region of the "Danubian Plain".
The climate is characterized by well-defined continental type. The annual rainfall amount was from 515 to 610 mm. The rainfall minimum was during the winter period (February and November) and the maximum was in the summer period (June and May) as the difference between summer and winter rainfall was average 15-20% of their annual amount (Kiriakov, 1954).
The area is characterized by cold winter and hot summer. The average air temperature in January was from 1.5 to 2.0 ^{o}C and the average air temperature in July was from 22.0 to 23.5 ^{o}C. The average annual air temperature was in ranges from 10.5 to 11.5 ^{o}C.
Spring comes later compared to the Middle and East region of "Danubian Plain". The average date of the danger passing of the last spring frost was April 5.
Some main data of the general climatic characteristic of the Northern climate region of "Danubian Plain" shown in Table 1.

Table 1. General climatic characteristics of the northern climatic region of “Danubian Plain”

Climate indicator	Measure	Value
Average starting date of permanent retention of the temperature above 10^{o}C	Date	5 IV
Average end date of permanent retention of the temperature below 10^{o}C	Date	24 X
The earliest date of the last spring frost	Date	17 III
Average date of the last spring frost	Date	5 IV
The latest date of the last spring frost	Date	2 V
The earliest date of the first autumn frost	Date	2 X
Average date of the first autumn frost	Date	22 X
The latest date of the last autumn frost	Date	22 XII
Average duration of free of frost period	Days	199

For characterization of the climate elements for the studied terrain in Archar village are used data from 55 years period of observation, registered at the nearest meteorological station - Vidin, with geography position 22^{o}51I East longitude; 43^{o}39I North latitude and 35 m altitude (Subev, 1959).

Solar radiation, radiation balance and sunshine duration

The average duration of sunshine for the period with average day air temperatures higher than 10^{o}C or for the vegetation period of the vine was 1500 hours. The total solar radiation for the period with average day air temperatures higher than 10^{o}C was about 4100 MJ/m^{2} and the radiation balance for the same period was 1800 MJ/m^{2}. The values were lower compared to those in the middle part of "Danubian Plain". Photo synthetically active radiation for the period with average day air temperatures, higher than 10^{o}C was 1900 MJ/m^{2} and was also lower. The influence of the light on the vine plant is assessed by the values of the helio thermal coefficient. The average value for the base station was 4.22 and in regard to the light determine the studied object as suitable for cultivation of all vine varieties.

Temperature conditions

Regime of the average day and night temperatures

The average annual temperature of the base station in Vidin town for a period of 55 years was 11.21^{o}C and vary in confidence interval from 10.62 to 12.39^{o}C (Kichukova, 1983).

Table 2. Average monthly air temperatures with confidence intervals

Month	Average temperature (^{o}C)	Standard digression	Confidence interval	
January	-1.71	3.21	-2.56	-0.86
February	0.59	2.87	-0.17	1.35
March	5.42	2.44	4.78	6.07
April	11.99	1.48	11.60	12.38
May	17.26	1.42	16.88	17.63
June	20.70	1.14	20.40	21.00
July	22.75	1.29	22.41	23.10
August	21.74	1.36	21.38	22.10
September	17.63	1.47	17.24	18.02
October	11.56	1.69	11.11	12.01
November	5.74	1.81	5.26	6.22
December	0.88	2.26	0.28	1.48
Annual	11.21	2.26	10.62	11.81

The regime of the average monthly temperature was stable, except January, February and March, when possible alternate of periods with suddenly warming with periods of cold weather.

The below zero average January temperatures were found for a total of 38 year for the observed 55 year period, or in 69% of the cases. The lowest average monthly temperature in January -10.6°C was registered in 1942 and the highest 4.9°C in 1983.

During the rest winter months - February and December average below zero temperatures are registered respectively for 20 years of the observed period (36% of cases) and for 18 years (33% of cases). The lowest average temperature in February was -8.9°C and in December -5.9°C.

In 69% of the cases, the average temperature in July had values above 22.0 °C. Average values below 21.0 °C marked only for one year of the observed period or 1.8% of the cases. The lowest average temperature in July was 20.7 °C registered in 1969 and the highest 28.0 °C in 1957.

Day and night motion of the air temperatures

The day and night motion of the temperatures characterized by day and night amplitude, formed as difference between the average monthly maximum and average monthly minimum temperature. The monthly average amplitude of the air temperature and the interval of variation shown in Table 3.

Table 3. Average monthly amplitude of day and night temperatures in °C

Month	Average monthly amplitude	Standard digression	Confidence interval	
January	5.1	3.2	4.3	6.0
February	6.0	3.8	5.0	7.0
March	7.8	4.9	6.5	9.1
April	9.3	5.5	7.8	10.8
May	9.4	6.0	7.8	11.0
June	10.1	5.9	8.5	11.6
July	10.8	6.2	9.1	12.4
August	11.1	6.5	9.4	12.8
September	10.6	6.2	9.0	12.3
October	8.8	5.3	7.4	10.2
November	5.7	3.7	4.7	6.7
December	5.2	3.8	4.2	6.2

Regime of the absolute minimum air temperatures

Actually measured temperature minimum and the average of the absolute minimum air temperature for Vidin station and observation period of 55 years shown in Figure 5.

The absolute temperature minimum -32.5°C was measured in January 1947. The temperature minimum for the rest winter months - February and December were respectively -27.0°C and -24.5°C and was registered in 1956 and 1931 and 1948.

The average of the absolute minimum temperatures for January was -15.97°C and defines the region as scooped. Scoop for the young vines during the creation of the vine plantation is absolutely necessary.

The probability for reporting of absolute temperature minimum of -26.0°C which can damage by frost the multiannual vine stem was low - 10% in January and 2% in February. Temperatures of -22.0°C which can damage one-year vine stem had higher probability - 14% in January; 8.0% in February and 5% in December. Absolute temperature minimum of -15.0°C which can damage by frost part of the buds of the vine had high probability 54% in January, 44% in February; 22% in December and 9% in March.

Economic significant amount of the possible damages by the effects of extremely low temperatures is determined by the continuance of their establishment, by cold resistance of the different varieties, by general physiological condition of the plants.

The average monthly number of the days with extreme low air temperature has the following values:

- 0.1 days in January for temperatures from -30.0 to -34.9°C;
- 0.4 days in January and 0.1 days in February for temperatures from -29.9 to -25.0°C;
- 0.8 days in January; 0.4 days in February and 0.2 days in December for temperatures from -24.5 to -20.0°C;
- 1.8 days in January, 1.0 days in February; 0.2 days in March and 0.8 days in December for temperatures from -19.9 to -15.0°C.

The extreme cold weather during the vegetation period also unfavourable affect the growth of the vine.

The probability for establishment of temperatures -2.5°C and -1.0°C in April was respectively 20 and 44%, or such temperatures is expected respectively for two and for five years of every 10 year period. Those

temperatures cause damage to the vine in late spring frosts and after bud swell and burst. Figure 8 shown, that with probability of 20%, or for 2 of every 10 years are expected late spring frosts after the average date of bud swell in the region - 15 April and this must be considered when choosing a system for pruning the plants.
Below zero temperatures in May were registered exceptionally rare and the probability of establishment was very low. In September were not reported below zero temperatures of -2.0; -3.0°C where can be observed damage to the unripe grapes. Temperatures of -4.0 °C, which damaged ripe grapes was reported in October with probability 12%, or such damage can be expected for a 1 of every 10 year period.
Regime of the absolute maximum air temperatures
The absolute temperature maximum, measured in Vidin station was in August 1945. The highest absolute maximum temperatures was registered in June and July 1938, respectively 38.8 and 40.8°C. The average of the absolute maximum air temperatures exceed 35.0°C in July and August, when in practice can be observed damages to the vine plants as a result of their action. The establishment of a temperature in the range of 35.0 to 40.0°C and over 40.0°C causes blight on the leaves and grapes, particularly in dry weather and hot winds.
Absolute maximum temperature of 35.0°C was not established in April, and in May the probability was low - 6.0%. During the summer months the probability for reporting of temperatures above 35.0°C was high: 28% in June; 66% in July and 60% in August, or such temperatures were established respectively for 3; 7 and 6 of every 10 year period. The probability for registering of extremely high temperatures over 35.0°C in September was 10%, or such temperatures are expected for 1 of every 10 year period.
The size of the economic important damages as a result of the extremely high temperatures depend on the continuance of their establishment. The average number of the days with temperatures from 35.1 to 40.0°C by months was as follows: in May - 0.2 days; in June - 0.7 days; in July - 3.2 days; in August - 2.9 days and in September - 0.2 days. Eventual damages to the plants can be expected in case of two consecutive days with temperatures above 35.0°C.
Temperature amount of biologically active temperatures
The average temperature amount of biologically active temperatures was 3737°C with confidence interval from 3642 to 3832°C.
The probability for recruitment of temperature amount of 3100°C, necessary for the ripening of the early vine varieties is provided with almost 100% probability. The probability for recruitment of temperature amount of 3500°C, necessary for the ripening of the medium early vine varieties was high - 77%. The sufficiency of the temperature sum of 3700°C, necessary for the ripening of late vine varieties was 50%. The temperature sum of 3900°C, which guarantee the ripening of very late vine varieties was insufficient with probability of 25%.
Regime of the atmospheric humidity
The average annual amount of the rainfall, registered for an observation period of 55 years in the base Vidin station was 541 mm and vary in the confidence interval from 512 to 570 mm. More important were the rainfall reported during the vegetation period - April 1 to September 30. The average rainfall amount during the vegetation for the area was low - 298 mm (confidence interval from 271 to 323 mm). Normal growth of the vine is realized at annual rainfall amount of 600 to 800 mm and during the vegetation period amount of 400 to 500 mm. The established in the area average values of the annual rainfall and the rainfall during the vegetation period were not enough and did not provide the necessary moisture for the growth of the vine.
Annual rainfall amount of 600 mm was found in 28% of the observed cases, or such amount was expected average for 3 of every 10 year period. The probability for reporting of annual amount of 800 mm was practically zero. The necessary rainfall amount during the vegetation period of 400 mm was reported with a probability of 15% or such amount of rainfall is expected for about 2 of every 10 year period. The probability of rainfall of 500 mm during vegetation period was very low - 1.9%.
The maximum rainfall was in June, and the minimum in August. The winter months -

January and February were relatively dry in which can not provide the necessary water reserve in the soil.
Importance for formation of the water reserve in the soil and for limiting the harmful effect of extremely low temperatures in the winter had snow precipitations. The average number of days with snow cover and its height were greatest in January and February.
The relative humidity has importance for the normal physiological processes in the vine. Average monthly values and their confidence interval shown in Table 4.

Table 4. Average monthly relative humidity, in %

Month	Average relative humidity (%)	Standard digression	Confidence interval	
January	84.29	5.13	82.93	85.65
February	81.02	6.05	79.42	82.62
March	74.15	6.93	72.31	75.98
April	68.38	4.96	67.07	69.69
May	69.71	4,.73	68.46	70.96
June	68.05	4.36	66.90	69.21
July	64.25	4.93	62.95	65.56
August	65.85	5.74	64.34	67.37
September	70.36	6.10	68.75	71.98
October	76.95	5.72	75.43	78.46
November	83.13	5.14	81.77	84.49
December	85.25	4.30	84.12	86.39

The intensive growth of the vine shoots is realized best at a relative humidity of 60 to 70%. For the period (April-June) in the area there were normal conditions for the process. During the period of the grains growth (July-August) the vine requires a higher relative humidity - 70-80%. The average monthly values of the index for these months were respectively 64.25 and 65.85% and assessed as insufficient. The critical minimum value of the air humidity of 40% and below 40%, in which reporting a decrease of the photosynthesis has not been established.
The conditions for humidification by months can be evaluated by the values of hydrothermal coefficient (HTC) by Selyaninov (Selyaninov, 1958) shown in Table 5.
The average monthly values of HTC were below the limit 1.00 in July, August and September for which the conditions for humidification assessed as insufficient.

Wind regime
During the coldest month of the year - January prevailing western winds, and in July - western and eastern winds.
During the warmest month of the year the speed was highest for the northwestern and western winds. In January the speed was highest also for the western and North-Western winds. Their appearance in winter was due to the transmission of cold winds.

Table 5. Average values of the hydrothermal coefficient by months

Month	Average amount of the average daily temperatures (^oC)	Average rainfall amount (mm)	Average values of the hydrothermal coefficient (HTC)
January			
February	23.4	37.5	16.1
March	175.5	40.9	2.3
April	358.6	50.8	1.4
May	531.6	60.9	1.1
June	617.6	68	1.1
July	693.7	45.6	0.7
August	659.3	35.6	0.5
September	518.5	36.7	0.7
October	354.1	49.1	1.4
November	172.6	53.5	3.1
December			

Extreme elements of the climate
The area is located in the path of movement of thunderstorms with a local center Byala Slatina. The average annual number of the days with thunders was 19.1 as the month with the most marked thunderstorms date was June (Subev, 1960).
The relative frequency of the hails in the area was in range of 0.25 to 0.58. The average annual number of the days with hail was 1.7. The greatest number of the days with hail was in May.
Phenological forecast
The phenological phases in the growth of the medium early vine varieties for the region shown with different provide in Table 6.
Durable establishment of biologically active temperature of 10^oC was on 6^{th} April and durable drop below 10.0^oC on 23^{th} October. The vegetation period was 200 days. That amount was sufficient and provides a normal vegetation period for most vine varieties.

Table 6. Dates of occurrence of the phenophase in the vine with different degree

Phase of growth	Provide, %								
	10	20	30	40	50	60	70	80	90
Bud break	2. 04	8. 04	10. 04	13. 04	15. 04	18. 04	19. 04	22. 04	23. 04
Flowering	31. 06	5. 06	7. 06	9. 06	10. 06	11. 06	15. 06	17. 06	19. 06
Ripening (medium early varieties)	8. 09	15. 09	17. 09	19. 09	20. 09	25. 09	28. 09	29. 09	1. 10

CONCLUSIONS

The influence of the light over the vine plant estimate by the values of the helios-thermos coefficient. The average value for the base station was 4.22 and in terms of the brightness determined the studied object as suitable for the cultivation of all vine varieties.

The radiation conditions in the studied area were suitable for growth of vines and did not impose restrictions on the choice of formations, planting distance and orientation of the rows of the plantation.

The data for the average monthly air temperature for the warmest month of the year shown, that the area was suitable for the production of vine intended for relatively large set of guidelines for realization - for champagne wine, white and red quality wines, white and red table wine, dessert wines, as well as for the production of dessert grapes.

During the period of grapes ripening - August and September were found relatively high values of the average temperature amplitudes. The stated values ensure optimal conditions for the process of photosynthesis and respiration and provides a normal and harmonious accumulation of sugars and acids in the grapes.

In order to avoid a significant amount of the damages from extreme low temperatures was not recommended planting of varieties with very weak (Ugni Blanc) and weak (Dimiat, Sauvignon Blanc) cold resistance. Frost damage can be limited by the use of appropriate technology of the plant growth.

The vegetation period was 200 days. The stated value was sufficient and provides a normal vegetation period for most varieties.

In order to prevent possible frost on the vine plantation recommended the direction of the rows to be in the direction of prevailing western winds.

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CULTIVATION POTENTIAL OF *Salvia tomentosa* AND *S. aramiensis* UNDER THE EASTERN MEDITERRANEAN CONDITIONS

Mehmet ARSLAN

Erciyes University, Agriculture Faculty, Department of Agricultural Biotechnology, Kayseri, Turkey

Corresponding author email: mehmetarslan@erciyes.edu.tr

Abstract

Salvia aramiensis and S. tomentosa species are naturally grown salvia species in Hatay province of Turkey. There has not been any attempt to cultivate these two species in Turkey. A two-year study was conducted to determine cultivation possibility of S. aramiensis and S. tomentosa under the eastern Mediterranean conditions in the 2011 and 2012 growing seasons in Hatay, Turkey. The measured plant parameters were plant height, herbage yield, essential oil content and components. Plant heights of S. tomentosa were 102.3 and 95.60 cm and plant heights of S. aramiensis were 88.35 and 97.40 cm in 2011 and 2012, respectively. Salvia tomentosa had the highest herbage yield with 40.45 g/plant while S. aramiensis had the lowest herbage yield with 37.30 g/plant in 2011. In the second year of the study, the herbage yield of S. aramiensis and S. tomentosa were 42.50 and 43.05 g/plant, respectively. Essential oil contents of S. aramiensis and S. tomentosa varied between 1.25 and 1.35% in 2011 and 1.30 and 1.20% in 2012, respectively. The major essential oil components of S. aramiensis were 1.8-cineole, camphor, para-cymeme, sabinene, germacrene-D, thujone, camphene and borneol. The major essential oil components of S. tomentosa were a-pinen, b-pinen, limonen, eucalyptol, linalool, b-mirsen, camfen, 1,8-cineole, camphor, β-caryophyllene α-humulene. With respect to herbage yield and essential oil content, Salvia aramiensis and S. tomentosa can be successfully cultivated under the eastern Mediterranean conditions.

Key words*: essential oil, herbage yield sage, Saliva tomentosa, Salvia aramiensis.*

INTRODUCTION

The genus *Salvia* (family Lamiaceae) is an annual, biannual or perennial shrubby herb consist of about 1000 species in the word and represented in the Turkish flora by 94 taxa belonging to 89 species with 45 are endemic (Davis, 1982; Güner, 2000). *Salvia* species are largely collected wild especially in Mediterranean basin and then sold in local markets or exported to the world markets. *Salvia aramiensis*, and *S. tomentosa* grown in *Pinus brutia* woodlands, rocky places and limestones in Hatay province,are perennial, evergreen and sub-shrub with woody stems. The dried leaves of thesespecies are used as herbal tea and in folk medicine to treat cold, diabetes, skin diseases and their essential oils are of economic importance worldwide due to their utilization mainly in food flavoring, perfumery and cosmetics (Yesilada et al., 1993; Demirci et al., 2002). Essential oil of these salvia species have wide range of biological activities (Haznedaroglu 2001; Kelen and Tepe, 2008; Askun et al., 2010). Many of *Salvia* species become rare and endangered due to increased domestic and foreign demands. Therefore, there is a rising trend for cultivation of *Salvia* species. Essential oil content and compositions of these three *Salvia* species were determined but their production potential has not been extensively studied yet. The essential oil content and composition of *S. aramiensis*, and *S. tomentosa* were studied extensively by many researchers (Demirci et al., 2002; Karaman et al., 2007). The objective of the current study was to determinethe herbage yield, essential oil content and essential oil component of *S. aramiensis*, and *S. tomentosa*. The interest in the commercial cultivation of sage suited for the sage market in Turkey is increasing and only few studies on the cultivation of these two species have been undertaken.

The purposes of the present study are to determine the yield potential of *Saliva tomentosa*and *S. aramiensis* under eastern Mediterranean conditions and to determine the growing possibilities of *Saliva tomentosa* and *S. aramiensis* as an alternative crop in the region.

MATERIALS AND METHODS

Salvia aramiensis and *Salvia tomentosa* plants were collected from Amanos mountains in the Eastern Mediterranean part of Turkey. The high yielding selected genotypes were vegetatively propagated by stem cuttings. The rooted cuttings were transferred in 4-row, 5 m long plots with 35 intra-row spacing at the experimental field of the Mustafa Kemal University. The crops were fertilized with 75 kg ha/ha of N and 75 kg/ha of P_2O_5 kg/ha. Drip irrigation was applied during the growing period. The soil of experimental plots was a clay silt loam with pH of 7.4, having 1.1% organic matter, 0.11% total nitrogen content, and water holding capacity of 0.36 cm^3. The long-term monthly mean temperatures from January to December were 8.2, 9.6, 13.2, 17.2, 21.2, 24.8, 27.2, 27.7, 25.6, 20.9, 14.0 and 9.4 °C, respectively. The long-term monthly mean precipitations from January to December were 172.7, 156.8, 141.3, 101.5, 90.4, 21.9, 21.9, 8.0, 39.8, 74.0, 114.2 and 172.1 mm, respectively.

The above ground parts of the plants were harvested at the onset of the flowering in the first week of May 2009 and 20010. At harvest, a sample of 10 plants was randomly selected from each plot to determine plant height, dry leaf weight/plant and dry stem weight/plant. Essential oil content, herbage and essential oil yield were determined by harvesting central two rows of the 4-row plots. The dried leaf samples (50 g) were subjected to steam distillation for 3 h using a Clevenger-type apparatus. The essential oil percentage was expressed as v/w with respect to dry matter of the initial material. GC-MS analysis: Analysis of the essential oils carried out by using Thermo Scientific Focus Gas Chromatograph equipped with MS, auto sampler and TGWAX-MS (5% Phenyl Polysilphenylene-siloxane, 0.25 mm x 30 m i.d, film thickness 0.25). The carrier gas was helium (99.9%) at a flow rate of 1 mL/min; ionization energy was 70 eV. Mass range m/z 50-650 amu. Data acquisition was scan mode. MS transfer line temperature was 250°C, MS Ionization source temperature was 220°C, the injection port temperature was 220°C. The samples were injected with 250 split ratio. The injection volume was 1 µl. Oven temperature was programmed in the range of 50°C to 220°C at 3°C/min. The structure of each compound was identified by comparison with their mass spectrum (Wiley9). The data were handled using Xcalibur software program. The retention indices (RIs) were calculated for all volatile constituents using a homologous series of n-alkane standard solutions C8-C20 (Fluka, product no. 04070) and C21-C40 (Fluka, product no. 04071).

RESULTS AND DISCUSSIONS

The climatic data indicate that the mean air temperatures January to December 2011 and 2012 were similar to the long-term mean. In July 2011 and 2012, the temperatures were slightly higher than the long-term mean. Consequently, the thermal conditions favored the growth and development of herbal plant. The long-term monthly mean precipitations from January to December in 2011 and 2012 was similar and being slightly lower than the multi-year average.

Salviatomentosa and *S.aramiensis* grow widely on the slopes at altitudes of 25 up to 450 m in the East Mediterranean region of Turkey. There is not any report on the commercial production of the plant in Turkey, since almost all of the domestically consumed *Salviatomentosa* and *S. aramiensis* have been gathered from the nature (Table 1). Plant heights varied between 88.35 and 102.3 cm in 2011 and 95.60-97.40 cm in 2012. *Salvia tomentosa* had the highest plant height than *S. aramiensis* in both years. When herbage yield was considered *S.tomentosa* had the highest herbage yield with 45.40 and 43.057 g/plant 2011 and 2012, respectively. Essential oil content did not significantly vary between two *Salvia* species. Essential oil content varied between 1.20 % and 1.35.

The constituents of *S. aramiensis* oil grown at two locations were given in Table 2. Thirty essential oil components were detected in the essential oil of *S. tomentosa* (Table 2). The major essential oil components of *S. tomentosa* were α-pinene, camphene, β-pinene, α-myrcene, 1,8 cineole, D-limonene, eucalyptol, β-thujone, thujone, limonene, camphor, and borneol. Thirty three essential oil components were detected in the essential oil of *S. aramiensis* (Table 3). The major essential oil components of *S. aramiensis* were α-pinene, camphene, β-pinene, limonene, eucalyptol, ocimene, linalool, thujone, α-humulene, palustrol, veridiflorol and carvacrol. This is in accordance with others values found in literature, which reported yields of 1.1 to 2.8% (Demirci et al., 2002; Karaman et al., 2007; Aşkun et al., 2010). The essential oil from widely cultivated common sage (*Salvia officinalis*) contained α- and β-thujone (50-70%), low camphor (less than 10%) and 1,8-cineole as the main components (Zawiślak and Dyduch, 2006; Boelens and Boelens, 1997; Chalchat et al., 1998; Pino et al., 1997; Putievsky et al., 1986).

Table 1. Plant height, herbage yield and essential oil content of *S. aramiensis* and *S. tomentosa*

	Plant Height(cm)		**Herbage yield(g/plant)**		**Essential oil content (%)**	
Species	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**
S.aramiensis	88.35	97.40	37.30	42.50	1.25	1.30
S.tomentosa	102.3	95.60	45.40	43.05	1.35	1.20
LSD (0.05)	13.90	14.20	53.86	42.60	0.24	0.24

Table 2. Essential oil components of *S. tomentosa*

			Area %	
Compound Name	**RT**	**RI**	*S.tomentosa*	*S.aramiensis*
δ.3-Carene	3.46	1014	0.28	-
α-Pinene	3.65	1029	11.89	23.75
Camphene	4.37	1073	6.67	1.47
β-Pinene	5.17	1113	5.67	4.84
Dimethylsiloxane pentamer	6.30	1162	0.79	0.16
Cyclopentasiloxane, decamethyl	6.31	1163	-	0.16
α-Myrcene	6.53	1171	1.69	-
1,8 cineole	6.92	1185	1.31	1.97
α-Terpinene	6.93	1252	-	0.41
D-Limonene	7.45	1202	2.30	1.97
Eucalyptol	7.64	1210	9.39	9.94
Sabinene	8.87	1252	0.38	-
γ-Terpinene	8.88	1252	-	0.77
β-Cymene	9.70	1276	1.25	0.11
Ocimene	9.71	1277	-	2.54
Cis-Ocimene	10.07	1276	0.18	0.11
β-Ocimene	10.08	1287	-	2.54
Linalool	12.46	1287	0.77	2.11
β-Thujone	14.96	1356	10.74	-
Thujone	15.69	1421	8.86	20.67
Limonene	16.19	1441	1.18	-
Camphor	18.38	1455	17.68	-
Tetradecamethylcycloheptasiloxane	19.24	1510	0.81	-
Hept-6-ynyl malonic acid	19.52	1533	0.11	-
Bornyl acetate	20.93	1541	1.84	0.31
Trans-Caryophyllene	21.43	1577	1.23	2.92
Terpinen-4-ol	21.82	1589	0.55	-
10,12-Octadecadiynoic acid	23.71	1599	0.20	-
α-Humulene	24.10	1652	1.01	3.29
Lcosapent	24.89	1662	0.32	-
Borneol	25.41	1682	4.75	3.96
Hexadecamethylcyclooctasiloxane	25.70	1696	0.94	0.45
Palustrol	33.19	1917	-	0.97
2,5-Octadecadiynoic acid, methyl ester	34.90	1969	0.21	-
α-Ionol	36.76	2027	-	1.85
Veridiflorol	38.28	2076	1.29	5.47
Carvacrol	42.65	2240	-	1.35
Tetraoxatetradecan-1-ol, 14 phenoxy	54.60	2651	0.53	--
Total			94.82	94.09

CONCLUSIONS

It can be concluded from these results that the eastern Mediterranean environments are suitable for cultivation of *S. tomentosa* and *S. aramiensis*. The essential oils of *S.tomentosa* and *S. aramiensis* could have desirable chemical characteristics for domestic and international trade due to the similar concentrations of its major constituents. Most of the exported *S. tomentosa*and *S. aramiensis* were gathered from the nature. In order to meet domestic and international marked criteria such as herbage quality, essential oil content and composition, *S. tomentosa* and *S. aramiensis* must be cultivated.

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HERBAGE YIELD, ESSENTIAL OIL CONTENT AND COMPONENTS OF CULTIVATED AND NATURALLY GROWN *Origanum syriacum*

Mehmet ARSLAN

Erciyes University, Agriculture Faculty, Department of Agricultural Biotechnology, Kayseri, Turkey

Corresponding author email: mehmetarslan@erciyes.edu.tr

Abstract

Origanum spp. is one of the most economically important culinary herbs in the World. Essential oil content, essential oil components and dry leaf color are the most important quality criterion in the oregano market. Origanum syriacum var. bevanii is both gathered from the nature and cultivated under the field condition. This study was conducted to determine herbage yield and quality criterion between cultivated and naturally grown oregano. Compared with non-cultivated wild oregano, cultivated oregano at the first and second harvest had the highest plant height, dry herbage yield in 2011 and 2012. The essential oil content of cultivated and naturally grown oregano varied between 2.9-3.5%, and between 2.4-3.5%, respectively. Essential oil component ratios of cultivated and naturally grown oregano were similar. Main essential oil components were carvacrol, β-terpinene, β-Cymene, α-thujene, β-myrcene and caren in both production type. Cultivated oregano had higher plant height, herbage yield and essential oil content than that of the wild grown oregano. Although there was not a visual difference between leaf color of natural grown and cultivated oregano, cultivated oregano was more homogenous and contains higher amount of essential oil than that of naturally grown oregano to meet quality criterion.

Key words: *Origanum syriacum, herbage yield, essential oil content, essential oil components.*

INTRODUCTION

The genus *Origanum* is broadly grown in wild in Turkey and has 22 species (Ietswaart, 1980; Kokkini, 1997). Turkey is one of the leading countries in the world supplying Mediterranean type of oregano (*Origanum* spp.). This type of oregano is considered as one of the most important spices in the Mediterranean countries (Baser et al., 1992; Baser et al., 1993). Beside the usage as a spice, essential oil of oreganos is utilized in pharmaceutical and cosmetic industries. Antibacterial (Biondi et al., 1993) and antifungal (Paster et al., 1993) actions of the oregano essential oils add extra value for the crop. Vegetative parts of oregano and its biochemical extracts are commonly used in food industry. In addition, the dried herb is also used by the food industry in flavoring of processed foods especially in vegetables, meat products, and condiments. Oregano is well known as the ‘‘pizza herb’’ and widely used in the Mediterranean kitchen as fresh and dried flavoring additive.

Origanum syriacum, a perennial herbaceous plant native to the Middle East and Eastern Anatolia, grows in mountainous areas with rocky, calcareous soil. It is very popular culinary herb that has been added to soups, casseroles, sauces, stew, stuffing, eggs, olives, teas, tomato-based dishes, chili and pizza.

The general interest of the market towards oregano is increasing not only for their traditional culinary use but also for the novel demands of the phyto-pharmaceutical sector.

The food and pharmaceutical industries have an increasing demand for homogeneous high quality materials for the standardization of their high quality outputs.

The essential oil and the constituents of *Origanum syriacum* has been intensively studied. It was reported that thymol and carvacrol represent the major constituents of the essential oils of *Origanum* species (Sarer et al., 1982).

The purpose of the present study was to determine essential oil content, composition and some plant parameters of naturally grown and cultivated O*riganum syriacum*.

MATERIALS AND METHODS

Origanum syriacum plants were collected from bottom of Amanos mountains (36°.10'.02" N, 35°.59'.70") in the Eastern Mediterranean region of Turkey. The collected plants were grown in a nursery to screen the superior high yielding genotypes. A high yielding selected genotype was vegetatively propagated by stem cuttings. The rooted cuttings were transferred in 4-row plots, 5 m long with 30 cm intra-row spacing at the experimental field of the Mustafa Kemal University. The experimental design was a randomized complete block with three replications. The crop was fertilized with 75 kg/ha of N and 75 kg/ha of P_2O_5. Drip irrigation was applied during the growing period. The soil of experimental plots was a clay silt loam with pH of 7.4, having 1.1% organic matter, 0.11% total nitrogen content, and water holding capacity of 0.36 cm3. The daily climatic data were recorded by using HOBO weather station, (Onset Computer Corporation, USA). The long-term monthly mean temperatures from January to December were 8.2, 9.6, 13.2, 17.2, 21.2, 24.8, 27.2, 27.7, 25.6, 20.9, 14.0 and 9.4°C, respectively. The long-term monthly mean precipitations from January to December were 172.7, 156.8, 141.3, 101.5, 90.4, 21.9, 21.9, 8.0, 39.8, 74.0, 114.2 and 172.1 mm, respectively.

The wild grown oregano in the bottom of Amanos mountains (36°.10'.02" N, 35°.59'.70") was harvested at the flowering stage to determine yield and quality criterion of wild grown oregano. Second harvest was done in late August when the plans were flowering stage.

The above ground parts of the plants were harvested at the onset of the flowering in the first week of the June for first harvest and late August for second harvest in 2011 and 2012. At harvest, a sample of 10 plants was randomly selected from each plot to determine plant height, dry leaf weight/plant and dry stem weight/plant. Essential oil content, herbage and essential oil yield were determined by harvesting the central two rows of the 4-row plots.

Dry leaves of *O. syriacum*, grown cultivated and wild were subjected to steam distillation for 3 h using a Clevenger type apparatus. Leaves and flowers of harvested plants were separated and dried under shadow. Essential oil was distilled from leaves and the volumetric determination of the essential oil content was carried out under following conditions: Neo-Clevenger apparatus with 500 ml flask. 20g drug, 250 ml water, 2 h distillation time by hydro-distillation. The distillation unit consisted of a retort (boiling flask), a condenser and a decanter (receptive flask). Dry plant leaves were immersed in double their volume of distilled water and boiled. The condensate was collected in the receptive flask, and the oil was removed with a pipette and stored in glass vials. The extracted oils were stored at –20 ºC until gas chromatography-mass spectrometry (GC-MS) analysis.

Analysis of the essential oil was carried out by using Thermo Scientific Focus Gas Choromatograph equipped with MS, auto sampler and TR-5MS (5% Phenyl Polysilphenylene-siloxane, 0.25 mm x 60 m i.d, film thickness 0.25). The carrier gas was helium (99.9%) at a flow rate of 1 mL/min; ionization energy was 70 eV. Mass range m/z 50-650 amu. Data acquisition was scan mode. MS transfer line temperature was 250 °C, MS Ionization source temperature was 220 °C, the injection port temperature was 220 °C. The samples were injected with 250 split ratio. The injection volume was 1μL. Oven temperature was programmed to 50 °C to 220 °C at 3 °C/min. The structure of each compound was identified by comparison of their mass spectrum (Wiley) using the Xcalibur software program. The retention indices (RIs) were calculated for all volatile constituents using a homologous series of n-alkane standard solutions C8-C20 (Fluka, product no. 04070) and C21-C40 (Fluka, product no. 04071).

Color Analysis

The color of dried product was quantified by using a Minolta (CR-400) Chroma meter (Osaka, Japan). The color meter was set to CIE Standard Illuminant C. The dried material was ground and then its color was measured using the ground material color measurement apparatus of the instrument. L*, a*, and b* values were measured to describe three-dimensional color space and interpreted as follows: L* is the brightness ranging from no reflection for black (L=0) to perfect diffuse reflection for white (L=100). The value a* is the redness ranging from negative values for green to positive values for red. The value b* is the yellowness ranging from negative values for blue and positive values for yellow. The data was presented as mean of 10 independent measurements for each treatment.

RESULTS AND DISCUSSION

The climatic data indicate that the mean air temperatures January to December 2011 and 2012 were similar to the long-term mean. The long-term monthly mean precipitations from January to December in 2011 and 2012 was similar and being slightly lower than the multi-year average.

Economically important part of oregano is the vegetative parts, mainly the leaves, and essential oil which are sold in the markets. The measured plant parameters between cultivated and wild grown oregano were given in Table 1, 2, 3 and 4. Plant heights at the first harvest varied between 81.5 and 65.1 cm and 74.4 and 42.6 cm in 2011 and 2012, respectively (Table 1). The highest plant heights were obtained from cultivated oregano due to more availability of water and plant nutrition. At the second harvest, similarly the cultivated oregano had the longest plant height with 58.9 and 45.1 cm in 2011 and 2012, respectively. Lower plant height at the second harvest could be attributable to the high air temperature during the period between the first and the second harvest.

Table 1. Plant height of cultivated and wild grown *Origanum syriacum*

Production type	Plant height (cm)					
	2011			2012		
	I. Harvest	II. Harvest	Mean	I. Harvest	II. Harvest	Mean
Cultivated	81.5 a	58.9 a	70.2 a	75.4 a	45.1 a	60.2 a
Wild grown	56.1 b	26.7 b	41.4 b	42.6 b	21.2 b	31.9 b
LSD 0.05	9.4	6.3	6.0	10.1	7.6	5.2

Table 2. Dry herbage yield of cultivated and wild grown *Origanum syriacum*

Production type	Herbage yield (g/plant)					
	2011			2012		
	I. Harvest	II. Harvest	Mean	I. Harvest	II. Harvest	Mean
Cultivated	65.5 a	38.9 a	50.7 a	62.4 a	42.1 a	53.7 a
Wild grown	45.1 b	26.7 b	35.9 b	43.8 b	24.2 b	34.5 b
LSD 0.05	11.5	8.4	7.3	12.4	9.7	5.7

Cultivated oregano at the first harvest always had the highest dry herbage (leaf) yield with 62.5, 65.4 g/plant in 2011 and 2012, respectively (Table 2). The lowest dry herbage yields at the first harvest were obtained from non-cultivated oregano with 45.1 and 43.8 g/plant in 2011 and 2012, respectively. At the second harvest, the lower dry herbage yields were obtained from non-cultivated wild grown oregano with 26.7 24.2 g/plant in 2011 and 2012, respectively. The highest dry herbage yields were obtained from cultivated oregano since water and plant nutrition were more available for plant growth and development under the cultivated field conditions. At the second harvest, the lower dry herbage yield could be attributable to the elevated air temperature between the first and the second harvest.

Table 3. Essential oil content of cultivated and wild grown *Origanum syriacum*

Production type	Essential oil content (%)					
	2011			2012		
	I. Harvest	II. Harvest	Mean	I. Harvest	II. Harvest	Mean
Cultivated	3.5 a	3.0 a	3.2 a	3.5 a	2.9 a	3.2 a
Wild grown	2.8 b	2.4 b	2.6 b	2.9 b	2.6 b	2.7 b
LSD 0.05	0.7	0.5	0.3	0.5	0.6	0.2

Essential oil contend variations between cultivated and non-cultivated oregano were significant at the first and the second harvest (Table 1). At the first harvest the highest essential oil was obtained from cultivated oregano with 3.5% and the lowest was obtained from non-cultivated wild grown oregano with 2.8% in 2011. However, opposite results were obtained by Ibrahim et al. (2012) that wild grown *O. Syriacum* produced more essential oil percentages compared with cultivated accessions. At the second year, the highest essential oil contents were obtained from the first harvest with 3.5 and 2.9% cultivated and non-cultivated oregano, respectively. The essential oil contents of the current study were in the range of reported by Sellami, et al. (2009), Ibrahim et al. (2012), and where they studied the variation in the oil content of *O. syriacum* who found that oil contend varied between 2.3 and 2.9%.

The average brightness, redness and yellowness values for cultivated and non-cultivated oregano were given in Table 4. The dry herbage color of cultivated oregano had lower brightness and yellowness values while having a higher greenness value than that of the non-cultivated oregano. When dried herb color is considered, green is preferred over grey in the oregano market.

Tablo 4. Dry herbage color of cultivated and wild grown *Origanum syriacum* in 2011 and 2012

Production type	Dry herbage color					
	2011			2012		
	*L**	*a**	*b**	*L**	*a**	*b**
Cultivated	46.95	-8.94	16.20	41.45	0.28	1.33
Wild grown	47.93	-9.32	18.12	43.14	0.45	0.75

*L** is the brightness ranging from no reflection for black (*L* = 0) to perfect diffuse reflection for white (*L* = 100).
*a** is the redness ranging from negative values for green to positive values for red.
*b** is the yellowness ranging from negative values for blue and positive values for yellow.

Table 5. Essential oil components of cultivated and wild grown *Origanum syriacum* in 2011 and 2012

No	Compound name	RT	Area %			
			2011		2012	
			First harvest		Second harvest	
1	α-Pinene,	3.92	0.35	0.82	0.68	1.19
2	α-Thujene	3.99	2.54	1.30	1.52	1.92
3	β-Ocimene	4.69	0.19	0.23	0.11	-
4	β-Pinene	5.55	0.21	0.49	0.19	0.39
5	Sabinene	5.87	0.22	-	0.27	-
6	β-Myrcene	6.99	2.22	2.60	1.89	2.85
7	Caren	7.41	2.17	1.25	2.02	3.10
8	L-Limonene	7.96	0.40	0.70	0.43	-
9	1,8-Cineole	8.16	0.28	0.18	0.38	0.49
10	Sabinene	8.24	0.24	-	0.20	-
11	β-cis-Ocimene	9.14	1.05	1.90	0.65	0.97
12	β-Terpinene	9.44	12.32	15.74	11.95	14.15
13	β-Cymene	10.30	6.44	8.63	5.74	9.37
14	1 Octen 3 Ol	16.92	0.39	0.67	0.21	0.41
15	Cis-Sabinenehydrate	17.36	0.47	-	0.37	-
16	trans Sabinene hydrate	20.56	0.87	1.14	0.17	0.28
17	Trans-caryophyllene	22.25	0.66	0.22	0.69	0.82
18	Terpinen-4-ol	22.65	0.31	0.65	0.34	0.39
19	Borneol	26.27	0.24	0.11	0.28	-
20	9-Octadecen-12-ynoic acid, methyl ester	27.25	0.29	0.42	0.21	0.36
21	9,12,15-Octadecatrienoic acid, methyl ester	35.84	0.13	-	0.14	-
22	Carvacrol	43.58	67.82	61.33	68.95	62.38
Total			99.81	98.38	97.39	99.07

The predominant components of the cultivated and wild oregano essential oil were carvacrol, β-terpinene, β-Cymene, α-thujene, β-myrcene and caren in the first and second year of the study

(Table 5). The amounts of above-mentioned compounds varied between cultivated and wild grown oregano and between the first and the second harvest. Carvacrol was the main dominant component both cultivated and wild grown oregano in both years and both harvest time (Table 5). Little variability occurred between the rate of essential oil component of cultivated and non-cultivated oregano. Baser and Kurkcuoglu (2003) reported that thymol (24-29%), cis-sabinene hydrate (18–20%), γ-terpinene (13–15%), p-cymene (5-8%) and terpinen-4-ol (4–8%) were characterized as the main constituents of *O.syriacum*. Similar oil components of *O.syriacum* was reported by Lukas et al., (2009) that carvacrol was dominant while thymol was present only in minor amounts.

CONCLUSION

Plant height, dry herbage yield and essential oil content of cultivated oregano were higher than the wild grown non-cultivated oregano. The color of cultivated oregano had higher greenness value than that of the non-cultivated oregano. Carvacrol and β-terpinene were dominant essential oil components in the cultivated and wild grown plants in both harvest times and both years. Most of the exported *O. syriacum* was gathered from the nature. In order to meet domestic and international marked criteria such as herbage quality, essential oil content and composition, *O. syriacum* must be cultivated.

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THE INFLUENCE OF GENOTYPE AND CLIMATIC FACTORS ON THE QUALITY OF SPRING BARLEY GROWN IN NORTH EAST BARAGAN

Nicoleta AXINTI[1], Maria CONTOMAN[2], Gabriela Alina CIOROMELE[1]

[1]"Dunărea de Jos" University from Galaţi, Faculty of Engineering and Agronomy from Brăila, 29 Călărasilor Street, 810017, Brăila, Romania
[2]"Dunărea de Jos" University from Galaţi, Faculty of Food Science and Engineering, Domnească Street, 800201, Galaţi, Romania

Corresponding author email: nicoleta.axinti@ugal.ro

Abstract

Knowing the contribution of genotype and environmental conditions (soil conditions and weather conditions), and especially the contribution of interactions between these factors in achieving quantitative phenotypic traits, is of particular importance for finding the most valuable varieties of barley that can be grown in a certain geographic area. The quality requirements for beer barley are quite strict and directly related to the efficiency of processing and the quality of the product obtained in the industry of malt and beer. Many of the quality traits needed for beer barley are controlled manufacturer, but others are determined by the weather during growing and harvest period. The research was conducted to determine the quality of studied spring barley varieties, compared to the quality standards in the beer industry. The experiments were conducted during 2008 - 2010 in the Vădeni area, Braila County, on four varieties of spring barley (Thuringia, Annabell, Cristalia and Tunika). To determine the quality of barley the following physical indicators were analyzed - the mass of 1000 grains (MMB g), the hectoliter mass (MH kg/hl), assortment (%), chemical indicators - humidity (%), protein content (% d.m.), starch content (% d.m.), and biological indicators - energy and germination capacity (%).The analysis of the quality indices of spring barley varieties in the conditions of Vădeni area highlights the value of these varieties for the production of malt for beer. Following the laboratory tests, we obtained the following results: the mass of 1000 grains (MMB) ranged from 39.06 g for the Cristalia variety in 2009 and 43.50 g for the variety Tunika in 2010; the hectoliter mass (MH) ranged from 57.9 kg / hl for the Cristalia variety and 64.6 kg/ hl for the Annabell variety in 2008; assortment ranged from 85.52% in 2009 for the Cristalia variety and 91.63% for the Tunika variety in 2008; humidity ranged from 12.55% for the Cristalia variety in 2009 and 14.9% for the Thuringia variety in 2010, protein content ranged from 9.75% for the Annabell variety in 2010 and 11.15% for the Cristalia variety 2008; starch content ranged from 56.5% in 2009 for the Cristalia variety and 61.75% in 2010 for the Tunika variety; the germination capacity was between 95% for the Cristalia variety and the 98% for the Thuringia variety. Despite the climatic conditions during the experimental period, the four spring barley varieties were found to match the quality requirements of the brewing industry.

Key words: *barley, varieties, climatic conditions, quality indices.*

INTRODUCTION

Barley can be used for multiple purposes: as human food, as animal food and in the industry (*as raw material in the making of beer* and in the industry of alcohol, dextrin, glucose, etc.) (Drăghici, 1975; Munteanu, 2001; Bâlteanu, 2003, Axinte, 2006).
The quality of barley as raw materiel for the industry of malt and beer is determined by factors of genetic nature (variety of barley), pedoclimatic factors (weather, soil) and by technological elements regarding growing the barley as: crop rotation, fertilization, soil works and the phytotechnical and technological elements of seeding, maintenance and harvesting of this species.
The variety is one of the main factors that determine the crops' success, abundance and its economic efficiency. For this reason, choosing to grow certain varieties of barley that are of superior quality, more productive, resistant to draught, disease and pests, that also correspond to the exigency imposed by malt and beer producers, has become a primary concern of the research of this species (Axinti and Dumitru, 2007).
Evidence the evolution of the number of dairy cows, milk yield and total milk production in the period 1990-2010.

MATERIALS AND METHODS

The experiments were conducted during 2008 - 2010 in the Vădeni area, Braila County, on four varieties of spring barley (Thuringia, Annabell, Cristalia and Tunika). To determine the quality of barley the following physical indicators were analyzed - the mass of 1000 grains (MMB g), the hectoliter mass (MH kg/hl), assortment (%), chemical indicators - humidity (%), protein content (% d.m.), starch content (% d.m.), and biological indicators - energy and germination capacity (%).

The quality parameters obtained after measurements made on grains of barley were compared to the parameters imposed by the norms of the beer industry.

Table 1 presents the standard quality conditions (SR 13477/2003) of malting barley necessary for the beer industry.

Table 1. Quality conditions for malting barley (source: *M.A.D.R.*)

No.	Quality parameter	limit
1	Foreign objects, (%)	max. 3
2	Grain humidity, (%)	max.14
3	Grain larger than 2.5 mm (assortment), (%)	min. 85
4	Germination, (%)	min. 95
5	Viability, (%)	min. 98
6	Mass of 1000 grains (MMB), (g)	min. 42
7	Protein content, (% d.m.)	max. 11,5
8	Variety purity, (%)	min. 93

The experimental perion, 2008-2010, had three dissimilar years in terms of hidric and termin regime.

In terms of rainfall, in comparison with the multiannual average (447 mm) the crop year of 2007-2008 was a normal one (481 mm), 2008-2009 was a draughty one (363 mm) and 2009-2010 was abundant in rain (714 mm) but the precipitations were unevenly distributed throughout the year.

In terms of the average multiannual temperatures recorded in the experimental years, compared to the normal (10.9°C), the crop years 2007-2008 and 2009-2010 were normal, with a positive deviation of 0.7°C from the multiannual average. The crop year of 2008-2009 was a warm year, with a positive deviation of 1.2°C from the multiannual average.

In terms of the evolution of weather conditions during the growing period of spring barley (March to June), in the three experimental years (Figure 1) we can observe that:

- *from a rainfall perspective* in 2008 we recorded values of 185 mm (with a positive deviation of 5mm from the average sum of March-June period), in 2009 of 97mm (with a negative deviation of 83mm from the average sum of March-June period) and in 2010 we recorded 257mm of rainfall (with a positive deviation of 77 mm from the average sum of March-June period.)

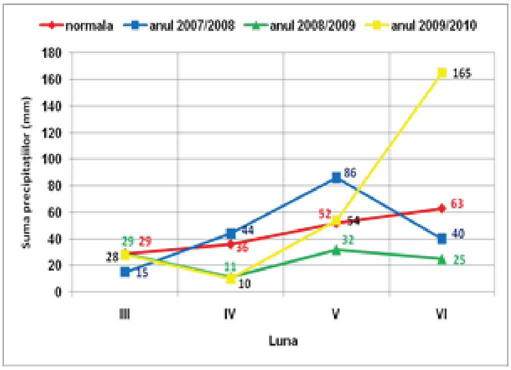

Figure 1. The evolution of monthly rainfall in the growing period of spring barley in 2008-2010, in Vadeni area, Braila county

- *from a thermica perspective*, the temperature distribution in the three experimental years has seen an upward trend, with deviations under 1°C from the normal values, with the exception of the year 2008 when there were positive deviations from the monthly average of 3.7°C in March and 1.4°C in April (Figure 2.)

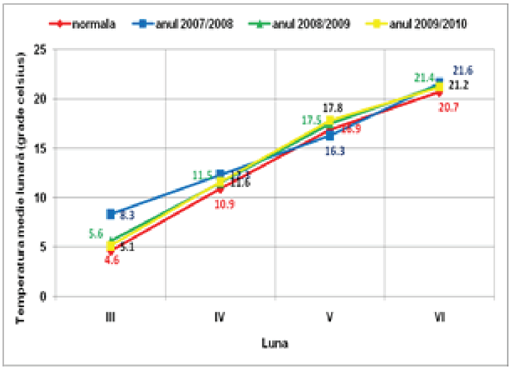

Figure 2. The evolution of average monthly temperatures in the growing period of spring barley in 2008-2010, in Vadeni area, Braila county

RESULTS AND DISCUSSIONS

Table 2 presents the average values of the main quality indices for the grains of barley coming from the varieties studied in Vadeni area, Braila county in 2008-2010.

From the experimental data obtained in 2008-2010, it is found that 2008 has given the best results for the majority of the quality parameters of spring barley, this beying a normal year in terms of weather.

Table 2. Summary of the average values of the quality parameters obtained for spring barley in Vadeni area, Braila county, between 2008 and 2010

Variety	Quality parameters*							
	U (%)	C.S. (%)	MH (kg/hl)	MMB (g)	S (%)	P (% s.u.)	A (% s.u.)	G (%)
2008								
Annabell	13.7	2.20	64.60	43.00	89.82	9.65	63.25	98.75
Thuringia	13.95	2.10	60.30	43.50	90.78	10.50	61.87	96.75
Cristalia	13.75	2.30	59.45	41.50	87.20	11.05	60.50	98.00
Tunika	14.2	1.75	64.30	43.62	91.63	10.05	63.12	99.00
average	13.9	2.08	62.16	42.90	89.86	10.31	62.18	97.94
2009								
Annabell	13.6	3.10	61.85	40.06	86.20	9.85	59.88	98.50
Thuringia	12.9	3.45	58.75	40.93	86.67	10.66	58.50	95.50
Cristalia	12.55	3.00	57.90	39.06	85.52	10.74	56.50	97.37
Tunika	12.75	2.90	61.85	41.31	87.56	10.35	59.12	98.75
average	12.95	3.11	60.08	40.34	86.59	10.40	58.50	97.53
2010								
Annabell	14.2	2.50	62.95	42.18	87.06	9.75	60.87	98.50
Thuringia	14.9	3.15	61.00	42.12	88.02	10.66	59.00	96.13
Cristalia	14.1	3.20	60.25	40.74	85.94	10.84	58.00	97.50
Tunika	14.45	2.83	62.80	43.49	87.56	9.89	61.75	99.00
average	14.41	2.92	61.75	42.13	87.75	10.28	59.90	97.78
2008-2010								
Annabell	13.83	2.60	63.13	41.75	87.70	9.75	61.33	98.50
Thuringia	13.92	2.90	60.01	42.12	88.50	10.61	59.79	95.92
Cristalia	13.47	2.83	59.20	40.44	86.32	10.88	58.33	97.67
Tunika	13.80	2.49	62.98	42.81	89.77	9.90	61.33	98.92
average	13.75	2.70	61.33	41.78	88.07	10.28	60.19	97.75
Standard	max.14	max.4	min.65	min. 42	min 85	max.11,5	57-65	min. 95

*Note: U (%) – barley grain humidity; C.S.(%) – foreign objects; MH (kg/hl) – hectolitric mass; MMB (g) – mass of 1000 grains; S (%) – assortment; P (% s.u.) – protein contents; A (% s.u.) – starch contents; G (%) – germination capacity.

The humidity is an important parameter in measuring the quality of the grains from several points of view. The optimal maturity state for harvesting of the malting barley is characterized by the grains water content, which cannot exceed 14%. Maintaining a high grain humidity for a long time can lead to quantitative and qualitative loses in the mass of spring barley and, as the temperature rises, can favour the appearance of diseases and the devaluation of barley grains. In draughty years, however, the water contents in the grains decreases drastically, making the grain stronger in the face of disease but also putting the grain in the danger of becoming shriveled.

The grain humidity varied between 13.70% for the Annabell variety and 14.20% for the Tunika variety. The grain humidity for the Tunika variety exceeded the maximum allowed standard value (SR 13477/2003) of 14%, which means the grains will have to be slightly dehidrated before storage (Figure 3).

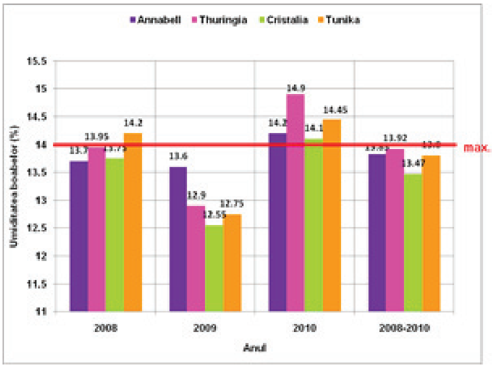

Figure 3. Grain humidity registered for the studied varieties in the three experimental years

The majority of the impurities that show in the grain mass is due to the growing and harvesting technologies that were used and to the way they adapt to the specific crop conditions.

The foreign objects contents varied between 1.75% for the Tunika and 2.30% for Cristalia, values which meet the quality requirements imposed for malting barley. This parameter depends largely on the harvesting conditions.

The hectolitric mass (MH) is influenced by the grain compaction and intergranulary space, by the nature and quality of the seed that are dry, cracked, shriveled, etc. (Figure 4).

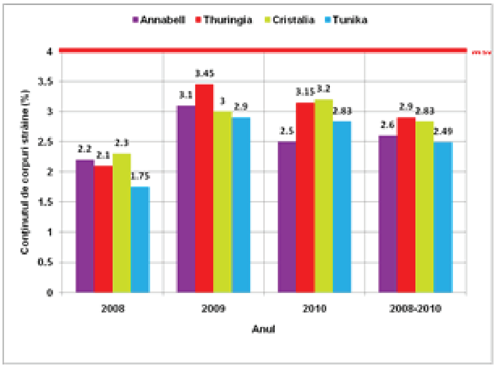

Figure 4. The content of foreign objects registered for the studied varieties in the three experimental years

The hectolitric mass fluctuated between 59.45kg/hl for the Cristalia variety and 64.30kg/hl for the Tunika variety. The Thuringia variety registered a hectolitric mass of 60.30kg/hl, similar to its genetic potential (64.2kg/hl). According to this quality conditions, none of the four studied varieties meets the standard requirement (SR 13477/2003) of min 65kg/hl (Figure 5).

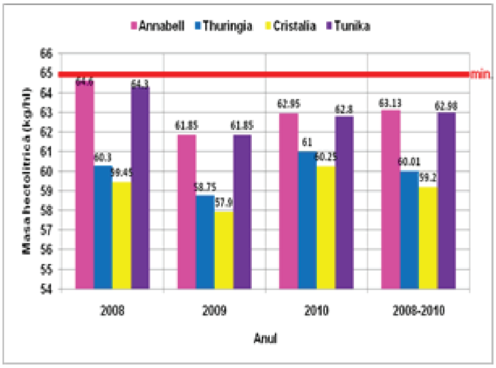

Figure 5. The hectolitric mass registered for the studied varieties in the three experimental years

In terms of ***mass of 1000 grains***, we recorded values between 41.50g for the Cristalia variety, which was below the minimum accepted (SR 13477/2003) (42 g), and 43.62g for the Tunika variety. From this perspective, only the Annabell, Thuringia and Tunika meet the standard requirements imposed (Figure 6).

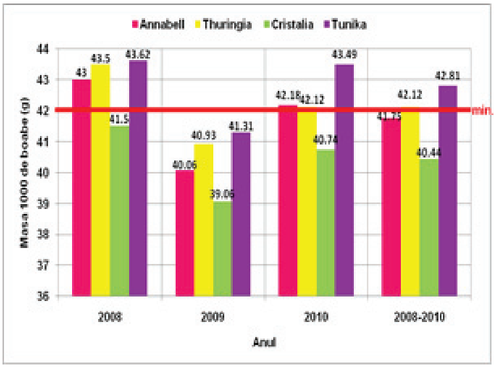

Figure 6. The mass of 1000 grains registered for the studied varieties in the three experimental years

The assortment registered values exceeding the standard (SR 13477/2003) (min. 85%) for all four studied varieties. The Cristalia variety registered 87.20% and the Tunika variety registered 91.63% (Figure 7).

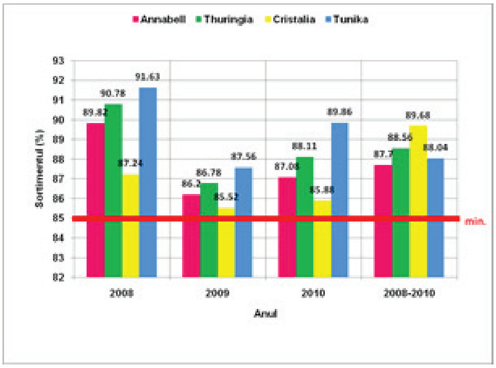

Figure 7. The assortment registered for the studied varieties in the three experimental years

The analysis of the values registered for the mass of 100 grains, hectolitric mass and assort-ment shows the negative influence of the cli-matic conditions manifested through the production of big seeds but with low specific mass.

In terms of assortment, all four studied varieties registered values that were superior to the standard (min. 85%).

The germination capacity of the studied varieties fluctuated between 96.75% for the Thuringia variety and 99.00% for the Tunika variety, values which exceed the standard (Figure 8).

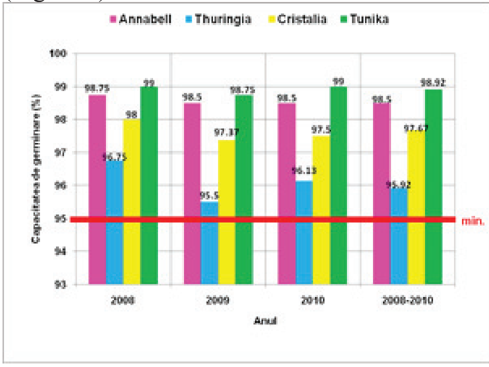

Figure 8. The germination capacity registered for the studied varieties in the three experimental years

The protein contents registered values between 9.65% d.m. for the Annabell variety and 11.05% d.m. for the Cristalia variety, meeting the standard requirement (Figure 9).

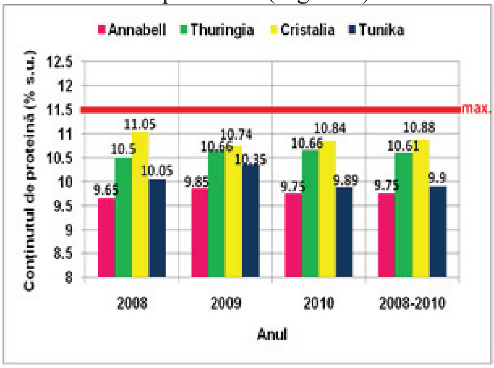

Figure 9. The protein contents registered for the studied varieties in the three experimental years

The starch content fluctuated between 60.50% d.m. for the Cristalia variety and 63.25% d.m. for the Annabell variety, which meets the requirements imposed by the beer industry (Figure 10).

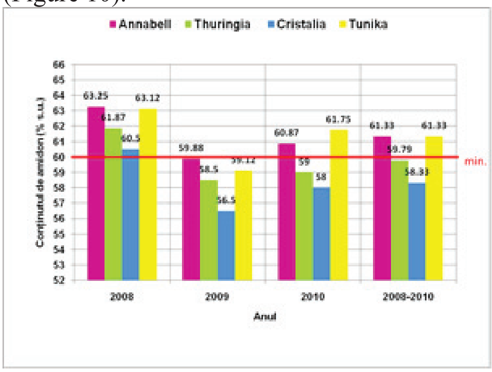

Figure 10. The starch contents registered for the studied varieties in the three experimental years

In **2009**, the reaction of the studied spring barley varieties was different in terms of harvest quality.

The humidity of the grains at harvest varied between 12.55% for the Cristalia variety and 13.6% for the Annabell variety, both of which meet the standard. (SR 13477/2003) (Figure 3).

The contents of foreign objects varied between 2.90% for the Tunika variety and 3.45% for the Thuringia variety, values which meet the quality requirements (Figure 4).

In the conditions of year 2009, ***the hectolitric mass*** for the studied varieties registered values under 65kg/hl, values which varied between 57.90kg/hl for the Cristalia variety and 61.85kg/hl for the Annabell and Tunika varieties (Figure 5).

The mass of 1000 grains for all four studied varietie had values below the standard requirement. (SR 13477/2003) (Figure 6).

In terms of ***assortment***, it obtained values over 85%, fluctuating between 85.52% for the Cristalia variety and 87.56% for the Tunika variety (Figure 7).

The protein content did not exceed the maximum admitted value of 11.5% d.m., varying between 9.85% d.m. for the Annabell variety and 10.75% d.m. for the Cristalia variety (Figure 9).

The starch content fluctuated between 56.50% d.m. for the Cristalia variety and 59.88% d.m. for the Annabell variety, which means that only the Annabell, Tunika and Thuringia varieties met the requirements imposed by the beer industry (Figure 10).

The germination capacity of the studied varieties registered values exceeding the standard (SR 13477/2003), fluctuating between 95.50% for the Thuringia variety and 98.75% for the Tunika variety (Figure 8).

In **2010** the value of the quality indices was also influenced by the environmental conditions. Thereby, the humidity of the grains registered a superior value to the standard admitted for all four varieties due to the weather conditions in the harvesting period, which means the seeds will need to be slightly dehidrated before storage. In terms of the content of ***foreign objects***, the four varieties met the qualitative requirements imposed by the beer industry (Figure 3).

Like in the other two experimental years, ***the hectolitric mass*** registered values below the imposed quality requirements, varying between 60.25kg/hl for the Cristalia variety and 62.96kg/hl for the Annabell variety. (figure 5)

The varieties which presented proper values of the ***mass of 1000 grains*** were Tunika (43.49g), Annabell (42.18g) and Thuringia (42.12g).

In terms of ***protein contents*** and starch contents, all four varieties were considered good for brewing (figure 9).

The germination capacity showed superior values to the standard imposed (SR 13477/2003), and fluctuated between 96.13% for the Thuringia variety and 99.00% for the Tunika variety (figure 8).

The analysis of the aggregated data of the quality indices average values obtained by the studied varieties in 2008-2010 shows the existance of different reactions towards the environmental factors.

In terms of hectolitric mass, the average value of this quality parameter varied between 59.20kg/hl for the Cristalia variety and 63.13kg/hl for the Annabell variety, values under the 65 kg/hl which is the minimum admitted. Only the Thuringia and Tunika varieties obtained values exceeding the standard (figure 5).

In order to be proper for brewing, the protein contents of barley grains must not exceed 11.5% of the dry matter because if this limit is exceeded, the malting process becomes dificult and results in malt with lower extract yield. The analysed varieties presented average values below the maximum standard, varying between 9.75% d.m. for the Annabell variety and 10.88% for the Cristalia variety (figure 9).

The starch content of the grains determines to the highest degree the quantity of extract. The high values of this indicator determine a greater malting quality. Thus, the varieties with a minimum content of starch of 58-60% will be better for malting. The average starch content in the experimental period varied between 58% d.m. for the Cristalia variety and 61.75% d.m. for the Tunika variety, which allows us to state that only the Tunika and Annabell varieties (61.33% d.m.) obtained values that meet the imposed standard requirements (figure 10).

The fast and full germination is an essential condition for the barley varieties used for obtaining the malt and making the beer, ensuring a high quality malt, well and fully disaggregated. The germination capacity of the grains for these barley varieties has to be of at least 95% and the germinative energy after 72 hours has to be 90%. The average values for this indicator were between 95.83% for the Thuringia variety and 99.18% for the Tunika variety (figure 8).

CONCLUSIONS

After an analysis of the data obtained, we can conclude that:

1. The value of the quality indices of spring barley grown in Vadeni area, Braila county was influenced by the specific pedoclimatic conditions of the experimental area.
2. The environmental conditions influence the filling of the grains, as evidenced by the values of the hectolitric mass (MH) and the mass of 1000 grains (MMB) obtained on all four varieties that were studied in the experimental period.
3. In terms of the protein contents of the four varieties, we can observe a good stability of this quality parameter.
4. Out of all four spring barley varieties, only the Annabell and Tunika varieties obtained starch content values that met the requirements of beer producers in all three experimental years.
5. The germinative capacity of all four varieties had values exceeding the minimum admitted by the beer industry in all three experimental years.
6. The lowest values of the quality indices of spring barley were obtained in 2009 both compared to the control year 2008 and to the experimental average.

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POTATO TUBER SPROUT ROT CAUSED BY *Fusarium sambucinum* IN TURKEY

Mehmet Hadi AYDIN, Fırat PALA, Cevdet KAPLAN

Siirt University, Faculty of Agriculture, Department of Plant Protection, 56100. Siirt/Turkey,

Corresponding author email: hadiaydin@siirt.edu.tr

Abstract

Fusarium dry rot is one of the most important diseases of potato (Solanum tuberosum L.), affecting the tubers in storage and the seed pieces after planting. Fusarium sambucinum Fuckel - teleomorph Gibberella pulicaris (Fr.) Sacc. - is a common pathogen causing dry rot of stored tubers in temperate areas. To establish strategies for the control of this disease it should be made primarily a correct diagnosis and detection symptoms of disease caused by fungus on potato tuber. Natural infected tubers was exemined macroscopically and incubated in controlled environment chamber. Pathogenicity study carried out in vitro condition that showed both tubers and sprout were diseased and decayed by F. sambucinum. Consequently, the same symptoms were observed both on natural infected and artificially infected tubers. To our knowledge, this is the first report of F. sambucinum causing a sprout rot of developing sprouts on seed tubers in Turkey.

Key words: *Fusarium sambucinum, potato (Solanum tuberosum), sprout rot.*

INTRODUCTION

Potato (*Solanum tuberosum L.*) and its products are known to be the most important source of food for human beings. The annual yield losses of potato crop in the developing countries like Turkey was determined to be 32.4 % because of insect, weed and diseases. of this yield reduction, diseases were responsible of 21 .8 % (Eken et al., 2000). Losses associated with dry rot have been estimated to range from 6 % to 25 %, and occasionally losses as great as 60 % have been reported during long-term storage (Estrada et al., 2010; Secor and Salas, 2001). Thus, many studies have been conducted to decrease yield losses due to diseases and increase the quality and quantity of potato production in the world. Dry rot is caused by a number of *Fusarium* species. *Fusarium sambucinum* Fuckel- teleomorph *Giberella pulicaris* (Fr.) Sacc.- is the most common pathogen causing dry rot of stored tubers in The wold, but other *Fusarium* species are also known to cause dry rot, particularly *F. solani* (Mart.) Sacc. and *F. avenaceum* (Fr.) Sacc. (Boyd, 1972; Hanson et al., 1996; Eken et al., 2000; Borca and Carmen, 2013). In the previous studies, some researchers had identified some species like *Fusarium, Rhizoctonia*, *Helminthosporium*, *Penicillium* and *Doratomyces* from the samples of potato in Turkey. Pathogenicity studies showed that *Fusarium sambucinum*, *F. solani, F. culmorum, F. oxysporum* and *Pythium ultimum* were causing severe rots in potato tubers of three different commercial potato varieties such as cvs. Agria, Granula and Marfona (Eken et al., 2000). Acording to Wharton et al. (2006), *Fusarium sambucinum* was isolated from diseased sprout and tuber tissue from potato in Michigan. After made patohogenicity, Sprouts on inoculated tubers developed symptoms that were observed in the initially collected seed pieces. They highlihted that firs time this symptom had seen on seed tubers sprout in the United States.

To establish strategies for the control of this disease, it should be made primarily a correct diagnosis and identification of the pathogen on potato (Borca and Carmen, 2013). The identification of *Fusarium sambucinum* isolated from potato tubers is performed after obtaining a pure culture using the single spore technique and were made observations regarding the colony growth diameters on agar media (PDA). After an incubation for 10 - 14 days with a daily exposure to light and the microscopic morphology including shape and size of the macroconidia, the presence or the

absence of the microconidia and of the chlamydospores (Burgess and Liddell, 1983).
Also need to know how the disease occurs on the potato (Wharton et al., 2006). The pathogen transmission is correlated with it ability to sporulate underground on the seed tubers or on the stem bases, *Fusarium sambucinum* Fuckel sporulates on the stem (Adams and Lapwood, 1983; Choiseul et al., 2001). The pathogen enters the tuber causing the rot, often rotting out the centre. The rotted cavities are often lined with mycelia and spores of different colours from yellow, to white or even pink (Boyd, 1972).
The aim of this study was to determine new symptom of *Fusarium sambucinum* associated with potato tubers of cv. Lady Rosetta commercially grown in Turkey and a correct diagnosis and identification of the pathogen on potato.

MATERIALS AND METHODS

Examination of natural diseased tubers: Potato tubers of cv. Lady Rosetta (200 tubers) taken from storage in Afyon province in Turkey in 2014 for seed certification control. After all samples were washed with top water and dried in the laboratory, they were macroscopically examined for presence or absence of dry rot on the surface of tubers. Natural infected Uncut potato seeds were kept at 18-25 ^{o}C in dark and light conditions until they sprouted. After sprouting, they were taken on the water-soaked cloth into plastic boxes and incubated in the dark at 18 ^{o}C by 95 % relative humidity for 20 days in controlled environmental chamber. The pathogen isolation was made both from infected tuber and sprouted tissue, were incubated at 24 ^{0}C for 7 days.
The pathogenicity and Isolation : Pathogenicity was tested in Potato tubers of cv. Lady Rosetta with a single isolate collected from diseased sprouts and tubers. Tubers (5-7 cm in diameter) free from symptoms of dry rot and other diseases were selected for the experiments. and washed in running tap water, dipped in sodium hypochlorite (2 %) for 2 min, rinsed twice with double distilled sterile water (10 min each) and air-dried (Hide et al., 1977). For inoculum production, isolate obtained from diseased sprouts and was grown on PDA at 22-24°C for 14 days prior to inoculation. The isolate of fungi grown on the plates was prufied. Whole seed tubers with 5-8 mm long sprouts were cut in half longitudinally with a sterile knife to ensure that seed pieces had viable sprouts. The cut surfaces of seed pieces were spray inoculated with 200 ml of conidial suspension (1×10^{4} conidia ml^{-1}) over the entire cut surface to give a final dosage of approximately 1 ml per seed piece (Wharton et al., 2006). Care was taken to limit inoculum spray to the cut surface so that sprouts were not inoculated. Seed pieces (15 per replicate × 4 replicates) were then placed in plastic boxes (40 × 20 × 10 cm) and incubated in the dark at 18°C and 95% relative humidity for for 4 weeks in a controlled environment chamber. As a control, cut seed pieces were spayed with sterile distilled water and incubated as above.
Identification : Identification of the pathogen was based on colonial - and conidial morphology (Booth, 1977; Gerlach and Nirenberg, 1982; Nelson et al., 1983; Hasenekollu, 1991; Leslie and Summerrell, 2006; Borca and Carmen, 2013). Firstly, the single spore technique was used to obtain a pure culture of *F. sambucinum* from diseased tuber and sprout samples. For microscopically identification of the pathogen the observations were made on shape and size of the abundant pink to salmon spores on PDA.

RESULTS AND DISCUSSIONS

Natural diseased tubers were macroscopically examined in laboratory and approximately 50 % of the tubers were found to be contaminated with dry rot. The first symptoms of dry rot were usually dark depressions on the surface of the tuber. In large lesions, the skin becomes wrinkled in concentric rings as the underlying dead tissue desiccates (Fig. 1). When diseased seed were cut in half, Internal symptoms are characterized by necrotic areas shaded from light to dark chocolate brown or black. This necrotic tissue is usually dry. The pathogen enters the tuber, often rotting out the center and rotted cavities are often lined with mycelia and spores of various colors from yellow to white to pink. The pathogen isolation was made from infected tuber tissue on to Potato Dextrose Agar (PDA), were incubated at 24 ^{0}C for 7 days. Eventually, *F. sambucinum* was isolated from all diseased potato.

It was observed that the disease had developed in tubers and sprouts during the waiting period in climate room. All tubers displayed typical Fusarium dry rot symptoms consisting of a brown, dry decay of tuber tissue with mycelia - lined cavities. Sprouts on infected tubers developed symptoms which were observed to cover with white mycelium and spores (Fig. 2). When diseased tuber with sprouts were cut in half, Brown and necrotic lesion could be seen expanding down the center of the sprout in vascular tissue and the base of the sprout in tuber tissue (Fig. 3). Pathogen isolations were made from diseased tuber tissue and infected sprouts on potato dextrose agar (PDA). In both cases, only *Fusarium sambucinum* was reisolated from diseased sprout and tuber tissue.

In pathogenicity study, the symptoms began to appear on tuber 72 hours after pathogen infected. Yellow-reddish symptoms occurred on tuber and they spread from the center to outward. The cracks and sunken were observed on tuber in later stages. After two weeks, the first symptom of disease appeared as brown black bruises on sprouts (Fig. 4). Reisolation has been performed from diseased sprout and tuber tissue. *Fusarium sambucinum* was only isolated.

For identification, it was firstly examined acording to colour change. The pathogen grew more rapidly on PDA plates, forming a thin, initially white mycelial colony turning from peach to orange later and crimson coloration of the colonies were observed from the upside and the underside of petri plate (Fig. 5, 6). For microscopically identification of the pathogen, the observations were made on shape and size of the spores. Conidia were rather uniform in type and size. Macroconidia were abundant, 3-6 septate with pointed apical cell and conspicuous food cell, measuring: 30-40 µm. Microconidia were rare, elliptical and 0-1 septate. None of the isolates formed chlamydospores (Fig. 7). According to Borca and Carmen (2013), the macroconidia have a falcate shape, are slender, comparatively short and usually rather uniform in size. The apical cell is pointed and the basal cell is foot shaped. The number of septa is 3 usually 6 septate. The microconidia are very rare, but found in the aerial mycelia when are present, they have an oval shape with 0 to 1 septate. The spores produced by the fungus culture on the surface of the agar media, vary in abundence. They are usually abundant in sporodochia which usually are orange and form in the center of the culture.

Previous studies have been demonstrated that *F. sambucinum* is important pathogen causing dry rot both in Turkey and the world (Boyd, 1972; Hooker, 1983; Hanson et al., 1996; Eken et al., 2000). According to the result of the study which carried out in USA, reported that the disease caused by the pathogen transmits from the tubers through to sprout (Hanson et al.,1996). However there is no such record in Turkey. This study have showed that the pathogen can kill developing sprouts outright in Turkey. In this case, potato tuber can result in delayed or non-emergence in field, so yield losses may more increase.

As a result, the same symptoms were observed both on natural infected tubers and artificially infected tubers. Since the sprouts of tubers were infected and spread towards the centre of seeds, it is assumed that infection of sprouts is systemic through the tuber (Fig. 3,4). In this case, when sprouts on potato seed affected heavily with *F. sambucinum,* it is thought that yield losses would more increase. <u>To our knowledge, this is the first report of *F. sambucinum* causing rot on potato sprouts developing from seed tubers in Turkey</u>.

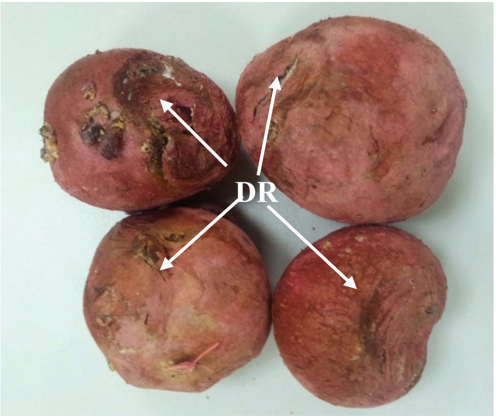

Figure 1. Dry rot symptoms on potato tubers. DR, dry rot

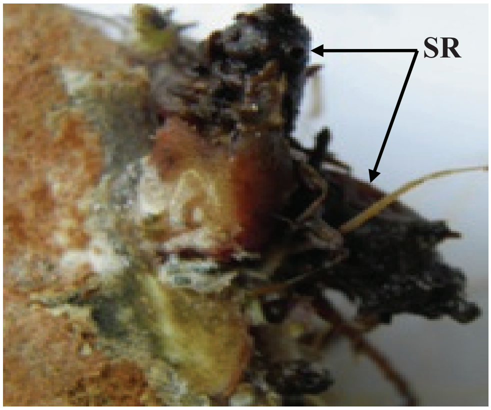

Figure 4. The symptom of disease appeared as brown black bruises on sprouts. SR, sprout rot

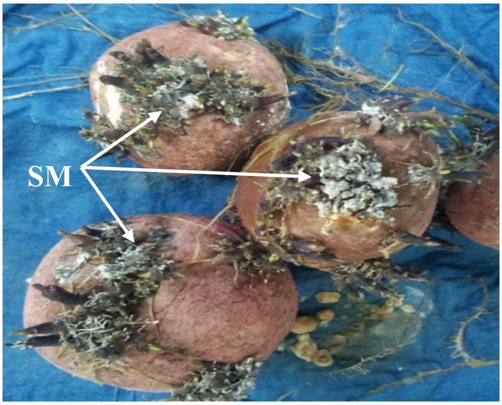

Figure 2. Sprouts on infected tubers developed symptoms to cover with white mycelium. SM, sprouts with mycelia

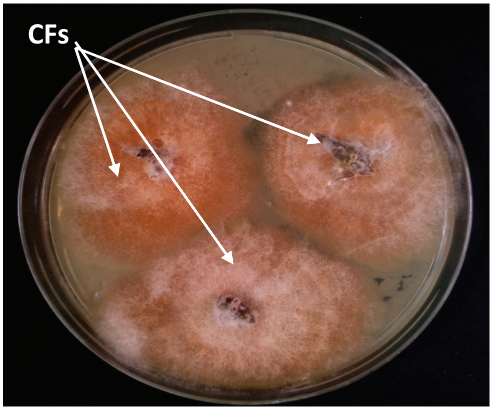

Figure 5. The colony aspect front of *Fusarium sambucinum* on culture media. CFs, Colonies of *Fusarium sambucinum*

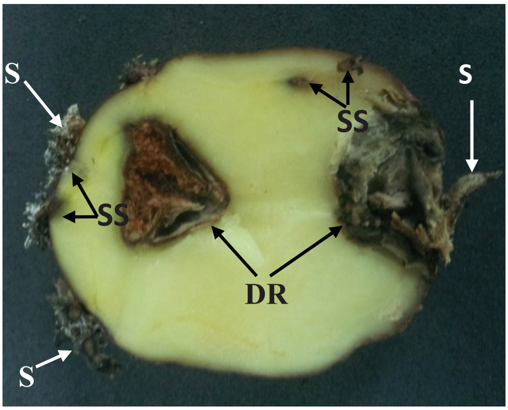

Figure 3. Potato seed piece cut in half. Showing internal symptoms of Fusarium dry rot in the tuber tissue and Fusarium sprout rot. DR, dry rot; S, sprout; SS, systemic symptom

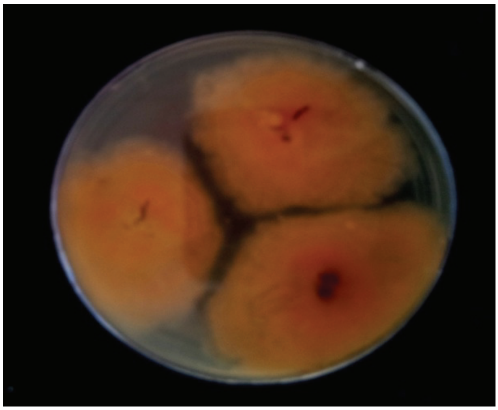

Figure 6. The colony aspect/back of *Fusarium sambucinum* on culture media.

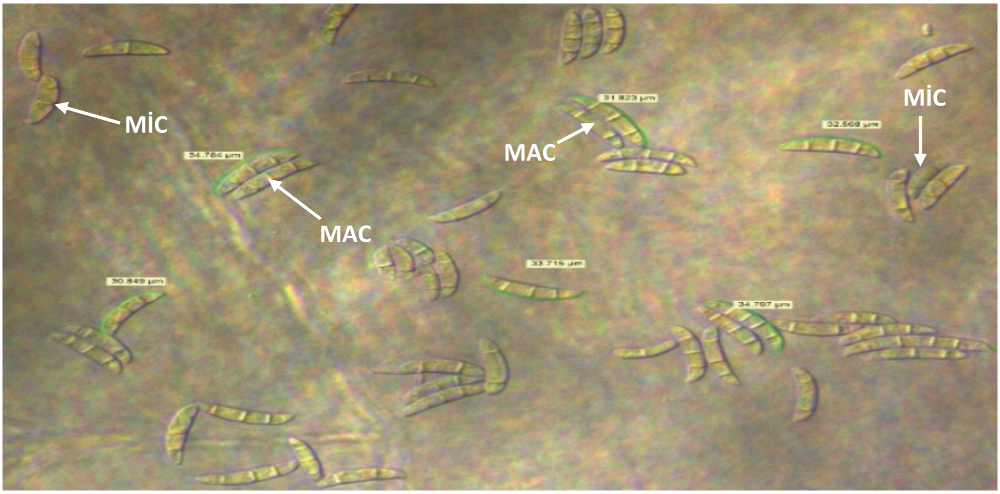

Figure 7. The microscopic view of *Fusarium sambucinum* macro-and microconidia, isolated from potato tubers. MAC, macroconidia; MİC, microconidia

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THE NPK FERTILIZATION EFFECTS OF TUBERS STARCH, DRY MATTER AND REDUCING SUGAR CONTENT

Nina BĂRĂSCU[1], Maria IANOŞI[1] , Marcel M. DUDA[2], Edward MUNTEAN[2]

[1]National Institute of Research and Development for Potato and Sugar Beet Braşov, Street Fundăturii no 2, Brasov, Romania
[2]University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Calea Mănăştur 3-5, Postal code 400372, Cluj-Napoca, Romania

Corresponding author email: nina.barascu@gmail.com

Abstract

The content of potato tubers in dry matter, starch and reducing sugar determines their quality characteristics. This study shows how the basic fertilization with different nitrogen doses and NPK ratios influence the content of potato tubers in dry matter, starch and reducing sugar.
The researches were conducted in the years 2013-2014 in the experimental field of INCDCSZ Brasov, located in Brasov Depression, on a cernoziomoid soil at an altitude of 520 m. For the two potato varieties used in the experiment, Christian and Roclas, was made a basic NPK fertilization with two different ratios 1: 1: 1 and 1: 0.9: 2 and two different doses of nitrogen, 100 and 200 kg/ha.
Fertilization ratio 1:0.9:2 as against 1:1:1 ratio had significant effect on reducing the starch content for both varieties, while the reducing of dry matter content is significant only for Christian variety. For both varieties, there were no significant differences in reducing sugar. The higher NPK ratio and nitrogen dose of 200 kg/ha determined reduction of starch in the two years, on average with 0.9-1.2%. Increasing the dose of nitrogen determined a significant decrease in the reducing sugar content only at Christian variety.
The decrease in starch content from tubers of Christian variety with increasing potassium ratio and nitrogen dose is more evident and statistically significant in 2014. For Roclas variety there is the same tendency, differences between variants in the two years are lower.
In the case of the dry matter content differences due to experimental years are stronger and are manifested mostly for dose N200 both at Christian as well as the Roclas. For the tubers reducing sugar content were found significant differences between the two years for both varieties. To all variants of fertilization the content level of reducing sugar was lower in 2013.

Key words: *dry matter, fertilization, potato, starch, reducing sugar.*

INTRODUCTION

Potato culture has a great potential of production, which can be achieved if ecological and technological conditions are ensured. Potato crop has strict requirement for a balanced fertilization management, without which the crop's growth and development of the crop are poor and both yield and quality of tubers are diminished (Imas and Bansal, 1999). Plant nutrition is a key instrument for managing potato quality (Achten, 2005). The content of reducing sugars, dry matter, and starch in potato tubers are important properties for potato processing (De la Fuente, 2011) because quality of final products and efficiency of processing depend on them (Hasse, 2004). Nitrogen is the dominant nutrient taken up by potato and plant nitrogen requirements are greater than other nutrient (El-Galil, 2006). A sufficient amount of nitrogen is important for achieving quality objectives for processing potatoes (Zebarth, 2012). Tuber specific gravity decrease if more nitrogen is available then needed for growth (Westermann et al., 1994; Atkinson et al., 2003).
Natural or chemical fertilization and soil type on which potatoes are grown may influence the tubers sugar content. Plants adequately fertilized with nitrogen had tubers with lower reducing sugar concentration at harvest (Kumar et al., 2004).
Potatoes require large amounts of soil K, since this nutrient is crucial to metabolic functions such as movement of sugars from the leaves to

the tubers and the transformation of sugar into potato starch (Mikkesen, 2006).
Phosphorus applications may improve specific gravity when soil test phosphorus levels are low (Laboski and Kelling, 2007).
A deficiency of phosphorus and potassium in the soil may lead to decreased synthesis of starch and sugar content increases (Mureşan, 1999). Potassium plays an important role in the starch structure and reduces the percentage of reducing sugars (Ianoşi, 2002).
Among the major nutrients, potassium not only improves yields but also affects some of the tuber quality parameters like percentage of dry matter and starch content (Imas and Bansal, 1999) and the fertilizer potassium source is known to affect tuber specific gravity (Westermann et al.,1994).
Potassium contributes to various aspects of tuber quality and the balance between nitrogen and potassium supply is of particular importance for potato crop (El-Latif, 2011).
The aim of this work was to assess the effects of different NPK fertilization on the tubers starch, dry matter and reducing sugar content.

MATERIALS AND METHODS

The experimental design was based on the knowledge acquired in the domain of fertilization, on a black earth soil from Braşov and according to current practices of fertilization in the region. In these polifactorial experience we propose levels of fertilization and different NPK ratios, for Roclas and Christian varieties created at N.I.R.D.P.S.B. Brasov.
The chosen levels of nitrogen fertilization, of 100 and 200 kg N/ha are situated at the lower and upper limit of OSPA Braşov recommendations valid for autumn potato crops. These doses are recommended for production of 20 t/ha and 40 t/ha under non-irrigated conditions.
Two complex fertilizers given before planting: C15-15-15, for NPK ratio of 1:1:1 and C5:10:22, supplemented with ammonium nitrate through for obtaining a 1:0.9:2 NPK ratio.
The experiment was done in Braşov in a non-irrigated crop, studied during 2013-2014. The research was conducted in two years with very different growth conditions in terms of climate.
In 2013 the vegetation period was warm, with an average temperature of 16ºC and 422.2 mm precipitation, compared to the year 2014, at which the average air temperature was 15.3°C and there has been rainfall of 505.1 mm (Figures 1 and 2).
In 2014, the amount of rainfall during the growing season exceeded the multiannual average (MMA) and the average temperature during the growing season was close to the multiannual value ensuring high yields in both studied varieties.

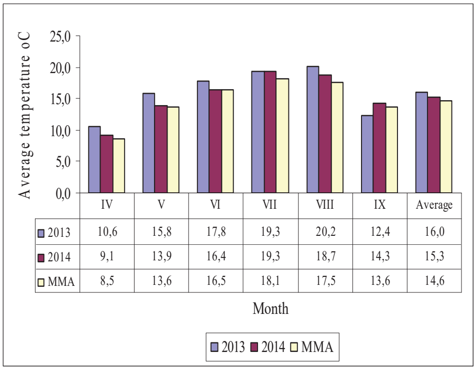

Figure 1. Average temperatures – Braşov 2013-2014

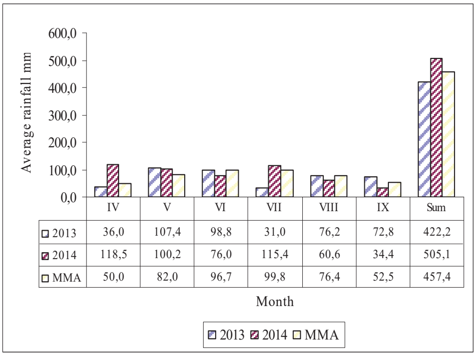

Figure 2. Average rainfall – Braşov 2013-2014

After harvesting and before cold storage of potato tubers, we made determinations on experimental variants and repetitions, regarding the tuber starch content, using the Polikeit balance. Also we determined the dry matter content of tubers by drying them in an oven at 105° C for 4 hours. Tubers content, from experimental variants, in reducing sugars (glucose, fructose) was determined by the chromatographic method using Shimadzu HPLC system.

RESULTS AND DISCUSSIONS

On average, for the two experimental years, varieties differed in starch content, dry matter and reducing sugar before storage (Table 1.). In Christian variety there were recorded on average lower levels of starch, dry matter and reducing sugar (15.0%, 23.9% and 0.18%) compared to the Roclas variety (16.5%, 24.8% and 0.34%). Standard deviations indicate moderate variation of values calculated for starch and dry matter and high variation for reducing sugar.

The fertilization ratio 1:0.9:2 compared with that of 1:1:1 had significant effect on reducing the starch content for both varieties, while the reducing of dry matter content was significant only for Christian variety. For both potato varieties there were no significant differences in reducing sugar. The higher NPK ratio and nitrogen dose of 200 kg/ha determined reduction of starch in the two years, on average with 0.9-1.2%

Increasing the dose of fertilizer from N100 to N200 determined a decrease in the starch content for both varieties, with no significant differences for dry matter. Although with increasing nitrogen level it can be noted a decrease for the reducing sugar content; decrease was significant only for Christian variety.

The Duncan test revealed that for the lowest level of fertilization (N100 NPK 1:1:1 ratio) was recorded the highest starch content, 16.1% for Christian variety and 17.7% for Roclas variety, while for variant with the highest level of fertilization (N200 1:0.9:2 ratio), the starch content for the two varieties decreased to 13.9%, for Christian and 15.6% la Roclas.

Table 1. Mean effects of different with NPK ratios and dozes fertilization on tubers starch, dry matter and reducing sugar content from Christian and Roclas varieties (Brașov 2013-2014)

Ratio NPK	Doses N Kg/ha	Starch %		Dry matter %		Reducing sugar %	
		Christian	Roclas	Christian	Roclas	Christian	Roclas
1:1:1	100	16.1 a	17.7 a	24.6 a	25.5 a	0.21 ab	0.41 a
	200	14.9 ab	16.2 bc	24.5 a	24.8 a	0.10 b	0.28 a
1:0.9:2	100	15.2 ab	16.5 b	23.7 a	24.7 a	0.29 a	0.33 a
	200	13.9 b	15.6 c	23.0 a	24.2 a	0.13 b	0.32 a
Means							
Ratio 1:1:1		15.5	17.0	24.6	25.1	0.16	0.35
Ratio 1:0.9:2		14.6 ^{o}	16.1 ^{o}	23.3 ^{o}	24.4	0.21	0.33
N 100 kg/ha		15.7	17.1	24.1	25.1	0.25	0.37
N 200 kg/ha		14.4 ^{o}	15.9 ^{o}	23.8	24.5	0.12 ^{o}	0.30
Mean		15.0	16.5	23.9	24.8	0.18	0.34
Standard deviation		1.5	1.0	1.9	1.9	0.16	0.21
LDS(variants)5%		2.0%	1.0%	2.7%	2.8%	0.21%	0.31%
DL (ratio) 5%		1.1%	0.7%	1.3%	1.4%	0.11%	0.15%
DL (doses N) 5%		1.0%	0.6%	1.4%	1.4%	0.10%	0.15%

On average fertilization variants were not significantly differentiated for the varieties researched, as regards the dry matter content.

The average content of reducing sugar of variants studied presented significant differences only for Christian variety. To this variety, for both fertilization ratios passing from N100 at N200 strongly reduced the content of reducing sugar (from 0.21% to 0.10% for NPK 1:1:1 and from 0.29% to 0.13% for NPK 1:0.9:2).

The content of starch, dry matter and reducing sugar of tubers was significantly influenced by growing conditions.

Due to the more favorable climatic hydro and thermal conditions alongside with higher yields for Christian variety accumulation of starch in tubers was significantly lower (16.2% as against 13.9%) in 2014 compared with 2013 (Figure 3.). On average, for Roclas variety, was maintained the high starch content from tubers, there are no significant differences between the two years (16.8% and 16.2%).

The decrease in starch content from tubers of Christian variety with increasing potassium ratio and nitrogen dose is more evident and statistically significant in 2014. For Roclas variety there is the same tendency, but the differences between variants in the two years are lower.

In the case of the dry matter content, the differences due to experimental years are stronger and are manifested mostly for the N200 dose, for both varieties (Figure 4).

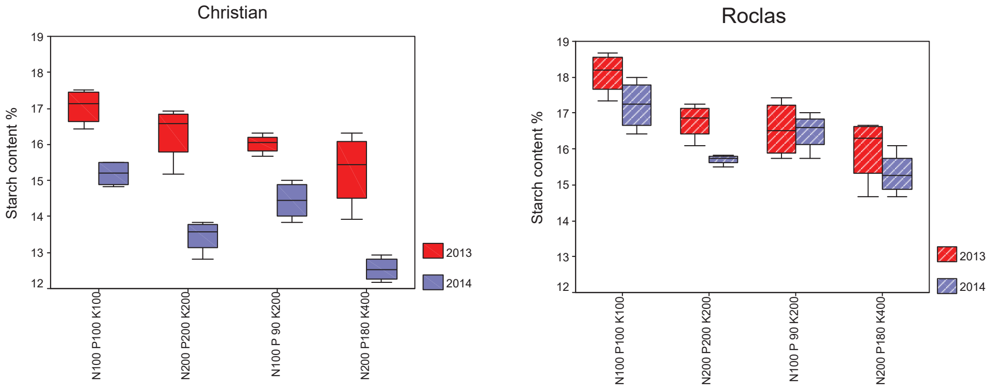

Figure 3. Comparison of the average starch content of tubers for fertilization variants - Brașov, 2013-2014

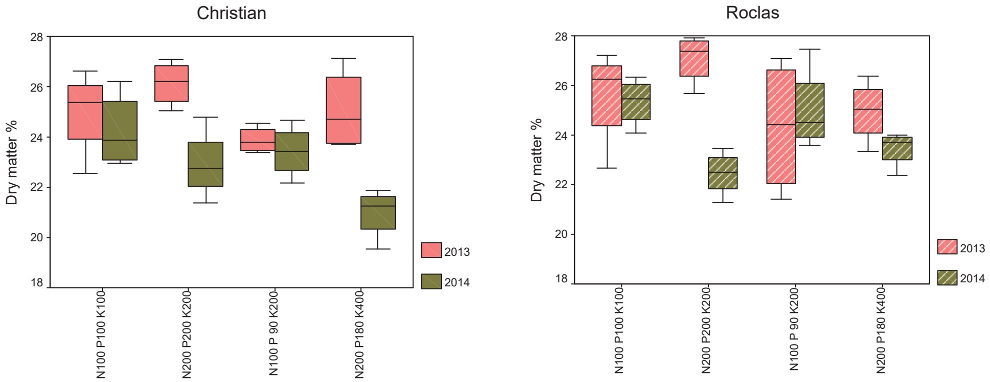

Figure. 4. Comparison of the average dry matter content of tubers for fertilization variants - Brașov, 2013-2014

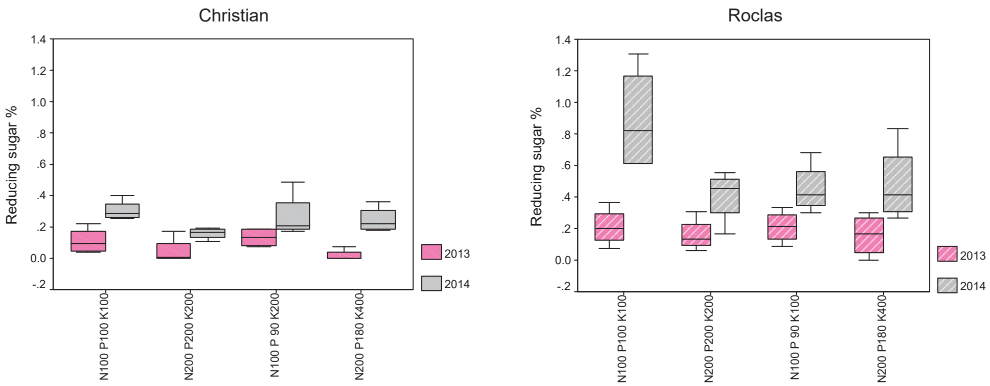

Figure 5. Comparison of the average reducing sugar content of tubers for fertilization variants - Brașov, 2013-2014

For the two studied years, correlations were made between the content of starch, dry matter and reducing sugar from tubers and total production from tubers. Pearson correlation coefficients for Christian and Roclas varieties are presented in Table 2.

Table 2. Pearson corelattion coefficients for total yield, starch, dry matter and reducing sugar content of tubers (Brașov, 2013-2014)

	Christian			Roclas		
	Starch	Dry matter	Reducing sugar	Starch	Dry matter	Reducing sugar
Starch	-	0.772**	-0.246	-	0.677**	-0.167
Dry matter	0.772**	-	-0.421*	0.677**	-	-0.331
Reducing sugar	-0.246	-0.421*	-	-0.044	-0.218	-
Total yield	-0.638**	-0.454**	0.488**	-0.315	-0.369*	0.689**

For both varieties the correlation between content of starch and dry matter is positive and statistically assured (r = 0.772** for Christian and r = 0.677** for Roclas). Correlations between reducing sugar, starch and dry matter for both varieties are negative. Only for Christian variety correlation between dry matter and reducing sugar content was statistically assured (r = -0.421*). Correlations of total production with concentration of starch from tubers was significant for Christian variety (r = -0.638**). The sense of correlations indicates very strong decreases of starch content due production increases, especially in 2014.

The correlations between the total production with starch content and dry matter from tubers were negative and statistically assured, for Christian variety and for Roclas variety correlations were lower. The correlations of the total production with reducing sugar were for both varieties positive and statistically assured.

CONCLUSIONS

Very different climatic conditions in those two years determined high yield differences from one year to another, and the accumulation of starch and dry matter in tubers was significantly lower in 2014 comparing with 2013.

On average, in both varieties, the highest starch content, was accumulated by the variants with fertilization N100: P100: K100 and on those two years, the differences due fertilization variants were not provided statistical for dry matter content of tubers. For 2014, the fertilization variants with high nitrogen level led to significant decreases in dry matter content for both fertilizing ratios, for both varieties.

Both potato varieties revealed a significantly higher content of reducing sugar in 2014 comparatively with 2013.

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STUDY OF NEMATODES ASSOCIATED WITH THE VEGETABLE CROPS IN SOME LOCALITIES IN TIARET (WEST OF ALGERIA)

Fatima Zohra BISSAAD[1], Farid BOUNACEUR[2]

[1]University M'Hamed Bougara, Science Faculty, Laboratory of Technologies Soft, Promotion, Physical Chemistry of Biological Materials and Biodiversity, BP 35000 Boumerdes, Algeria
[2]University Ibn Khaldoun Tiaret, Faculty of Agricultural and Veterinary Sciences, Laboratory of Agro Biotechnology and Nutrition in Semi Arid Areas, Algeria

Corresponding author email: bissaad@yahoo.com

Abstract

The present study aims to examine the nematode population at some stations of vegetable crops of the province of Tiaret.
The results of the study showed various species of nematodes associated with vegetable crops in the Algerian steppe especially the province of Tiaret and Djelfa. We counted eleven genres of phytophagous nematodes represented by Aphelenchus, Aphenchoides, Ditylenchus, Tylenchus, Psilenchus, Pratylenchus, Tylenchorhynchus, Paratylenchus, Cephalobus, Dorylaimus, Rabtidis and Helicotylenchus.
The densities of these nematodes vary by location and method of sampling and the nature of the soil.
The Cephalobus, Dorylaimus, Ditylenchus and Aphelenchus are the most common and abundant in the three stations of study. These taxa seem to adapt to different types of vegetable soils. Their existence may be subject to significant damage to installed cultures. Furthermore the use of ecological indicators of structure (Frequency and Abundance) class nematodes in 04 groups:

- *Nematodes abundant and frequent, dangerous for the vegetable crops.*
- *low abundance and frequent Nematodes, less harmful and adapts to different soil types*
- *abundant and infrequent nematodes, their presence in some soils, can be dangerous for the vegetable crops.*
- *Nematodes low abundance and infrequent occasionally meet their densities are low and have little or no damaging. Vegetable crops appear not to be their special host.*

***Key words**: nematodes phytopages, not phyatophages nematodes, vegetable crops, Tiaret, Algeria.*

INTRODUCTION

Vegetable crops under greenhouses appear as one of the most promising sectors of the Algerian agriculture. The areas occupied by these crops in Algeria are constantly evolving, they increased from 345,558 ha in 2004 to 363,030 ha in 2005 for field crops for the greenhouse crops have increased from 0.02 ha in 1970 to 5500 ha 1990 (Benhamou, 1990), to 6862.87 ha in 2004 (Agricultural statistics, 2004) and 6736.67 ha in 2005 (Agricultural statistics, 2005). Vegetable crops are in second place after cereals in the daily consumption of Algerians (El- Kebiri, 1993).

In the Algerian steppe areas reserved to vegetable crops seem to be of considerable local importance. The District of Tiaret and that of Djelfa have large potential for vegetable production in large quantities due to climatic and soil conditions are very favorable in particular represented by abundant sunshine throughout the year and the diversity of conditions such environments spread to satisfy not only domestic needs but also the food industry (Agricultural statistics, 2007).

Apart from the best climatic conditions offered shelter greenhouses developments cultures, they also create an environment conducive to the spread of disease and pullulation many pests such as nematodes, the most abundant organisms in the world and almost common in soils (De Guiran, 1983). These nematodes cause considerable damage and decreases in yields on many crops. The damage depends on the density pullulations in the soil it varies depending on climate, soil conditions, cultural practices (Scotto La Massese, 1986).

This work aims to study the diversity of the communities of phytophagous nematodes of vegetable crops in two regions of the steppe in western Algeria or market garden begins to take certain importance in recent years "case of onion plantations in the Rechaigua region "; since awareness phytophagous nematodes leads to better understand the risks associated with their introductions or their disseminations to guard by putting in place the methods of focused struggles.

MATERIALS AND METHODS

In order to inventory the phytophagous nematodes associated with vegetable crops the steppe of western Algerian in province of Tiaret and evaluate their densities, their diversity and their structures. The experimental method is made of functions of the following steps:

- outputs on field and collection of soil samples and when possible it is accompanied by whole plant at the selected sites.
- Extraction of soil nematodes by the method of flotation and sedimentation methods buckets (Dalmasso, 1966).
- Characterisation of phytophagous nematodes (counting and identification) under a binocular microscope based on the identification key (Jacob and Middepiaats, 1988).

The samples have been made in different vegetable crops with three stations in province of Tiaret "Rechaigua, Ksar El If Echellala and Houes".

Our methodology consists of a faunal comparison, for this we have adopted two sampling modes. A simple sample: one sample is taken per plot weighing more than one kilogram which will be placed in a sealed bag and labeled.

A composite sample consisting of soil samples of about 200 g to one sample every 10 meters on the diagonal of the plot are taken and combined into one in a sealed referenced bag. All samples of soil and roots are made in the rhizosphere of plants at a depth between 10 and 30 cm of soil.

The extraction method used is that of buckets (Dalmasso, 1966) method called flotation and sedimentation. The evaluation of the total density is after enumeration and morphological identification essentially based on the observation of some discriminative characters (the length and shape of the pen, the shape of the head, the tail, the body length, layout esophageal gland in relation to the intestine) under a binocular microscope.

Nematode populations in the soil are expressed in number of nematodes per dm^3 (N/dm^3) (Merny and Luc, 1973).

Statistical analysis of data

The analysis of nematode populations subservient to the various vegetable crops was the subject of a statistical treatment using factorial correspondence analysis (FCA) and hierarchical ascending classification (HAC) by software "PAST". The frequency and abundance was established on the principle of Fortuner and Merny (1973).

RESULTS

1. Inventory and structure of phytophagous nematodes of vegetable crops in some stations.

1.1. Inventory phytophagous nematodes vegetable crops.

1.1.1. Overall density of nematodes identified in composite and single samples.

Our study was performed in 03 stations of the province of Tiaret known to vocation by vegetable crops namely Ksar Chellala, and Rechaiga Si Haoues. The samples were focused on picked up ground (simple and composite) in the rhizosphere of vegetable crops.

The nematode analysis revealed the presence of 11 genera of nematodes in the simple soil sample. They are represented by Aphelenchus, Aphenchoides, Ditylenchus, Tylenchus, Psilenchus, Pratylenchus, Tylenchorhynchus, Paratylenchus, Cephalobus, Dorylaimus, Rabtidis and Helicotylenchus.

Table I covers different densities of taxa encountered in the 02 single and composite samples. It appears from these results that the densities of nematodes identified vary depending of the stations prospected. The most represented phytophagous in our study sites are Aphelenchus, Ditylenchus, Cephalobus, Dorylaimus, Tylenchorhynchus and Tylenchus. They have been detected in more than 50% of the stations. However, for the remaining taxa (Aphelenchoides, Psilenchus, Meloidogyne, Psilenchus, Pratylenchus, Paratylenchus) They are limited to a few sites (- 50%).

The highest densities are recorded in the Tylenchorhynchus Ksar Chellala station (1940 N/dm^3) and for by way of example Pratylenchus in the same station; with a density not exceeding 440 N/dm^3.

Moreover, the results show that the diversity varies from one site to another and in the two sampling modes.

Also in Rechaigua station phytophagous nematodes are maintained at relatively low densities levels, the most represented taxa is the kind Ditylenchus with densities ranging from 260 to 60 N/dm^3 and those for all prospected crops in this station.

At the station Si Haoues, our investigations have carried on a single type of a large surface area leguminous crops lenses that appear to be free of all nematode infestations, only the kind Ditylenchus was collected in numbers ranging from 160 to 60 N/dm^3 respectively for the composite sample and simple.

3.1.1.2. Overall density of nematodes identified in Rechaigua station.

1. Cases of the composite sample.

The results of the composite samples revealed the presence of 10 kinds of nematodes, Ditylenchus, Aphelenchus, Tylenchus, Psilenchus, Pratylenchus, Tylenchorhynchus, Cephalobus, Dorylaimus Helicotylunchus, and gender Rabtidis (Figure1 and Table 1).

Large populations are observed for the kind Cephalobus, Dorylaimus, Ditylenchus, Tylenchus, with densities of 1780 N/dm^3, 440 N/dm^3, 180 and 184N/dm^3 respectively in the tomato, pepper crops, on tomato and pepper. To genres Rabtidis, Aphelenchus and Helicotylenchus, we recorded respective densities 120 N/dm^3 on tomato and 60 N/dm^3 on pepper and 20 N/dm^3 on tomato and pepper. For the genus of Pratylenchus densities are in the order of 80 N/dm^3 of pepper cultivation.

1. **Inventory and overall densities of phytophagous nematodes in three locations in the province of Tiaret**

Table 1. Density (N/dcm^3) of free nematodes in the soil sampled in the province of Tiaret

Stations	Culture	Type of sampling	Total number of nematodes	Différents genres de nématodes											
				Aphelenchus	*Aphelenchoides*	*Ditylenchus*	*Tylenchus*	*Psilenchus*	*Pratylenchus*	*Tylenchorhynchus*	*Paratylenchus*	*Cephalobus*	*Dorylaimus*	*Rabtidis*	*Helicotylenchus*
Ksar Chellala	Oignon	Composite	3600	260	0	200	0	0	60	0	20	760	440	60	0
		Simple	3900	380	0	160	20	0	200	100	20	640	120	0	0
	Fève	Composite	8460	40	0	120	0	140	200	520	40	120	200	40	60
		Simple	16640	60	0	160	0	0	440	1940	0	0	140	460	40
	Ail	Composite	2100	480	0	120	80	0	180	140	0	400	180	20	0
		Simple	2700	300	0	20	60	0	120	60	0	920	200	120	0
Rechaigua	Tomate	Composite	2500	0	0	0	140	0	0	0	0	1788	440	120	20
		Simple	3280	120	0	260	80	0	0	0	0	2800	20	0	0
	Oignon (Parcelle 1)	Composite	260	0	0	40	20	0	0	0	0	160	40	0	0
		Simple	1120	40	0	140	40	0	0	0	0	560	340	0	0
	Oignon (Parcelle 2)	Composite	560	0	0	120	0	0	0	0	0	340	100	0	0
		Simple	640	20	0	120	60	0	0	20	0	320	120	0	0
	Poivron (Parcelle 3)	Composite	400	0	0	60	20	0	0	0	0	280	40	0	0
		Simple	540	40	0	60	120	0	0	0	0	180	120	20	0
	Poivron (Parcelle 4)	Composite	1080	60	0	180	20	0	40	140	0	360	280	0	0
		Simple	1360	180	0	180	140	0	80	60	0	560	140	0	20
Si lHaouas	Lentilles	Composite	1120	240	0	140	0	0	0	0	0	580	160	0	0
		Simple	800	0	0	60	0	0	0	0	0	660	60	20	0

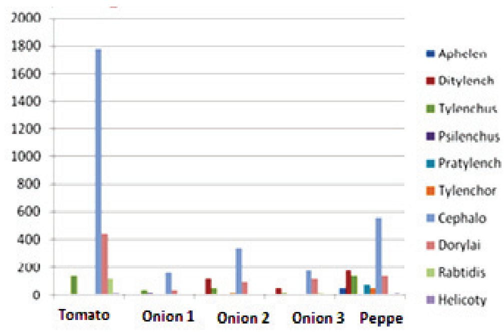

Figure 1. Density of nematode populations at the locality of Rechaigua

2. For simple sample

Examining the figure below shows a strong dominance of Cephalobus kind with a density of 2800 N/dcm^3 on tomato crop. The kind Dorylaimus comes in 2nd place with a density of 340 N/dcm^3 on onion crop (Parcel 1), the genus Ditylenchus with a density of 260 N/dcm^3 on tomato cropthe kind Aphelenchus is represented exclusively on culture tomato with a density on the order of 120 N/dcm^3. As for the other genres are represented by low densities as Tylenchus and Pratylenchus respectively with densities 80 and 20 N/dcm^3 on growing tomato and onion (Parcel 2).

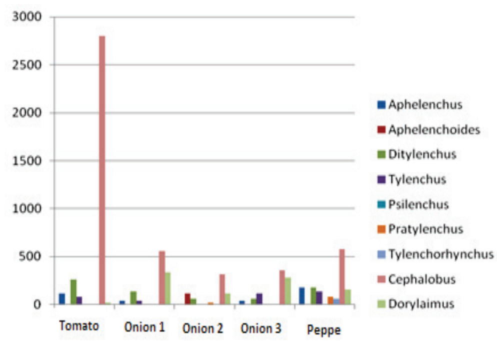

Figure 2. Density of nematode populations at the locality of Rechaigua

The analysis of dendrograms (Figure 3) identifies three groups for both sampling "the composite and simple", but these groups are not similar. For composite samples Group 1 (G1) essentially brings together two stations onion crops "Parcel 2 and 3" and the tomato field with the presence of 05 nematode taxa particular the following genres: Tylenchus, Dorylaimus Helicotylenchus , and Cephalobus Rabtidis.

Group 2 (G2) is formed only by Psilenchus kind associated with the onion crop land 1. As for Group 3 (G3), we note the presence of 04 genera represented by Tylenchus, Ditylenchus, Aphelenchus and Pratylenchus on one type of crop (pepper).

The analysis of Figure 4 distinguishes 03 groups that are similar to those obtained by hierarchical classification, and those for composite samples and simple.

AFC composite groups reveals the following groups: Group (1) G1 generates Tylenchus genres Dorylaimus, Cephalobus, Helicotylenchus and Rabtidis on following crops Onion (Parcel 2 and 3) and Tomato.

The Group (2) G2 is made exceptionally by the kind Psilenchus on onion crop only in that culture and those for the two sampling techniques adopted simple and composite.

As for the group (3) G3 is formed by 04 Tylenchorhynchus genres Aphelenchus, Ditylenchus and Pratylenchus only growing in peppers.

The generated groups are as follows: Group (1) represented by G1 and Ahenchoides Cephalobus only three onion plots (1, 2 and 3).

The Group (2) G2 formed by 05 Aphelenchus genres Tylenchus, Ditylenchus, Tylenchorhynchus and Dorylaimus tomato crop.

The Group (3) G3 is represented by Pratylenchus, Psilenchus on pepper culture.

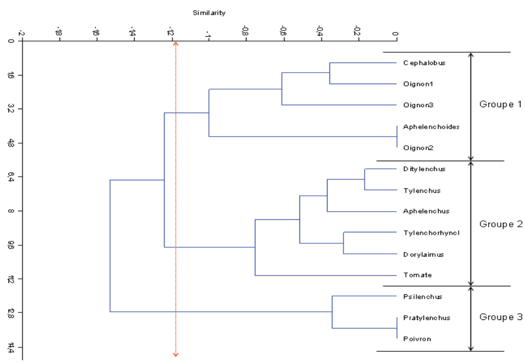

Figure 3. Dendrogram of the classification of types of nematodes inventoried by crop in Rechaigua station

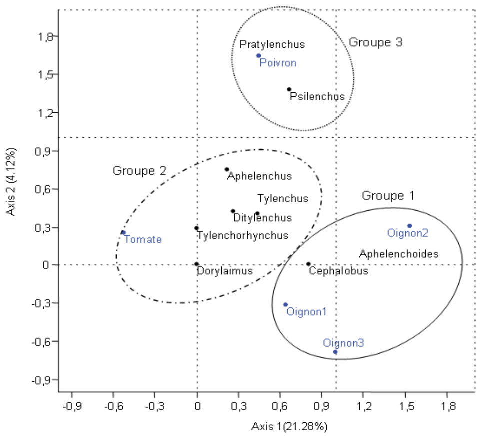

Figure 4. Arrangement of different kinds of nematodes inventoried along the axes 1 and 2 in different cultures in Rechaigua station

3.1.1.4. Overall density of nematodes identified in Ksar Chellala station. 1. Cases of the composite sample.

The results shown in the figure below show that the genre is predominant Cephalobus with a density of about 760 N/dcm^3 on onion crop, followed by genre, Tylenchorynchus 580 N/dcm^3 on bean culture. Garlic cultivation has two nematode genera namely Aphelenchus and Rabtidis 480 N/dcm^3 with respective average densities of 480 N/dcm^3 and 460 N/dcm^3.

The genre Dorylaimus often onion crop with a density of 440 N/dcm^3, as to Ditylenchus genera, Tylenchus on garlic cultures with respective densities 220 and 80 N/dcm^3; also on culture bean we note the presence of Helicotylenchus and Aphelenchus 60 and 40 N/dcm^3.

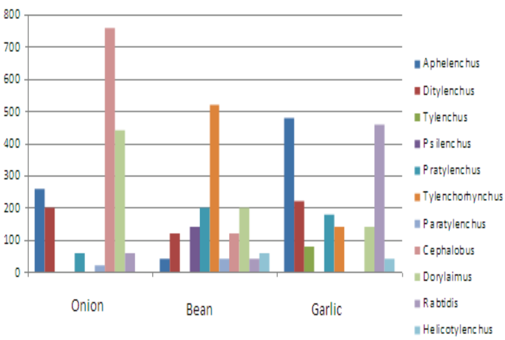

Figure 5. Density of nematode populations in the city of Ksar Chellala

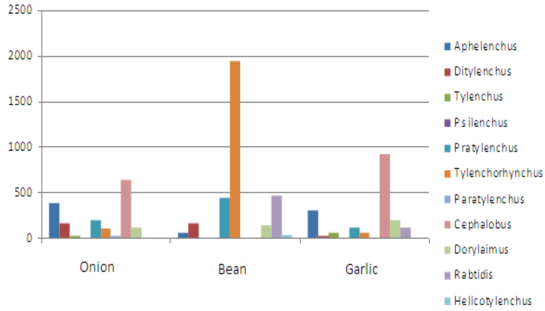

Figure 6. Density of nematode populations in the city of Ksar Chellala

On the basis of Euclidean distances and with respect to a similarity of 38.37% on the axis 1 and 2.13% along the axis 02. The classification gave 03 distinct groups and those for the two types of sampling composite and simple (Figures 7 and 8).

For composite samples, Group 1 (G1) essentially brings together the onion crops, with the presence of 04 nematode taxa particular the following genres: Aphelenchus, Ditylenchus, Cephalobus and Dorylaimus. Group 2 (G2) is formed only by the kind Tylenchus and Rabtidus associated with garlic culture. As for Group 3 (G3), we note the presence of 05 genera represented by Pratylenchus, Helicotylenchus Tylenchorenchus, Paratylenchus and Psilenchus on bean culture. For the single samples there are 03 distinct groups precedents. The Group (1) G1 formed by 03 genera Tylenchorynchus, Aphelenchus and Cephalobus on Onion culture.

The Group (2) G2 formed by Pratylenchus and Tylenchus on Garlic culture, while Group (3) G3 is represented by Ditylenchus, Psilenchus, Pratylenchus, Rabtidis, Dorylaimus and Helicothylenchus on bean culture.

Analysis of the AFC composite groups reveals the following groups: Group (1) G1 generates genres Aphelenchus, Ditylenchus, Cephalobus and Dorylaimus.

The Group (2) G2 is made exceptionally by 02 genres of naked garlic culture. As for the group (3) G3 is formed by 05 genres: Pratylenchus, Helicotylenchus, Tylenchorhynchus Paratylenchus and Psilenchus on Culture bean.

For the second type of single sampling there are 03 different groups:

- The groups are released as follows: Group (1) G1 represented by Tylenchorynchus, Aphelenchus and Cephalobus only on onion crops.
- The Group (2) G2 formed by 02 Paratylenchus and Tylenchus genres of garlic culture.
- The Group (3) G3 is represented by 06 genres Pratylenchus, Psilenchus, Ditylenchus, Rabtidis Dorylaimus and Helicotylenchus on culture bean culture.

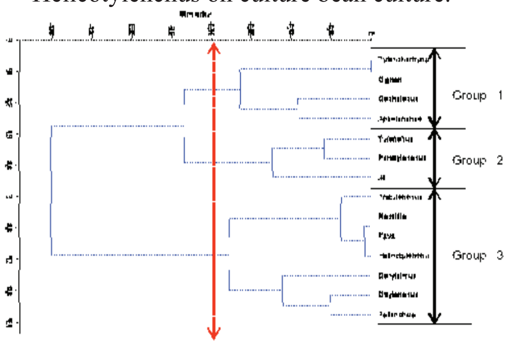

Figure 7. Dendrogram of the classification of types of nematodes inventoried by crop in Ksar Chellala station

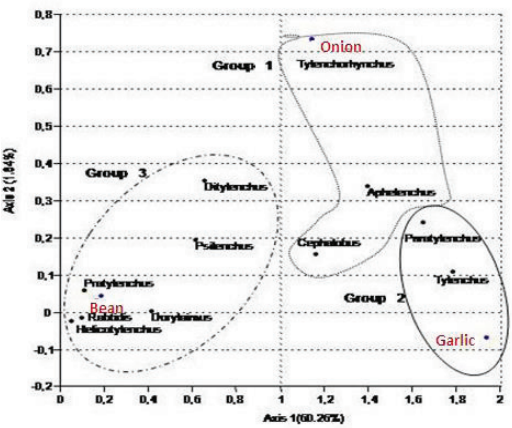

Figure 8. Arrangement of different kinds of nematodes inventoried along the axes 1 and 2 according to the crops in the Ksar Chellala station

3.1.1.5 Overall density of nematodes identified in Si Haoues station

1. Cases of the composite sample

On this station, one culture sample was taken due to the large area devoted to this crop. The review of the following histogram shows the presence of 04 genres significant at this type of composite sampling and are as follows (Figure 9): Cephalobus 580 N/dcm^3, Aphelenchus 240 N/dcm^3, Ditylenchus 140 N/dcm^3 and Dorylaimus 160 N/dcm^3

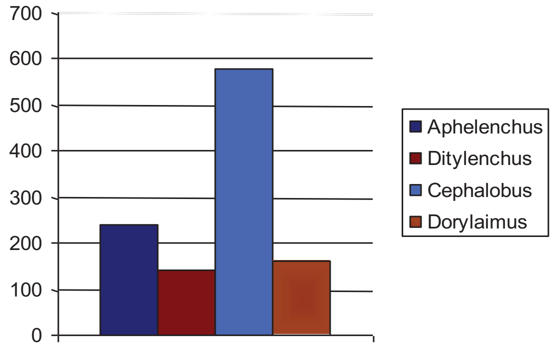

Figure 9. Density nematode populations at Si El Haoues station

2.2 For simple sample.

For simple sample is almost similar to the previous lack of Aphelenchus only one note to be replaced by the kind Rabtidus with a relatively low density is 20 N/dcm^3 only (Figure 10).

The most important kind consists Cephalobus 660 N / dcm3, Ditylenchus and Dorylaimus 60 N/dcm^3

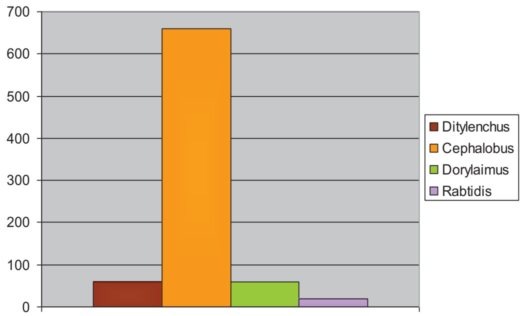

Figure 10. Density of nematode populations at the station Si El Haoues

DISCUSSIONS

The completion of this study allowed us to identify eleven types of nematode "phytophagous and not phytophagous" in distributed vegetable soils in both porbeagle different stations of the province of Tiaret They are represented by: Aphelenchus, Aphenchoides, Ditylenchus, Tylenchus, Psilenchus, Pratylenchus, Tylenchorhynchus, Paratylenchus, Cephalobus, Dorylaimus,

Rabtidis and Helicotylenchus The results obtained on the inventory of parasitic nematodes vegetable crops join a species found point of view those Netscher and Luke (1974).
The highest average total of the phytophagous nematodes recorded in this study is observed (16640 N/dm^3) distributed as follows;
Our observations have shown the presence of the more genres represented as Cephalobus with a density of 2800 N/dm^3, Dorylaimus, with a density of 440 N/dm^3 Ditylenchus with a density of 260 N/dm^3 and Aphelenchus with a density of 480 N/dm^3.
The Cephalobus and Dorylamus genre are the most representative genres in both regions studied. However, there is a total absence Meloidogyne and Heterodera although both regions are oriented cereals. The abundance and frequency of this type of vegetable crops in Niger (Diongue, 1986). Furthermore, the populations of Pratylenchus are shown to be important in both regions, however in Ksar Chellala station their densities reached 440 N/dm^3. Through, they reached 160 N/dm^3 in the Ain Ouassara station in the Djelfa region.
The frequency of this kind with a rate of 33.3% was reported in Garden Soils of Senegal (Sawadogo et al., 1993). In contrast, studies on banana in Burkina Faso [14] and in Ivory Cost (Fargette and Quenherve, 1988) were able to show that this kind grows poorly on this crop. *Pratylenchus thornei* was the dominant species in the soil and in the roots of wheat in arid areas of Israel. Which could explain its presence in the plain, cereal region (Orion et al., 1984).
The genre Ditylenchus presented high densities in Ksar Challala station in the province of Tiaret, these have reached 260N/dm^3 on onion plantations. In contraste in the Ain Ouassara station beans, they are estimated to 600N/dm^3.
About the genre of Aphelenchus it was reported in the two regions with densities of 480N/dm^3 in Ksar Chellala station, and 200 N/dm^3 in the Ain Ouassara station on bean crops.
For the genre of Tylenchorhynchus, it was recorded a density of bean culture 1940 N/dm^3 in Ksar Chellala station, the Ain Ouassara on pea culture is of the order of 120N/dm^3. On the other hand, the investigations into tomato respectively in Mauritania and Senegal have detected the presence of Tylenchorhynchus (Netstcher and Luc, 1974; Diongue, 1986). It is recognized that these phytophagous nematods are parasitic nematodes in agro ecosystems. They have a deleterious effect on plant growth and yields (Verschoor, 2001).
The use of ecological indices of structures such it has been previously described by the use of the frequency and abundance were classified phytophagous nematodes in two groups in the surveyed sites.
Scanty nematodes and frequent, they are active parasitic of vegetable crops. They met in the two locations, on different types of soil, but with low population levels. Scanty and infrequent nematodes considered minor pests. Their parasitism on vegetable crops seem less important than the first group. These species are rarely observed and too few to have any economic significance include, of Tylenchorhynchus in Ksar Chellala station with a density of 1940 N/dm^3. Calculating the diversity index Shannon Weaver helped confirm that the nematofauna is quite diverse in the two regions studied.
As for the equal distribution, it shows that there is a balance between the species studied habitats, except the kind Psilenchus present only on crop beans at the Ksar Chellala station and absent in the other stations of the region. Regarding the diversity at the stations. We record a nematofauna rather diverse. For equal distribution values tend to 1, it means that there is a balance between the species found in these habitats studied in the two regions studied.

CONCLUSIONS

The results of this study revealed various species of nematodes associated with vegetable crops in the Algerian steppe including in province of Tiaret. We counted eleven genres of phytophagous and frequent nematodes represented by Aphelenchus, Aphenchoides, Ditylenchus, Tylenchus, Psilenchus, Pratylenchus, of Tylenchorhynchus, Paratylenchus, Cephalobus, Dorylaimus, Rabtidis and Helicotylenchus.
The densities of these nematodes and frequent may vary by location and method of sampling and the nature of the soil.

The Cephalobus, Dorylaimus, Ditylenchus and Aphelenchus are the most frequent and abundant in the three stations of study. These taxa seem to adapt to different types of vegetable soils. Their existence may be subject to significant damage to installed cultures. Furthermore the use of ecological indicators of structure (Frequency and Abundance) class nematodes in 04 groups:

- Nematodes abundant, dangerous for market gardening.
- scarce Nematodes, less harmful and adapts to different soil type
- abundant and infrequent nematodes, their presence in some soils, can be dangerous for market gardening.
- Nematodes scanty and infrequent occasionally meet their densities are low and have little or no damaging. Vegetable crops appear not to be their special host.

At the end of this study, it seems important to advise gardeners, the application of proper rotation, or use of fallow or resistant varieties that may constitute a simple and effective alternative the species of phytophagous nematodes in these little infested areas to avoid the phenomena of adaptation and resistance.

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EFFECT OF *Bacillus thuringiensis* AND DIMILIN ON THE DATE MOTH *Ectomyelois ceratoniae* ZELLER

Fatima Zohra BISSAAD[1], Farid BOUNACEUR[2], Bahia DOUMANDJI-MITICHE[3]

[1]University M'Hamed Bougara, Faculty of Science, Department of Biology, BP 35000 Boumerdes, Algeria
[2]University Ibn Khaldoun Tiaret, Faculty of Agricultural and Veterinary Sciences, Algeria
[3]National School of Agronomy, ENSA Department of Agricultural and Forest Zoology

Corresponding author email: bissaad@yahoo.com

Abstract

The date moth is a pest that causes damage to the date palm and decline the quality walking of this production. For this, in this study, the 4th instar larvae of Ectomyelois ceratoniae three tests were performed. *In the first, we tested a biopesticide Bacillus thuringiensis kurstaki only with 3 concentrations (0.25 g/0.5l, 0.50g/0,5l, 0.75 g/0,5l). In the second test, we added 1% of dextrin to each bacterial concentration. In the third test, 3 doses the Diflubenzuron (0.2 g/l, 0.4 g/l, 0.6 g/l of.*
The toxicity of B. thuringiensis showed a highly significant mortality on the added media and larval stages. Mortalities recorded with the addition of 1% dextrin were relatively higher compared to biopesticide only.
Regarding the toxicity of Diflubenzuron, it should be noted that the percentages of mortality recorded for this growth regulator were not very important for the three doses tested. The dose D3 (0,6 g/l) had superior mortalities to those of doses D1 (0,2 g/l) and D2 (0,4 g/l).

Key words*: Bacillus thuringiensis, Ectomyelois ceratoniae,* Diflubenzuron, mortality, LD50, TL50.

INTRODUCTION

The date palm, *Phoenix dactylifera* is for the populations of the Sahara the welfare of the tree that provides not only dates, but also a large number of different productions that are very useful for families. It is also the backbone of which are true oasis of greenery and islets of life in the desert (Louvet et al., 1970). It is a perennial plant species of great importance in the economy of many hot countries (Baaziz and Bendiab, 1994).
The date production in Algeria is a more important place in marketing. However, it is constantly subject to phytosanitary problems, among which the moth date: *E. ceratoniae* constitutes the main constraint on exports whose larvae are worms that grow inside of dates (Dridi, 1999). The damage it causes is estimated between 7.24% and 28.69% (Adila, 2006), and can reach up to 29% of the date production (Feliachi, 2005) Polyphagia of this species and its wide distribution on various hosts make it difficult to develop an effective chemical control (Biliotti and Daumal, 1969).
Faced with this worrying situation, it is necessary to move towards the application of biological control using entomopathogenic microorganisms.
It is in this context, we have tested the effect of the biopesticide (*Bacillus thuringiensis*) only then added to the dextrin as the biological control and insect growth regulator (dimilin) as chemical control against the 4th instar larvae of the date moth *Ectomyelois ceratoniae*.
We associate the dextrin to the biological control in other to facilitate the ingestion of a food containing with the bacteria, which allows to increase its digestion and toxicity of the biopesticide.

MATERIALS AND METHODS

Biological material

Ectomyelois ceratoniae: The *E. ceratoniae* larvae were from a mass rearing conducted within the unity of the INPV Biskra by two techniques: individual and mass rearing livestock.
Individual farming involves spreading of wormy dates in plastic film in a breeding room,

dropping below a card to collect chrysalises when needed. Dates were kept under controlled conditions to allow better adult emergence. While for the artificial medium on mass-rearing was to recover adults from the individual housing in plastic bottles with fine-mesh tulle chiffon for aeration by keeping within filter paper serve nesting support for female borer. After 24 hours mating occurs, the eggs laid on the filter paper in the support were collected and deposited on an artificial medium in plastic boxes of 24x12x10 cm in dimensions. These boxes were previously disinfected with ethanol 70% (v/v). Control of these boxes was made every 3 to 4 days. The eggs hatch after a few days of incubation and the emergence of the larvae (L1). The breeding was conducted under a temperature of 25°C to 30°C, relative humidity ranging from 60-75% and a photoperiod of 16 hours light and 8 hours of darkness.

Bacillus thuringiensis var *kurstaki*: The preparation of different doses of biopesticide (Biobit DF-E-phy) treatment was made from a commercially available powder, consisting of a freeze-dried bacterial strain, as described by the producer. In this study, two tests were carried out. Test 1: the biopesticide was used added only at distilled water, three concentrations were chose BH1 (0.25 g/0.5l), BH2 (0.50g/0.5l) and BH3 (0.75 g/0.5l). The test 2: we added 1% of dextrin and distilled water at each concentrations (BHS1; 0.25 g/0.5l+1% dextrin, BH2:0.50g/0.5l +1% dextrin and BH3: 0.75 g/0.5l+1% dextrin.

Insecticide: The selection of the growth regulator doses the Diflubenzuron (Dimilin SC Syngenta) of this trial was made from the approved dose of 40g/hl: Three doses were choose :DIF1=0.2 g/l, DIF2=0.4 g/l, DIF3=0.6 g/l.

Treatments

The 4th instar larvae were spread over 10 boxes of experiments at 5 individuals per box with three repetitions to avoid cannibalism. In each box, 80g of culture medium was put. The control groups were treated only with sterile distilled water. To determine the daily mortality rate after treatment, the dead individuals both in treated and in control series sets was counted within 14 days of observation.

Calculation of percentage mortality

Percent mortality was calculated for reated larvae of *E. ceratoniae* compared to control by the formula of Abbot (1925).

Data analysis

To estimate the efficacy of each treatment we calculated LC50 (fifty percent lethal concentrations) and LT50 (time required to achieve 50% mortality) by Probit-analysis (Finney, 1971).

RESULTS

1. Effect of *B. thuringiensis* var kurstaki on 4th instar larvae of *E. ceratoniae*

The corrected cumulative mortalities on the larvae (L4) appeared weak during the first days after treatment especially for the dose BH1; the mortality rate increased slightly to reach its maximum (100%) at the end of day 12 for dose BH2; and after the 11th day for the dose BH3. However, the dose BH1 showed a rate of 86.73% for the 14th day. It was found that the corresponding mortalities dose BH3 were greater than BH1 and BH2 doses. Indeed mortalities recorded exceed 50% after the 3rd day and were of the order of 99% after the 10th day. Daily observations allowed us to note also that the first mortalities occurred on the first day after treatment with the bacteria (Figure 1).

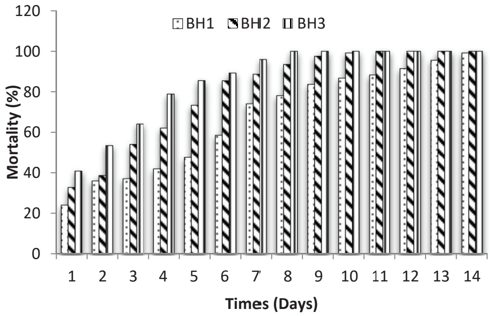

Figure 1. Larval mortality rate of the 4th instar larvae of *E. ceratoniae* treated with *B. thuringiensis* var *kurstaki*

1. Effect of *B. thurigiensis* treatment associated with dextrin on 4th instar larave of *E. ceratoniae*

The mortalities caused by the first dose (BHS1) ranged between 24.16% and 78.19% during the first week after treatment, reaching 99.12% at the end of the last day of monitoring. The percentages of deaths recorded by the dose BHS2 were in the order of 32.88% for the first day increased slightly to reach 50% from the 3rd day; the maximum rate was 100% mortality wasobtained after the 11th day. The third dose BHS3 recorded a rate of 40.94% from 1 day to reach 100% by Day 8. It should be noted that mortalities recorded with the addition of 1% of dextrin are relatively higher compared to one biopesticide (Figure 2).

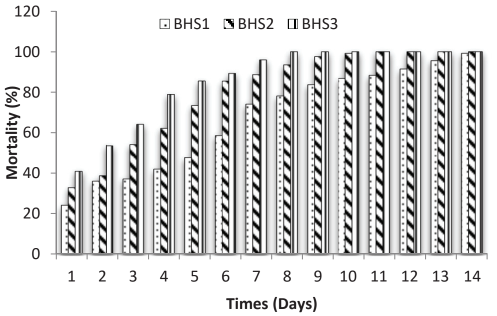

Figure 2. Mortality rate of the 4th instar larvae of *E. ceratoniae* treated with *B. thuringiensis* var *kurstaki* associated Dextrins

An examination of Figure 2 shows a significant evolution in daily mortalities recorded after 14 days of observation. BHS1 dose proved less virulent by comparing it with the other two doses. Indeed, registered mortality peaks are of the order of 24.16% at the 1st day remain between 73.48 and 85 61% for the 5 days following treatment, they remain between 60% and 80% for days with the exception of 14 days or there is a total mortality is 100%.

Parallel both doses BHS2 and BHS3 do not appear to exhibit wide variations there between, it should be noted that the peaks of mortalities were obtained after the 9th day after ingestion of the product associated with 1% of dextrin.

3. Effect of Diflubenzuron on the 4th instar larvae of *E. ceratoniae*

Mortalities were insignificant for DIF2 and DIF3 doses during the first three days after treatment application, and exceeded the fourth day dose DIF1. The latter causes a mortality that ranges from 1.33% for the first days or a rate of about 1.33% to 53.33% and 5th day after the 14th day. However, a percentage of about 3.33% was recorded from the 4th day for the dose DIF2, the latter increases to reach 68.89% after the 14th day. The DIF3 has a mortality rate mortality rate of around 74.81% and after 14 days of follow-up. It should be noted that mortalities percentages recorded for this insecticide or growth regulator are not very important and those for the three doses tested. DIF3 dose has superior mortalities those doses DIF1 and DIF2 (Figure 3).

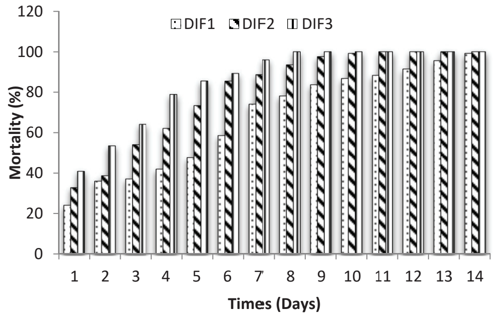

Figure 3. Mortality rate of the 4th instar larvae of *E. ceratoniae* eller treated with Diflubenzuron

The highest toxicity is obtained with the bacteria added to the dextrin (0.13g/0.5l) and then only with the bacteria (0.23g/0.5l). The lower toxicity is obtained with diflubenzuron (1.03g/0.5l).

Table 1. LC50 values of the treatments applied in larvae of the fourth stage of *E. ceratoniae*

Traitements	BH	BHS	DIF
LC50 (g/0.5l)	0.23	0.13	1.03

The review of correlation coefficients showed that they were significant for all products and doses used except dose D1du Diflubenzuron, with relatively low value or $R^2 = 0.492$. The mortality rate and time vary in the same direction (Table 2).

The table 6 brings together the LT50 which are calculated from the regression line equations of each dose tested in the 4th instar larvae of *E. ceratoniae* Zeller. These show that the highest LT50 14.2 days is recorded by the dose (DIF1); by against the weakest time of 1.81 days is observed for the dose (BHS3).

Table 2. LT50 values in larvae of 4th stage of *E.ceratoniae*

Concentrations	LT 50 (days)
BH1	6.09
BH2	2.92
BH3	2.35
BHS1	3.16
BHS2	2.15
BHS3	1.81
DIF1	14.2
DIF2	11.6
DIF3	10.71

DISCUSSIONS

The results showed that the toxicity of the entomopathogenic: *B. thuringiensis* var *kurstaki* for the 4th instar larvae of the moth dates is greater than that of the insecticide Diflubenzuron. It can be returned to the mode of action the latter, whose ingestion crystals *B. thuringiensis* var *kurstaki* containing endotoxin causes direct mortality on the larvae against Diflubenzuron takes time; these results are confirmed by Jardak and Ksantini (1986), they stated that the integrated control framework, control test against the 3rd generation *Prays oleae*, *Bacillus thuringiensis* resulted a larval mortality rate approaching 50%, while that diflubenzuron net effect was not compared to the control. However, control of the pupae in the traps corrugated showed some effectiveness of this product tested which result in a reduction of emerging populations of about 74-79% compared to the control. It should be noted that *B. thuringiensis* affects only the larval stages, while Diflubenzuron has a slow action that runs until pupation stage (pupae mortality can reach 40%).

The bacterial strain of *B. thuringiensis* has proven very virulent against *E. ceratoniae* causing larval mortality up to 86.73% and 100% thereof are in agreement with the results obtained by Jerraya (2003). In examining the results from treatments with bacteria alone or associated with dextrin, we note that the mortality rate observed in our experiment is justified as follows: the scale and speed of poisoning vary with the stage we examined larval mortality noting that the latter is strongly evident from the first day after treatment.

According noticed mortalities during the single *Bacillus* tests are assumed due mainly to the effect of the ingestion of the crystals of this bipopesticide containing endotoxin. This hypothesis just been arguing with the studies of other authors in particular those of: Frankanhuyzen et al. (1992). Which report that the *B. thuringiensis* kurstaki is effective against caterpillars of various lepidopteran pests in fruit trees and forest crops. It is one of the best selectively toxic strains for a wide variety of lepidopteran larvae. For his part, Abdel Razek (1998), used formulations of *B. thuringiensis* and var. *indiana*. and var. *morrisoni*, the latter have proven effective with respect to *Cadra cautella* Walker and *Tribolium confusum* Duval respectively. Moreover Saadawi et al., (2007), showed a hyper toxicity of a strain of *B. thuringiensis* var *kurstaki* on insect larvae which allowed him to confirm that this strain has a hyperactivity against them. Our results are comparable to Zouiouech and Rahim (2008), who tested a biopesticide from the same family ie Dipel 8L, the results they led, shows high efficiency of this biological insecticide on hatched larvae (L1). Similarly Kardi and Rouici (2007) showed in laboratory conditions that the sputtering of a bacterial suspension after a local strain based *B.thuriengiensis* applied to the artificial culture medium for the larvae feed of neonates *E. ceartoniae* causes mortality percentages of about 64% in L3 and 40% in 5th instar larvae of *E. ceratoniae*.

Moreover Dhouibi (1992), noted that mortality among this same pest occurs at any larval stages but it is very important for young stages and even older caterpillars die when she received the lethal dose, the caterpillar reached by *B. thuringiensis* stops eating due to metabolic disruption while causing narrowing of the body of the larvae and this bacterium has the advantage of being compatible with the auxiliaries and other biological agents, on the other hand he noticed the Bactospein does not present a knockdown against E.ceratoniae.

Simpson et al., (1971), Gary and Karl (1992) and quoted by Charles Coderre (1992), reported that *B. thuringiensis* toxin produced several important effects, including death of the larvae before moulting and the cessation of all power after moulting, sub-lethal doses generally produce teratology including malformations of the mouthparts, eyes, antennae and wings. According to Taoufik, (1993) cited by Brahmi, (1998), after the inclusion of endotoxin by the insect, the protease active protoxin which then causes swelling in the digestive tract cells; therefore breaks at the perithrophic membrane with a destruction of the basement membrane, which opens the way for the invasion of pathogens and other secondary parasites found in the digestive tract, they causes paralysis of midgut in general and induces the word of the insect.

The toxicity of the growth regulator diflubenzuron showed relatively low mortality rates for the three doses tested; D1, D2 and D3, on the larvae of the moth stage (L4) relative to the testing of the tested entomopathogenic. Given the unavailability of bibliographical works available on this growth regulator against borer dates, we sum focused to compare our data with the literature on other pests.

The mode of action of this insect growth regulator reduced significantly the lipids contents, the proteins and carbohydrates from the 4^{th} day after ingestion. Boudebous and Djoumeh (1995) demonstrated this effect on adult female *Tenebrio molitor* treated by ingestion of 10 mg/g. Soltani-Mazuni (1994) its side observes of the same alterations for pupae of this beetle.

At the base of doses applied on L4 larvae *Ectomyelois ceratoniae* Zeller, CPA has identified four groups with the doses tested, including the Prime group (Gp1) and the fourth group (Gp4) are not correlated with the period treatment, the second group (Gp2) correlated to the last days of monitoring mortality, and the third group (Gp3) correlated to the early days the application of biopesticide.

CONCLUSIONS

This work mainly devoted to the study and assessment of toxicity compared to a strain of a marketed entomopathogen *B. thuringiensis* alone or with 1% dextrin added and a growth regulator Diflubenzuron on the 4^{th} instar larvae of *E. ceratoniae,* a potential pest of dates.

It was found that the corresponding mortalities high doses are greater than the middle and low doses. The highest adjusted mortality relate to corresponding doses 3 and those for the three products which were the subject of our follow.

The LD50 of *B. thuringiensis* treatment was 0.23 g/0.5l; and 0.13 g/0.5l when dextrin was added. For Diflubenzuron the value of LD50 as 1.03 g/0.5l.

It seems interesting to us to see the action of these entomopathogenic on target cells, thereby broadening of such treatment for applications on date-palms for sustainable phoeniculture in environmental conservation framework and biodiversity. It can be concluded that the doses currently used in the field to these insecticides could be reduced to an economic interest and for good protection of the environment against pollution.

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THE STUDY OF THE INFLUENCE OF THE LIQUID ORGANIC FERTILIZER ON THE PROCESS OF EMERGENCE AND DEVELOPMENT OF MAIZE

Tatiana BOCLACI, Larisa CREMENEAC

Scientific and Practical Institute of Biotechnologies in Zootechny and Veterinary Medicine
V. Maximovca, District Anenii Noi, Republic of Moldova

Corresponding author email: draganta8@gmail.com

Abstract

Worm compost is an organic fertilizer which is obtained in the result of bioconversion technology of organic waste by worm cultivation.
In the article is reflected the evaluation of the influence of liquid organic fertilizer, obtained from worm compost and drinking water, on the process of emergence and particularities of the development of maize. As a research materials were used liquid organic fertilizer obtained from worm compost and maize.
In the result of observations carried on the process of emergence of maize and its development it was found that more early started to arise the maize plants in variants in which the seeds were macerated and soil was sprinkled with liquid organic fertilizer obtained from crude worm compost and that with the fraction of 1 mm, using the proportions of 1:10 and 1:100. Analyzing the results obtained on the process of emergence at the end of the experiment, it was found that the maceration of maize seeds in that two variants of liquid fertilizer, accelerated the emergence and physiological development in the experimental variants in comparison with that of plants from variant control.
So, the macerating of seeds in the liquid organic fertilizer had a positive impact on the process of emergence and development of maize.

Key words: *liquid organic fertilizer, maceration, maize, seeds, worm compost.*

INTRODUCTION

In the recent decades the problem of protecting the environment occupies an important position in the development of sustainable agriculture. One of this problem areas is that of the processing of organic waste. For solving this problem are proposed several technologies. An important role belongs to the technology of bioconversion of organic waste by worm cultivation, which deserves a special attention with fundamental research (Cremeneac and Boclaci, 2012) because it solves some important problems of the zootechny sector and phytotechnic improving the situation of the environment, enhancing soil fertility and improving the quality of agricultural production. The technology for processing organic waste by this method is based on the biological capacity of rhymes to use the solid fraction of organic waste in a quality of environmental life and as a source of nutrients. In a relatively short period of time it can be obtained a valuable organic fertilizer (worm compost). The technology of bioconversion of organic waste by worm cultivation is a prospective method that can be practiced in all kinds of households (public, private peasant). This technology provides the use, as a nutrient substrate for worm culture animal organic waste, household, vegetable that have been subjected partially to the fermentation process.
One of the final products of the process the bioconversion of organic waste by worm cultivation is worm compost obtained in the result of the processing of organic waste obtained by using rhymes, especially of the rhyme Hybrid Red of California. The product obtained represents a natural organic fertilizer, ecologic, consisting of small grains of dark brown color, scentless, hygroscopic, long-acting (Cremeneac, 2001). In the result of investigations it was found that in worm compost is well balanced the content of macro and micronutrients, are concentrated considerable qualities of ferments, vitamins, growth stimulators, non-pathogenic microflora. The worm compost's role is essential in the

development of organic farming (Cremeneac and Boclaci, 2013). In the literary sources are present data which support that from the worm compost is obtained a liquid fertilizer with a higher efficiency than that of the solid, on the process of emergence and development of plants.

It is noted that liquid extracts "Vermistim" and "Gumistar" (Klimciuc, 2010) are natural organic fertilizers, ecologic with high efficiency that have color opened or closed brown (depending on concentration), scentless with a transparent texture.

The study of the conducted researches demonstrate that the use of liquid organic fertilizer influences positively on the process of growth, photosynthesis, increasing the productivity and quality of agricultural production (Boclaci and Cremeneac, 2015). This was the reason to conduct research in order to determine its use for macerating the maize seeds in order to accelerate their germination process and the evaluation of their physiological features of plant development.

From the obtained worm compost in the laboratory conditions, was prepared a liquid organic fertilizer, which was later used for macerating the seeds before sowing and watering the soil during the experiment.

MATERIALS AND METHODS

In order to appreciate the role of a liquid organic fertilizer on the process of germination, emergence and particularities of the development of maize in the laboratory Methods of Control and Disease Prevention at the Scientific and Practical Institute of Biotechnologies in Zootechny and Veterinary Medicine, was organized an experiment in chamber conditions. As research materials were served worm compost and drinking water. In order to obtain the liquid fertilizer were used two fractions of worm compost (crude and of 1.0 mm) and potable water in a ratio of 1:10 to 1:100. For the preparation of the proposed concentrations were used, 100 and 10 g of worm compost of both fractions, which were dissolved in one liter of water. Fraction of 1.0 mm was obtained by sifting crude worm compost through a sieve with apertures of 1.0 mm. Liquid fertilizer was obtained from worm compost, in the laboratory conditions, at the water temperature and room air. The separation of the liquid fertilizer from the solid fraction was carried out after 24 hours, and then it was used for macerating the maize seeds and for spraying the soil during the experiment. Maize seeds were subjected to the process of maceration for 12 hours.

After the macerating, under the laboratory conditions, the maize was sown in special boxes with dimensions 20 x 10 x 13 cm. In each box were planted 18 seeds each. In accordance with the scheme of the experiment (Table 1) for obtaining liquid fertilizer were used both types of worm compost and drinking water, in the mentioned proportions (1:10 and 1: 100).

Table 1. The experimental scheme

No.	Lots	The experimental conditions
1	The control	Not or soak the seeds, the soil sprinkled with water
2	Experimental lot	Macerated seeds in fertilizer obtained from worm compost and water, soil being sprinkled with of these
3	Experimental lot	Macerated seeds in fertilizer obtained from worm compost and water, soil sprinkled with water
4	Experimental lot	Not or soak the seeds, the soil sprinkled with extract obtained from worm compost and water

In the experiment were used 4 lots (one-control and three - experimental). In each experimental group, for each ratio (1:10 and 1: 100) were included threes variants, inclusive for each fraction of worm compost 4 variants were used. During the experimental period the control version was sprayed with water and that experimental - with water and fertilizer obtained from crude worm compost and that with fraction of 1.0 mm in proportion 1:10 and 1:100.

During the experiment the observations were made on the emergence of maize and its development in the first 20 days.

Thus, in the result of the carried research it was appreciated the role of the liquid organic fertilizer obtained from worm compost, on the process of emergence and particularities of the maize development.

RESULTS AND DISCUSSIONS

The investigations were carried out in order to appreciate the role of the liquid fertilizer obtained from worm compost, on the process of emergence and particularities of development of maize.

In the result of observations carried on the process of plant emergence it was found that in all experimental lots, in which the seeds were macerated and the ground sprinkled with liquid fertilizer obtained from worm compost with fraction 1.0 mm and crude in proportions 1:10 to 1:100, in these have sprung more plants than in the control lot.

Table 2. The process of emergence of maize

Lot	Variant	Fraction and concentration of fertilizer	The conditions of the experiment	Date and number of plants					
				31.03	02.04	04.04	07.04	09.04	11.04
Control			Not or soak, the soil sprinkled with water	3	10	12	12	14	16
Experimental I	Variant 1	1 mm; 1:10	Seeds macerated with fertilizer and sprinkled with ferilizer	4	13	13	15	15	16
Experimental II		1 mm; 1:10	Seeds macerated with fertilizer, sprinkled water	5	12	15	17	17	17
Experimental III		1 mm; 1:10	Seeds not or soak, sprinkled with fertilizer	6	14	16	16	17	17
Experimental I	Variant 2	1 mm; 1:100	Seeds macerated with fertilizer and sprinkled with ferilizer	5	12	14	14	15	16
Experimental II		1 mm; 1:100	Seeds macerated with fertilizer, sprinkled water	7	14	17	17	17	17
Experimental III		1 mm; 1:100	Seeds not or soak, sprinkled with fertilizer	5	13	16	17	17	17
Experimental I	Variant 3	Crude; 1:10	Seeds macerated with fertilizer and sprinkled with ferilizer	17	17	17	18	18	18
Experimental II		Crude ; 1:10	Seeds macerated with fertilizer, sprinkled water	5	15	17	17	17	17
Experimental III		Crude; 1:10	Seeds not or soak, sprinkled with fertilizer	5	16	17	17	17	17
Experimental I	Variant 4	Crude; 1:100	Seeds macerated with fertilizer and sprinkled with ferilizer	4	10	12	14	15	16
Experimental II		Crude; 1:100	Seeds macerated with fertilizer, sprinkled water	4	10	14	14	15	16
Experimental III		Crude; 1:100	Seeds not or soak, sprinkled with fertilizer	6	16	18	18	18	18

From the analysis of the data concerning to germination a maize, reported in Table 2 result that after 10 days after the sowing, in all variants of the experiment manifested the emergence of the plants, only the that the number of risen plants was different.

In the experimental lot I (variant 3), in which the seeds were macerated with liquid fertilizer obtained from crude worm compost in proportion 1:10 the process of sprouting was the most intensive, constituting 17 the maize plants, respectively with 14 plants more than in the control lot.

In the experimental lots: I (variant 1), I and II (variant 4), II (variant 1), I and III (variant 2) and II and III (variant 3) sprung respectively 4; 5 plants, which has exceeded their number respectively with 1; 2 plants on the control lot. In the experimental lots III (variants 1; 4) and II (variant 2) have sprung 6; 7 plants, respectively with 3; 4 plants more in comparison with control lot.

The observations made in the coming days on the process of sprouting of maize in demonstrated that emergence thereof has occurred in all lots, but in those experimental the quota of the emergence surpassed with 6.25-12.50% on the one from the control group.

After 20 days from the sowing in all the experimental lots and in the control have sprung the majority of plants and observations made in the following days demonstrated more plants will not emerge, because their numbers during three days had not changed. Analyzing the research carried out on the emergence of the maize plants in the experimental variants it was found that in the experimental lots in which the maize seeds were macerated in liquid organic fertilizer obtained from crude worm compost, in proportion of 1:10 and 1:100, and sprinkled with the same fertilizer, the germination rate was higher with 2.0% comparatively with experimental lots, in which the maize seeds were macerated in liquid organic fertilizer obtained from worm compost with fraction of 1mm in the same proportions.

So, in the process of emergence of maize an important role returned as to the maceration of the seeds as to the sprinkling of the soil with liquid fertilizer.

So, the maceration of the seeds was important for the process of emergence of maize in all experimental variants, only at the initial stage, when it was noted the earlier emergence the a plants.

Table 3. Physiological development of maize

Lot	Vari ant	Fraction and concentration of fertilizer	The conditions of the experiment	The measurement date and plant length (cm)					
				04.04	09.09	14.04	17.04	18.04	22.04
Control			Not or soak, the soil sprinkled with water	1.58 ± 0.50	4.22 ± 0.51	7.34 ± 0.34	9.28 ± 0.81	11.0 ± 0.73	13.3 ± 1.28
Experimental I	Variant1	1 mm; 1:10	Seeds macerated with fertilizer and sprinkled with ferilizer	1.20 ± 0.51	5.0 ± 0.47	7.16 ± 1.11	11.4 ± 0.53	11.5 ± 0.60	15.1 ± 1.50
Experimental II		1 mm; 1:10	Seeds macerated with fertilizer, sprinkled water	1.86 ± 0.54	5.20 ± 0.23	6.46 ± 0.87	10.1 ± 0.53	10.4 ± 0.47	16.1 ± 0.47
Experimental III		1 mm; 1:10	Seeds not or soak, sprinkled with fertilizer	3.56 ± 0.62	5.5 ± 0.54	8.64 ± 1.00	11.9 ± 1.13	12.2 ± 0.96	17.9 ± 1.63
Experimental I	Variant 2	1 mm; 1:100	Seeds macerated with fertilizer and sprinkled with ferilizer	1.96 ± 0.38	4.26 ± 0.27	6.70 ± 0.64	8.90 ± 1.18	9.30 ± 0.96	14.5 ± 1.30
Experimental II		1 mm; 1:100	Seeds macerated with fertilizer, sprinkled water	2,60 ± 0,54	5.08 ± 0.36	8.1 ± 0.49	10.8 ± 0.96	11.5 ± 0.70	15.4 ± 0.70
Experimental III		1 mm; 1:100	Seeds not or soak, sprinkled with fertilizer	2.00 ± 0.49	5.32 ± 0.47	6.16 ± 0.49	9.94 ± 0.83	10.1 ± 0.77	13.8 ± 0.73
Experimental I	Variant3	Crude; 1:10	Seeds macerated with fertilizer and sprinkled with ferilizer	4.68 ± 0.81	7.18 ± 0.75	11.2 ± 0.79	12.6 ± 0.64	14.1 ± 0.15	15.2 ± 0.38
Experimental II		Crude ; 1:10	Seeds macerated with fertilizer, sprinkled water	1.70 ± 0.27	4.88 ± 0.45	7.50 ± 0.90	9.76 ± 0.81	10.5 ± 1.07	13.9 ± 1.52
Experimental III		Crude; 1:10	Seeds not or soak, sprinkled with fertilizer	1.64 ± 0.32	4.92±0.086	6.32 ± 0.64	9.44 ± 0.90	10.6 ± 0.85	13.5 ± 0.62
Experimental I	Variant 4	Crude; 1:100	Seeds macerated with fertilizer and sprinkled with ferilizer	1.22 ± 0.36	4.36 ± 0.70	5.84 ± 1.11	8.76 ± 0.90	9.60 ± 1.07	14.8 ± 1.25
Experimental II		Crude; 1:100	Seeds macerated with fertilizer, sprinkled water	1.30 ± 0.58	3.60 ± 0.40	6.74 ± 0.60	18.4 ± 2.78	10.2 ± 1.32	14.6 ± 1.41
Experimental III		Crude; 1:100	Seeds not or soak, sprinkled with fertilizer	1.80 ± 0.32	4.86 ± 0.55	8.06 ± 0.40	9.06 ± 0.66	9.90 ± 0.83	14.2 ± 0.77

Control Experimental

Figure 1. Physiological development of the maize with seeds not soak but the earth sprinkled with ferilizer from worms compost

Control Experimental

Figure 2. Physiological development of maize seeds macerated and sprinkled with fertilizer from worms compost (crude 1:10)

In the result of observations effectuated on the process of the physiological development of maize (Figures 1 and 2) and (Table 3), it was ascertained that the liquid fertilizer had a positive impact on the physiological development of it in all rounds of the measure of the length of plants.

At the end of the experiment, in the result of the length measuring of plants of maize it was found, that the length of the plant in which the liquid organic fertilizer was used, obtained from the worm compost with fraction of 1 mm and of that crude, in proportion of 1:10 and 1:100 had surpassed that of plants from the control lot, respectively with 13.53-34.58%; 3.75-15.78- 16.92% and 1.50%; 6.76% and 11.27%.

Therefore, in the result of the carried out experiment it was found a beneficial influence of the liquid organic fertilizers obtained from worm compost with a fraction of 1 mm and crude, in proportion of 1:10 and 1:100, on the process of sprouting and physiological development of maize in the first 3 weeks.

CONCLUSIONS

It was found, that the early emergence of the maize plants was held in all the experimental lots in which the liquid organic fertilizer was used, obtained from fractions of worm compost and water in a proportion of 1:10 and 1:100.

The emergence of the maize plants was more intense in the experimental variants, where the number of risen plants to exceeded that of the control group with 6.25-12.50%.

The maceration of the seeds and sprinkling the soil with liquid organic fertilizer accelerated the process of the emergence and of the physiological development of maize.

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DISTRIBUTION, LIFE HISTORY AND BIOLOGY OF ALMOND SAWFLY (*Cimbex quadrimaculata* (Müller, 1766), HYMENOPTERA: CIMBICIDAE)

Halil BOLU

Dicle University, Faculty of Agriculture, Plant Protection Department, 21280 Diyarbakır, Turkey

Corresponding author e-mail: besni@dicle.edu.tr

Abstract

Cimbex quadrimaculata Müll. is an important pest in fruit-growing areas of Turkey where its hosts include almond, pear, plum, peach, apricot, and cherry. Surveys on C. quadrimaculata in various ecologies have been conducted in the provinces (Adıyaman, Diyarbakır, Elazığ, Mardin) of Southeastern and Eastern Anatolia regions of Turkey between the years 2010-2014. C. quadrimaculata larvae collected from Amygdalus communis L. (Rosacae) in Adıyaman, Diyarbakır, Elazığ, Mardin. There were similarities in the larvae population changes in Adıyaman-Diyarbakır and Elazığ-Mardin. The highest density of the larvae was recorded of Besni location in Adıyaman province. Population density of the larvae was low in Mardin. Occurrence of the larvae generally observed between April and July in the all of province. C. quadrimaculata overwinter as a pre-pupa in a cocoon in the ground or other protected place, pupating in the spring. In early summer, adults lay eggs in or on plant tissue and the larvae feed on the leaves.

Key words: *Cimbex quadrimaculata, Almond pest, Hymenoptera, Cimbicidae.*

INTRODUCTION

The almond (*Amygdalus communis*) is a species of tree native to the Middle East and South Asia. Turkey is a country with high almond production. Almonds are produced mostly in the Aegean, Marmara, Mediterranean, Southeast and Eastern Anatolia regions, and the almond has great economic importance (USDA 2010). Some pests and disease have caused important crop losses affecting almond growth and production all over the world. Studies on the determination of pests and disease in almonds have shown that *Cimbex quadrimaculata* (Hymenoptera: Cimbicidae) is a common pest on almond trees in Turkey and worldwide (Maçan, 1986; Russo et al., 1993; Bolu et al., 2005). Its larvae feed on the leaves of almonds and can occasionally become numerous enough to cause injury to some trees.

The Cimbicidae are a small family of large-bodied, often hairy sawflies, with only 130 species in six genera worldwide. Larvae are solitary herbivores. The family is distinctive in having antennae with prominent apical clubs or knobs. The adults of some species can exceed 3 cm in length, and are among the heaviest of all Hymenoptera.

Cimbex quadrimaculata Müll. (Hymenoptera: Cimbicidae) is a polyphagus pest, with almond, apple, pear, plum, peach, apricot, and cherry among its most important hosts. First instars attack newly opened buds of the host, while older instars feed along the main leaf veins. Damage to fruit was documented by Maçan (1986). Bodenheimer (1958) discussed the importance of this species to fruit trees in Turkey. Bolu et al. (2005) reported it from the southeastern and eastern Anatolia region of Turkey.

Because of its considerable economic importance and given that details of the life history are poorly documented, I studied the biology of this species in the laboratory and in nature. Also the distribution of the pest in the Southeastern Anatolia Region was determined. The results are presented in this paper.

MATERIALS AND METHODS

Cimbex quadrimaculata larvae were captured in the vicinity of Adıyaman, Diyarbakır, Elazığ, Mardin between 2010-2014. The sampling method was based on the techniques usually applied in orchards, namely knocking the larvae out of the trees by the frappage (beating) method. Twenty-five trees at about the same stage of growth were randomly selected in each biotope and four branches per tree (4 X 25= 100 branches) were sampled. These branches were given three blunt beatings with a stick wrapped in foam rubber and the larvae that fell onto a piece of cloth, 50 X 50 cm were collected. The development of larvae observed daily and shed larval head capsules were collected, measured and preserved in 70% ethyl alcohol. Pupae were harvested daily and transferred to a new cage (40x30 cm) containing a potted host plant. The length larvae and pupae were measured. The colony was maintained under controlled laboratory conditions at 26°C with 16:8 (L: D) photoperiod. All data were subjected to analysis of variance (ANOVA), and means were separated using Fisher's Least Significant Difference (LSD) ($P < 0.05$).

RESULTS ANS DISCUSSIONS

C. quadrimaculata larvae collected from *Amygdalus communis* L. (Rosacae) in Adıyaman, Diyarbakır, Elazığ, Mardin. There were similarities in the larvae population changes in Adıyaman-Diyarbakır and Elazığ-Mardin. The highest density of the larvae was recorded of Besni location in Adıyaman province. Population density of the larvae was low in Mardin. Occurrence of the larvae generally observed between April and July in the all of province. *C. quadrimaculata* overwinter as a pre-pupa in a cocoon in the ground or other protected place, pupating in the spring. In early summer, adults lay eggs in or on plant tissue and the larvae feed on the leaves.

Description of the pest

Adult: The color of the adult varies from dark brown to black, and there are yellow spots on the body. Differs from male and female individuals (Figure 1). Head dark brown, covered with short hairs. The head is large. Clypeus is colored yellow. The antennae are black at the base and yellow-orange at the tip. The antennae end in a club and have seven segments. The last segment took the shape of the club. The antennae are black at the base and yellow-orange at the tip. The thorax is dark brown. Brown scutellum is shaped like a narrow trapezoid. The abdomen is yellowish, with two large dark brown bands. Wings are transparent and are colored yellow. The tip of the front wing is slightly darker. This darkness in the form of a strip extends along the wing. The back wing is lighter than in dark places and not be seen. In the male, the coxa and the femur is very swollen. Coxa, trochanter and femur black. In females, the legs brown, the segments of the tarsus are yellow. Coxa and femur is made thinner. The average length of female individuals 18.40 millimeters (16.57-21.88). The average length of male individuals 14.25 millimeters (12.57-18.10).

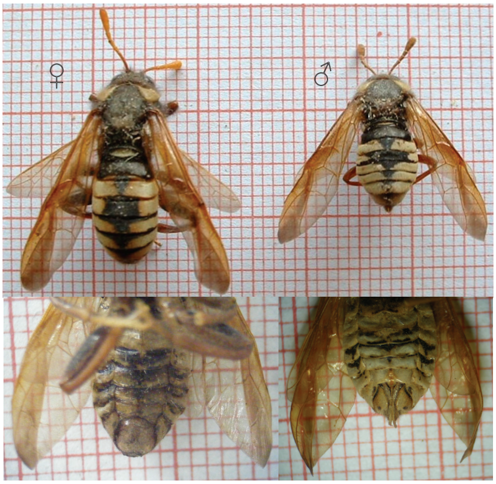

Figure 1. Female and Male adults of *Cimbex quadrimaculata*

There is only one generation per year. Larvae gnaw the leaf margins of the host plants (especially *Amygdalus communis* L., *Crataegus monogyna* Jacq. (Figure 2), *Prunus domestica* L. and *Prunus cerasus* L.). When they reach the maturity they build a strong oval cocoon (Figure 3), in which they change to pupa, within which they overwinter. Cocoons the average length of 16.25 millimeters (14.17-23.00) average width of 10.50 millimeters (10.10-11.00).

Figure 2. Last larval stage of *Cimbex quadrimaculata* on *Crataegus monogyna*

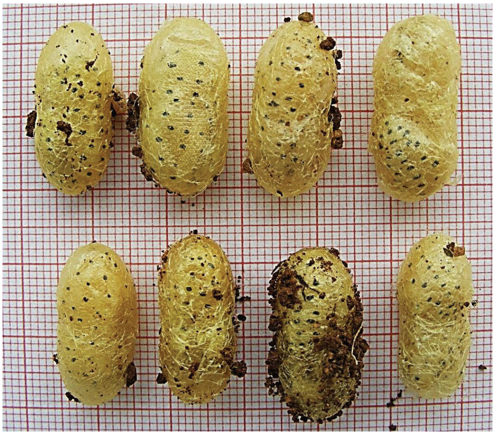

Figure 3. Cocoons of *Cimbex quadrimaculata*

Larvae: Larvae of *Cimbex quadrimaculata* are grayish and black markings. The average length of these larvae can reach about 20 millimeters (0.79 in), with a maximum of about 50 millimeters (1.9 in) in last larval instars. The larvae are big and full-bodied. The larval head capsule is black in the first larval instars. The last larval instar head capsule is white (Figure 4). It stops on the curved leaves during larval feeding. The larvae secrete a yellowish substance tapping by hand.

Damage: Young larvae after eating a portion of the leaf, to leaf through a nearby pass. The larvae are fed up to a month and will grow more voracious. This completely leafless almond trees where they can leave their high population during the period (Figures 5 and 6). Such a formation of almond trees do not fruit next year cannot afford to continue their normal activities; it greatly improves the susceptibility to falls and cold.

Figure 4. The first larval instars and the last larval instars of *Cimbex quadrimaculata*

Figure 5. The last larval instars of *Cimbex quadrimaculata*

Biological Control: In Turkey, the presence of 3 parasitoid species of *C. quadrimaculata*, which is an important almond pest, has significant importance in enhancing the potential to control the abundance of *C. quadrimaculata* in almond orchards. Larvae and pupae of *Cimbex quadrimaculata* are parasitized by *Opheltes glaucopterus, Listrognathus mactator* and *Phobetes nigriceps* (Özgen et al., 2010; Özbek, 2014).

Figure 6. The damage on almond tree of larvae *Cimbex quadrimaculata*

Cultural Control: Harmful cocoons found in the soil (Figure 7) in the tree crown projection can be destroyed by cultivation. Simply tilling or plowing a almond orchard before winter may disrupt a pest's life cycle by causing mechanical injury, by increasing exposure to lethal cold temperatures, by intensifying predation by birds or small mammals, or by burying the pests deep beneath the soil surface.

Figure 7. Cocoons in soil of *Cimbex quadrimaculata*

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VARIOUS OBSERVATIONS ON SOME BIOLOGICAL CHARACTER OF PISTACHIO WHITE SCALE [*Suturaspis pistaciae* (*Lindinger*) *Hemiptera*: *Sternorrhyncha*: *Coccoidea*: *Diaspididae*]

Halil BOLU

Dicle University, Faculty of Agriculture, Plant Protection Department, 21280 Diyarbakır, Turkey

Corresponding author email: besni@dicle.edu.tr

Abstract

Suturaspis pistaciae (Lindinger) Hemiptera: Sternorrhyncha: Coccoidea: Diaspididae) is an important pest on pistachio trees of Turkey. Various observations on the biology of Suturaspis pistaciae were carried out under laboratory conditions. In this study, development time of immature stages of one of most important pest of pistachio Suturaspis pistaciae were studied at 27 ± 1°C and 65% ± 5 Rh. with 16/8 hours lighting period under laboratory conditions.

Development time of immature stages of S. pistaciae determined first larvae stage: mean 16 (10-28) days, second larva stage mean 12.9 (7-15) days and virgin female stage 8.5 (4-12) days shortened when biological stages increase. Development time from active larva to adult was 37.4 days. The death rate from larvae to adult until it becomes 50% is determined. Stereoscopic binocular Microscope with different biological periods of the pests was measured. Biological measurements are made for a biological stage of 25 individuals each. In addition, morphological characteristics of each stage were also investigated.

Key words: *Suturaspis pistaciae, Hemiptera, Diaspididae, biology.*

INTRODUCTION

Pistacia Linnaeus (*Anacardiaceae*) is mainly a subtropical genus comprising some 11 species of wind pollinated deciduous and dioecious trees and shrubs. Geographically, the largest concentration of *Pistacia* species is found in West Asia and in the Mediterranean region (Zohary, 1995; Tous and Ferguson, 1996). The pistachio, *Pistacia vera* Linnaeus, originated in Asia Minor, in the northern part of Afghanistan, but has largely spread throughout the Mediterranean and the Middle East (Shrestha, 1995).

Pistachio is one of the most important economic crops in Turkey, with about 43,000 ha of plantations, mostly in Adıyaman, Batman, Gaziantep, Diyarbakır, Kilis, Mardin, Siirt and Şanlıurfa province in the southern Anatolia region of the country (TUİK, 2012). Turkey is in the third place in pistachio production following Iran and USA 90% of the pistachio production is Southeastern Anatolia (USDA, 2016).

Scale insects are a diverse group of mostly-sap sucking insects with at least 30 families and around 8,000 species. These insects feed on leaves or branches of many ornamental plants grown in landscapes and nurseries. They attach themselves to a plant and feed by sucking fluids through straw-like mouthparts.

Scale insects can be divided into two broad categories: armored scale and soft scale. The distinction is important because behavior and management of the two groups are different. Both groups live beneath waxy covers that protect them from predators, parasitoids and pesticides. Soft scales secrete a waxy layer over themselves that cannot be separated from their body. Soft scales also excrete sugary honeydew and may move from branches to leaves during their life cycle.

The most species-rich family of scale insects is Diaspididae, the armored scales, with more than 2,400 described insects. Armored scales are also some of the toughest nursery pests around, because they cause severe plant damage and their "armor" makes them difficult for growers to manage effectively. They have colonized every continent except Antarctica, and are among the most invasive insects in the world. Some of the most common armored

scale species in nurseries are euonymus scale, tea scale, oystershell scale, Japanese maple scale, false oleander scale, poplar scale and juniper scale (Anonymous, 2016).
Scale insects vary dramatically in their appearance from very small organisms (1-2mm) that occur under wax covers (some look like oyster shells), to shiny pearl-like objects (about 5mm), to creatures covered with mealy wax. They spend most or all of their lives feeding on plants and are primarily important as plant pests in greenhouses, backyards, and on fruit trees. Scale insects damage millions of dollars worth of food, ornamental, fiber and greenhouse crops each year (Ben-Dov et al., 2010).
Turkey is one of the origins of the pistachio. Pistachio was cultured for the first time in Southeastern Anatolia in Eti's period. Turkey is in the third place in pistachio production following Iran and USA 90% of the pistachio production is Southeastern Anatolia (TUİK 2012). There are a lot of pests' effects pistachio production Bolu (2002) has determined 8 important hazardous species in the investigation made on the insect and mite fauna in the pistachio fields within Southeastern Anatolian Region. These species are: *Anapulvinaria pistaciae* Bod., *Eulecanium rugulosum* Arch., *Kermania pistaciella Amsel., Chatoptelis* (*Hylesinus*) *vestitus* Mulsant et Rey, *Suturaspis pistaciae* Lindinger., *Megastigmus pistaciae* Walker, *Idiocerinus stali* Fieb. and *Agonoscena pistaciae* Burck. and Laut..
Suturaspis pistaciae Lind. (Homoptera; Diaspidiae) the pistachio tree's trunk, branches, shoots, leaves, and rip the fruits which is harmful by absorbing a widespread species. Depending on the population density, trunk, branch, twig, shoot, leaf and fruit damage as a result of sticking and sucking on plants, leaves, flowers, fruits and the loss of bud, and hence it leads to the loss of product (Bolu, 2002; Bolu and Uygun, 2003; Bolu and Uygun, 2005).
Because of its considerable economic importance and given that details of the life history are poorly documented, I studied the biology of this species in the laboratory and in nature. The results are presented in this paper.

MATERIALS AND METHODS

Collection and identification of scale insect

A field survey on the host plants of the armored scale was carried out in different region of Şanlıurfa province. Infected scale insects were most often found on trunks and branches of host pistachio trees and were removed by cutting out small pieces of bark, which were placed in paper bags and kept cool for return to the laboratory.
Infestation was accomplished by placing a branch with crawlers of *S. pistaciae* onto each sapling for a period of two weeks. After the crawlers had settled, 25 nymphs on each sapling were marked by attaching numbered tags to needles bearing one or two nymphs each.

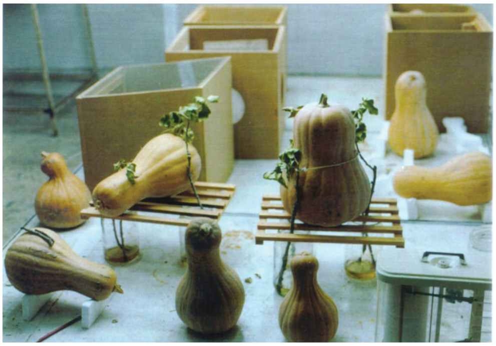

Figure 1. Crawlers over the pumpkin settlement

Following initial infestation, biology of pistachio scale was studied in the laboratory on pumpkin nursery plants in pots at 27±1 °C and 65±5 % RH. All life stages were marked separately to observe change in size, color and shape. Insects sample also inspected under compound microscope by using an ocular micrometer to measure length of the armored scale. A total of 25 individuals of each representative life stage were examined, measured.
Host identification (*Suturaspis pistaciae*) was made by Dr. Lerzan ERKILIÇ (Plant protection Research Institute, Adana/Turkey).

RESULTS AND DISCUSSIONS

Development time of immature stages of *S. pistaciae* determined first larvae stage: mean 16

(10-28) days, second larva stage mean 12.9 (7-15) days and virgin female stage 8.5 (4-12) days shortened when biological stages increase. Development time from active larva to adult was 37.4 days. The death rate from larvae to adult until it becomes 50% is determined.

Description of the pest

Eggs

Eggs are whitish pink, oval in shape. Shortly before hatching, the egg will appear dull pink. In a number ranging from 2 to 4 eggs in the abdomen of the females were found to have.

Crawlers

Crawlers are flat, oval, and pink with six well-developed legs and two antennae.

Larvae 1st instar

The larvae are fixed, after the pink color is a darker color, turning to black. During this period, the larvae; antenna, eyes, legs, and atrophy were observed. The first instar nymph averaged 0.45 ± 0.02 mm in length by 0.26 ± 0.02 mm in width.

Larvae 2nd instar

With the start of the second larval period: starting over with the expansion of the abdomen, covered with a crust of white that are observed. Over this period the measurements: The second instar larvae, averaged 0.65 ± 0.02 mm in length by 0.34 ± 0.02 mm in width.

Virgin female

Virgin female, a wine-red color, the body began to grow and covered with a completely white shell (Figure 2). The female third instar nymph, or virgin adult, averaged 1.06 ± 0.02 mm in length by 0.37 ± 0.02 mm in width.

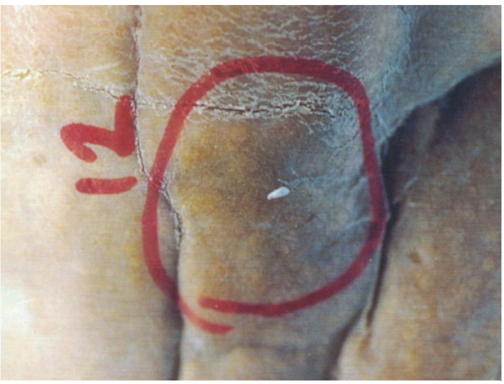

Figure 2. Virgin female on pumpkin

Adult Female

In adult females, a wine-red color, the abdomen swells, the part began to widen, and are elongated. The adult female, averaged 2.31 ± 0.02 mm in length by 0.75 ± 0.02 mm in width (Figure 3).

Figure 3. Adult female on pumpkin

Pupae

Pupae period: Eyes, antennae, legs, and abdomen formation is marked. A wine-red color, the pupae averaged 1.26 ± 0.02 mm in length by 0.50 ± 0.02 mm in width.

CONCLUSIONS

There is no detailed information about the biology of the Pistachio white scale in controlled conditions in the world. Studying is very difficult because of the viviparous the Pistachio white scale. My opinion is that the information obtained to shed light on future studies.

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THE YIELD AND GRAIN QUALITY OF WINTER TRITICALE VARIETY INGEN 93 IN THE MULTIFACTORIAL EXPERIMENT

Victor BURDUJAN, Mihail RURAC, Angela MELNIC, Victor STARODUB, Sergiu GAVRILAS, Vasile DREBOT

State Agricultural University of Moldova, 44 Mircesti street, MD-2049, Chisinau, Republic of Moldova

Corresponding author email: m.rurac@uasm.md

Abstract

This article presents the data of an experiment were a winter triticale (X Triticosecale Wittmack) variety Ingen 93 was studied depending on the previous plants (dry pea and vetch + oats), sown in three different sowing terms (8.X., 18.X.,28.X.) and according to three sowing rates - 4.0, 5.0 and 6.0 million seeds/ha. The amount of precipitation was of 556.3 mm, with 64.3 mm (13.1%) higher than the multiannual average quantity of precipitation. In the multifactorial experiment, the greatest influence on the yield of the studied variety was recorded by the previous crop (Factor A) – 99.24%, followed by the sowing rate (Factor C) only 0.76 %, and zero influence by the sowing terms and interaction of factors. In the conditions of 2015, the highest yield of winter triticale variety Ingen 93 was obtained after dry pea - 3353 kg/ha that significantly exceeded the predecessor vetch + oats to 717kg/ha. The highest quality of grain and crude protein content was recorded where dry pea was used as a previous plant. The highest test weight value was obtained after vetch + oats - 707.1 kg/hL, which exceeds the values of test weight after dry pea by 5.2 kg/hL. The largest grains of winter triticale variety Ingen 93 was forming after previous plant vetch + oats, - 49.7g.

***Key words**: previous crop, quality of grain, sowing rate, sowing term.*

INTRODUCTION

One of the means to increase the production of high-quality grain for food and feed is a better use of the biological potential of the new crop for grain triticale. This crop very successfully combines high ecological plasticity and yield of winter rye and grain quality of winter wheat. However, the absence of the technology of cultivation of these varieties has prompted us to conduct this study. Seeding in particular represents a substantial input cost in many cereal cropping systems (Spink et al., 2000), but only limited field studies are available for triticale which explored sowing densities together with other agronomic or environmental interactions (Giunta and Motzo, 2004; Bassu et al., 2013).

MATERIALS AND METHODS

The studies were conducted in the conditions of 2015 at The Research Experimental Station "Chetrosu" of SAUM located in the central agro-climatic zone of Moldova. The variety Ingen 93 of winter triticale, bred in the Institute of Plant Physiology and Genetics of Moldova's Academy of Sciences was studied in the experiment. Three sowing terms (8 of October, 18 of October, and 28 of October), two previous plants (dry pea and the mixture of vetch + oats) and three sowing rates (4.0; 5.0 and 6.0 million seeds per 1 ha) were in the experiment. The experiment was held in 3 replications with the plot area of 40 m^2. The content of total nitrogen was determined by Kjeldahl method. Crude protein is calculated by a factor of 5.72. Yields were calculated on 100% purity and 14% humidity. Statistical data processing was carried out the crop by analysis of variance for Dospekhov B. (1984). One thousand-kernel weight (WTK) was obtained as the mean value of 3 replicates of 100 seeds from each plot. Test weight was calculated using a Shopper chondrometer equipped with a 1 L container and reported as kg/hL without reference to the moisture content. The soil of the field is presented by calcic chernozems, strong clay loam, on silty loess. The thickness of humus horizon is 90-100 cm. Humus content in arable layer from 2.70 to 2.92%. Climatic conditions in the 2014-2015 agricultural year were favourable for plant growth and development of winter triticale. The average air temperature exceeded the seasonal multiannual average (1881 – 2003yrs.) by 0.9 - 2.1°C, and for the whole year by 1.7°C. The amount of precipitation was 556.3 mm, 64.3 mm (13.1%) higher than the multiannual average quantity of precipitation. For the autumn time, the amount of precipitation was 197.4 mm, which is of 86.8 mm higher than the multiannual average quantity of precipitation (110.6 mm). In the spring months, rainfall was of 151.4 mm, that exceeding the norm of 45.3 mm. A significant moisture deficiency was noted in the summer time - 125.3 mm, 56.3 mm less than normal quantity of precipitation (181.6 mm).

RESULTS AND DISCUSSIONS

In the conditions of 2015, the average yield of winter triticale variety Ingen 93 studied after previous plants was 3353 kg/ha after dry pea and 2636 kg/ha after vetch + oats (Table 1). The yield of triticale sown after dry pea were of 717 kg/ha higher than after vetch + oats. This increase was significant, as it is much more than the least significant difference (LSD_{05} - 81 kg/ha). After dry pea as previous crop the higher grain yield of triticale was obtained in the first sowing term (8.X), which amounted to 3399 kg/ha. Reduced yield of winter triticale grain in the second term (18.X - 3346 kg/ha) and the third term (28.X - 3314 kg/ha), was statistically non-significant. After vetch-oats the highest yield of grain was obtained in the second term of sowing (18.X), amounted to 2714 kg/ha, significantly exceeded the first term (8.X) to 120 kg/ha. In the third sowing term was obtained the lowest yield after both predecessors 3314 kg/ha after dry pea and 2560 kg/ha after vetch + oats.

Increasing the sowing rate from 4.0 to 6.0 million seeds per 1 ha do not contribute significantly to the increase in productivity of phytocoenosis. No significant yield variations have received with respect to the rate of 5.0 million of seeds per 1 ha. The greatest degree of influence on the yield of winter triticale variety Ingen 93 exerted predecessors - 99.24% (Table 2.). The influence of sowing rate was of 0.76%. The sowing dates, double and triple interaction between the studied factors had no impact on the yield of the variety.

Table 1.The yield of winter triticale, variety Ingen 93, kg/ha, 2015

Sowing rate Factor C, m/ha	Previous plant (Factor A)						The average for factor C, LSD_{05} kg/ha C-99	± to the Control
	Dry pea (control B)			Vetch + oats				
	Sowing term (Factor B)							
	8.X (cont. B)	18.X	28.X	8.X (cont. B)	18.X	28.X		
4,0	3402	3255	3167	2516	2669	2484	2916	-88
5,0(Control)	3373	3372	3284	2625	2821	2549	3004	-
6,0	3421	3412	3490	2702	2713	2647	3064	+60
The average for factor A	3353			2636				
LSD_{05} kg/ha, A-81	-717							
The average for factor B	3399	3346	3314	2614	2734	2560		
HCP_{05} kg/ha, B-99	-	-53	-85	-	+120	-54		
LSD_{05} kg/ha of the experiment	243							
P%	2,8							
Coefficient of variation, %	4,9							

Table 2. The proportion of factors in the yield formation of winter triticale, variety Ingen 93, 2015

Factor, Portion	Previous crop, A	Sowing term, B	Sowing rate, C	AB	AC	BC	ABC	Total
%	99,24	0	0,76	0	0	0	0	100

The content of crude protein in the grain of winter triticale after dry peas ranged from 12.82% in the first sowing period (8.X) to 14.91% in the third sowing period (28.X) (Table 3). It has been noticed a steady upward trend in the crude protein content from the first sowing period (8.X) to the third sowing period (28.X). In the second sowing term (18.X) the crude protein content of winter triticale kernels was of 13.60%, 0.78% higher than in the first sowing term (8.X - 12.82%). Further delay in sowing resulted in higher crude protein content. In the third sowing term (28.X) the value of this indicator was 14.91%, which is 2.09% higher than in the first sowing term (8.X) and 1.31% higher in the second term (18.X). On average, the crude protein content after dry pea was of 13.78%. After the previous plant vetch

+ oats the dynamics of the crude protein content is different.

From the first sowing period (8.X) to the second sowing period (18.X) decrease in crude protein content was 1.32%, from 15.14 to 13.82%, and comparing to the third (28.X) decreased to 14.81%. The average crude protein content after the previous plant vetch + oats was of 14.59%. If to compare crude protein content by previous plants, then after vetch + oats content was higher of 0.81%. The yield of crude protein with grain harvest after dry pea for grain increases from the first sowing term (8.x) 375.1 kg / ha to 421.1 kg / ha in the third sowing term (28.X). On average, the yield of crude protein after dry pea was of 396.9 kg/ha. After previous plant vetch + oats the yield of crude protein reached the highest value in the first sowing term (8.X) - 341.8 kg/ha, up 6.5 and 17.1 kg/ha more than in the second (18. X) and the third (28.X) terms respectively. In general, after vetch + oats, this index was of 333.9 kg/ha. After the previous plant dry pea the yield of crude protein was higher than after vetch + oats by 63 kg/ha due to higher grain yield, although the content of crude protein in grain is below.

Table 3. The content of crude protein and yield of protein in winter triticale, variety Ingen 93

	Previous plant					
	Dry pea			Vetch + oats		
	Sowing terms					
	8.X	18.X	28.X	8.X	18.X	28.X
Protein content, %	12.82	13.60	14.91	15.14	13.82	14.81
	13.78			14.59		
	-	+0.78	+2.09	-	-1.32	-0.33
± to dry pea	-			+0.81		
Yield of protein, kg/ha	375.1	394.4	421.1	341.8	335.3	324.7
	396.9			333.9		
	-	+19.3	+46.0	-	-6.5	-17.1
± to dry pea	-			-63		

Determination of WTK of winter triticale kernels variety Ingen 93 has shown the variability of this indicator depending on the studied elements of technology. After dry pea the weight of 1000 kernels was of 47.0 g, which is by 2.7 g less than after vetch + oats (Table 4). After dry pea, the weight of 1000 kernels by sowing terms did not change significantly, accounting for 46.85 g in the first sowing term (8.X) and 47.1 grams in the second (18.X) and third sowing terms (28.X). An important physical indicator of winter triticale kernels is test weight, which characterizes the ability of the grains to occupy a certain amount of storage space. The average test weight of the experience of winter triticale grain was of 704.7 kg/hL (Table 5). On average, after vetch + oat the test weight was 707.1 kg/hL, which is of 5.2 kg/hL exceeds the value of this index after dry pea (702.3 kg/hL). After dry pea this indicator tends to decrease from the early sowing term (8.X) to the middle term with 704.3 kg/hL, to 699.4 kg/hL. After vetch + oats test weight increases from the early sowing term (8.x) to the middle term of 704.7 kg/hL up to 712.4 kg/hL.

Table 4. The weight of thousand kernels of winter triticale, variety Ingen 93

Sowing rate Factor C, m/ha	Previous plant (Factor A)						The average for factor C	± to control C
	Dry pea (control) A			Vetch + oats				
	Sowing terms (factor B)							
	8.X (control B)	18.X	28.X	8.X (control B)	18.X	28.X		
4,0	44.6	49.4	50.0	51.6	50.0	49.7	49.2	+1.3
5,0 (control C)	46.2	43.5	48.4	50.2	49.9	49.4	47.9	-
6,0	49.6	48.5	43.0	49.3	48.1	49.1	47.9	0
Average for previous plant	47.0			49.7				
± to dry pea	+2.7							
Average for sowing terms	46.8	47.1	47.1	50.4	49.3	49.4		
± to the first term	-	+0.3	+0.3		-1.1	-1.0		

Table 5. Test weight of winter triticale kernels, variety , Ingen 93, kg/hL

Sowing rate, Factor C, m/ha	Previous plant (Factor A)						Average for factor C	± to Control C
	Dry peas (Control) A			Vetch + oats				
	Sowing term (Factor A)							
	8.X (Control B)	18.X	28.X	8.X (Control B)	18.X	28.X		
4,0	704.6	698.9	703.7	702.0	715.0	704.1	704.7	-0.3
5,0 (control)	705.1	704.9	702.9	703.6	714.7	698.6	705.0	-
6,0	707.3	695.9	703.4	708.6	707.6	709.0	705.3	+0.3
Average for previous plant	702.3			707.1				
± to dry pea	+5.2							
Average for sowing terms	704.3	699.4	703.3	704.7	712.4	704.2		
± to the first term	-	-4.9	-1.0	-	+7.7	-0.5		

The effect of sowing rate on the change in test weight was not significant and depending on sowing rate was of 704.7 - 705.3 g/l. Thus, it has established the dynamics of reducing the test weight of kernels of winter triticale variety Ingen 93 from early sowing period (8.X) to the middle (18.X) sown after dry pea. After another studied predecessor vetch + oats on the contrary, an increase in the test weight from the early sowing period (8.X) to the middle sowing period (18.X) was noticed. Thus, the studied elements of the technology of cultivation of winter triticale had a different effect on the yield and quality of grain and physical indicators of variety Ingen 93.

CONCLUSIONS

After dry pea as a previous plant, the highest grain yield of winter triticale variety Ingen 93 was obtained in the first sowing term (8.X) at the sowing rate of 6.0 million/ha, accounting 3471 kg/ha. After vetch + oats, the highest grain yield was obtained in the second sowing term (18.X) at the rate of 5.0 million/ha, accounting for 2821 kg/ha. In the conditions of 2015, the highest yield of winter triticale variety Ingen 93 was obtained after dry pea - 3353 kg/ha that significantly exceeded the predecessor vetch + oats to 717 kg/ha. On the productivity of winter triticale the largest share of the impact of falls on the previous plant - 99.24%. Other factors and their interaction had no significant influence on the formation of grain yield. The highest content of crude protein was obtained after dry pea sown in the third term (28.X) - 14.91%, and after vetch - oats sown in the first term (8.X) - 15.14%. In general, after vetch + oats the crude protein content was higher than after dry pea as the previous plant with 0.81%. The yield of crude protein from the grain after dry pea was higher than after vetch + oats with 63 kg/ha. Larger grains of winter triticale variety Ingen 93 was forming after previous plant vetch + oats, - 49.7g. After dry pea, the weight of 1000 kernels increased from the early sowing period (8.X) to late sowing period (28.X), while after vetch + oats contrary, the weight reduction to the late sowing period was noticed. The highest test weight value was obtained after vetch + oats - 707.1 kg/hL, which exceeds the values of test weight after dry pea by kg/hL. After dry peas grain the test is reducing from the early sowing period (8.X) to the middle sowing period (18.X), while after vetch + oats on the contrary, is increased. The study of sowing rate of winter triticale had no significant effect on the change of physical characteristics of seed - test weight and WTK.

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PRODUCTIVITY OF THE WINTER DURUM WHEAT IN POLYFACTORIAL EXPERIENCES

Victor BURDUJAN, Nicolae PALADE, Mihail RURAC, Victor STARODUB, Angela MELNIC, Sergiu GAVRILAȘ

State Agricultural University of Moldova, 44 Mircesti street, Chisinau, Republic of Moldova, MD-2049

Corresponding author email: m.rurac@uasm.md

Abstract

The aim of this research was to assess the influence of some technological elements upon productivity and quality of winter durum wheat (Triticum turgidum L. var. durum), during of four agricultural years (2010-2014). Climate conditions were very different in the years of experiments. Two varieties of winter durum wheat were studied in most of the years. There were three sowing terms and three densities sown on two previous plants in this field experiment. There were recorded the data: the average yield, TKW, Hardness index and gluten content. In the conditions of the years relatively favourable after humidity, with long and warm autumn and in the years less favourable with insufficient wetting of seedbed, the maximum average yield of winter durum wheat reached 3275-4900 kg/ha by sowing from the optimal - acceptable terms until the late term with the sowing density of 4-6 m seeds/ha. In the conditions of an unfavourable year with extreme drought conditions associated with heat during the growing period, the maximum average yield of winter durum wheat was of 746-1157 kg/ha by sowing in the late term of sowing at the density of 5-6 m seeds/ha. The quality of grains (the hardness index, gluten content, and other indices) as a rule is inversely proportional to the level of average production.

Key words: *previous crop, quality of grain, sowing density, sowing term.*

INTRODUCTION

The winter durum wheat due to its biological particularities and requirements for environmental factors require different attitude to the term and sowing density and as well to other technological processes in comparison with winter common wheat. Kirkegaard et al. (2008) carried out a survey of the literature on the effects of break crops, that is, crops interrupting the sequence of continuous wheat, and showed mean yield benefits of up to 20% or more, the magnitude of response depending on site, weather conditions, and other aspects of crop management. Sowing date is one of the most important management factor affecting cereal production and quality (McLeod et al., 1992). In a given region, the optimum sowing date depends mainly upon the timing of rainfall (Jackson et al., 2000). In most cases, delaying sowing beyond the optimum period reduces wheat yields (Bassu et al., 2009). The research concerning the assessing the influence of some technological elements upon productivity and quality of winter durum wheat grains were carried out at the Chetrosu Research Station of the State Agricultural University of Moldova in 2011-2014.

MATERIALS AND METHODS

The climatic conditions in the years of experiments were different. Thus, the agricultural year 2010-2011 was less favourable as compared to the value of multi-annual average (440.9 mm and 492.0 mm respectively), and primarily in the period of months February - March, but in June fell down two-month norm. The 2011-2012 agricultural year was unfavorable, with extreme conditions, dry, associated with spring scorching, the quantities of precipitation were of 324.4 mm (492.0 mm is value of multiannual average). Especially dry were the autumn months, the spring months and the early summer month. Only in the month of May, the quantity of precipitation was double, comparing to the norm. The 2012-2013 agricultural year was also less favorable, with the annual quantity of precipitation of 443.3 mm. The driest months were October, November, May and June. Only in the month of December fell down two monthly norms of the precipitations. The 2013-2014 agricultural year was relatively favorable with the annual quantity of precipitation of 430.2 mm. The months of September and May were the wettest months; the months of October, November and June were drier months than usual. In the field experiments there has been studied the role of previous plant (dry pea and mixture of oats and vetch), the sowing terms: the optimal (III decade of September), the acceptable (I decade of October) and the late (II and III decade of October) and the sowing density (basically 4-5-6 million seeds/ha) on the average yield and to the quality of winter durum wheat grains. The average yield in our paper is the mean value of the yield (kg/ha) from sowing densities and/or from sowing terms. One thousand-kernel weight was obtained as the mean value of 3 replicates of 100 seeds from each plot. Test weight was calculated using a Shopper chondrometer equipped with a 1 L container and reported as kg/hL without reference to the moisture content. Gluten content according to the State Standard 27839-88. In the most of the years they were studied two varieties of winter durum wheat: Hordeiforme 335 and Auriu 273. As the witness (W) served the variety Hordeiforme 335 sown after pea in the optimum term or optimum -acceptable at the density of 5 million of seeds/ha. The soil of the field is presented by a calcic chernozems.

RESULTS AND DISCUSSIONS

The yield of winter durum wheat was different depending on the climate, the variety, the previous crop as well as the sowing term and the sowing density (Table 1).

Table 1. The yield of winter durum wheat depending on climatic conditions and some techniques of cultivation. 2011-2014 yr., kg/ha

Indicators		Previous crop	
		Dry pea	Mixture of oats and wetch
2010-2011 ag. yr.			
Avarage yield	after terms	2592 – 3275	2800 – 3683
	after densities	3108 – 3500	3275 – 3917
The variant of maximum average yield	after terms	Dolphin, late	Hordeiforme 335, acceptable
	after densities	Hordeiforme 335;6.5 m	Hordeiforme 335; 6.5 m
2011-2012 ag.yr.			
Avarage yield	after terms	823 – 1157	706 – 1138
	after densities	774 – 843	658 – 746
The variant of maximum average yield	after terms	Hordeiforme 335; late	Auriu – 273; late
	after densities	Hordeiforme 335; 5 m	Hordeiforme 335; 6 m
2012-2013 ag.yr.			
Avarage yield	after terms	2574 – 4900	1652 – 3886
	after densities	4187 – 4900	3414 - 3982
The variant of maximum average yield	after terms	Hordeiforme 335; optimum	Auriu – 273; late
	after densities	Hordeiforme 335; 5 m	Hordeiforme 335; 4 m
2013-2014 ag.yr.			
Avarage yield	after terms	3843 – 4383	3606 – 4259
	after densities	3843 – 4627	3914 – 4436
The variant of maximum average yield	after terms	Auriu 273; late	Auriu 273; late
	after densities	Auriu 273; 6 m	Auriu 273; 4 m

The average yield was the lowest in the agricultural year 2011-2012, an unfavorable year with extreme conditions and a higher yield in other years, relatively favorable or less favorable. Thus the average yield in the year 2011, a less favorable year, after dry pea as a previous plant, the yield of grain varied within the 2592-3275 and 3108-3500 kg/ha, and after the mixture of oats and vetch - 2800-3683 and 3275-3917 kg/ha (3175 kg/ha at the W.) after the terms and respectively after the sowing densities. The maximum average yields were recorded at the varieties Dolphin and Hordeiforme 335, sown in the late term and the acceptable term and at an increased sowing density (6.5 million seeds /ha). The exceedances from the witness were significant, except the variety Dolphin (LSD_{05} - 557 and 73 kg/ha respectively for the sowing terms and the sowing densities). In the 2011-2012 agricultural year, an year with extreme humidity conditions, the average yield was of 823-1157 and 774-843 kg/ha after pea and 706-843 and 658-746 kg/ha and after mixture of oats and vetch (843 kg/ha at W) by the terms and the sowing densities respectively. The average maximum yields were recorded in the variants of the late sowing term, where exceedances were significant compared to the witness (LSD_{05} -54 kg/ha). After the sowing densities in most cases the witness significantly exceeded other variants. In the years with condition like this (drought associated with heat) the priority should be given to the late sowing terms and to the greater sowing densities. In the 2012-2013 agricultural year, the less favorable (drought pronounced May-June) , the average production of winter durum wheat varied within the limits of 2574-4900 and 4187-4900 kg/ha (after pea) and 1652-3886 and 3414-3982 kg/ha (after mixture of oats and vetch) respectively at the terms of sowing and sowing densities (W = 4900 kg/ha). In most of cases the witness significantly exceeded other variants (LSD_{05} = 170 and 123 kg/ha for the sowing terms and the seeding densities respectively). In the 2013-2014 agricultural year, a relatively favorable year, the average production of winter durum wheat was increased compared to previous years and amounted to 3843-4383 and 3843-4627 kg/ha (after peas) and 3606-4259 and 3914-4436 kg/ha (mixture of oats and vetch) respectively for terms and sowing densities W = 3843 kg/ha). The maximum average yield was recorded at the variety Auriu 273 sown after the both previous crops in the late term of sowing (LSD_{05} = 170 kg/ha) and also to this variety after sowing densities of 6 and 4 m seeds/ha respectively after pea and mixture of oats and vetch (LSD_{05} = 128 kg/ha).

Table 2. Quality of winter durum wheat, 2011 – 2014 yrs.

Variant		TKW, g	Test weight kg/hL	Hardness index, %	Gluten content, %
2010-2011					
Previous crop – dry pea	Dolphin, the late term of sowing	41,8	776	83	37,1
	Hordeiforme 335, 6 million	41,4	779	76	30,5
Witness (W)		44,8	750	78	35,1
Previous crop - mixture of oats and wetch	Hordeiforme 335, the acceptable term of sowing	44,4	777	85	38,0
	Hordeiforme 335, 6.5 million	43,5	776	80	29,5
2011-2012					
Previous crop – dry pea	Hordeiforme 335, termenul târziu de semănat	38,4	782	83	34,3
	Hordeiforme 335, 5 m	39,5	773	90	35,4
Witness (W)		39,5	773	90	35,4
Previous crop - mixture of oats and wetch	Auriu 273,the late term of sowing	40,8	765	88	32,8
	Hordeiforme 335, 6 million	39,2	778	79	31,1
2012-2013					
Previous crop – dry pea	Hordeiforme 335, the optimum term of sowing	44,9	719	47	25,1
	Hordeiforme 335, 5 million	44,9	719	47	25,1
Witness (W)		44,9	719	47	25,1
Previous crop - mixture of oats and wetch	Auriu 273, the late term of sowing	44,7	-	47,5	24,1
	Hordeiforme 335, 4 m	43,9	726	44,5	24,0
2013-2014					
Previous crop – dry pea	Auriu 273, the late term of sowing	39,2	772	77	28,1
	Auriu 273, 6 million	39,1	779	82	28,8
Witness (W)		40,4	771	92	30,8
Previous crop - mixture of oats and wetch	Auriu 273, the late term of sowing	41,2	759	90	31,2
	Auriu 273, 4 million	41,3	750	79	30,2

In the condition of this year, a year relatively favorable, the priority is given to the peas as a previous plant, the seedbed being well supplied with moisture and nutrients (primarily N_2). To the concern of sowing term in a long autumn, warm and well supplied with moisture, the priority is given to the later term of sowing. But to the variety Auriu 273, the average production within acceptable sowing term has not been significantly exceeded by the variant of the average production level of the late sowing terms. Regarding the sowing density, the priority is given to the density of 6 m (after peas for grain). The divergence after level of average yield between the sowing densities in the case of the mixture of oats and vetch as the previous plant of the variety Hordeiforme 335 is insignificant and significant enough at the variety Auriu 273. Perhaps the favorable conditions of this year, in this case, the denisity of productive strains was offset by a higher productive twinning of plants, higher in the variants with lower sowing densities. This year has proved more productive variety Auriu 273.

The quality of kernels of winter durum wheat in general was inversely proportional to average production levels in various years. But in a big portion of the variants of maximum average yield, the most indices of grain quality were satisfactory until the level of the witness or even have exceeded (Table 2). Thus, the values of quality main indices were higher in the 2010-2011 agricultural year, an unfavorable year, when the average yield was the lowest (except TKW). At the opposite pole was located the 2012-2013 agricultural year, when the average yield was higher, the most of kernel quality indices (except TKW) were reduced, but almost satisfactory. The kernels were slightly small and the content of gluten in kernels was slightly lower. The 2013-2014 agricultural year was relatively favorable and the average yield was the highest, the content of gluten in kernels exceeded their values from 2011 and 2012. The 2010-2011 agricultural year, a less favorable year with a level of average production quite satisfactory, the quality indexes of grains in the variants of maximum average yield were good enough in many cases exceeded the witness. The content of gluten in grains was at the level of the 2011-2012 agricultural year or even higher. The hardness index of grains is directly proportional with the quantity of gluten in them.

CONCLUSIONS

In the conditions of the years relatively favorable after humidity, with long and warm autumn and in the years less favorable with insufficient wetting of seedbed, the maximum average yield of winter durum wheat reached 3275-4900 kg/ha by sowing from the optimal - acceptable terms until the late term with the sowing density of 4-6 m seeds/ha. In the conditions of an unfavorable year with extreme drought conditions associated with heat during the growing period, the maximum average yield of winter durum wheat was of 746-1157 kg/ha by sowing in the late term of sowing at the density of 5-6 m seeds/ha

The quality of grains (the hardness index, gluten content, and other indices) as a rule is inversely proportional to the level of average yield. In our experiences in the most of the variants of maximum average yield, the indicators of grains quality were from the satisfactory to the near level witness or even exceeding it.

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THE USE OF ENTOMOPATHOGENS IN THE CONTROLLING OF INSECT PESTS OF STORED PRODUCT

Ramazan CANHILAL

Erciyes University, Faculty of Agriculture,
Department of Plant Protection, 38039 Kayseri, Turkey

Corresponding author email: r_canhilal@hotmail.com; ramazancanhilal@erciyes.edu.tr

Abstract

A chemical method called fumigation is mainly applied to control of stored product pests in the world and in Turkey. The alteration of natural balance among living organisms, the resistance of pests for pesticides, and residues on crops are produced by application of pesticides widely. Nowadays, incremental necessity has been occurred to find out alternatives to chemicals. Biological control is a novel method to replace chemicals. Insect pathogens which kill insects causing disease are agents such as bacteria, fungi, nematodes, viruses, protozoa. The mass of entomopathogenic bacteria are in genera Coccobacillus and Bacillus. Coccobacillus acridiorum produced disease in grasshoppers. Bacillus thuringiensis and Bacillus popillia are important disease causing agents against lepidopteran pests. Entomopathogenic fungi Beauveria bassiana, Metarhizium anisopliae, and Verticillium lecanii cause disease on larger insects than other pathogens. These are rather prevalent on the insects in orders Lepidoptera, Homoptera, Hymenoptera, Coleoptera, and Diptera. Insects, especially living in soil at one of its life cycle such as larva, pupa or adult are highly susceptible against entomopathogenic nematodes. Neosteinernematidae, Steinernematidae and Heterorhabditidae are the families containing these nematodes. They are obligatory insect pathogens in nature. Entomopathogenic nematodes impacts many insect species with a broad host range. Entomopathogenic viruses at least 16 families are very important in biological control to affect insects pests. Baculoviruses are produced commercially and applied as a biological control agent to manage significant agricultural and forestry insects, especially in Orders Lepidoptera and Hymenoptera. Entomopathogenic protozoans such as Nosema locusta are a substantial role in the ecologically management of populations of insect pests. In this review, application and potentials of entomopathogens as biological control agents of insect species harmful on stored products has been abstracted.

Key words: *entomopathogens, insect pests, stored products.*

INTRODUCTION

Infestation of stored bulk grain and processed commodities by insects causes big economic loss (Hagstrum and Flinn, 1995). These insects damage the product by physical yield and quality loss, inducing mould growth, contamination of products with insect bodies [1]. They can shelter inaccessible places and survive on even little bit food. They reproduce and increase their population quickly. Then move from cracks and crevices, perforated floors, and inside machinery into stored bulk products to infest them (Campbell et al., 2004). The order Coleoptera includes about 250.000 species. Fourty families of this order contain insects harmful on stored products world-wide. Bostrichidae, Bruchidae, Cucujidae, Curculionidae, Dermestidae, Silvanidae and, Tenebrionidae are some of these families (Rees, 1996).

Government regulations, environmental and human health concerns, resistances of insects to insecticides, pesticide residues on crops, changing consumer demands limit the presence and use of chemical insecticides against these pests (Durmuşoğlu et al., 2010).

Entomopathogens are biological control agents causing diseases in insect populations. These are organisms such as bacteria, fungi, nematodes, viruses, and protozoa. They can be a safe alternative for stored-product pests in unreachable places, because some biological control agents actively search out pests in these cryptic habitats (Schöller and Flinn, 2000). In this paper, the research and applications of entomopathogens against stored products are summarized.

ENTOMOPATHOGENIC BACTERIA

Entomopathogenic bacteria are most commonly used microorganisms against insect pests present. The most widely used ones, spore-forming facultative bacteria producing crystals. The bacteria enter the insect body through the mouth with food. They form endospor and protein crystals. These crystals contain toxins. The insects are killed because the toxins or bacteria wrapp the body of insect.
The majority of entomopathogenic bacteria take place in *Coccobacillus* and *Bacillus* species. *Coccobacillus acridiorum* is a type of grasshopper pathogen. *Bacillus thuringiensis* and *Bacillus popillia* are the other two important species. In our country, bacteria are recommended and used against harmful species in Order Lepidoptera below.


Heliothis armigera


Lobesia botrana


Hyponomeuta sp.

Cydia pomonella

Lymantria dispar


Archips sp.


Thaumetopoea pityocampa

ENTOMOPATHOGENIC FUNGI

Fungal diseases in insects, the lighting in the Italian Agostino Bass silk white musk nature of fungal diseases in insects were known since the 1834-1835 year.

Entomopathogenic fungi, capable of infecting insects in Order Lepidoptera, Homoptera, Hymenoptera, Coleoptera and Diptera included, are quite common. The fungi encounters host with chance in environmental conditions. Population density depends on the amount of surrounding fungal spores and insect pests. The host entrance into cuticle is realized by both with lytic enzymes and by means of mechanical formation of appressorium (Figure 1). After penetrating the cuticle and epidermis, spores germinate and multiply in the insect body. The metabolites formed by fungi cause physiological and biochemical changes in the host and results in insect death.

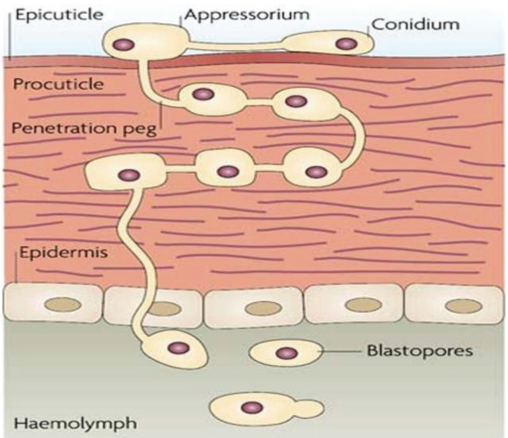

Figure 1. Penetrating of fungus into the cuticle and epidermis, and appressorium formation

Lord (2011) used *Beauvaria bassiana against Dermestes maculatus* and it was successful with 82% in 75% humidity. Khashaveh (2011) observed 68-92% mortality in the population of *Sitophilus granarius* and *Tribolium castaneum* adults against which *Beauvaria bassiana* applied. Ahmad (2010) used *Lecanicili lecanii, Isaria fumosarose* and *Metarhizium anisoplia* against *Sitophilus zeamays* adults and determined 100% insect mortality.

Lord (2009) obtained 10% more mature death on *Rhyzopertha dominica*, *Oryzaephilus surinamensis*, *Cryptolestes ferrusineus* using *Beauvaria bassiana with* diatomaceous powder formulation.

Batta (2008) used *Beauvaria bassiana* and *Metarhizium anisoplia* against *Rhyzopertha dominica*, *Sitophilus oryzae, Tribolium castaneum, Sitophilus oryzae* adults and got the highest mortality rate (85-96%) on *Sitophilus oryzae*. Hansen (2007) determined *Beauvaria bassiana* to be a successful control agent against *Sitophilus granarius with* rate of 83-98% mortality.

ENTOMOPATHOGENIC NEMATODES

Entomopathogenic nematodes (EPNs) (*Rhabditida: Neosteinernematidae Steinernematidae and Heterorhabditidae*) do not cause contamination of ground water and are harmless to plants and animals. As biological control agents, EPNs attract attention increasingly in research area recently. Their ideal properties such as; the broad host spectrum, to be able to kill their hosts within 24-48 hours, to be producible commercially easily in vivo or in vitro, having ability to search actively their hosts, settling in application areas and staying effective for a long time, having easy applicability, being in compliance with many chemicals and being safe for the environment are important for their preferability.

They are soil dwelling, aquatic organism. They have motile bacteria (*Xenorhabdus* spp. and *Photorhabdus* spp.) living in their intestine. Nematode and bacterium are mutualistic symbionts and obligate, lethal parasites of insects. EPNs can be found everywhere on earth and infect many different insects (Smart, 1995). Infective juveniles of the nematodes living in the soil enter the host insect’s haemocoel through mouth, anus, and respiratory openings or cuticle’s thin sections. Once in the insect, infective juveniles of the nematode release the bacteria that are carried in the intestine. Bacteria block the insect's immune system, multiply and kill the insect using many different toxins and causing septicemia in the hemolymph (Figure 2).

Bacterial cells reproduce rapidly. The nematodes eat the bacteria and some of body tissue of the insect, and reproduce for 3 or 4 generations depending on the food source. Over 100,000 nematodes exit the insect (Burnell and Stock, 2000) (Figure 2).

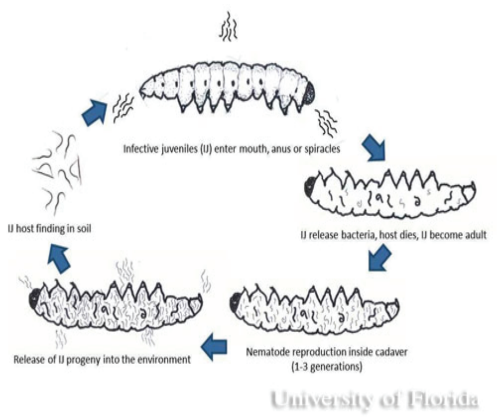

Figure 2. The simple life cycle of entomopathogenic nematodes

Tradan et al., (2006) in their study used four species of entomopathogenic nematodes (*Steinernema feltiae*, *S. carpocapsa, Heterorhabditis bacteriophora* and *H. megidis*) against storage pests, *Sitophilus granarius* and *Oryzaephilus surinamensis* in the laboratory to determine the activity of nematodes against adults. LC_{50} value was found as 803-1195 Ijs/adult on *S. granarius* and 921-1335 Ijs/adult on *O. surinamensis.*

Shahina and Salma (2010) studied seven local (Pakistani) entomopathogenic nematodes (*Steinernema pakistanense, S. asiaticum, S. abbasi, S. siamkayai*, *S. feltiae*, *Heterorhabditis bacteriophora* and *H. indica* on *Sitophilus oryzae's* adults and pupae in the laboratory. Consequently, the LC_{50} value for pupae of *S. oryzae* was 42-169 Ijs/pupae and for adults, 55-370 Ijs/adult.

Canhilal et al., (2013) determined the biological activity of nine endemic nematodes obtained from a survey conducted in the various districts of Kayseri Province against *Sitophilus oryzae* adults. The lowest LC_{50} value was 57.96 IJs/adult for *S. carpocapsae* 076 isolate, while the highest LC_{50} values was 922.95 Ijs/adults for *S. feltiae* OZV-5-S isolate.

ENTOMOPATHOGENIC VIRUSES

Baculovirus is important as biological control agents especially in the control of pests in agriculture and forestry. It is produced commercially and used against pests belonging to Lepidoptera and Hymenoptera.

In Brazil, *Baculovirus anticarsi* is used successfully against *Anticarsi gemmatalis* causing substantial harm in soybeans.

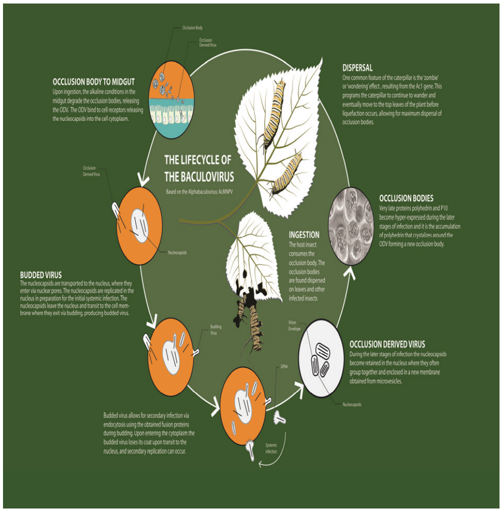

Figure 3. The life cycle of the baculovirus.

Nakai (2013) in Japan used granulovirüs (GV) as a biological agent against the tea leaf crimpers (*Adoxophyes honmai* and *Homona magnanima*, Lepidoptera: Tortricidae) and there was no harmful infections during the four growing seasons.

ENTOMOPATHOGENIC PROTOZOA

Entomopathogenic protozoa are usually host-specific and slow effect is caused due to chronic infection. *Nosema locustae* has been developed as a commercial product for grasshoppers control (Henry and Oma, 1981). Entomopathogenic protozoa needs live hosts to be produced and shows quite slow effect. Therefore, it has limited application for biological control.

CONCLUSIONS

Chemical fumigation is the most commonly used method against of stored product pests in the world and in our country. Widely used insecticides against harmful organisms damage the natural balance existing among organisms, cause harmful organisms to acquire resistance to pesticides and residues in the crops. In recent years, biological control is emphasized as an alternative to chemical control. Entomopathogens have an important place in the biological control because they have a wide host range, are harmless to the environment and human, and could be applied with conventional sprayers. They can be used more against stored product pests with the development of new biotechnical methods such as collecting pests in some stations to meet them with entomopathogens.

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ECONOMIC THRESHOLD IN THE MANAGEMENT OF THE SUNN PEST

Ramazan CANHILAL

Erciyes University, Faculty of Agriculture,
Department of Plant Protection, 38039 Kayseri, Turkey

Corresponding author email: r_canhilal@hotmail.com; ramazancanhilal@erciyes.edu.tr

Abstract

Wheat and barley have a significant insect pest, the sunn pest, Eurygaster integriceps Puton (Heteroptera: Scutelleridae) in Turkey. It affects the yield and the quality of flour of which bread is made. In this study; the yield loss due to white spike damage caused by overwintered adults and kernel damage by nymphs and new-generation adults in wheat fields were defined to set up an economic threshold (ET) for the sunn pest. To evaluate the relationship between overwintered adult density and white spike damage, and between percent kernel damage and sedimentation value of the flour, a regression analysis was performed. White spike damage comprised at low levels (0.1 – 1.7%) in the study fields and the relationship between overvintered adult density and white spike damage was not statistically important in bread and durum wheat. Average damaged kernels by E. integriceps were 4.2% in bread wheat and 5.4% in durum wheat. A positive relationship between nymph and new-generation adult density, and kernel damage in bread and durum wheat was found. We determined the sedimentation values of flour that was made of wheat kernels on which the pest fed. It was 7-89 in bread wheat, and 9-28 in durum wheat. There was no effect of sunn pest density on gluten strength up to 2.1% kernel damage in bread wheat or up to 0.9% kernel damage in durum wheat, but kernel damages above these levels restrained dough quality. We assessed these limit values in the regression formula and we found the economic thresholds as 8.1 and 9.2 nymphs/m² in bread and durum wheat, respectively. While the existing ET (10 nymphs/m²) may still be acceptable in durum wheat, it may be reduced to 7-8 nymph/m² for some wheat varieties and regions, especially for low yield levels (~2000 kg/ha) in bread wheat.

Key words: *economic threshold, wheat, sunn pest*.

INTRODUCTION

Wheat, *Triticum aestivum* L. is grown on about 9 million ha area annually with the production of approximately 20 million tons in Turkey (Anonymous 2008). It is important basic food crop consumed mostly as bread in the country. It provides a substantial component of the human diet; cereal (mostly wheat) products provide 53 and 66% of the per capita dietary supply of calories and protein, respectively (Anonymous 1980). It is also consumed as animal feed and used in industry to make various processsed foods. The country exports the about 10% of wheat production. The South Eastern Region of the country represents 13 and 8% of wheat acerage and production, respectively (Anonymous 2008).

The sunn pest, *Eurygaster integriceps* Put. (Hemiptera: Scutelleridae), is a very damaging insect pest of wheat and barley in Turkey (Lodos 1982). Overwintered adults of the sunn pest attack the leaves and stems of young, succulent wheat and barley plants, causing them to wither and die prior to spike formation. They also suck the base of the spike during the early growing period resulting in whitish spikes without kernels, producing white spikes. Yield losses by this pest are estimated at 50-90% in wheat and 20-30% in barley. Apart from the direct yield reduction, the insect injects digestive enzymes during feeding that reduce the baking quality of the dough. If as little as 2-3% of the grain has been fed on, the entire grain lot may be rendered unacceptable for baking purposes because of poor quality flour (Lodos 1982).

The sunn pest is univoltine. Adults rest under bushes and litter at high elevations around cereal fields during the hot and dry months of late summer and autumn. They hibernate during the cold and often severe winter months on hillsides of the mountains. In spring, when soil surface temperature reaches 15°C at overwintering sites, adults migrate to cereal fields. Migration typically continues for 7-10 d. Overwintered adults appear in the fields over a 1-4 week period. After feeding, females lay eggs on leaves, stems, and spikes. After five nymphal instars, a pupal stage occurs and new-generation adults are seen. These new-generation adults feed and return to higher elevations after barley and wheat harvest (Lodos 1982).

When migration to the fields ends, technical consultants survey fields and overwintered adults are counted in 0.25 m^2 frames to determine field densities. Fields are also monitored for egg parasitism by *Trissolcus* spp. (Hymenoptera, Scelionidae) when 20-30 % of the eggs are 10-12 day-old. Spraying is not conducted if the overwintered adult densities are at or below 0.8, 1.0 and 1.5 adult/m^2 and the parasitism rates are 40%, 50% and 70%, respectively, (Simsek & Sezer 1985). Finally, nymph density is determined in the same manner as for the overwintered adults. The most effective time to spray the sunn pest is during the first two nymphal instars. At the end of the survey, if nymph density reaches 10 nymphs/m^2, fields are sprayed, and this usually coincides with the milky stage of winter wheat (Lodos 1982).

This insect was first reported from the South Anatolia Region of Turkey in 1927 and there have been many outbreaks from the 1950s to the present. Detailed studies on the sunn pest were begun in the 1950s in Turkey (Simsek 1998). The government managed sunn pest control from 1927, until 2001 when an integrated pest management (IPM) approach was adopted. Sunn pest management was changed from aerial application to ground spraying, shifting responsibility to farmers. Currently, ground sprays for sunn pest control are conducted on 1-2 million ha area annually (Anonymous 2004). Government provides technical support and farmers are supposed to apply insecticide with their equipment, as determined by official technical consultants.

One of the key factors affecting the success of IPM programs is economic threshold (ET). The economic threshold used for sunn pest control was established about 50 years ago in the region and Country (Yuksel 1968). There is a need to revise the ET because of changes in climatic conditions, wheat varieties used, agronomical practices, and crop diversity. The purpose of this study was to determine plants (spikes), nymphs and new-generation adults (NGAs) density, and kernel damage caused by nymphs plus NGAs in wheat fields to redefine the ET for the sunn pest in the region.

MATERIALS AND METHODS

The study was conducted in 17 one-ha insecticide-free bread and durum wheat fields in Gaziantep, Kilis and Kahramanmaras provinces in southeastern of Turkey. There were 9 fields of bread wheat and 8 fields of durum wheat. Several varieties of bread and durum wheat were used. Variety was not held constant over all fields.

When the migration of adults from overwintered sites to cereal fields ended, weekly surveys to determine adult and nymph density were begun in each field by using a 0.25 m^2 frame. A total of 25 frames tossed at random in each field were sampled, and overwintered adults, nymphs, and new generation adults were counted in the each frame. The results of these counts were multiplied by 4 and presented.

During the surveys, at the beginning of the milky stage of wheat, all healthy and damaged spikes in each frame were recorded. Before harvest, all plants in each frame were cut and put in a paper bag, and brought to laboratory. In the laboratory, spikes were dried and threshed, and the kernels cleaned. The kernels from each frame were weighed to determine yield per field. The mean yield from 25-0.25 m^2 was used to estimate the yield per ha for each field. Then kernels from all 25 frames were combined and 1-kg kernels taken from this combined kernels for each field. From this sample, 100 kernels, up to 20 times, (total = 2000 kernels) were randomly selected. These sub-samples were checked under the dissecting microscope and damaged and undamaged kernels were separated (Dortbudak 1974), and percent kernel damage was regressed against nymphs and new-generation adult density at the final count in each field.

Sedimentation test: The kernels combined from 25 sampling frames were also used for sedimentation test. All milling was conducted at 23°C and 60% relative humidity. Wheat samples were cleaned and tempered overnight to optimum moisture, as described by Williams et al. (1988). Tempered wheat was milled using

Buhler laboratory mill type MLU-202 (Uzwil, Switzerland), with break roll gaps adjusted to B_2 = 1.2/1000 cm, B_3 = 0.8/1000 cm, C_1 = 1.2/1000 cm and C_3 = 0.8/1000 cm. Medium hard soft-wheat clothing was used. Buhler Bran finisher MLU-302 (Uzwil, Switzerland) was used to extract “bran flour”, which was combined with all six flour streams. The Modified Sodium Dodecyl Sulphate (SDS) Sedimentation Test (Cressey & McStay 1987) was used to evaluate wheat-insect damaged in wheat.

Statistical analysis: Regression analysis was used to predict kernel damage (%) based on final nymph and new-generation adult density (P < 0.05). A correlation analysis was applied to determine the relation between overvintered adult density and white spike damage, and between percent kernel damage and sedimentation value (P < 0.05). All statistical analysis was done using SPSS for windows (2003). Data from the two years was combined for regression and correlation analyses.

RESULTS AND DISCUSSIONS

Adult migration was completed during the last week of April and weekly survey studies were started. Sunn pest adults were present in field trials two to four weeks after migration was completed. Nymphs of the sunn pest were seen in the middle of May and reached the new-generation adult stage, which is the most damaging stage, in the first week of June.

Average overwintered adult density was 1.1 per m^2 in bread wheat (Table 1), and 1.4 per m^2 in durum wheat (Table 2). Adult populations in some study fields decreased or increased in consecutive sampling dates. This was likely because of sunn pest movement in or out of the fields.

The nymph population averaged 7.2/m^2 in bread wheat, and 15.5/m^2 in durum wheat, respectively. While bread wheat yield averaged 4798 kg/ha (Table 1), yields for durum wheat were 3820 kg/ha (Tables 2).

No leaf or stem damage was observed because when the sunn pest completed migration to the fields, wheat plants reached 10-15 cm in height, and it was late for the sunn pest to damage leaves and stems, as observed by Lodos (1961).

White spike damage (overwintered adult damage): White spike damage occurred at low levels. It averaged 0.3% in bread wheat (Table 1), and 0.6% in durum wheat (Table 2). Correlation analysis indicated that there was no significant relationship between overwintered adult density and white spike damage caused by overwintered adults in bread (r = 0.288, r^2 = 0.083, P = 0.226) or durum wheat (r = 0.568, r^2 = 0.322, P = 0.071).

Canhilal et al. (2005) also found that the low level of white spike damage (<0.1-0.9%) occurred at various overwintered sunn pest adult densities (1, 2, 3, 5, 10 overwintered adults/m^2) in large field cages (2 by 2 by 1.7 m) and was not statistically significant in bread or durum wheat.

On the other hand, Kılıç et al. (1973) found that 0.4, 1.0-1.5, 1.6-2.0, and 2.1-2.3 overwintered sunn pest adults/m^2 caused 1.1%, 3.6%, 4.2% and 6.6% white spike damage in wheat fields, respectively.

Şimşek et al. (1997) stated that when overwintered adult density was one adult/m^2, 7% stem damage and 1.9% spike damage occurred.

These high levels of white spike damage differ from our results, perhaps because of high levels of overwintered adult parasitism that might have occurred in the fields, reducing adult feeding and damage.

Kernel damage (nymph and new-generation adult damage) in bread wheat: Average kernel damage caused by nymphs and new-generation adults was 4.2% in bread wheat (Table 1).

There was a positive relation between nymph and new-generation adult density, and percent kernel damage in regression analysis (r = 0.947, r^2 = 0.898, P = 0.000).

The regression equation used to predict percent kernel damage, based on nymph and new-generation adult density per m^2, was Y = -0.899+0.364X, (SE a=1.041, SE b=0.046, P = 0.000).

Table 1. Overwintered adult and nymph + new generation adult densities of the sunn pest, % kernel damage, sedimentation values, % white spike damage, varieties, and yield in bread wheat field trials in Gaziantep and Kahramanmaras provinces

Place	Variety	Yield kg/ha	No. OW adults[a]/m²	% White spikes	No. nymphs + NGA[b]/m²	% Kernel Damage	Sedimen-tation
T. Tigem	Golye	5210	0.5±0.1	0.1±0.1	1.9±0.2	0.6±0.2	77
I. Hanagzi	Golye	5210	0.5±0.1	0.1±0.1	2.9±0.2	0.4±0.1	64
I. Zincirli	Golye	6260	1.1±0.1	0.2±0.1	4.0±0.3	1.6±0.3	82
N. Ciftlik	Golye	6130	0.6±0.1	0.1±0.1	10.4±0.5	2.1±0.3	52
I. Sakcagozu	Özdemir Bey	4210	4.1±0.2	0.3±0.1	34.1±1.1	6.2±0.6	18
T. Tigem	Golye	4860	0.3±0.1	0.2±0.1	1.0±0.1	0.5±0.1	89
N. Ciftlik	Basribey	4200	0.3±0.1	0.9±0.2	6.2±0.4	1.2±0.2	69
I. Kozdere	Golye	3710	0.5±0.1	0.1±0.1	8.5±0.4	2.2±0.4	63
S. Degirmenonu	Golye	3392	2.4±0.1	0.9±0.2	55.8±1.2	22.7±1.2	7
Mean		4798	1.1	0.3	13.9	4.2	

[a]Over wintered adults, [b]New generation adults

Sedimentation values ranged from 7 to 89. The relation between sedimentation values and percent damaged kernels was strongly negative ($r = -0.821$, $r^2 = 0.674$, $P = 0.003$). The sedimentation value dropped to 52 when percent kernel damage was 2.1 in sedimentation tests (Table 1). No effect of sunn pest density on gluten strength up to kernel damage of 2.1% was detected. Sedimentation value around 50 is generally accepted as the value at which dough quality is ruined (Fouad et al. 2005). When this value is entered in our equation, the nymph density that causes the kernel damage that ruins dough quality (the economic threshold) is 8.1nymphs/m².

The practical tolerance for damaged kernels in industry, regardless of wheat type (bread or durum) or variety, is 2-3%. We found that the expected ET was 9.4 nymphs/m² when the 2.5 value, which is the average of 2-3% of tolerance for damaged kernels, is used in our equation.

The expected ET of 8.1 nymphs/m² obtained from the sedimentation value is different from the ET of 9.4 nymphs/m² calculated from the tolerance level for damaged kernels used in industry and ET (10 nymph/m²) regardless of wheat variety and region in Turkey. Thus, the ET (10 nymph/m²) may be lowered to 7-8 nymph/m² for wheat varieties and regions where there are complaints and practical observations, and especially for low-yield levels (~ 2000 kg/ha) until more detailed research is conducted.

Durum wheat: Average kernel damage was 5.4% in durum wheat (Table 2). A strong, positive relation was determined between nymph and new-generation adult density, and percent kernel damage in regression analysis ($r = 0.859$, $r^2 = 0.738$, $P = 0.003$). The regression equation obtained to predict percent kernel damage, based on nymph and new-generation adult density per m^2, was $Y = -3.206+0.443X$, (SE a = 2.368, SE b = 0.108, $P = 0.006$).

Sedimentation values varied from 9 to 22. Most fields yielded low sedimentation values and were of poor quality. There was a strong negative relation between sedimentation values and percent damaged kernels ($r = -0.699$, $r^2 = 0.489$, $P = 0.027$). The sedimentation value was 28, which is around the limit that weakens gluten strength (Fouad et al. 2005), when the kernel damage was 0.9% (Table 6). When this level of kernel damage (0.9%) is placed in the equation, the nymph density that causes the kernel damage that spoils dough quality is 9.2 nymphs/m².

As in bread wheat, the expected ET is calculated as 12.9 nymphs/m² when 2.5, which is the average of 2-3% of tolerance for kernel damage, is used in our equation. This is much over the ET that is used (10 nymphs/m²) now in Turkey.

Table 2. Overwintered adult and nymph+new generation adult densities of the sunn pest, % kernel damage, sedimentation values, % white spike damage, varieties, and yield in durum wheat field trials in Gaziantep and Kilis provinces

Place	Variety	Yield kg/ha	No. OW adults[a]/m²	% White spikes	No. nymphs + NGA[b]/m²	% Kernel Damage	Sedimen-tation
O.Kutlar	Ege 88	4015	1.6±0.1	1.7±0.3	29.6±1.0	6.7±1.0	10
O. Havaalanı	Akcakale 2000	4680	2.4±0.1	1.0±0.2	38.7±0.8	19.0±1.6	9
O. Sanko	Ege 88	4660	2.6±0.2	0.6±0.2	14.9±0.5	3.5±0.7	22
E. Yavuzlu	Ege 88	5240	1.1±0.1	0.4±0.1	12.6±0.5	2.7±0.3	13
O. Kutlar	Ege 88	1692	0.2±0.1	0.1±0.1	5.3±0.2	0.9±0.2	28
O. Havaalanı	Akcakale 2000	3000	0.5±0.1	0.3±0.2	14.2±0.4	4.0±0.6	10
Y. Arpaci	Zenit	4776	1.9±0.1	0.4±0.2	26.9±1.0	4.2±0.5	9
E. Yavuzlu	Ege 88	2496	0.6±0.1	0.1±0.1	13.0±0.4	2.3±0.3	17
Mean		3820	1.4	0.6	19.4	5.4	

[a]Overwintered adults, [b]New generation adults

Although the level of kernel damage (0.9%) that weakens the gluten in our study differed from practical tolerance for kernel damage in industry (2-3%), the ET of 9.2 nymphs/m² calculated from the equation and the ET that is currently used (10 nymphs/m²) are similar. Hence, in durum wheat, the tolerance for kernel damage in industry should be lowered about 1%, but the ET which is 10 nymphs/m² appears to be still valid. However, almost no low-level kernel damage was recorded in the study plots; sedimentation was low and damage was high for all measured points. Thus the regression operated close to the lower limit of its valid range when it was used for gluten strength and ET calculations, or for 2.5% damage and ET. This should be considered when the results are used.

CONCLUSIONS

Differences between our results on the tolerance for kernel damage and ET, and the ones that are used in the country might have occurred because our studies and the previous studies were not conducted on the same varieties or in the same region, and there were some changes in climatic conditions, agronomical practices, and crop diversity over time. Therefore, future research should be done based on region, irrigated and rain-fed farming condition, wheat type and variety, and various yield levels.

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STEINERNEMATID AND HETERORHABDITID NEMATODES AGAINST *ZABRUS* SPP.

Ramazan CANHİLAL

Erciyes University, Faculty of Agriculture
Plant Protection Department, 38039 Kayseri, Turkey

Corresponding author email: r_canhilal@hotmail.com; ramazancanhilal@erciyes.edu.tr

Abstract

Experiments were conducted to find out the susceptibility of the larvae of Zabrus spp. (Coleoptera: Carabidae), an important insect pest of wheat, against entomopathogenic nematodes (Rhabditida: Steinernematidae and Heterorhabditidae) in the laboratory first time in the World. The entomopathogenic nematodes used in the trials were Steinernema feltiae-Commercial, S. feltiae-Endemic, S. carpocapsae, S. bicornutum, Heterorhabditis bacteriophora, and H. indica. Small plastic pots with a lid (8 cm in height, 6 cm in diameter) containing autoclaved soil have been utilized in trials. In the experiments, rates of 50, 100 and 200 infective juveniles (IJs)/cm^2 at 15, 20 and 25°C applied and they were repeated 2 times. Raising rate and temperature expanded the mortalities caused by nematodes. S. carpocapsae produced 75% mortality at the rate of 200 IJs/cm^2, which was the highest at 15°C. The lowest mortality with 5% at the rate of 50 IJs/cm^2 was caused by S. bicornutum 15°C. Steinernema carpocapsae at the rate of 200 IJs/cm^2, and S. feltiae-Endemic and H. indica at the rate of 50 IJs/cm^2 provided the highest (85%) and the lowest (20%) mortality, respectively at 20°C. At 25°C, S. carpocapsae at the rate of 200 IJs/cm^2 was the nematode caused the highest mortality with 95% while S. feltiae-Endemic at the rate of 50 IJs/cm^2 was producing 25% mortality which was the lowest. As a result, S. carpocapsae performed the best efficacy against Zabrus spp. and it was followed by H. bacteriophora and S. bicornutum.

Key words: *Zabrus* spp., entomopathogenic nematods, *Steinernema*, *Heterorhabditis, biological control.*

INTRODUCTION

Being an important crop in our country and in the world, wheat is an indispensable source of food for human nutrition. Annual wheat production in our country is approximately 18-20 million tons, wheat consumption however is approximately 16-17 million tons (Anonymous, 2008). Despite of an excessive wheat production, the losses in crop quality caused by pests and diseases makes a significant amount of wheat to be imported into our country. In addition to the diseases such as bunt, rust, smut, insect pests; sunn pest, cereal bugs, cereal spike beetles, and cereal ground beetles, *Zabrus* spp. are important and cause losses in wheat yield and quality (Lodos, 1989). Occurrence of high population densities of *Zabrus* spp. (Coleoptera: Carabidae) can cause yield losses of up to 100% in years and areas where none of control methods are applied. In our country, there are only seeds and surface chemical applications as control methods against this important pest.

In terms of plant protection, although there are many different control options against pests, the biological control is highly preferred over other methods, because of being the human, animal and environmental friendly method, maintaining the ecological balance and sustainability. As biological control agents, entomopathogenic nematodes (EPNs) (Rhabditida: Steinernematidae and Heterorhabditidae) attract attention increasingly in research area recently. Their ideal properties such as; the broad host spectrum, to be able to kill their hosts within 24-48 hours, to be producible commercially easily in vivo or in vitro, having ability to search actively their hosts, settling in application areas and staying effective for a long time, having easy applicability, being in compliance with many chemicals and being safe for the environment are important for their preferability. They are soil dwelling, aquatic organism and have motile bacteria living their intestine. The bacteria in Steinernematidae are *Xenorhabdus* spp. and in Heterorhabditidae are *Photorhabdus* spp.

Nematode and bacterium are mutualistic symbionts and obligate, lethal parasites of insects. EPNs can be found everywhere on earth and infect many different insects (Smart, 1995). Nematodes enter insect through natural openings. Once in the insect, the nematode releases the bacteria that are carried in the intestine. Bacterial cells reproduce rapidly and kill the insect within 24-48 hours using many different toxins. They also produce antibacterial and antifungal antibiotics not to allow any other other organisims in the host. The nematodes eat the bacteria and reproduce for 3 or 4 generations depending on the food source. Over 100,000 nematodes exit the insect (Burnell and Stock, 2000).

Entomopathogenic nematodes have been used in controlling insects since the 1930s (Smart 1995) in various climatic regions of the world. They are important biological control agents of soil-inhabiting insects (Gaugler, 1981; Georgis and Poinar, 1984; Klein, 1990) such as Japanese beetles, mole crickets, and root weevils. They have also been used successfully against above-ground insects in cryptic habitats (Bedding and Miller, 1981; Ralph, 1981; Kaya, 1988; Begley, 1990; Kaya, 1990; Vreditelyami, et al., 1992), for example, navel orange worm, the codling moth and the artichoke plume moth, carpenter worms, and clearwing moths.

However, studies on EPN are very limited and some of them have just started in Turkey. Turkey having a diverse ecology shelters nine EPN species but the studies on the investigating of efficacy and usage of these species on pests of cultivated plants are very rare. In this study; we conducted experiments to find out the susceptibility of the larvae of *Zabrus* spp. against entomopathogenic nematodes in the laboratory first time in the World to produce basic data to use in the biological control of the insect.

MATERIALS AND METHODS

We studied entomopathogenic nematodes as an alternative to chemical control. The entomopathogenic nematodes used in the trials were *Steinernema feltiae-Commercial, S. feltiae*-Endemic, *S. carpocapsae, S. bicornutum*, *Heterorhabditis bacteriophora*, and *H. indica*.

Zabrus larvae from wheat fields were collected digging into soil 25-30 cm at the end of March and beginning of April. They brought to lab in ice box. They let stay in plastic containers for 24 hours to differentiate the damaged ones during collecting and transportation. The trials have been conducted in small plastic pots with a lid (8 cm in height, 6 cm in diameter) containing autoclaved soil and repeated 2 times. The nematodes at 3 rates of 50, 100 and 200 infective juveniles (IJs)/cm^2 with 4 replicates applied evenly into plastic with pipet. Pots were placed in incubators at dark adjusted 15, 20 and 25^{o}C. They were checked after 7 and 10 days to count dead larvae. Efficacy was evaluated by comparing the treatments with untreated control.

RESULTS AND DISCUSSIONS

The mortalities caused by nematodes increased by increasing rate and temperature at the 10th day. The highest mortality with 75% at the rate of 200 IJs/cm^2 was caused by *S. carpocapsae* followed by *S. carpocapsae* at the dose of 100 and 50 IJs/cm^2 with 70% mortality and *H. bacteriophora* at dose of 200 IJs/cm^2 with 60% mortality. However they were statistically at the same group. The lowest mortality with 5% mortality at the rate of 50 IJs/cm^2 was caused by *S. bicornutum* at 15°C (Table 1).

S. carpocapsae at the rate of 200 IJs/cm^2, and *S. feltiae*-Endemic and *H. indica* at the rate of 50 IJs/cm^2 provided the highest (85%) and the lowest (20%) mortality, respectively at 20°C. *H. bacteriophora* at the rate of 200 IJs/cm^2 with 75% mortality and *S. bicornutum* at the rate of 200 IJs/cm^2 with 67.5% mortality followed *S. carpocapsae*. They did not differ from each other statistically (Table 2). At 25°C, *S. carpocapsae* at the rate of 200 IJs/cm^2 was the one producing the highest mortality with 95% while *S. feltiae*-Endemic at the rate of 50 IJs/cm^2 was causing 25% mortality which was the lowest (Table 3). *S. bicornutum* at the rate of 100 and 200 IJs/cm^2 with 70% and 85% mortality and *H. indica* at the rate of 200 IJs/cm with 70% mortality followed *S. carpocapsae* at the rate of 200 IJs/cm^2, which were at the same group statistically.

Table 1. The efficacy of entomopathogenic nematods against *Zabrus* larvae at 15^{o}C in laboratory

Nematod	Dose (IJ/ cm^2)	Larva used 1st and 2nd year	7th day count			10th day count		
			Death (%) 1st year	Death (%) 2nd year	Death average (%)	Death (%) 1st year	Death (%) 2nd year	Death average (%)
S.feltiae Endemic	50	20+20	30	10	20bcde	30	30	30de
S.feltiae Endemic	100	20+20	35	15	25cde	35	35	35ef
S.feltiae Endemic	200	20+20	45	25	35def	50	50	50f
S.feltiae Commecial	50	20+20	15	25	20bcdef	15	15	15abcd
S.feltiae Commercial	100	20+20	30	25	27,5cde	30	30	30de
S.feltiae Commercial	200	20+20	50	30	40ef	55	55	55gh
H. bacteriophora	50	20+20	15	50	32,5cde	40	70	55fg
H. bacteriophora	100	20+20	25	35	30cde	45	65	55gh
H. bacteriophora	200	20+20	15	60	37,5ef	50	70	60ghi
S. carpocapsae	50	20+20	30	50	40ef	55	85	70hi
S. carpocapsae	100	20+20	40	60	50f	60	80	70hi
S. carpocapsae	200	20+20	35	70	52,5f	65	85	75i
S. bicornutum	50	20+20	5	0	2,5ab	5	5	5ab
S. bicornutum	100	20+20	10	15	12,5abc	15	25	20bcde
S. bicornutum	200	20+20	25	25	25cde	30	30	30de
H. indica	50	20+20	5	5	5ab	10	10	10abc
H. indica	100	20+20	10	10	10abc	25	25	25cde
H. indica	200	20+20	15	15	15ab	25	25	25cde
Control	0	20+20	0	0	0a	0	0	0a

Table 2. The efficacy of entomopathogenic nematods against *Zabrus* larvae at 20^{o}C in laboratory

Nematod	Dose (IJ/ cm^2)	Larva used 1st and 2nd year	7th day count			10th day count		
			Death (%) 1st year	Death (%) 2nd year	Death average (%)	Death (%) 1st year	Death (%) 2nd year	Death average (%)
S.feltiae Endemic	50	20+20	25	15	20abc	25	15	20b
S.feltiae Endemic	100	20+20	50	10	30bcde	50	45	47,5de
S.feltiae Endemic	200	20+20	50	20	35bcde	55	50	52,5def
S.feltiae Commercial	50	20+20	20	25	22,5abcd	25	30	27,5bc
S.feltiae Commercial	100	20+20	35	35	35bcde	40	35	37,5cd
S.feltiae Commercial	200	20+20	50	20	35bcde	55	50	52,5def
H. bacteriophora	50	20+20	30	50	40bcde	55	50	52,5cde
H. bacteriophora	100	20+20	40	35	37,5bcde	50	40	45cde
H. bacteriophora	200	20+20	60	70	65g	70	80	75gh
S. carpocapsae	50	20+20	35	55	45defg	50	60	55def
S. carpocapsae	100	20+20	55	50	52,5efg	55	55	55def
S. carpocapsae	200	20+20	40	80	60fg	80	90	85h
S. bicornutum	50	20+20	30	30	30bcde	45	45	45cde
S. bicornutum	100	20+20	30	30	30bcde	45	45	45cde
S. bicornutum	200	20+20	45	45	45defg	75	60	67,5fg
H. indica	50	20+20	15	15	15ab	20	20	20b
H. indica	100	20+20	40	40	40cdef	55	65	60efg
H. indica	200	20+20	25	35	30bcde	55	65	60efg
Control	0	20+20	5	0	2,5a	5	0	2,5a

Table 3. The efficacy of entomopathogenic nematods against *Zabrus* larvae at 25 °C in laboratory

Nematod	Dose (IJ/ cm²)	Larva used 1st and 2nd year	7th day count			10th day count		
			Death (%) 1st year	Death (%) 2nd year	Death average (%)	Death (%) 1st year	Death (%) 2nd year	Death average (%)
S.feltiae Endemic	50	20+20	25	15	20abcd	25	25	25b
S.feltiae Endemic	100	20+20	15	25	20abcd	45	55	50def
S.feltiae Endemic	200	20+20	15	30	22,5bcde	50	70	60efg
S.feltiae Commercial	50	20+20	20	10	15abc	30	30	30bc
S.feltiae Commercial	100	20+20	15	10	12,5ab	35	25	30bc
S.feltiae Commercial	200	20+20	30	40	35bcdef	45	45	45cde
H. bacteriophora	50	20+20	55	65	60gh	60	70	65fg
H. bacteriophora	100	20+20	15	60	37,5cdefg	50	80	65fg
H. bacteriophora	200	20+20	40	60	50fg	50	80	65fg
S. carpocapsae	50	20+20	45	30	37,5cdefg	50	50	50def
S. carpocapsae	100	20+20	60	60	60gh	60	60	60efg
S. carpocapsae	200	20+20	95	60	77,5h	100	90	95i
S. bicornutum	50	20+20	40	40	40defg	60	60	60efg
S. bicornutum	100	20+20	45	45	45efg	70	70	70gh
S. bicornutum	200	20+20	45	20	32,5bcdef	90	80	85hi
H. indica	50	20+20	45	45	45efg	35	40	37,5bcd
H. indica	100	20+20	45	45	45efg	50	55	52,5defg
H. indica	200	20+20	20	45	32,5bcdef	60	80	70gh
Control	0	20+20	0	0	0a	0	0	0a

CONCLUSIONS

As a result, *S. carpocapsae* showed the best efficacy against *Zabrus* sp. and it was followed by *H. bacteriophora* and *S. bicornutum*. Field trials with these nematodes showed high efficacy against *Zabrus* should be planned for future studies.

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THE EFFECTS OF DIFFERENT HARVEST TIMES ON FORAGE YIELD AND QUALITY OF SOME VETCH (*Vicia spp.*) SPECIES

Ihsan ÇETIN, Mevlut TURK

Suleyman Demirel University, Faculty of Agriculture, Department of Field Crops, Isparta, Turkey

Corresponding author email: mevlutturk@sdu.edu.tr

Abstract

This research was conducted to determine the effects of four harvesting stages (beginning of flowering, 50% flowering, full flowering and beginning of seed filling stages) on forage yield and quality of some vetch (Vicia spp) species. The common vetch (Vicia sativa L.), Hungarian vetch (Vicia pannonica Crantz.) and hairy vetch (Vicia villosa L.) were used in this trial. Dry matter (DM) yield, crude protein (CP), acid detergent fibre (ADF), neutral detergent fibre (NDF), total digestible nutrient (TDN) and relative feed value (RFV) were determined. According to results, the highest DM yield was obtained from hairy vetch. Harvesting at the late stages caused a reduction in forage quality. The CP, TDN and RFV decreased with advancing stages while DM yield, ADF and NDF contents increased in all vetch species.

Key words: *acid detergent fibre, dry matter, common vetch, Hungarian vetch, RFV.*

INTRODUCTION

Vetches can be used for the grazing of livestock, green manure, forage or silage, or the grain fed to livestock (Caballero, 1993; Chowdhury et al., 2001; Egan and Crouch, 2006). Hairy vetch, common vetch and Hungarian vetch are commonly grown to provide a seed and hay crop in many different farming systems in Turkey (Albayrak et al., 2004). Several researchers found that dry matter yield varied from 1.50 to 8.65 t ha^{-1} in common vetch grown in the different regions of Turkey (Gokkus et al., 1996; Anlarsal et al., 1999; Avcıoğlu et al., 1999; Albayrak et al., 2006). Common vetch is less winter hardy and is grown as a fall-seeded winter annual in regions with mild winters. Hairy vetch and common vetch are adapted to a wide range of soil types, but hairy vetch is better adapted to soil type extremes.

The factors influencing the nutritive value of forage are many and the degree to which they are interrelated may vary considerably from one area to another. These factors may include, alone or in combination, plant type, climate, season, weather, soil type and fertility, soil moisture, leaf to stem ratio, physiological and morphological characteristics and others, and may change depending on whether the plants are annuals perennials, grasses or legumes. Nutrient composition levels are not necessarily the only criterion in evaluating the nutritive value of plants (Stobbs, 1975; Cook and Harris, 1979).

The aim of this research was to determine the effects of harvest times on forage yield and quality of some vetch (*Vicia* spp.) species.

MATERIALS AND METHODS

The field experiment was conducted at Ipsala/Edirne located in the Marmara region of Turkey. Total precipitation was 348 mm in 2014 (March–June). The long-term average is 275,7 mm. Average temperature was 14.7^{o}C in 2014. The long- term average is 15.3^{o}C.

The experiments were established in a randomised complete block design with three replications in March in 2014. Three vetch species ('Zemheri' cultivar of common vetch, 'Tarm Beyazi' cultivar of hungarian vetch, 'Selcuklu' cultivar of hairy vetch) and four harvesting stages (beginning of flowering, 50% flowering, full flowering and seed filling stages) were used in this trial. Five different phosphorus rates (0, 30, 60, 90 and 120 kg P ha^{-1}) were applied in this study. Seeding rate was 100 kg ha^{-1} in common vetch, 80 kg ha^{-1} in hungarian vetch and 70 kg ha^{-1} in hairy vetch. Individual plot size was 1.5 × 8 m = 12 m^2. Phosphorus was applied as triple superphosphate (46% P_2O_5) during sowing in March.

Dry matter (DM) yield, CP, acid detergent fibre (ADF), neutral detergent fibre (NDF), total digestible nutrient (TDN) and relative feed value (RFV) were investigated in samples were taken from quadrats (1 m^2). Samples taken from each plot were dried at room temperature then dried in an oven at 65°C till they reached constant weight. After cooling and weighing, the samples were ground for mineral contents analyses. Nitrogen content was calculated by Kjeldahl method (Kacar, 1972). The ANKOM Fibre Analyser was used for NDF and ADF analysis. ANKOM F57 filter bags were used for ADF and NDF analysis in this study.

Total digestible nutrients (TDN), dry matter intake (DMI), digestible dry matter (DDM) and relative feed value (RFV) were estimated according to the following equations adapted from (Horrocs and Vallentine, 1999):

TDN = (-1.291 x ADF) + 101.35
DMI = 120% NDF % dry matter basis
DDM = 88.9-(0.779 x ADF % dry matter basis)
RFV = DDM% x DMI% x 0.775

The data were analysed together using the Proc GLM (SAS, 1998). Means were separated by LSD at the 5 % level of significance.

RESULTS AND DISCUSSIONS

The results of ANOVA summarized in Table 1. The results of variance analysis showed that there were statistically significant differences among vetch species for DM yields. Hairy vetch had the highest DM (3.19 t ha^{-1}) yield while the lowest DM yield (1.97 t ha^{-1}) was obtained from common vetch. The DM yield, CP, ADF, NDF, TDN contents and RFV value in vetch species were influenced significantly by harvesting times (Table 1). The lowest DM yield was obtained at the beginning of flowering, while the highest DM yield was obtained at the beginning of seed filling stages (Figure 1). In this study, the DM yield significantly increased at advanced harvest stages. As plants begin to concentrate DM in pods and seeds, an enhanced forage yield with advancing maturity is consistent with results of several researchers (Munoz et al., 1983; Hintz et al., 1992; Osborne and Riedell, 2006).

Table 1. Results of Analysis of Variance Traits Determined

	df	DMY	CP	ADF	NDF	TDN	RFV
Block	2	0.32**	0.33	0.06	0.08	0.10	2.58
Vetch species (V)	2	560.83**	0.09	1.26	0.47	2.09	19.11
Harvesting Times (HT)	3	272.42**	41.67**	70.24**	86.83**	117.07**	4007.2**
V x HT intr.	6	7.35**	0.23	0.55	0.63	0.92	7.71
Error	22	0.05	0.11	0.37	0.19	0.61	6.04

DF, degrees of freedom; ns, not significant. * : P < 0.05, ** : P < 0.01.

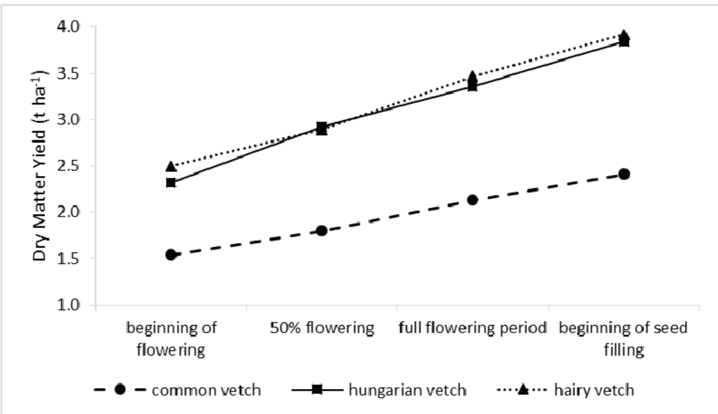

Figure 1. The DM yields of vetch species at different harvesting stages

There were no statistically significant differences in CP contents among vetch species. Crude protein contents of vetch species decreased with advancing stages. The highest CP content was obtained at the beginning of flowering, while the lowest CP content was obtained at the beginning of seed filling stages in all vetch species (Figure 2). There is a rapid uptake of minerals during early growth and a gradual dilution as the plant matures (Lanyasunya et al., 2007). The changes in element content with maturity are related to the increasing stem to leaf ratio. Our results confirm those of Turk et al. (2007, 2009), Tan et al. (2003).

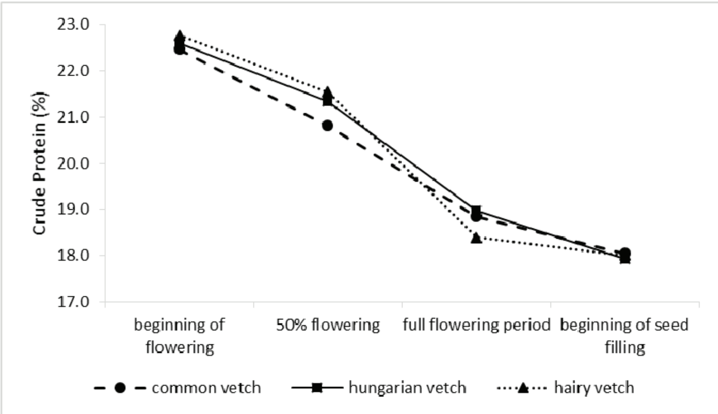

Figure 2. The CP ratios of vetch species at different harvesting stages

The effects of harvesting times on ADF and NDF contents of vetch species were found statistically significant. The ADF and NDF contents of vetches increased with advancing maturity. The lowest ADF and NDF contents were obtained at the beginning of flowering, while the highest ADF and NDF contents were obtained at the beginning of seed filling stages (Figure 3 and 4). Our results confirm the finding of Albayrak et al. (2009), Sürmen et al. (2011) and Türk et al. (2007). The trends in ADF and NDF contents with increasing maturity are normally the reverse of protein (Oelberg, 1956; Rebole et al., 2004). Young plant cells has the primary cell wall, but also the secondary cell wall occurs with maturing. This causes being the more fibrous of mature plants (Arzani et al., 2004).

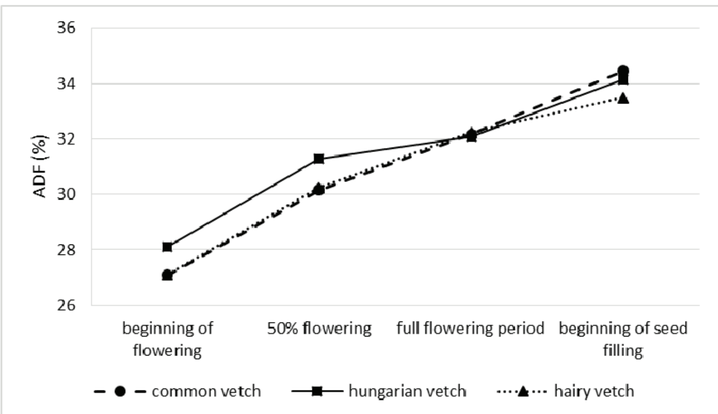

Figure 3. The ADF ratios of vetch species at different harvesting stages

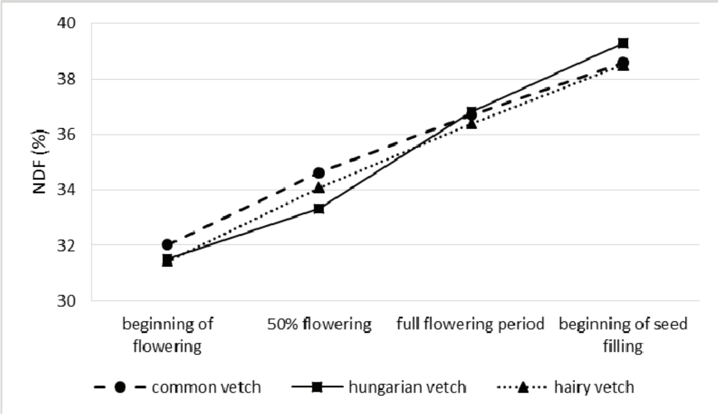

Figure 4. The NDF ratios of vetch species at different harvesting stages

The highest TDN values were obtained at the beginning of flowering, while the lowest TDN values were obtained at beginning of seed filling stages (Figure 5). The TDN refers to the nutrients that are available for livestock and are related to the ADF concentration of the forage (Sürmen et al., 2011). As ADF increases there is a decline in TDN which means that animals are not able to utilize the nutrients that are present in the forage (Aydın et al., 2010). Turk and Albayrak (2012) reported that the contents TDN values decreased as plant growth advanced. These results are in agreement with our results.

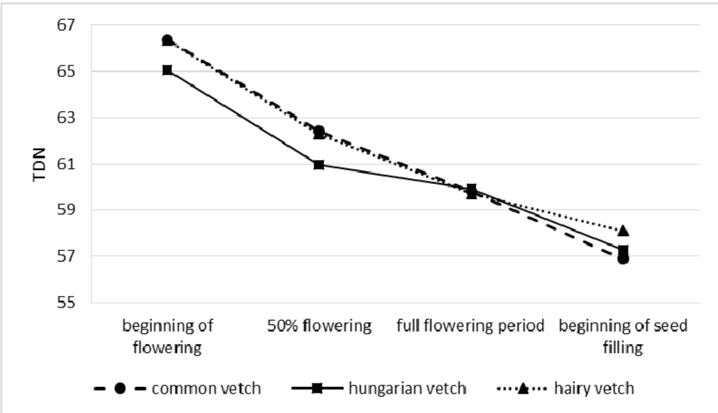

Figure 5. The TDN values of vetch species at different harvesting stages.

The RFV is an index that is used to predict the intake and energy value of the forages and it is derived from the DDM and dry matter intake (DMI). Forages with an RFV value over 151, between 150-125, 124-103, 102-87 and 86-75, and less than 75 are considered as prime, premium, good, fair, poor and reject, respectively (Lithourgidis et al., 2006). The highest RFV values were obtained at the beginning of flowering, while the lowest RFV values were obtained at beginning of seed filling stages in all vetch species (Figure 6). Similar results were reported by Sürmen et al. (2011), Turk and Albayrak (2012).

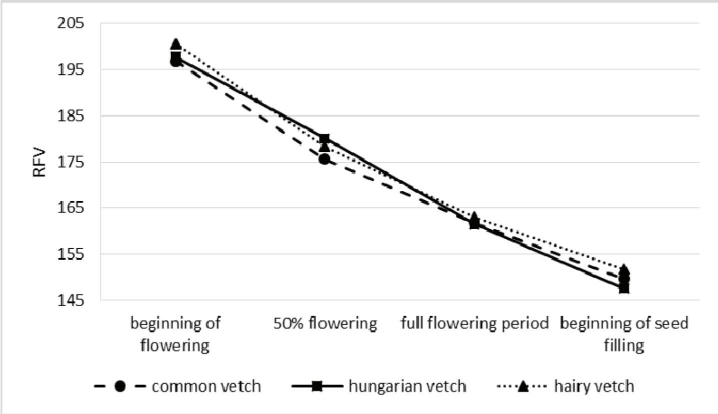

Figure 6. The RFV values of vetch species at different harvesting stages

CONCLUSIONS

Results further showed that vetches have mineral content well above the suggested requirement limits for dairy cattle. The results of this study showed that hairy vetch had the highest DM yield. The lowest DM yield was obtained from common vetch. There were no statistically significant differences in CP ratio, ADF, NDF, TDN and RFV among vetches. Harvesting at the late stages caused a reduction in forage quality. Contents of CP, TDN and RFV decreased with advancing growth while DM yield, ADF and NDF contents increased.

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THE NEW WAY OF EVALUATING THE PROTEIN POLYMORPHISM FOR MAIZE BREEDING AND SEED PRODUCTION

Galina COMAROVA[1], Alexandr ROTARI[2], Eugen ROTARI[2]

[1]State Agrarian University of Moldova, 44 Mircești str., 2049, Chishinau, Republic of Moldova
[2]Institute of Phytotechny "Porumbeni", 4834, Pașcani, District Criuleni, Republic of Moldova

Corresponding author email: galinacomarova@gmail.com

Abstract

The paper proposes to discuss the possibility of a logical connection between the existing methods of digital and visual documentation of protein electrophoretic spectra (PES). Therefore, the aim of this work was to develop a methodological approach to the study of zein polymorphism (ZP) as a basis for assessing the hybridity degree of corn seeds and to determine the effect of heterosis level using protein molecules. The method of electrophoresis in gel polyacrylamide was used to study ZP of 49 maize genotypes (hybrids and their parent forms) with the following calculation of their PES formulas. It's known that during the identifying of hybridity using the marker zones in protein profiles arises the personalization item of visual estimation of the maize heterosis effect. Therefore, it is necessary to improve the accuracy of the PE documentation. So, it is suggested to characterize every component of the genotype protein track by using the number of zein molecules subunits (ZMS), each of which is equal to 0,1 rf. This technique has been used as a basis for the development of software "FOREZ" for computer modeling, storage, and for the synthesis of hybrid PES from parental forms PES on the basis of codominance principle. As a result of its use it is possible to create the corresponding matrix of the analyzed electrophoregram. It was found that the quantitative analysis of ZMS using PE matrices greatly increases the methodological possibility of identifying the hibridity with PE markers: the number of homogeneous peptide subunits is increased by 55% for lines; 63% - for the simple parental hybrids and 68% - for zoned hybrids. Thus the proposed methodological modification extends the study of heterosis effect using protein profiles.

***Key words**: maize, protein, zein, hybridity, electrophoregram.*

INTRODUCTION

Traditional methods to help the high quality seeds production of maize hybrids for the purpose of their further commercialization is the method of soil-control. Soil-control is carried out in the field conditions on the 2nd vegetation season of plants grown from hybrid maize seeds of the first generation. Exactly these hybrid seeds of the first generation is estimated in accordance with the requirements of the International Union of the Protection of New Varieties of Plants - UPOV (www.upov.int) using the large complex of morphological traits (from 40 to 60 or more). However, the morphological traits are the manifestation result of the interaction between genotype and the environment.

Thus became necessary to overcome these difficulties. Therefore, in the 80th years of the last century an alternative method has been proposed: the method of the maize genome marking at the level of protein molecules by electrophoresis - along with other cultures (Comarova, 1998; Rotari, 2011).

The protein electrophoresis method, compared to the traditional field methods of soil-control is more effective to assess the hybridity level of corn seeds (Rotari et al., 2008): by saving time (one growing season) and due to the higher accuracy (proteins are the primary product of the gene activity).

Zein electrophoresis method used to determine the hybridity level of hybrid seed maize from the first generation is based on the following two principles:

1) the use of specific properties of the protein prolamin fraction in maize endosperm – the polymorphism of zein;

2) the use of codominance effect, i.e. the phenomenon of the simultaneous presence in the zein (storage protein) electrophoretic spectrum (ZES) of hybrid F_1 seeds the amount of peptide subunits that characterize the maternal and paternal parent forms of the estimated hybrid ("hybrid" spectrum).

Accordingly, at the level of protein molecules, the hybridity degree determination of comercial F_1 seeds is doing by using protein subunits markers namely paternal forms of the estimated hybrid combinations. At the same time, evaluation of the heterosis effect degree in the first generation (F_1) should be carried out using the zein molecular forms (ZMF) from both parental forms (Rotari et al., 2004).

Consequently, at a higher zein polymorphism value of studied genotype the possibilities of selection and genetic analysis at the protein level are increasing for such important indicators as maize hybridity degree and value of the heterosis effect (Palii et al., 2005; Comarova et al., 2011).

There was typical to carry out the visual discussion of the ZES in the period 60 -80-ies of the last century. However, this method was limited and uninformative. At present, the interpretation of zein polymorphism is based on digital ZES documentation and analysis with using a variety of techniques and methods (Comarova et al., 2012).

In the present article, we propose to discuss possibilities of logical connection between the existing methods of digital and visual documentation of zein electrophoretic spectrum (ZES) in order to develop a new way for evaluating zein polymorphism as a basis of more precise definition of the seeds hybridity degree and heterosis effect by using protein markers.

MATERIALS AND METHODS

As biological material was used maize endosperm of 49 genotypes, namely: 12 commercialized hybrids and 37 parent forms (11 simple hybrids and 26 lines). ZMF study was conducted by electrophoresis on polyacrylamide gel in the acidic buffer in the presence of urea (Rotari et al., 2003). ZES formulas calculation of maize hybrids and their parental forms were performed according the method of Konarev et al.(1987). The scheme design of initial ZES was performed using standard computer programs EXCEL and PAINT. Drawing up of zein profile matrices of studied genotypes was performed using the software «FOREZ», developed by A. Adamchuk through the technical idea proposed by G.Comarova (Comarova et al., 2003).

RESULTS AND DISCUSSIONS

By zein electrophoretic spectrum (ZES) of the studied genotypes can be stated that the number of zein electrophoretic zones (bands) vary from 6 to 11. However, the electrophoretic zones have different sizes, i.e. peptide subunit of zein are heterogeneous that is experimentally provable on ranges of variation of the relative electrophoretic mobility (rf) each of these zones. For example, one of the most stable zein electrophoretic zones (ZEZ) is a zone with rf (55-60) almost at every investigated genotype and to a lesser degree - the zone with rf (38-40) and others.

The encountered difficulty in interpreting is especially clearly manifested in the process of identifying ZEZ marker of studied hybrid - by comparing ZEZ of its parental forms. During scrupulous comparison of protein profiles of maternal and paternal forms for the majority of hybrid combinations should be noted that in most cases of labeling hybridity it is necessary to carry out by the fused composite components of widely zein electrophoretic zones.

Thus, the detection of marker zones of hybridity in protein profiles has an personalization element of professional analyst who carries out a visual assessment of the analyzed hybridity degree for the corresponding commercial seed lots of hybrid maize.

Therefore, to improve the accuracy of documenting the results of protein electrophoresis in order to standardize their interpretations G. Comarova (2003) proposed to characterize each component of the protein electrophoretic spectrum of the corresponding genotype by the number of zein molecules subunits (hereinafter referred to as molecular forms of zein -) for each of them the relative electrophoretic mobility (rf) is equal to 0.1.

This approach is considered as a methodological principle, which is the basis of development of software "FOREZ", designed for computer modeling, storage, as well as for the synthesis of hybrid electrophoretic spectra from the electrophoretic spectra of parental forms by using the principle of codominance.

As a result of computer modeling of input formulas derived by calculating the rf ZEZ values, we obtain the matrix of analyzed electrophoregrams, consisting of corresponding zein molecular forms (ZMF), for each of them the relative electrophoretic mobility (rf) is equal to 0.1.

For example, the protein profile of the line F2mC (Figure 1, EF) consists of 9 zein electrophoretic zones (ZEZ), which differ not only by the electrophoretic mobility, but also on size of the interval for each ZEZ (Figure 1, rf). If it is used the other methodological principle which underlies the program "Forez" to calculate the electrophoretic matrix, then the matrix of ZES for line F2mC is characterized by the 21st of ZMF (Figure 1, M).

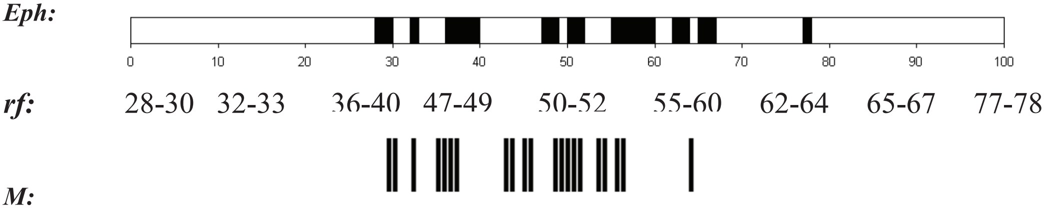

Figure 1. Comparison of the ways used to processing the results of electrophoretic zein analysis for the line F2 mC. *Symbols*: ***Eph*** - scheme of the original zein electrophoregram of the studied line F2 mC ; ***rf*** - the calculation formula by rf, corresponding to the resulting electrophoretic spectrum; ***M*** - the matrix of protein profile for the line F2 mC (one unit of rf=0.1).

Analogous analysis of electrophoretic passports conducted for the all studied maize genotypes allowed to compare the level of zein polymorphism manifestation depending on the technique used for the documentation and analysis of the received electrophoregrams.

It was found that the range of zein electrophoretic zones variation for all studied initial zein electrophoregrams from the endosperm of the studied genotypes (lines, simple parent hybrids or regionalized hybrids) is quite small and limited: from 6 to 12 ZEZ.

Conversely, the zein polymorphism on the matrix of the zein electrophoregrams has a higher level and a wider variation range.

So for the lines - the total number of zein molecular forms (ZMF) varies from 14 to 24; for parental simple hybrids their level increases and varies from 21 to 27 ZMF and for regionalized hybrids the zein polymorphism is even higher: from 23 to 33 ZMF.

Therefore, quantitative analysis of ZMF by electrophoretic matrixes greatly increases the methodological ability to identify electrophoretic markers of hybridity: the number of homogeneous peptide subunits is increased by 55% for lines; 63% - for the simple parental hybrids and 68% - for regionalized hybrids.

CONCLUSIONS

As a result the study of zein polymorphism in 49 maize genotypes by various methods of a digital and visual documentation were formulated recommendations for the use of these methods and techniques of processing results of zein electrophoretic analysis in the following order:

1. production of the starting electrophoregrams with colored zein electrophoretic zones (ZEZ);
2. carrying out of one type of intermediate documents: densitometry, or photographing, or conservation the plates;
3. measuring the relative electrophoretic mobility *(rf)* each of the colored electrophoretic zones characterizing the electrophoretic protein profile of the corresponding studied genotypes;
4. the calculation formulas by *rf*, corresponding to the electrophoretic spectrum of zein endosperm hybrids and their parental forms;
5 - design the scheme of the original zein electrophoretogram using standard computer programs EXEL and PAINT, if it is necessary to carry out an official electrophoretic certification of studied genotype;
6. using the software "FOREZ", that allows to carry out:
- the compilation of a databank on the protein profiles of the parental forms;
- the computer modeling for the synthesis of hybrid electrophoretic spectra from the electrophoretic spectra of parental forms by using the principle of codominance;
- the comparison of the hybrid synthesized zein electrophoretic spectrum (ZES) with calculation formulas and visual documentation of hybrid ZMF by the original hybrid ZES;
- the identification of marker zones hybridity based on analysis the computer matrixes of zein electrophoregrams;

- the assessment of the heterosis effect manifestation by ZES of hybrids: a quantitative analysis the total and marker zones of ZMF.

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STABILITY VALUATION OF SOME MIXTURES BETWEEN RETARDANTS AND ANTIBROADLEAVED HERBICIDES FOR THE GRAIN YIELD OF DURUM WHEAT

Grozi DELCHEV

Trakia University, Faculty of Agriculture, Department of Plant Production,
6000, Stara Zagora, Bulgaria

Corresponding author email: delchevgd@dir.bg

Abstract

The research was conducted during 2010 - 2012 on pellic vertisol soil type. A field experiment was carried out with durum wheat cultivar Progress (Triticum durum var. leucurum Desf.). Factor A included the years of investigation. Factor B included no treated check and 3 retardants – Cycocel extra (chlormequat + cholinechloride) – 1.5 l/ha, Vivax (chlormequat + ethephon) – 1.7 l/ha, Terpal (ethephon + mepiquat) – 3 l/ha. Factor C included weeded no treated check and 4 antibroadleaved herbicides – Granstar 75 DF (tribenuron-methyl) – 20 g/ha, Granstar super 50 SG (tribenuron-methyl + tiphensulfuron-methyl) – 40 g/ha, Laren 20 SG (methsulfuron-methyl) – 30 g/ha, Ally max SG (methsulfuron-methyl + tribenuron-methyl) – 35 g/ha. All of retardants, antibroadleaved herbicides and their tank mixtures were treated in tillering stage of the durum wheat. The weak adhesion of Granstar, Granstar super, Laren and Ally max required its application with adjuvant Trend 90 – 0.1%. Herbicide Granstar super cannot be mixed with retardants containing chlormequat - Cycocel extra and Vivax. There is antagonism at mixtures of retardant Terpal with herbicides containing methsulfuron-methyl – Laren and Ally max. The lowest durum wheat grain yields are obtained by these tank mixtures. Tank mixtures of herbicide Granstar super with retardants Cycocel extra and Vivax and retardant Terpal with herbicides Laren and Ally max are the most unstable for grain yield. Tank mixtures of retardants Cycocel extra and Vivax with herbicides Ally max, Laren and Granstar and of retardant Terpal with herbicides Granstar super and Granstar are technological the most valuable. They combine high grain yield with high stability with relation to different years. Self-use of retardants Cycocel extra, Vivax and Terpal without herbicides have low estimate and do not be used in the durum wheat crops.

Keywords: *durum wheat, herbicides, retardants, selectivity, stability.*

INTRODUCTION

In the last years are used biologically active substances that increase plant resistance to lodging and contribute to more fully realize the productive potential of the durum wheat cultivars (Bhaskara et al., 1998; Sharma and Kumar, 1998; Panayotov and Stoeva, 2000; Delchev, 2004).

The studies showed that in wheat retardants based of chlormequat are more effective than those based of ethephon (Green et al., 1986; Kolev and Terziev, 1996).

Common and durum wheat are differ in their response to a different preparations (Rapparini et al., 1984, 1998; Woodward and Marshall, 1989).

There is evidence that the effectiveness of retardants depends on the biology of cultivars and mineral fertilization (Popov, 1966; Peev, 1977; Wiersma et al., 1986; Sharma and Kumar, 1998; Delchev, 2004a; Delchev, 2004b).

In modern agriculture the herbicides are an effective instrument of weed control in wheat.

Since their entry into agriculture to now be recommend the terms, the doses, treatment methods, and their influence on grain yield and grain quality in their self-use (Orth, 1965; O'Sullivan, 1980; Ahmed et al., 1993; Kudsk and Streibig, 2003; Delchev, 2008, Stoyanova and Georgiev, 2014, Styanova et al., 2015).

These studies do not provide enough light to questions about the impact of mixtures between different pesticides on durum wheat.

The purpose of this investigation was to establish the selectivity and stability of some retardants, antibroadleaved herbicides and their tank mixtures on the durum wheat by influence of different meteorological conditions.

MATERIALS AND METHODS

The research was conducted during 2010 - 2012 on pellic vertisol soil type. It was carried out a three factors field experiment as a block method in 4 repetitions, on a 20 m^2 harvesting area, after sunflower predecessor. Under investigation was Bulgarian durum wheat cultivar Progress, which belongs to *Triticum durum var. leucurum*. Factor A included the years of investigation. Factor B included no treated check and 3 retardants – Cycocel extra (chlormequat + cholinechloride) – 1.5 l/ha, Vivax (chlormequat + ethephon) – 1.7 l/ha, Terpal (ethephon + mepiquat) – 3 l/ha. Factor C included weeded no treated check and 4 antibroadleaved herbicides – Granstar 75 DF (tribenuron-methyl) – 20 g/ha, Granstar super 50 SG (tribenuron-methyl + tiphensulfuron-methyl) – 40 g/ha, Laren 20 SG (methsulfuron-methyl) – 30 g/ha, Ally max SG (methsulfuron-methyl + tribenuron-methyl) – 35 g/ha.

The weak adhesion of Granstar, Granstar super, Laren and Ally max required its application with adjuvant Trend 90 – 0.1%. All of retardants, antibroadleaved herbicides and their tank mixtures were treated in tillering stage of the durum wheat with working solution 200 l/ha. Investigated herbicides have not antigraminaceous effect and the fight against graminaceous weeds in all variants was carried out with herbicide Traxos 045 EK in dose 1.2 l/ha.

The selectivity of herbicides has been established through their influence on grain yield. The math processing of the data was done according to the method of analyses of variance (Shanin 1977; Barov, 1982; Lidanski 1988). The stability of retardants, herbicides and their tank mixtures for grain yield with relation to years was estimated using the stability variances σ_i^2 and S_i^2 of Shukla (1972), the ecovalence W_i of Wricke (1962) and the stability criterion YS_i of Kang (1993).

RESULTS AND DISCUSSIONS

Data for the influence of stimulators, antibroadleaved herbicides and their tank mixtures on grain yield (Table 1) show that the lower yield is obtained in untreated and weeded check. The separate uses of herbicides Granstar, Granstar super, Laren and Ally max increase grain yield, because destroy existing annual and perennial broadleaved weeds. The separate uses of retardants Cycocel extra, Vivax, and Terpal also increases yield because they stimulate the growth and development of durum wheat. The increase was less than its mixtures with herbicides, because available broadleaved weeds neutralize part of its positive effect. At all variants, grassy weeds are destroyed with antigrass herbicide Traxos which treated 10 days before the application of the relevant products.

There has been antagonism of combined use of herbicide Granstar super with retardants containing chlormequat - Cycocel extra and Vivax. Antagonism is biggest in 2011, when grain yields by tank mixtures Cycocel extra + Granstar super and Vivax + Granstar super are smaller and mathematically proven than grain yields by the other tank mixtures with 6 – 7%. Tank mixtures of herbicide Granstar super with retardants Cycocel extra and Vivax have not antagonism to grain yield during any of the years of investigation. Grain yields by these mixtures are higher than grain yields by the self-use of the preparations. This means that it is the antagonism between the active substance chlormequat containing in retardants Cycocel extra and Vivax by one hand and the active substance thifensulfuron - methyl containing in herbicide Granstar super by other hand. Herbicides Granstar, Laren and Ally max do not contain thifensulfuron- methyl and their mixtures with chlormequat from retardants Cycocel extra and Vivax have not antagonism. At combined use of retardant Terpal containing ethephon + mepiquat, but not containing chlormequat with herbicide Granstar super antagonism is also missing.

There has been antagonism of combined use of retardant Terpal with herbicides containing methsulfuron-methyl - Laren and Ally max. Antagonism is biggest in 2010, when grain yields by tank mixtures Terpal + Laren and Terpal + Ally max are smaller and mathematically proven than grain yields by the other tank mixtures with 3-4%.

Table 1. Influence on grain yield

Variants		2010		2011		2012	
Retardants	Herbicides	kg/ha	%	kg/ha	%	kg/ha	%
-	-	3333	100	4040	100	4660	100
	Granstar	3600	108.0	4396	108.8	4982	106.9
	Granstar super	3610	108.3	4424	109.5	5010	107.5
	Laren	3573	107.2	4412	109.2	4972	106.7
	Ally max	3610	108.3	4436	109.8	4982	106.9
Cycocel extra	-	3560	106.8	4198	103.9	4930	105.8
	Granstar	3633	109.0	4460	110.4	5042	108.2
	Granstar super	3660	109.8	4206	104.1	5033	108.0
	Laren	3633	109.0	4452	110.2	5089	109.2
	Ally max	3650	109.5	4488	111.1	5117	109.8
Vivax	-	3550	106.5	4189	103.7	4930	105.8
	Granstar	3643	109.3	4476	110.8	5070	108.8
	Granstar super	3656	109.7	4177	103.4	5042	108.2
	Laren	3650	109.5	4476	110.8	5103	109.5
	Ally max	3666	110.0	4464	110.5	5135	110.2
Terpal	-	3586	107.6	4202	104.0	4991	107.1
	Granstar	3626	108.8	4484	111.0	5093	109.3
	Granstar super	3620	108.6	4472	110.7	5126	110.0
	Laren	3423	102.7	4440	109.9	5070	108.8
	Ally max	3463	103.9	4444	110.0	5079	109.0

LSD, kg/ha:

F.A	$p\leq5\%=126$	$p\leq1\%=134$	$p\leq0.1\%=144$
F.B	$p\leq5\%=130$	$p\leq1\%=140$	$p\leq0.1\%=151$
F.C	$p\leq5\%=134$	$p\leq1\%=145$	$p\leq0.1\%=157$
AxB	$p\leq5\%=152$	$p\leq1\%=169$	$p\leq0.1\%=189$
AxC	$p\leq5\%=158$	$p\leq1\%=177$	$p\leq0.1\%=199$
BxC	$p\leq5\%=167$	$p\leq1\%=189$	$p\leq0.1\%=215$
AxBxC	$p\leq5\%=217$	$p\leq1\%=254$	$p\leq0.1\%=299$

Tank mixtures of retardant Terpal with herbicides Granstar and Granstar super have not antagonism to grain yield during any of the years of investigation. Grain yields by these mixtures are higher than grain yields by the self-use of the preparations. This means that it is the antagonism between the active substance mepiquat containing in retardant Terpal by one hand and the active substance methsulfuron-methyl containing in herbicides Laren and Ally max by other hand. Retardants Cycocel extra and Vivax do not contain mepiquat and their mixtures with methsulfuron-methyl from herbicides Laren and Ally max have not antagonism. At combined use of herbicides Granstar and Granstar super with retardants Cycocel extra and Vivax containing respectively chlormequat + cholinechloride and chlormequat + ethephon, but not containing mepiquat antagonism is also missing.

Analysis of variance for grain yield (Table 2) shows that the years have the highest influence on grain yield – 81.7% on the variants. The strength of influence of retardants is 1.3% and the strength of influence antibroadleaved herbicides is 2.4%.

The reason is the large differences in the meteorological conditions during the three years of investigation. The influence of years and of herbicides is very well proven at $p\leq0.01$. The influence of retardants is well proven at $p\leq0.1$. There is a well proven interaction between retardants and meteorological conditions of years (AxB) – 1.2%, between herbicides and meteorological conditions of years (AxC) – 1.4% and between retardants and antibroadleaved herbicides (BxC) – 1.6%. They are proven at $p\leq0.1$. The interaction between three experiment factors (AxBxC) is not proven.

Based on proven retardant x year interaction and antibroadleaved herbicide x year interaction, it was evaluated stability parameters for each variant for grain yield of durum wheat with relation to years (Table 3).

It was calculated the stability variances σ_i^2 and S_i^2 of Shukla, the ecovalence W_i of Wricke and the stability criterion YS_i of Kang.

Table 2. Analysis of variance for grain yield

Source of variation	Degrees of freedom	Sum of squares	Influence of factor, %	Mean squares
Total	179	714244	100	-
Tract of land	2	66616	9.4	33308.0***
Variants	59	641484	89.8	10872.6***
Factor A – Years	2	619772	81.7	309886.0***
Factor B – Retardants	3	1908	1.3	636.0**
Factor C – Herbicides	4	9844	2.4	2461.0***
AxB	6	1700	1.2	2830.3**
AxC	8	2836	1.4	354.5**
BxC	12	4012	1.6	334.3**
AxBxC	24	1412	0.2	58.8
Pooled error	118	6144	0.8	521

*p≤5% **p≤1% ***p≤0.1%

Table 3. Stability parameters for the variants for grain yield with relation to years

Variants		$\bar{x}$	σ_i^2	S_i^2	W_i	YS_i
Retardants	Herbicides					
-	-	4011	93.2	-7.5	183.4	-5
	Granstar	4326	36.0	34.4	80.4	10+
	Granstar super	4348	32.1	52.5	73.5	13+
	Laren	4319	69.6	127.8	140.9	9+
	Ally max	4343	92.9	133.7	183.0	12+
Cycocel extra	-	4229	158.6	237.3*	301.1	1
	Granstar	4378	38.1	73.3	84.3	14+
	Granstar super	4300	478.5**	871.4**	877.0	-3
	Laren	4391	4.3	6.2	23.6	16+
	Ally max	4418	19.8	26.4	51.3	21+
Vivax	-	4223	158.3	258.5*	300.7	0
	Granstar	4396	28.9	63.2	67.7	17+
	Granstar super	4292	619.0**	1177.9**	1129.8	-4
	Laren	4410	9.7	18.7	33.3	20+
	Ally max	4422	0.7	-11.6	16.8	22+
Terpal	-	4260	203.4	467.2**	453.7	0
	Granstar	4401	43.4	71.9	93.5	18+
	Granstar super	4406	48.1	14.4	102.2	19+
	Laren	4311	556.7**	321.8*	1017.7	-2
	Ally max	4329	400.1**	225.7*	735.8	-1

Stability variances (σ_i^2 и S_i^2) of Shukla, which recorded respectively linear and nonlinear interactions, unidirectional evaluate the stability of the variants. These variants which showed lower values are considered to be more stable because they interact less with the environmental conditions. Negative values of the indicators σ_i^2 and S_i^2 are considered 0. At high values of either of the two parameters - σ_i^2 and S_i^2, the variant are regarded as unstable. At the ecovalence W_i of Wricke, the higher are the values of the index, the more unstable is the variant.

On this basis, using the first three parameters of stability, it is found that the most unstable are tank mixture of herbicide Granstar super with retardants Cycocel extra and Vivax and of retardant Terpal with herbicides Laren and Ally max. Self-use of retardants Cycocel extra, Vivax and Terpal without herbicides are unstable too. In these variants values of stability variance σ_i^2 and S_i^2 of Shukla and ecovalence W_i of Wricke are the highest and mathematically proven. The reason for this high instability is greater variation in grain yields during years of experience as weather conditions affect those most. At tank mixture of herbicide Granstar super with retardants Cycocel extra and Vivax and thank mixtures of retardant Terpal with herbicides Laren and Ally max, instability is linear and nonlinear types - proven values of σ_i^2 and S_i^2. At retardants

Cycocel extra, Vivax and Terpal without herbicides instability is nonlinear type - proven values of S_i^2, the values of σ_i^2 are not proven. Other tank mixtures between retardants and antibroadleaved herbicides exhibit high stability because they interact poorly with the conditions of years.

To evaluate the complete efficacy of each tank mixture between retardant and antibroadleaved herbicide should be considered as its effect on grain yield of durum wheat and its stability - the reaction of wheat to this variant during the years. Valuable information about the value of technologic value of the variant give the stability criterion YS_i of Kang for simultaneous assessment of yield and stability, based on the reliability of the differences in yield and variance of interaction with the environment. The value of this criterion is experienced that using nonparametric methods and warranted statistical differences we get a summary assessment aligning variants in descending order according to their economic value.

Generalized stability criterion YS_i of Kang, taking into accounts both the stability and value of yields gives a negative assessment of weeded, untreated control, tank mixtures Cycocel extra + Granstar super, Vivax + Granstar super, Terpal + Laren and Terpal + Ally max, characterizing them as the most unstable and low yields. According to this criterion, the most valuable technology appears tank mixtures Vivax + Ally max, Cycocel extra + Ally max, Vivax + Laren, Terpal + Granstar super, Terpal + Granstar, Vivax + Granstar, Cycocel extra + Laren and Cycocel extra + Granstar. These tank mixtures combine high levels of grain yield and high stability of this index during the years. From the viewpoint of technology for durum wheat growing, high rating also have self-use of herbicides Granstar, Granstar super, Laren and Ally max. These herbicides combine relatively good grain yields with high stability during the years of the investigation. Variants with self-use of retardants Cycocel extra, Vivax and Terpal without a partner herbicide get low ratings and they to be avoided. In these variants, the positive effect of the retardant use is neutralized by the negative effect of the present weeds, because of the absence of effective chemical control against them.

CONCLUSIONS

Herbicide Granstar super cannot be mixed with retardants containing chlormequat - Cycocel extra and Vivax. There is antagonism at mixtures of retardant Terpal with herbicides containing methsulfuron-methyl – Laren and Ally max. The lowest durum wheat grain yields are obtained by these tank mixtures.

Tank mixtures of herbicide Granstar super with retardants Cycocel extra and Vivax and retardant Terpal with herbicides Laren and Ally max are the most unstable for grain yield.

Tank mixtures of retardants Cycocel extra and Vivax with herbicides Ally max, Laren and Granstar and of retardant Terpal with herbicides Granstar super and Granstar are technological the most valuable. They combine high grain yield with high stability with relation to different years.

Self-use of retardants Cycocel extra, Vivax and Terpal without herbicides have low estimate and do not be used in the durum wheat crops.

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STABILITY VALUATION OF SOME MIXTURES BETWEEN FOLIAR FERTILIZERS AND ANTIGRAMINACEOUS HERBICIDES FOR THE GRAIN YIELD OF DURUM WHEAT

Grozi DELCHEV

Department of Plant Production, Faculty of Agriculture, Trakia University, 6000, Stara Zagora, Bulgaria, Phone: +359 894 615068, Email: delchevgd@dir.bg

Corresponding author email: delchevgd@dir.bg

Abstract

The research was conducted during 2010 - 2012 on pellic vertisol soil type. A field experiment was carried out with durum wheat cultivar Deyana (Triticum durum var. valenciae Desf.). Factor A included the years of investigation. Factor B included no treated check and 3 foliar fertilizers - Humustim - 1 l/ha, Lactofol O - 8 l/ha, Masterblend (20-20-20) – 3.5 kg/ha^{-}. Factor C – included weeded, no treated check and 4 antigraminaceous herbicides - Foxtrot 69 EB (fenoxaprop-ethyl) – 1 l/ha, Axial 050 EC (pinoxaden) - 900 l/ha, Topic 080 EC (clodinafop) - 450 l/ha, Traxos 045 EC (pinoxaden + clodinafop) – 1.2 l/ha. All of foliar fertilizers, antigramunaceous herbicides and their tank mixtures were treated in tillering stage of the durum wheat.
There is antagonism of combined use by antigraminaceous herbicide Foxtrot with three foliar fertilizers Humustim, Lactofol O and Masterblend. The grain yield increase in compared to self-use of the preparations is only 0.6 - 0.9%. There is an additive effect by tank mixtures of fertilizers Humustim, Lactofol O and Masterblend with antigraminaceous herbicides Axial, Topic and Traxos. The highest grain yields are obtained by these tank mixtures. Tank mixtures of herbicide Foxtrot with foliar fertilizers Humustim, Lactofol O and Masterblend are the most unstable for grain yield. Tank mixtures of herbicides Axial, Topik and Traxos with organic foliar fertilizer Humustim and complex foliar fertilizers Lactofol O and Masterblend are technological the most valuable. They combine high grain yield with high stability with relation to different years. Self-use of foliar fertilizers Humustim, Lactofol O and Masterblend without herbicides have low estimate and do not be used in the durum wheat crops.

Key words: *durum wheat, foliar fertilizers, herbicides, grain yield, selectivity, stability.*

INTRODUCTION

Mixed treatment of foliar fertilizers with herbicides is essential for agricultural production. Mixed treatment reduces phytotoxicity to the culture and increases the herbice efficacy (Shaban, 2007; Gupta et al., 2011). Foliar fertilizers help to overcome the plants stress by treating with herbicides (Pavlova, 2004). The introduction of more herbicides and complex fertilizers for foliar feeding necessitates research on their combination, in order to create optimal conditions for the growth and development of the durum wheat (Grundy et al., 1996; Rola et al., 1999; Kolev and Gorbanov, 2000; Brzozowska and Brzozowski, 2002; Sangi et al., 2012).
Continuous and repeated use of the herbicide of the same active base leads to the emergence of resistant biotypes weeds (Hartmann et al., 2000; Labrada, 2000). Competitive interaction between crops and weeds are complex and dynamic, depend on many factors and are amended as during the growing season and from year to year (Montemurro, 1998; Bell, 1999; Scursoni and Satorre, 2005; Guillen et al., 2006).
A prerequisite for the introduction of herbicides in agricultural practices has been studying their influence on the culture. Reduction in yield in winter cereals as a result of phytotoxic effects of various herbicides have proven by many authors (Lyubenov, 1987; McMullan, 1993; Orr, 1996; Derylo and Szynankiewicz, 1996; Derylo, 1997; Tonev et al., 2001; Dimitrova et al., 2003; Delchev and Stoychev, 2009; Stoyanova and Georgiev, 2014; Styanova et al., 2015).
The purpose of this investigation was to establish the selectivity and stability of some foliar fertilizers, antigraminaceous herbicides

and their tank mixtures on the durum wheat by influence of different meteorological conditions.

MATERIALS AND METHODS

The research was conducted during 2010 - 2012 on pellic vertisol soil type. It was carried out a three factor experiment as a block method in 4 repetitions, on a 20 m^2 harvesting area, after sunflower predecessor. Under investigation was Bulgarian durum wheat cultivar Deyana (*Triticum durum var. valenciae*). Factor A included the years of investigation. Factor B included untreated check and 3 foliar fertilizers - Humustim – 1 l/ha, Lactofol O – 8 l/ha, Masterblend (20-20-20) – 3.5 kg/ha. Factor C included weeded untreated, weeded check and 4 antigraminaceous herbicides - Foxtrot 69 EB (fenoxaprop-ethyl) – 1 l/ha, Axial 050 EC (pinoxaden) - 900 l/ha, Topic 080 EC (clodinafop) - 450 l/ha, Traxos 045 EC (pinoxaden + clodinafop) – 1.2 l/ha.

Complex fertilizers Lactofol O and Masterblend contain nitrogen in amide, ammonium and nitrate forms, easily absorbable phosphorus and potassium, trace elements, amino acids, physiologically active substances, and organic fertilizer Humustim - potassium salts of humic acids and fulvia acids. Both complex foliar fertilizers differ mainly in the nature of the complexing agent – in Lactofol O it is lactic acid, and in Masterblend it is ethylene-diamine-tetra-acetic acid (EDTA).

All of foliar fertilizers, herbicides and their tank mixtures were treated in tillering stage of the durum wheat with working solution 200 l/ha. Mixing was done in the spray tank. Due to investigated herbicides have not antibroadleaved effect the control of broadleaved weeds in all variants was done with the herbicide Secator OD at 100 ml/ha.

The selectivity of herbicides has been established through their influence on grain yield. The math processing of the data was done according to the method of analyses of variance (Shanin, 1977; Barov, 1982; Lidanski, 1988). The stability of foliar fertilizers, herbicides and their tank mixtures for grain yield with relation to years was estimated using the stability variances σ_i^2 and S_i^2 of Shukla (1972), the ecovalence W_i of Wricke (1962) and the stability criterion YS_i of Kang (1993).

RESULTS AND DISCUSSIONS

The data showed that the lowest grain yield is obtained in weeded and untreated check (Table 1). At self-use of herbicides Foxtrot, Axial, Topic and Traxos grain yield increases because the weeds are destroyed. The increase is at least by Foxtrot - 6.9%, and the highest by Traxos - 8.5%. The increasing of grain yield is greatest at the herbicide Traxos because it is controlled at a large number of graminaceous weeds including *Bromus arvensis*. The reason for the effective control of *Bromus arvensis* at Traxos is synergism in combination of active substances - pinoxaden and clodinafop. Herbicides Axial and Topic which containing respective only pinoxaden and clodinafop cannot control this grassy weed. Herbicide Foxtrot except against *Bromus arvensis* is ineffective against *Lolium multiflorum* and *Lolium temulentum*.

Self-use treatment of organic foliar fertilizer Humustim and complex foliar fertilizers Lactofol and Masterblend increases grain yield because they stimulate the growth and development of durum wheat. The increase ranged from 4.4% by Humustim to 5.7% by Masterblend. The self-use of fertilizers lead to less increase than self-use of antigraminaceous herbicides due to available graminaceous weeds neutralize some of the positive effects. At all of variants, the fight against annual and perennial broadleaved weeds is done with antibroadleaved herbicide Secator which was treated 10 days after treatment of the investigated preparations.

It is established manifestations of antagonism by concurrent use of antigraminaceous herbicide Foxtrot with three foliar fertilizers Humustim, Lactofol and Masterblend. The grain yields are unproven higher than those in the self-use of these preparations. The increase in grain yield is only 0.6% to 0.9%. The mixing of fertilizers Humustim, Lactofol and Masterblend with the other three antigraminaceous herbicides Axial, Topik and Traxos not lead to antagonism. They have an additive effect. At these tank mixtures grain yield and herbicidal effect is equal to the aggregate effect of these fertilizers and antigraminaceous herbicides. The increase of grain yield is the bigger in tank mixture Humustim + Traxos. The increase is 10.4% or 445 kg/ha average for the investigated period.

Table 1. Grain yield, $kg*ha^{-1}$

Variants		2010		2011		2012	
Foliar fertilizers	Herbicides	$kg*ha^{-1}$	%	$kg*ha^{-1}$	%	$kg*ha^{-1}$	%
	-	4300	100	4106	100	4567	100
	Foxtrot	4584	106.6	4393	107.0	4891	107.1
-	Axial	4618	107.4	4439	108.1	4932	108.0
	Topic	4623	107.5	4434	108.0	4941	108.2
	Traxos	4644	108.0	4459	108.6	4969	108.8
	-	4472	104.0	4303	104.8	4767	104.3
	Foxtrot	4605	107.1	4069	99.1	4946	108.3
Humustim	Axial	4752	110.5	4439	108.1	5015	109.8
	Topic	4739	110.2	4434	108.0	5033	110.2
	Traxos	4773	111.0	4476	109.0	5074	111.1
	-	4506	104.8	4320	105.2	4814	105.4
	Foxtrot	4644	108.0	4114	100.2	4987	109.2
Lactofol O	Axial	4696	109.2	4483	109.2	4955	108.5
	Topic	4709	109.5	4521	110.1	4969	108.8
	Traxos	4739	110.2	4480	109.1	5024	110.0
	-	4494	104.5	4295	104.6	4928	107.9
	Foxtrot	4687	109.0	4196	102.2	4942	108.2
Masterblend	Axial	4801	111.6	4488	109.3	5015	109.8
	Topic	4730	110.0	4480	109.1	4992	109.3
	Traxos	4700	109.3	4444	108.3	4956	108.5

LSD, $kg*ha^{-1}$:

F.A	p≤5%=128	p≤1%=137	p≤0.1%=148
F.B	p≤5%=132	p≤1%=143	p≤0.1%=155
F.C	p≤5%=136	p≤1%=148	p≤0.1%=164
AxB	p≤5%=156	p≤1%=174	p≤0.1%=195
AxC	p≤5%=163	p≤1%=183	p≤0.1%=207
BxC	p≤5%=172	p≤1%=196	p≤0.1%=224
AxBxC	p≤5%=226	p≤1%=266	p≤0.1%=314

Analysis of variance for grain yield (Table 2) shows that the years have the highest influence on grain yield – 53.9% on the variants. The strength of influence of foliar fertilizers is 1.0% and the strength of influence antigraminaceous herbicides is 9.6%. The reason is the large differences in the meteorological conditions during the three years of investigation. The influence of years and of herbicides is very well proven at p≤0.01. The influence of foliar fertilizers is well proven at p≤0.1. There is a well proven interaction between foliar fertilizers and meteorological conditions of years (AxB) – 1.0%, between antigraminaceous herbicides and meteorological conditions of years (BxC) – 1.7% and between foliar fertilizers and antigraminaceous herbicides (BxC) – 1.7%. They are proven at p≤0.1. The interaction between three experiment factors (AxBxC) is not proven.

Based on proven foliar fertilizer x year interaction and antigraminaceous herbicide x year interaction, it was evaluated stability parameters for each variant for grain yield of durum wheat with relation to years (Table 3). It was calculated the stability variances σ_i^2 and S_i^2 of Shukla, the ecovalence W_i of Wricke and the stability criterion YS_i of Kang.

Stability variances (σ_i^2 и S_i^2) of Shukla, which recorded respectively linear and nonlinear interactions, unidirectional evaluate the stability of the variants. These variants which showed lower values are considered to be more stable because they interact less with the environmental conditions. Negative values of the indicators σ_i^2 and S_i^2 are considered 0. At high values of either of the two parameters - σ_i^2 and S_i^2, the variant are regarded as unstable. At the ecovalence W_i of Wricke, the higher are the values of the index, the more unstable is the variant.

Table 2. Analysis of variance for grain yield

Source of variation	Degrees of freedom	Sum of squares	Influence of factor, %	Mean squares
Total	179	175104	100	-
Tract of land	2	45240	25.8	22620.0***
Variants	59	122732	70.1	2080.2***
Factor A – Years	2	94348	53.9	47174.0***
Factor B – Foliar fertilizers	3	1744	1.0	581.3**
Factor C – Herbicides	4	16836	9.6	4209.0***
AxB	6	1820	1.0	303.3**
AxC	8	2964	1.7	370.5**
BxC	12	2936	1.7	244.7**
AxBxC	24	2094	1.2	86.8
Pooled error	118	7132	4.1	60.4

*p≤5% **p≤1% ***p≤0.1%

Table 3. Stability parameters for the variants for grain yield with relation to years

Variants						
Foliar fertilizers	Herbicides	$\bar{x}$	σ_i^2	S_i^2	W_i	YS_i
-	-	4324	75.4	2.3	153.7	-2
	Foxtrot	4623	38.7	29.5	87.7	7
	Axial	4663	53.2	49.0	113.8	10+
	Topic	4666	36.0	41.5	82.9	11+
	Traxos	4691	92.5	99.0	44.4	12+
Humustim	-	4513	92.9	37.7	185.2	1
	Foxtrot	4540	978.1**	358.3*	1778.6	-7
	Axial	4735	14.2	38.5	43.6	18+
	Topic	4735	9.5	8.7	35.1	18+
	Traxos	4774	5.2	1.1	27.5	23+
Lactofol O	-	4547	45.6	35.4	100.2	2
	Foxtrot	4582	563.6**	166.1	1032.1	-3
	Axial	4711	55.1	-6.0	117.3	15+
	Topic	4733	96.1	2.2	194.7	16+
	Traxos	4748	-7.3	-6.1	4.9	20+
Masterblend	-	4572	196.5	71.5	375.3	1
	Foxtrot	4608	487.8**	454.4**	896.1	-2
	Axial	4768	52.4	95.7	112.4	21+
	Topic	4734	11.5	-3.7	38.9	17+
	Traxos	4700	13.7	0.3	42.8	12+

On this basis, using the first three parameters of stability, it is found that the most unstable are tank mixtures of herbicide Foxtrot with foliar fertilizers Humustim, Lactofol O and Masterblend. In these variants values of stability variance σ_i^2 and S_i^2 of Shukla and ecovalence W_i of Wricke are the highest and mathematically proven. The reason for this high instability is greater variation in grain yields during years of experience as weather conditions affect those most. At tank mixtures Humustim + Foxtrot and Masterblend + Foxtrot, instability is linear and nonlinear types - proven values σ_i^2 and of S_i^2. At tank mixture Lactofol O + Foxtrot instability is linear type - proven values σ_i^2, the values of S_i^2 are not proven. Other tank mixtures between foliar fertilizers and antigraminaceous herbicides exhibit high stability because they interact poorly with the conditions of years.

To evaluate the complete efficacy of each tank mixture between foliar fertilizer and antigraminaceous herbicide should be considered as its effect on grain yield of durum wheat and its stability - the reaction of wheat to this variant during the years. Valuable information about the value of technologic value of the variant give the stability criterion YS_i of Kang for simultaneous assessment of yield and stability, based on the reliability of the differences in yield and variance of interaction with the environment. The value of this criterion is experienced that using nonparametric methods and warranted statistical differences we get a summary assessment aligning variants in descending order according to their economic value.

Generalized stability criterion YS_i of Kang, taking into accounts both the stability and value of yields gives a negative assessment of weeded, untreated control and tank mixtures Humustim + Foxtrot, Lactofol O + Foxtrot and Masterblend + Foxtrot, characterizing them as the most unstable and low yields. According to this criterion, the most valuable technology appears tank mixtures Humustim + Traxos, Masterblend + Axial, Lactofol O + Traxos, Humustim + Axial, Humustim + Topik, Masterblend + Topic, Lactofol O + Topic, Lactofol O + Axial and Masterblend + Traxos. These tank mixtures combine high levels of grain yield and high stability of this index during the years. From the viewpoint of technology for durum wheat growing, high rating also have self-use of herbicides Axial, Topic and Traxos, but without Foxtrot. These herbicides combine relatively good grain yields with high stability during the years of the investigation. Variants with self-use of foliar fertilizers Humustim, Lactofol O and Masterblend without a partner herbicide get low ratings and they to be avoided. In these variants, the positive effect of the foliar fertilizer use is neutralized by the negative effect of the present weeds, because of the absence of effective chemical control against them.

CONCLUSIONS

There is antagonism of combined use by antigraminaceous herbicide Foxtrot with three foliar fertilizers Humustim, Lactofol O and Masterblend. The grain yield increase in compared to self-use of the preparations is only 0.6 - 0.9%.

There is an additive effect by tank mixtures of fertilizers Humustim, Lactofol O and Masterblend with antigraminaceous herbicides Axial, Topic and Traxos. The highest grain yields are obtained by these tank mixtures.

Tank mixtures of herbicide Foxtrot with foliar fertilizers Humustim, Lactofol O and Masterblend are the most unstable for grain yield.

Tank mixtures of herbicides Axial, Topik and Traxos with organic foliar fertilizer Humustim and complex foliar fertilizers Lactofol O and Masterblend are technological the most valuable. They combine high grain yield with high stability with relation to different years.

Self-use of foliar fertilizers Humustim, Lactofol O and Masterblend without herbicides have low estimate and do not be used in the durum wheat crops.

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THE EFFICIENCY USE OF DOUBLED-HAPLOID TECHNOLOGY IN MAIZE BREEDING – OBTAINING DH PARENT LINES AND HYBRIDS

Georgeta DICU[1,2], Stelica CRISTEA[1]

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, 011464, Bucharest, Romania
[2]Procera Genetics SRL, 47 Muncii Street, 915200, Fundulea, Călăraşi County, Romania

Corresponding author email: georgeta.dicu@procera.ro

Abstract

The current challenge faced by the breeders and maize growers worldwide is the pressure determined by the climate changes causing the expansion of desertification phenomenon and aggravating the draught in soil and the atmospheric heat. Considering these aspects, for market introduction of the new maize hybrids improved in terms of their main characters, breeders have perfected and developed doubled-haploid technology, so now all the multinational companies use this technology widely in obtaining doubled-haploid lines.
The aim of this paper is to present the doubled-haploid parent lines and hybrids obtained through using doubled-haploid technology in maize breeding program. In this respect, there were used Procera Haploid Inducers (PHI) which have been obtained into Procera Genetics maize breeding program. Researches were conducted within the maize breeding fields belonging to the Procera Genetics Ltd Company.

***Key words**: maize, doubled-haploid, haploid inducer, heterosis, hybrids.*

INTRODUCTION

The use of haploid plants in the breeding was possible after detection of the line Stock 6 (Coe, 1959), which has the ability to induce maternal haploids with a frequency of 2%, while the appearance through the natural way of the maize haploids is 0.1%.
The doubled-haploid method greatly reduces the time required to develop new parent inbreds. Observation, testing and selection work is conducted on these newly developed lines. The goals of the traditional method and the doubled-haploid technology are the same. However, the doubled-haploid technology reaches those goals much faster.
Advantages of using DH lines in hybrid breeding include: maximum genetic variance in line per se and testcross trials, high reproducibility of early-selection results, high efficiency in stacking targeted gene arrangements and simplified logistics (Röber et al., 2005).
The first objective is to develop an inbred parent line that has the same genes on both the left and right chromosome of the pair. This is called a genetically stable or homozygous inbred.
The second stage is to select the best of the newly developed inbreds through an intense breeding and testing program.
An inbred parent line must be homozygous or genetically stable so that it will produce the hybrids year by year and it can be certain the hybrids are the same genetically, and they have the same agronomic performance potential, each time they are produced.
The double haploid technology is much faster and can produce a new, genetically stable inbred line in one year. The plants in the genetic population (germplasm pool) are pollinated with a haploid inducer.
When the harvested kernels are planted, they produce haploid plants. A haploid plant has only one chromosome from each pair. One can say that a haploid plant has ten single chromosomes, while a normal plant has ten pairs of chromosomes.
The haploid plants are subjected to a special treatment compound that causes the single chromosome to double – think of it as making a "photocopy" of the chromosome. This "photocopy" is genetically identical to the original.

Doubled-haploid (DH) technology versus Traditional breeding technology

The DH technology shortens the breeding cycle significantly by rapid development of completely homozygous lines (in 2-3 generations), instead of the conventional inbred line development process, which takes at least 6-8 generations to derive lines with ~99% homozygosity (Forster and Thomas, 2005; Geiger and Gordillo, 2009; Chang and Coe, 2009).

Doubled-haploid technology:

1. First generation: obtaining haploids: donors x haploid inducers; haploids selection.
2. Second generation: doubling haploids; obtaining DH lines.
3. Third generation: increase DH lines and their crossing with testers for combining ability, marker assisted selection (MAS).
4. Fourth generation: hybrids testing for level of high heterosis and selection of the advanced DH lines.

Traditional breeding technology:

1. First generation: selfing F1 populations.
2. Second generation: selfing F2 populations, phenotypic selection.
3. Third generation: selfing F3 lines, phenotypic selection, marker assisted selection (MAS) and early testing for general combining ability (GCA).
4. Fourth generation: Hybrids testing for level of high heterosis, selfing F4 lines, phenotypic selection.
5. Fifth generation: selfing F5 lines, phenotypic selection, testing for specific combining ability (SCA).
6. Sixth generation: hybrids testing for level of high heterosis and the main morphological, physiological and agronomic traits, selfing and selection F6 lines.
7. Seventh generation: maintaining and increase parental lines, seed production for advanced hybrids, testing advanced hybrids in a large network.

During maize breeding program, the new inbred parent lines are crossed to make experimental hybrids that are tested for a number of traits, including:

- Yield;
- Moisture;
- Dry Down;
- Stay Green;
- Thousand Grain Weight (TGW);
- Grain Percentage;
- Test Weight;
- Emergence;
- Vigor;
- Phenotypic Uniformity;
- Anthesis-Silking Interval (ASI);
- Stalk Strength;
- Root Strength;
- Disease Resistance;
- Harvest Appearance;
- Plant Height;
- Ear Height;
- Various Grain Quality Traits (protein, starch, oil content).

Haploidy is frequently used in recurrent selection to haploid level.

Single doubled haploid descent recurrent selection will be one of the most efficient methods for low heritabilities and with a rapid development of doubled haploid lines (Gallais, 1990).

The aim of this paper is to present the DH parent lines and hybrids obtained through using doubled-haploid technology in maize breeding program.

MATERIALS AND METHODS

For producing maternal haploids, the haploid inducers are used as the male parents in induction crosses, with the source germplasm or donors as the female parents. Maternal haploids carry both cytoplasm and chromosomes from the donor.

In this study there were used Procera Haploid Inducers (PHI; Figure 1) (Rotarenco et al., 2010), with high inducer rate (HIR), enough and good pollen, good phenotype and very adapted to temperate climate conditions (Table 1).

PHI have been obtained into Procera Genetics maize breeding program, with own funds.

Three synthetic populations belonging to the most important heterotic groups were used as donors, in crossing with PHI for obtaining haploids, respectively doubled-haploid parent lines (Table 2).

Table 1. Main characteristics of the initial and PHI inducers

Inducer	Planting-flowering, days	Plant height, cm.	Haploid-inducing frequency
Stock 6	60	158	1.2%
MHI	65	192	7.2%
PHI-1	55	151	12.1%
PHI-2	60	198	13.0%
PHI-3	70	180	14.5%
PHI-4	65	200	12.8%

Figure 1. Procera Haploid Inducers (PHI): a) PHI-1; b) PHI-2; c) PHI-3; d) PHI-4

Table 2. Obtaining DH parent lines and experimental maize hybrids

Synthetic population	Heterotic group	No. of haploids selected	No. of DH parent lines obtained	No. of DH parent lines selected	No. of DH parent lines selected	No. of hybrids obtained for GCA	No. of hybrids obtained for SCA
SP-01-012SSS	SSS	970	92	60	20	40	100
SP-02-012Lanc.	Lancaster	1025	108	80	20	40	100
SP-03-012Iod.	Iodent	1010	98	70	20	40	100

Stages of obtaining DH parent lines and experimental hybrids were the following:

1. 2012: Fundulea season-SP as donors were crossed with PHI;
2. 2012: winter-haploids seeds have been selected;
3. 2013: Fundulea season-haploids were doubled and have been obtained DH parent lines;
4. 2013-2014: winter season (Chile)-DH parent lines were increased and crossed with two testers each for testing general combining ability;
5. 2014: Fundulea season-DH parent lines were increased, phenotypic selected and hybrids have been tested for the main agronomic traits and high level of heterosis; twenty DH parent lines from each heterotic groups were selected and used in crossing with two testers each;
6. 2015: Fundulea season-DH parent lines selected have been per se tested and crossed with five testers each for testing specific combining ability.

Each SP population was made up of four elite parental lines, very used in registered and commercial Procera maize hybrids.

Researches were conducted within the maize breeding fields belonging to the Procera Genetics Ltd Company, which are located in Fundulea city, Calarasi County, Romania.

RESULTS AND DISCUSSIONS

This paper presents the results obtained with DH parental lines versus parental lines that formed synthetic populations as donors.

The results were obtained in 2014 when DH lines were tested in the observation plots in Fundulea location.

Each plot was made up of two rows, row length was 4.8 meters, the distance between rows 75 cm, and the plant density was 68,000 plants/ha.

Each trial was made up of 24 lines, 20 DH parent lines and the 4 initial parental lines that were the controls of the trial.

In total, there were three trials, one for each set of DH parental lines belonging to the three synthetic populations.

Important per se traits that have been taken in the initial study were the following:

- phenotypic uniformity;
- anthesis-silking interval (ASI);
- stay green;
- uniformity of insertion of ear;
- prolificity (two cobs per plant).

For the following traits: phenotypic uniformity, stay green, and uniformity of insertion of ear, the scoring system was with notes: 1-very weak, 9-very good. Anthesis-silking interval (ASI) was noted in days between anthesis and silking, and prolificacy (two cobs per plant) was noted in percent.

For the first set of DH lines belonging to synthetic population SP 01-012SSS the results are presented in Table 3.

It can be observed that for all traits studied DH parent lines are superior comparative with parental lines components of synthetic population.

The best results were obtained for ASI and prolificity, two traits involved in atmospheric heat tolerance. When these two traits appear in normal conditions, it means that in conditions of heat stress parental line will have a high tolerance. For ASI trait, number of days noted with minus (-3, -2, -1) that means the lines silking before anthesis.

For the second set of DH parent lines which belong SP-01-012 synthetic population, the results are presented in Table 4.

The best lines for ASI were: SP 02-DH-108 (-2), SP 02-DH-110(-2), SP 02-DH-111 (-3), SP 02-DH-115 (-2), SP 02-DH-116 (-1), and for prolificity: SP 02-DH-104 (78%), SP 02-DH-110 (80%), SP 02-DH-111 (82%), SP 02-DH-113 (76%).

Table 3. Results obtained for first set of DH parent lines comparative with based lines belonging SP-01-012SSS

Line number	Line code	Plants uniformity, note	Anthesis-silking interval (ASI), number of days	Stay-green, note	Uniformity of insertion of ear, note	Prolificity (two cobs per plant), %
1	SP 01-DH-01	9	0	8	9	55
2	SP 01-DH-02	8	0	8	9	68
3	SP 01-DH-03	9	1	8	9	65
4	SP 01-DH-04	9	0	8	8	60
5	SP 01-DH-05	8	0	9	9	78
6	SP 01-DH-06	9	0	7	9	80
7	SP 01-DH-07	8	1	9	9	82
8	SP 01-DH-08	8	-1	9	8	75
9	SP 01-DH-09	8	-2	7	8	68
10	SP 01-DH-10	9	-1	8	9	55
11	SP 01-DH-11	8	-2	8	9	59
12	SP 01-DH-12	9	-2	8	9	60
13	SP 01-DH-13	8	-2	9	9	75
14	SP 01-DH-14	8	-3	7	8	66
15	SP 01-DH-15	8	0	9	9	78
16	SP 01-DH-16	9	0	8	8	82
17	SP 01-DH-17	9	0	8	9	80
18	SP 01-DH-18	9	-1	8	8	67
19	SP 01-DH-19	9	-2	8	9	55
20	SP 01-DH-20	9	-3	9	9	75
21	PL-01SSS	7	0	8	8	33
22	PL-02SSS	6	2	7	7	59
23	PL-03SSS	7	1	7	8	67
24	PL-04SSS	7	3	8	8	56

Table 4. Results obtained for second set of DH parent lines comparative with based lines belonging SP-02-012Lanc

Line number	Line code	Plants uniformity, note	Anthesis-silking interval (ASI), number of days	Stay-green, note	Uniformity of insertion of ear, note	Prolificity (two cobs per plant), %
1	SP 02-DH-101	8	1	9	8	53
2	SP 02-DH-102	8	0	9	9	48
3	SP 02-DH-103	8	0	8	8	66
4	SP 02-DH-104	9	0	9	8	78
5	SP 02-DH-105	7	0	8	9	66
6	SP 02-DH-106	9	0	9	9	56
7	SP 02-DH-107	9	1	8	9	53
8	SP 02-DH-108	9	-2	7	8	60
9	SP 02-DH-109	8	0	9	8	72
10	SP 02-DH-110	8	-2	9	8	80
11	SP 02-DH-111	8	-3	8	9	82
12	SP 02-DH-112	9	0	8	7	56
13	SP 02-DH-113	8	0	7	9	76
14	SP 02-DH-114	9	0	9	8	73
15	SP 02-DH-115	8	-2	7	9	74
16	SP 02-DH-116	9	-1	9	8	67
17	SP 02-DH-117	8	0	9	9	59
18	SP 02-DH-118	9	0	9	8	68
19	SP 02-DH-119	9	1	9	8	55
20	SP 02-DH-120	8	2	8	9	72
21	PL-101Lanc.	8	2	7	7	48
22	PL-102Lanc.	7	1	8	8	61
23	PL-103Lanc.	8	0	7	8	51
24	PL-104Lanc.	8	2	7	7	43

Table 5. Results obtained for second set of DH parent lines comparative with based lines belonging SP-03-012Iod

Line number	Line code	Plants uniformity, note	Anthesis-silking interval (ASI), number of days	Stay-green, note	Uniformity of insertion of ear, note	Prolificity (two cobs per plant), %
1	SP 03-DH-201	9	-1	8	8	67
2	SP 03-DH-202	9	0	8	8	73
3	SP 03-DH-203	9	0	8	8	71
4	SP 03-DH-204	8	1	9	9	76
5	SP 03-DH-205	7	0	8	9	70
6	SP 03-DH-206	8	-2	9	9	69
7	SP 03-DH-207	8	-2	9	9	78
8	SP 03-DH-208	9	0	8	9	78
9	SP 03-DH-209	8	1	7	8	73
10	SP 03-DH-210	9	0	9	9	70
11	SP 03-DH-211	9	0	9	8	69
12	SP 03-DH-212	9	2	9	9	81
13	SP 03-DH-213	8	1	8	7	75
14	SP 03-DH-214	9	-2	9	9	77
15	SP 03-DH-215	8	0	8	9	68
16	SP 03-DH-216	9	0	9	9	72
17	SP 03-DH-217	8	1	8	8	56
18	SP 03-DH-218	9	-2	9	9	73
19	SP 03-DH-219	7	-3	9	9	68
20	SP 03-DH-220	9	-1	9	8	80
21	PL-201Iod.	7	1	8	8	50
22	PL-202Iod.	7	0	6	7	52
23	PL-203Iod.	8	1	7	7	61
24	PL-204Iod.	7	1	7	7	49

For the third set of DH parent lines which belongs SP-03-012Iod synthetic population, the results are presented in the Table 5.
The DH parent lines that performed for ASI were: SP 03-DH-201 (-1), SP 03-DH-206 (-2), SP 03-DH-207 (-2), SP 03-DH-214 (-2), SP 03-DH-218 (-2), SP 03-DH-219 (-3), SP 03-DH-220 (-1), and for prolificity performed the DH parent lines: SP 03-DH-207 (78%), SP 03-DH-208 (78%), SP 03-DH-211 (81%0, SP 03-DH-214 (77%), SP 03-DH-220 (80%).

CONCLUSIONS

From our study it can be concluded that haploid technologies are characterized by the following:

- Allow to reduce time and expenses in maize breeding and to increase the efficiency of selection procedures significantly.
- Reduced expenses.
- Complete homozygosity of doubled-haploid lines
- Phenotipic and genotypic uniformity of doubled-haploid and hybrids
- Increase anthesis-silking interval (ASI), prolificity, stay green.

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INFLUENCE OF FERTILIZATION ON RYE PRODUCTION IN THE SANDY SOILS CONDITIONS FROM SOUTHERN OLTENIA

Iulian DRĂGHICI, Reta DRĂGHICI, Mihaela CROITORU

Research - Development Center for Agricultural Plants on Sands, Dabuleni, Dolj County, Romania

Corresponding author email: iuliandraghici54@yahoo.com

Abstract

The research was conducted during 2012-2014 to the crop of rye, in the sandy soils condition from southern Oltenia, and focused radicular and foliar fertilization effect on the quantity and quality of production of rye. Rye crop was located on a sandy soil, poorly stocked as nitrogen (0.06 to 0.07%), well stocked in extractable phosphorus (65 ppm and 81 ppm) and low to medium stocked in exchangeable potassium (37 ppm and 131 ppm). The results obtained to rye, about the quantity and quality of grain yield at harvest, highlights the experimental variant in which was applied a radicular fertilized with $N_{150}P_{80}K_{80}$ + two foliar fertilizations with Green Plant, which is composed N_9-P_{45}-K_{15} + 6 microelements (first treatment - early spring at the beginning of vegetation in concentration of 0.5% and the second treatment during the formation of the straw, in concentration of 1%), where there was a maximum production of 4278 kg / ha and a content balanced in grain protein (12, 3%) and gluten (26.7%). The radicular fertilization with NPK, has determined to obtain a production increase of 113.5%, compared to unfertilized and the foliar fertilization has led to increased production by 23%, compared to foliar unfertilized.

***Key words**: radicular and foliar nutrition, productivity, quality.*

INTRODUCTION

The recent climate changes have led to the agricultural drought in the sandy soils, with negative implications on growth and development of plants. Therefore, finding solutions to counteract the negative effects of drought is absolutely necessary, and in this regard the cultivation of plants adapted to a specific area, can be successfully a measure of economic growth. Research conducted to the crop of rye, emphasizes plant resistance to drought and very good pretability for sandy soils (Márton, 2002; Gheorghe et al., 2008; Rahnavard, 2009), compared to the wheat. The results obtained in Latvia in terms of fertilization on rye cultivated in conditions of luvisol cambic showed the nitrogen role in increasing production by 66.6 to 70.4%, compared to unfertilized (Nedzinskiene and Asakavičiūte, 2008). The application of fertilizers on irrigated sandy soils presents specific features, determined by soil properties including: complex clay - humic poorly formed and physical and physicochemical capacity reduced for retaining the fertilising substances (Rauta et al., 1979; Hera, 1984). For reducing nitrogen losses by levigating into the groundwater as a nitrate it is necessary to apply nitrogen dose fractionated (Gheorghe et al., 2003). In order to reduce the negative impact which these poor qualities deficient soil have on the plant rye, was followed optimization of fertilization by using radicular and foliar nutrients.

MATERIALS AND METHODS

The investigations were carried out during the culture of rye 2012-2014 in the conditions of sandy soils from southern Oltenia. The study aimed the radicular and foliar fertilization effect on the quantity and quality of rye grain yield, by studying two factors: Factor A - radicular fertilization with 3 graduations and foliar fertilization B- Factor 5 graduations. Experimental factors are shown in Table 2. Phosphorus and potassium fertilizers were administered autumn under plowing base and the nitrogen were administered divided into two stages: one third of the dose at sowing + 2 thirds of the dose in the vegetation (early spring). The foliar fertilization was applied in two stages of plant vegetation (first treatment - early spring at the beginning of vegetation in concentration of 0.5% and the second treatment during the formation of the straw, in concentration of 1%). Determinations were carried out on experimental laboratory chemical characteristics of the soil, the determination of total nitrogen, phosphorus mobile exchangeable potassium, organic carbon and soil reaction. In vegetation were performed the biometric determinations of the plant and the ear, and the harvest was determined and the total protein production of the device Perten grain (grain quality analyzer). The results were interpreted in statistically by analysis of variance and using mathematical functions.

RESULTS AND DISCUSSIONS

The results obtained concerning soil quality, emphasizes a reduced fertility, soil is poorly stocked nitrogen (0.06 to 0.07%), well stocked in extractable phosphorus (65 ppm and 81 ppm) and low to medium stocked in exchangeable potassium (37 ppm and 131 ppm). Reserves of nutrients which them available to plants they are closely related with parental rocks and somewhat proportional with the volume of soil explored by their roots. The variation of climatic conditions can lead to changes in accessibility and potassium uptake by plants. Moisture deficit recorded at a time in the soil requires increased fertilizer application of potassium to combat the decreased accessibility. Organic carbon, presented values in the range 0.29 % - 0.56 %, and the pH of the soil ranged from 5.85 to 6.50, value showing a moderate acidic to neutral reaction. Croitoru Mihaela and Şoimu T., 2001 shows the presence of nitrates in groundwater on different types of soil, in the south-west of the country, over AML 50 mg / l provided to national and international. To preserve and enhance the soil fertility, for his protection and water against pollution with nutrient, is necessary that fertilization to be under supervision so as to ensure the optimum use by the crop nutrient from the soil and to those coming from mineral and organic fertilizers applied. As to the of plant nutrition, pH of the soil has direct implications for mobility and accessibility of soil nutrients (Table 1). The nutrition regime of the plants significantly influence development of the plant rye and the production obtained (Table 2). The application radicular of $N_{150}P_{80}K_{80}$ dose and foliar of two treatments with foliar fertilizer, Green Plant , which is composed N_9-P_{45}-K_{15} + 6 microelements increased the degree of twinning by 2 brothers / plant and plant height by 24.8 cm, compared with unfertilized, which recorded two brothers / plant and plant height 84.7 cm. Also, a balanced fertilizer with macro and micronutrients resulted in increases in of 2.8 cm of ear length and by 14.5 grains / spike, compared to unfertilized. It is observed distinct significant positive correlations between productivity elements (ear length and number of grains per ear) and grain yield obtained from rye (Figures 1 and 2). Maximum production of 4278 kg / ha was obtained in the variant in which the biometric determinations were maximum values.

The results on the quality of the grain rye highlight the influence of fertilization, especially nitrogen dose applied on the content of protein and gluten (Figure 1).

Table 1. The chemical characteristics of sandy soil

Experimental variant	Depth in the soil (cm)	Total nitrogen %	Extractable phosphorus (P-AL) ppm	Extractable potassium (K-AL) ppm	Organic carbon %	pH in water
$N_0P_0K_0$	0-20	0.06	65	70	0,31	6,50
	20-40	0.07	65	54	0,42	6,16
$N_{150}P_0K_0$	0-20	0.07	67	131	0,56	6,17
	20-40	0.09	68	51	0,24	6,03
$N_{150}P_{80}K_{80}$	0-20	0.07	68	37	0,53	5,95
	20-40	0.07	81	70	0,29	5,86

Table 2. Influence of radicular and foliar fertilization on the research results obtained from rye, under the conditions of sandy soils

Nr. var.	Experimental variant			Nr. brothers / plant	Plant height (cm)	Ear length (cm)	No. grains per ear	Grain yield	
	Radicular fertilization (A Factor)	Foliar fertilization (B Factor)						Kg / ha	The difference compared to the control
		Foliar fertilizer name	Content foliar fertilizer (N-P-K + microelements)						
1	$N_0P_0K_0$	Unfertilized	-	2	84.7	10.7	29.4	1510	control
2		Green Plant	26-5-12+Zn	2.3	71.1	11.5	30.5	1855	345
3		Green Plant	20-20-20+microelem.	2.6	88.8	12	36.15	1978	468
4		Green Plant	9-45-15+6 microelem	2.3	88.4	11,75	34.9	1983	473
5		Timasol	15-15-30+13 microelem	2	88.8	12.05	36.5	2033	523*
6	$N_{150}P_0K_0$	Unfertilized	-	2.6	87.95	11.25	35.5	2006	control
7		Green Plant	26-5-12+Zn	3	90.3	12	36,5	2305	299
8		Green Plant	20-20-20+microelem.	2.6	98.25	12.15	41.4	2578	572*
9		Green Plant	9-45-15+6 microelem	3.3	96.2	12.35	41.75	2697	691**
10		Timasol	15-15-30+13 microelem	3.6	100.25	12.25	42	2655	649**
11	$N_{150}P_{80}K_{80}$	Unfertilized	-	3.3	94	11.8	41.8	3630	control
12		Green Plant	26-5-12+Zn	3,6	96	12.5	42.5	3977	347
13		Green Plant	20-20-20+microelem.	3.6	103.3	12.8	43.8	3989	359
14		Green Plant	9-45-15+6 microelem	4	109.5	13.5	44.3	4278	648**
15		Timasol	15-15-30+13 microelem	3.6	106	13	44.5	4111	481*
Correlation: Length ear x Grain yield			Y = 1142.5x - 11060; r = 0.831**						
Correlation: Number of grains per ear x Grain yield			Y = 171.74x – 3885.6; r =0.880**						
LSD 5%									475
LSD 1%									645
LSD 0.1%									864

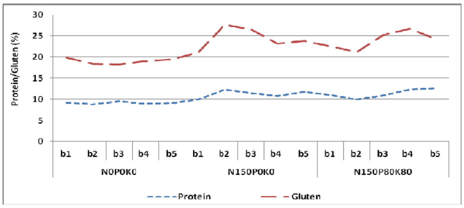

Figure 1. The quality of the production of rye, depending on the regime of plant nutrition

The percentage of protein has presented values ranging from 8.8 to 9.5% in the version without chemical fertilizer, but treated foliar and values between 10.8 to 12.3% in variants fertilized with $N_{150}P_{80}K_{80}$ and also treated foliar. The foliar fertilization with Green Plant product (N_9-P_{45}-K_{15} + 6 microelements) and Timasol product (N_{15}-P_{15}-K_{30} + 13 microelements), on an agrofond $N_{150}P_{80}K_{80}$, has improved the grain quality, by increasing the percentage of protein with 1.3 - 1.6%, compared to unfertilized. The gluten content is a very important quality indicator for the technological process of obtaining bread, contributing to the characterization of dough, especially processing capacity and the potential for its cooking. In sandy soil conditions, the gluten content was between 18.3% in the variant fertilized radicular with $N_{150}P_{80}K_{80}$ and treated foliar with Green Plant (N_{20}-P_{20}-K_{20} + micronutrients) and 27.7% in the variant fertilized with $N_{150}P_0K_0$ and treated with Green Plant (N_{26}-P_5-K_{12}+Zn). The gluten content in grains of rye is smaller compared to that of wheat grains, which is why rye flour is used in bakery products more for baking bread and less for other bakery products (Croitoru Mihaela et al, 2012). If we analyze the average influence of NPK radicular fertilization on rye, are observed differences of production by 2124.2 kg / ha, statistically highly significant as compared to the unfertilized (Table 3). In pedoclimatic conditions of sandy soils with a humus content of less than 1%, the results obtained to rye shows he can be obtained yield increases statistically assured at unilateral application of nitrogen. As to the of grain quality analysis, compared unfertilized the radicular fertilization resulted in increases in the percentage of 2.1 to 2.26% of protein and 4.96 to 5.46% the percentage of gluten. From the three macronutrients applied to rye, nitrogen has been most good.

Also, foliar fertilizers, applied to the culture of rye, have influenced the the production and quality of the grain rye (Table 4). The biggest production of grain was registered by applying in the vegetation two foliar treatments with the product Green Plant, which has in its composition N_9-P_{45}-K_{15} + 6 microelements (first treatment - early spring at the beginning of vegetation in concentration of 0.5% and the second treatment during the formation of the straw, in concentration of 1%). Compared with the untreated control, where there was 10.1% protein and 21.2% gluten, the foliar fertilization has led to increase with 0.3 to 1.1% protein percentage of grain and 1.2 to 2.2 % percentage of gluten.

Table 3. Influence of NPK fertilization on the grain yield obtained from rye

Nr. crt.	NPK dose	Grain yield Kg/ha	Protein %	Gluten %
1	$N_0P_0K_0$	1871.8	9.1	19
2	$N_{150}P_0K_0$	2448.2**	11.28	24.46
3	$N_{150}P_{80}K_{80}$	3997***	11.36	23.96
LSD 5%		268.5		
LSD 1%		444		
LSD 0.1%		832		

Table 4. Influence of foliar fertilization on the grain yield obtained from rye

No. var.	Experimental variants		Grain yield Kg/ha	Protein %	Gluten %
	Foliar fertilizer	Content N-P-K + micro			
1	Unfertilized	-	2382	10.1	21.2
2	Green Plant	26-5-12+Zn	2712.3*	10.4	22.4
3	Green Plant	20-20-20 + microelem.	2848.3**	10.6	23.3
4	Green Plant	9-45-15 + 6 microelem	2986***	10.7	23.0
5	Timasol	15-15-30 + 13 microelem	2933**	11.2	22.5
LSD 5%			287		
LSD 1%			371.5		
LSD 0.1%			598.5		

CONCLUSIONS

The radicular fertilization with $N_{150}P_{80}K_{80}$, and two foliar treatments Green Plant, which is composed N_9-P_{45}-K_{15} + 6 microelements (first treatment - early spring at the beginning of vegetation, in concentration of 0.5% and the second treatment during the formation of the straw, in concentration of 1%), have led to increased twinning degree with 2 brothers / plant, of the plant height with 24.8 cm, of the ear length with 2.8 cm and number of grains per ear with 14.5 grains / ear, compared to unfertilized.

Ensuring an optimal nutrition of the plant, the radicular and foliar fertilization has led to obtain a maximum yield by 4278 kg/ha rye grains and at achieving a balanced protein content (12.3%) and gluten (26.7%).

The radicular fertilization with NPK, has led to increased production by 113.5%, compared to radicular unfertilized, and foliar fertilization has led to increased production by 23%, compared to foliar unfertilized.

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THE STUDY OF SOME CULTIVARS OF COWPEA UNDER CLIMATE CHANGE IN SOUTHERN OLTENIA

Reta DRĂGHICI, Iulian DRĂGHICI, Mihaela CROITORU

Research - Development Center for Agricultural Plants on Sands, Dabuleni, Romania

Corresponding author email: retadraghici@yahoo.com

Abstract

The research was conducted during 2012-2015 in Research - Development Center for Agricultural Plants on Sands Dabuleni, and were aimed the study of 16 cultivars of cowpea in a comparative culture of competition, in order to introduce culture of the most valuable. In sandy soil conditions, the cultivars of cowpea registered a vegetation period in 92-109 days, requiring approximately 1997.2 to 2499.9°C, for maturing. The earliest varieties were: Aura 26, Aura, D4-1, Ofelia, and most late were Jiana, D12 / 2000 cowpea cultivars. The results concerning the productivity elements made from cowpea, indicate values differentiated by cultivar. They were marked by high levels of productivity elements, Aura 26, Ofelia, D2-b / 93, Aura, D2-3a, D3-5 cultivars, which recorded over 11 pods / plant and over 10 grains / pod. Between leaf area index (L.A.I.) and grain yield obtained at cultivars of cowpea, there is a distinct significantly negative correlation. The cultivars of cowpea, which have developed a value of L.A.I. by 5 to 5.4, were recorded the highest grain yields of 2603.7 to 2857 kg/ha (Ofelia, Aura, Aura 26, D2-3a, D3 / 93). Analysis on grain quality by cowpea cultivars, studied in sandy soils conditions, reflects an average protein by 22.4%, with values within limits from 20.5 to 23.8% and fats content with an average of 2.5%, which varied depending on the cultivar, between 1.9 to 2.9%.

Key words: *drought resistance, foliar index, productivity, quality.*

INTRODUCTION

Food safety is based, among other, and ensuring the genetic progress in agriculture, which is based on the evaluation of existing germplasm resources and from their specificity for a particular area (Draghici, 1999, 2003; Demooy, 1989). Originally from Central Africa, cowpea (*Vigna unguiculata* L. Walp), by biological characteristics of the plant, concerning increased resistance to drought and reduced requirements compared to soil fertility, can be a good alternative plant for bean and soybean, crop plants very sensitive to stress factors in areas with excessive drought (Marinica,1994; Sinclair et. al., 2015). As a result of the high content of protein, both in the plant and in grain, cowpea is considered the queen of areas with psamosoils, having multiple uses: human nutrition in the form of pods or beans, improvement of soil fertility by cultivating of the plant at crop rotations on sands, or by incorporation into the soil as green manure (Petre, 1981), in animal nutrition, through its participation, along sorghum and rye, when constituting dried fodder and ensiled (Ajeigbe and Singh, 2010). Due to of biological and morphological characteristics (very strong root system, a high power absorption a wax layer on the leaf, which imprints a greater resistance to thermo-hydric stress conditions and the possibility of biological fixation of atmospheric nitrogen using symbiotic bacteria of the genus Rhizobium), cowpea are grown successfully in crop rotations from sandy soils area in Nigeria (Hamidou et al., 2007) and Romania (Draghici, 2000; Celac, 2009). The choice of variety with the best adaptability to dry areas, is a priority for research in terms of climate change.

MATERIALS AND METHODS

The research was conducted during 2012-2015 in Research - Development Center for Agricultural Plants on Sands, Dabuleni, and were aimed the study of 16 cultivars of cowpea in a comparative culture of competition, in order to introduce in culture of the most valuable. Experience has been placed on a sandy soil, with low natural fertility, containing 0.6 to 0.95% humus, being characterized as poorly stocked in nitrogen (0.07 to 0.075%), well stocked in extractable phosphorus (72 ppm and 88 ppm) and low to medium stocked in exchangeable potassium values (51 ppm and

117 ppm). In vegetation, have been registered determination for resistance cowpea cultivars by pathogens and pests, biometry measurements and plant productivity, and at harvest were determined quantity and quality of the production achieved (protein and fats). The results were interpreted in statistically, by analysis of variance and using mathematical functions.

RESULTS AND DISCUSSIONS

The climatic conditions prevailing in the sandy soils of southern Oltenia during 2012-2015, emphasizes accentuation of drought during the summer months, compared to the multiannual average (Figure 1), poor conditions for plant growth and development in this area. The phenomenon was accentuated during July - August, through increase of the average air temperature by 1.4-1.7^{o}C, against the background recording a monthly average of 44.9 mm rainfall, which is of a non-uniform distribution.

Though rainfall recorded during the study period was above the multiannual average, was needed application 2-3 waterings with a watering rate of 150-200 m^3 of water, for completing consumption to cowpea plant, by 4160 m^3, which is half the rate of consumption of soya (Marinică, 1994).

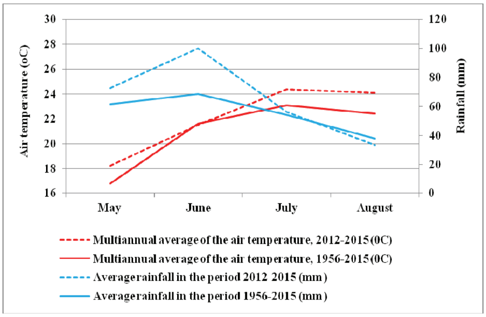

Figure 1. Climatic conditions prevailing at the meteorological station from R&DCFCSS Dabuleni

In sandy soil conditions, cultivars by cowpea have reached maturity over the course of 92-109 days, requiring approximately 1997.2 to 2499.9 ^{0} C. The earliest cultivation were: Aura 26, Aura, D4-1, Ofelia, and most delayed have been: Jiana, D12 / 2000 (Table 1).

Table 1. Biometric determinations regarding the development of the plant by cultivars cowpea

No.var.	Cowpea cultivars	Plant height (cm)	Foliar surface of one leaf (cm^2)	Leaf area index L.A.I.	The vegetation period days	∑^{o}C
1	Jiana	130.3	70.0	6.9	109	2499.6
2	Aura	110.5	54.0	5.0	93	2125.2
3	Aura 26	107.9	62.3	5.3	92	1997.5
4	Ofelia	120.7	62.4	5.4	98	2225.4
5	D2-3a	110.3	66,5	5.3	101	2289.2
6	D3-5	125.6	59,1	4.6	100	2281.3
7	D4-1	130.3	56.6	5,8	96	2176.7
8	D4-4	143.8	59.7	5,6	99	2251.2
9	D5-3	100.2	58.5	5,8	98	2235,9
10	D2-b/93	125.3	70.1	6.7	99	2267,7
11	D3/93	120.8	65.3	5.3	100	2285,8
12	D9/2001	120.7	63.4	6.1	100	2304.0
13	D12/2001	141.3	69.4	6.9	103	2359.6
14	D14/2001	123.8	56.7	5.4	100	2288.9
15	D8/2000	100.4	49.4	4.4	103	2365.4
16	D12/2000	143.2	69.3	6.5	104	2381.2
Average		122.2	62.0	5.7	99.7	2270.9

The cultivars studied, have recorded an average of plant height by 122.2 cm and a average of foliar surface of one leaf by 62 cm^2. Competition intraspecific of the plants, is conducted during foliar system development and root system, and the results show that it achieved greater increases by biomass energy as the plant is cultivated in an area as similar to of origin (Dadson, RB, 2005). The results obtained during the testing shows that cultivars by cowpea have developed a rich vegetative mass, with an index of leaf area, determined during blossoming period, by 4.4 to 6.9, based on which can be selected cowpea cultivars destination production of grain or biomass. Between the leaf area index and the production of grain, obtained from cowpea, there is a distinct negative significant correlation (Figure 2).

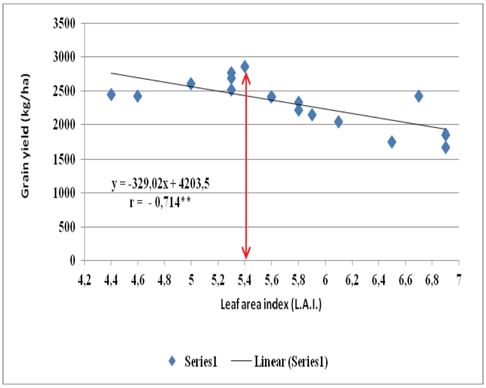

Figure 2. The correlation between leaf area index (LAI) and grain yield obtained from cowpea

The cowpea cultivars which developed an L.A.I. by 5 to 5.4 registered the highest yields of grain of 2603.7 to 2857 kg/ha (Ofelia, Aura, Aura 26, D2-3a, D3 / 93). As the cowpea cultivars developed a luxuriant vegetative mass, the process of fructification of the plant was lower, because light could not get to the flower vexil, essential condition in the process of fecundation of pollen. Analyzing the behavior by cowpea cultivars to attack pathogens and pests, under natural infection (Table 2), can notice a good behavior to Cowpea aphid borne virus infection, the frequency of plant attacked being in the range from 0 to 4.7. Infection with Aphyis fabae of cowpea plant has a frequency range from 10.2 to 75%. At this pest, showed higher sensitivity cultivars D4-1, D3 / 93 and D12 / 2000. At harvest were determined frequency grains attacked by Acanthoscelides obtectus, and the results highlight as tolerant 11 cultivars and 5 cultivars with higher sensitivity, being attacked with a frequency greater than 50%.

Table 2. Resistance cultivars by cowpea to attack pathogens and pests

No. var.	Cultivars	The frequency of infection (%)		
		Virusul Cowpea aphid borne	Aphis fabae	Acanthos celides obtectus
1	Jiana	0	10.2	25
2	Aura	0	20.7	35
3	Aura 26	0	21.3	34
4	Ofelia	0	25	38
5	D2-3a	1	16.3	50
6	D3-5	1	24	33
7	D4-1	1	75	22
8	D4-4	1.3	33.1	28
9	D5-3	0	24	75
10	D2-b/93	0	25.6	48
11	D3/93	1	62.3	55
12	D9/2001	1	25.4	50
13	D12/2001	4.7	15.3	25
14	D14/2001	0	18.6	26
15	D8/2000	0	43.5	38
16	D12/2000	1	68.5	62
Scale frequencies to pathogens	0-5 5.1-10	HR – Highly resistant R- Resistant		
Scale frequencies to pests	0-50 50.1-100	T – tolerant S- Sensitive		

The results concerning the productivity elements registered to cowpeas (Figure 3) indicates values differentiated depending on cultivar. The number of pods per plant varied within the limits of 7 to 13.6 pods / plant, with an average of 10.2 pods / plant. The number of grains per pod ranged from 10.1 to 12.2 and an average of 10.7 grains / pod and pod length was from 13.8 to 16.9 cm, with an average of cultivars by 15.1 cm. Were revealed through high values of productivity elements the cowpea cultivars: Aura 26, Ofelia, D2-b/93, Aura, D2-3a, D3-5, which recorded over 11 pods / plant and over 10 grains / pod.

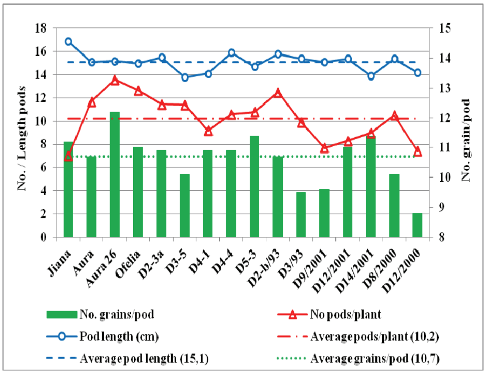

Figure 3. Differentiation the productivity traits registered at cowpea cultivars

Of the 16 varieties of cowpea studied under sandy soils, 10 were different from the statistical point of view, compared to the control genotype, Jiana (Table 3). Were registered very significant differences of production at cultivars Aura 26 and Ofelia, followed by cultivars Aura, D2-3a, D3/93, with production differences distinct significant. Thousand grain weight (TGW) has presented values ranging from 147.5 to 205.5 g, being a character variety.

Table 3. Production results obtained at cowpea cultivars in pedoclimatic conditions of the sandy soils from R&DCAPS Dabuleni

No.var.	Cowpea cultivars	Grain Yield (kg/ha)	The difference compared to the control		Significance	TGW g
			Kg/ha	%		
1	Jiana	1677.2	Control	100	Control	186
2	Aura	2603.7	925.8	157	**	190
3	Aura 26	2771	1083,8	167	***	188.5
4	Ofelia	2857.7	1186,8	172	***	185.5
5	D2-3a	2683.3	1006.1	162	**	168
6	D3-5	2420	742.8	146	*	190
7	D4-1	2331.7	654.5	141	*	189
8	D4-4	2407.7	729.8	145	*	188
9	D5-3	2219	541.8	134	-	147.5
10	D2-b/93	2427	749.8	146	*	153.5
11	D3/93	2513	835.8	152	**	169
12	D9/2001	2044.3	367.1	123	-	205.5
13	D12/2001	1854	176.8	112	-	165
14	D14/2001	2143.7	466.5	129	-	163.5
15	D8/2000	2439	761.8	147	*	183
16	D12/2000	1758.7	81.5	106	-	183

LSD 5% 542.8 kg/ha
LSD 1% 774.5 kg/ha
LSD 0.5% 1028.7 kg/ha

Analyzing the functional link between production and the number of pods per plant, to the 16 cultivation of cowpea experienced in 2012-2015 period, it highlights a positive correlation distinct significant (r = 0.904**), which shows that with increasing number of pods the grain yield obtained recording an upward trend (Figure 4). Also, there is a negative correlation, distinct significantly, between the grain yield and vegetation period (r = - 0.712**). The shortening the vegetation period at cowpea cultivars with higher yield is because to them, the development of shoots from the basal buds is more inhibited, that after the growth of the leaves metafile stems, evolution of generative organs becomes dominant (Drăghici, 1999). The prolongation of vegetation cowpea can be determined, also, by the non-uniformity in baking of the pods, unwanted character in the breeding of this species

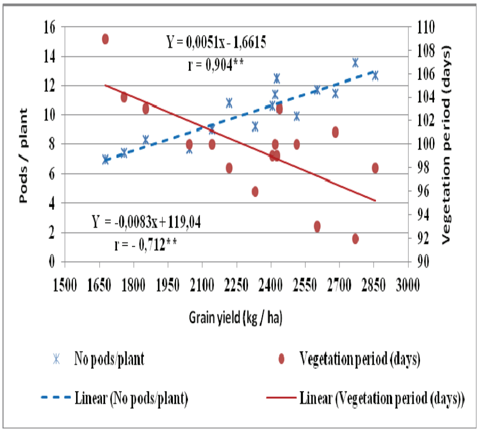

Figure 4. Correlation between the grain yield to cowpea and number of pods / plant and vegetation period

Analysis on grain quality by cowpea cultivars studied in sandy soils conditions, reflects an average protein by 22.4%, with values within limits from 20.5 to 23.8%, emphasizing in this regard cultivars: D12 / 2000, Aura 26, Aura, Ofelia, D2-b / 93, D4-4, D9 / 2001, which exceeded with 0.9 to 2.2%, the control cultivar (Figure 5). The fats content varied depending on the cultivar, from 1.9 to 2.9%, with an average of 2.5%.

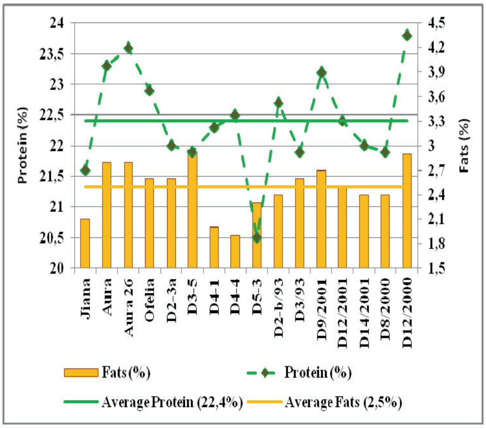

Figure 5. Quality of the cowpea production, depending on the cultivar

CONCLUSIONS

In sandy soil conditions, the cultivars of cowpea registered a vegetation period in 92-109 days, requiring approximately 1997.2 to 2499.9°C, for maturing. The earliest cowpea cultivars were: Aura 26, Aura, D4-1, Ofelia, and most late were Jiana, D12 / 2000.

The results concerning the productivity elements made from cowpea, indicate values differentiated by cultivar. They were marked by high levels of productivity elements, Aura 26, Ofelia, D2-b / 93, Aura, D2-3a, D3-5 cultivars, which recorded over 11 pods / plant and over 10 grains / pod.

The cultivars of cowpea, which have developed a value of leaf area index by 5 to 5.4, were recorded the highest grain yields of 2603.7 to 2857 kg/ha (Ofelia, Aura, Aura 26, D2-3a, D3/93).

Analysis on grain quality by cowpea cultivars studied in sandy soils conditions, reflects an average protein by 22.4%, with values within limits from 20.5 to 23.8% and fats content with an average of 2.5%, which varied depending on the cultivar, between 1.9 to 2.9%.

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INFLUENCE OF DIFFERENT LEVELS OF WATER SUPPLY ON PRODUCTION AND ECONOMIC EFFICIENCY UNDER MAIZE CULTIVATED IN DOBROGEA REGION OF ROMANIA

Cristian Laurentiu DRAGOMIR[1], Elena PARTAL[2]

[1]Agricultural Research and Development Station Valu lui Traian, Constanța, County,
[2]National Agricultural Research Development Institute, Fundulea

Corresponding author email: cl.dragomir@yahoo.com

Abstract

Profitability is one of the most important economic parameters taken into account in any economic activity. The aim of the paper was to establish maize productivity and profitability of some hybrids with different precocity under several levels of water, in the conditions of Romanian Dobrogea region. Economic efficiency was evaluated using specific economic indicators (production cost, net profit and net profit rate) in order to establish which hybrids perform better. Identification, establishment and improvement of technological links to determine and maintain the achievement of high yields in order to reduce costs per hectare, we must determine as specialists, to grant a real influence of technological parameters and climatic conditions. In this study, the main technological parameters are: application of irrigation, the origin of germplasm (hybrids) and the early hybrids.

Key words: *hybrid, maize, yield, irrigation, productivity, profitability.*

INTRODUCTION

Economic efficiency and the yield in irrigated agriculture depend in part on the irrigation regime applied to each crop.

Establishing and applying a rational irrigation regime is aimed at controlling of soil water supply in accordance with plant requirements.

The evolution of the thermal and rainfall regime, in the southeast area of Romania causes an increased moisture deficit, while the average annual values of heat are high (Botzan, 1972).

For optimal irrigation of maize, it is imperative to know when to intervene with watering and how much water to use for every watering (Muresan, 1970).

The hybrid genetic qualities participate decisively in the evolution of plants and thier productivity (Jadav and Shelke, 2006).

In irrigated crop, maize secures approximately 70-80% of necessary water from superficial layer located between 0-80 cm depth.

After irrigation, the yields increase with 60-70% and irrigation also reduces variability of yields from 40-45% to 10-15%: the profitability of irrigated crops compared to non-irrigated crop is clear (Luca, 1996).

MATERIALS AND METHODS

The research was conducted under the conditions of Agricultural Research and Development Station Valu lui Traian - Constanta, on the verma chernozem soil, using the method of split plots:

Factor A - irrigation regime: a1 - irrigated, a2 – irrigated at 50% of recommended amount (350m^3/ha), a3 - full irrigation (700m^3/ha).

Factor B - germplasm, including hybrids: b1 - Turda 145; b2 - Severo, b3 - PR37D25, b4 - Oituz, b5 - Kamelias, b6 - PR36D79, b7 - Rhapsody, b8 - KWS 1394; b9 - PR35F38.

Experience was placed in plots in three repetitions, with the protection zone of 24 m between the variants regime. Water management has been sprinkler irrigation. Measuring the amount of water was performed using rain gauges placed on the column of sprinkler. The technology used in these experiments with corn hybrids was that recommended for the climatic conditions of Dobrogea area.

The preceding crop was: in 2010 - wheat, in 2011 - pea, in 2012 - corn. Complex fertilizer was applied in the autumn: 200 kg/ha of NPK 20:20:0 type, and in the spring, at the seedbed preparation: 200 kg/ha NPK 28:28:0 type. During the growing season, the nitrogen dose was supplemented with 40 kgN/ha. Results have been calculated statistically.

The year 2010 was a particularly rainy year, with a total of 662.8 mm rainfall recorded, respectively with 230.7 mm more than the annual average.

The year 2011 in contrast to the previous one, was particularly dry with a total rainfall of 368.9 mm to 62.7 mm rainfall less than the annual average, and 2012 was dry, to 393.4 mm rainfall recorded at Valu lui Traian and 38.2 mm less than the annual average (Figure 1).

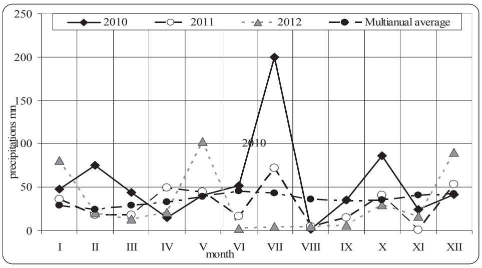

Figure 1. Recorded rainfall in SCDA Valu lui Traian during the years 2010-2012

During the period June-July, when the maize crop is achieved highest water consumption, have been recorded different amounts of water from rainfall: in 2010 to 251.3 mm, in 2011 to 88.1 mm, and in 2012 by 6.9 mm under the annual average.

Deviations from the average mutianuală (71years) of rainfall recorded at Valu lui Traian had large variations, with a peak in 2010 of 156.7 mm in July. The minimum level of rainfall was recorded in June 2012 with a deficit of 43.3 mm.

The average temperature in 2010 was 12.3°C, by 1.3°C above the annual average. Also, the temperatures exceeding average were recorded in June (+1.5°C), July (+1.8°C), august (+4.4°C) and September (+1.9°C).

The average temperature in 2011 was 11.2°C with 0.2°C above the annual average. Temperatures above average were recorded in June (+1.2°C), July (+1.8°C), august (+2.3°C) and September (+3.3°C).

Temperatures recorded in 2012 demonstrates once again increased aridity trend in this area of the country, with temperatures of 2.4°C above the annual average. Deviations from the annual average temperature recorded at Valu lui Traian, showed high variations both on a monthly and annually.

These values confirm that, in Dobrogea, the rainfall is insufficient and unevenly distributed for maize crop (Figure 2).

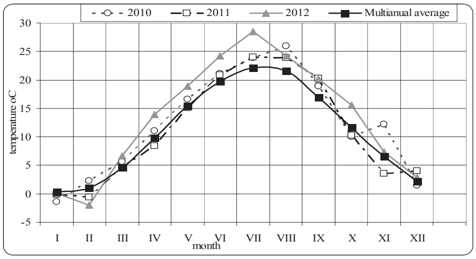

Figure 2. Temperatures recorded in Dobrogea during the years 2010-2012

RESULTS AND DISCUSSIONS

Variation of the climatic conditions from the period of experimentation combined with the influence of technological factors have contributed to production results between very wide limits.

Thus, we can make a real comparison and to establish the best technological variants.

Analyzing the productions obtained was found that cultivated hybrids were different in terms of production capacity depending on the norm of watering and precocity.

The highest yields were recorded for PR35F38-Pioneer hybrids (b9) with 13 901 kg/ha, followed by Rapsodia (b3) with 13 183 kg/ha and KWS-1394 (b8) with 12 970 kg / ha, with full irrigation and late precocity (Figure 3).

The lower productions have realized without irrigation, the hybrid Turda 145 (b1) with 1509 kg/ha under the average. For irrigated with 350 m^3/ha the hybrid KWS Severo (b2) was placed with 1143 kg/ha under the average and for full-time irrigation (700 m^3/ha),

Turda 145 hybrid obtained a production of 9750 kg/ha, with 2460 kg/ha below the average of the testing.

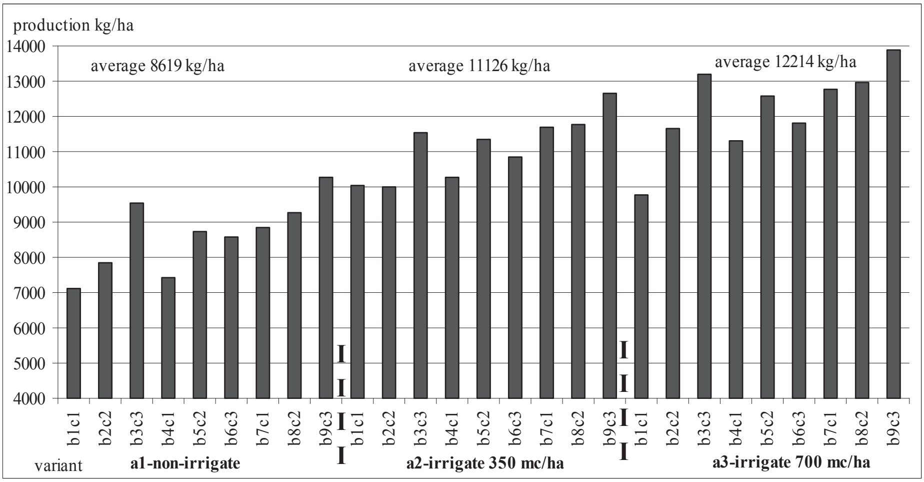

Figure 3. Production obtained according to the technological variants

These results are confirmed by other researcher, who emphasize that the most important tehnological elements is the irrigation, germplasm and precocity (Hall et al., 1982; Năescu şi Alionte, 2008; Ouda et al., 2008; Samakande et al., 2004).

The recorded rainfall and irrigation norms applied, both the 700 m^3/ha and the reduced with 50% (350 m^3/ha) have partially attenuated the effects of drought and contributed decisively to ensure production, particularly in 2012, considering the deficiency rainfall recorded from the annual average of the area.

Analyzing the main elements determining the economic efficiency respectively the profit, profit rate and production, as the average for the entire experimental period, results that the highest profit values were recorded at the hybrid Pionier PR35F38 with late precocity, with 10.590 RON/ha in irrigated full-time (700 m^3/ha) (Table 1).

For irrigation on part-time (350 m^3/ha) were recorded averages of 9678 RON/ha, at the hybrid Pionier PR35F38 with late precocity, compared with non-irrigated variant, at which were obtained lower values with 2144 RON/ha.

Regarding the profit rate, the highest values were recorded at the variant irrigated part-time (350 m^3/ha) with 438 % and the variant irrigated full-time (700 m^3/ha) with 428 %, both at the hybrid Pioneer PR35F38 with late precocity.

The rate of profit indicates a higher profitability for all hybrids, regardless of precocity, with the application of irrigation. This shows that, depending on the source of genetic material, it is necessary to apply the watering (Figure 4).

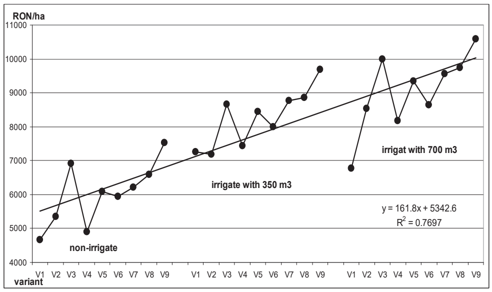

Figure 4. The comparation of profit between variants

The variants with the lowest profit rate was achieved without irrigation, with values between 230-340% for Romanian hybrids, with 235-288 % for KWS hybrids and 295-356 % for Pioneer hybrids, compared with similar variance from full irrigation (700 m^3/ha) who obtained values ranging between 282 to 415% for romanian hybrids, 332-378 % for KWS hybrids and 391-428 % for Pioneer hybrids (Figure 5).

Table 1.The classification of experimental variants under the influence of the profit realized (average 2010-2012)

Class.	Tehnological variants	Production (kg/ha)	Total profit (lei/ha)	Semnification
1	a3b9c3	13901	10590	A
2	a3b3c3	13183	9984	A
3	a3b8c2	12970	9738	AB
4	a3b7c1	12780	9567	AB
5	a2b9c3	12647	9678	AB
6	a3b5c2	12560	9336	ABC
7	a3b6c3	11827	8940	ABC
8	a2b9c2	11767	8854	ABC
9	a2b7c1	11673	8764	ABCD
10	a3b2c2	11637	8535	ABCD
11	a2b3c3	11543	8657	ABCD
12	a2b5c2	11343	8446	ABCDE
13	a3b4c1	11313	8171	ABCDE
14	a2b6c3	10857	7987	ABCDE
15	a2b4c1	10273	7540	BCDE
16	a1b9c3	10267	7534	BCDE
17	a2b1c1	10047	7257	BCDEF
18	a2b2c2	9983	7191	CDEFG
19	a3b1c1	9753	6966	DEFG
20	a1b3c3	9523	6915	DEFG
21	a1b8c2	9263	6598	EFG
22	a1b7c1	8843	6209	FG
23	a1b5c2	8717	6080	GH
24	a1b6c3	8573	5946	GH
15	a1b2c2	7853	5347	HI
26	a1b4c1	7417	4892	HI
27	a1b1c1	7110	4657	I
(Theoretic SD values) RON/ha		2560.2 2890.5 3080.3		

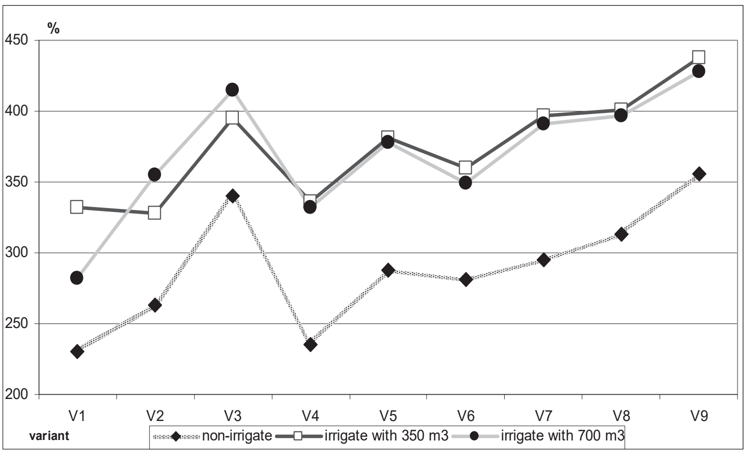

Figure 5. The comparison of profit rates between variants

CONCLUSIONS

1. The rainfall recorded during the experiment confirms that the Dobrogea they are insufficient and unevenly distributed for maize culture.
2. Irrigation rules applied, the norm of 700 m^3/ha and the the norm of 350 m^3/ha have contributed decisively to ensure production, given the deficit of rainfall and drought.
3. The maize crop profitability is dependent on the climatic conditions of the year, agrophytotechnical factors and genetic particuliarities of hybrid (drought tolerance).
4. The economic results underlines productivity and profitability of some variants that show the posibility to cut the watering norm by 50 % (from pedological norm of 750 m^3/ha).
5. In terms of economic perspective, in the climatic conditions existing in the study area, is important the genetic value of the hybrids and the irrigation in the key moments of the plants development.
6. In conclusion, the hybrid selection and application of watering should be done judiciously, depending on the culture and climatic conditions, so that the maize can efficiently exploit the climate and increase economic efficiency.

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ACHIEVEMENTS AND PROBLEMS IN THE WEED CONTROL IN BARLEY (*Hordeum vulgare* L.)

Mitko GEORGIEV, Grozi DELCHEV

Trakia University, 6000, Stara Zagora, Bulgaria

Corresponding author email: mgeorgiev@uni-sz.bg

Abstract

Stated in the literature review gives an idea that many issues are published contrasting views due primarily to the different conditions under which they have conducted experiments and the biological particularities of barley. A serious problem is a resistance and compensatory processes in the weeds. Many authors exported data, which indicate that the barley is different from the common wheat in reaction to some of herbicides, herbicide combinations and reservoir herbicidal mixtures. In the literature there is growing consensus, that periodically have to be make a new mapping of crops and to seek new solutions to chemical control with the changing weed associations.

Key words: *barley, herbicides, weed, yield.*

REVIEW

In recent years, the areas occupied by barley tend to decrease, caused by a series of economic, climatic and other factors. Retaining high and stable yields of barley required optimization all of processes in the technology of cultivation and consideration of climate changes. An important stage in the technology for growing is a crop protection and particular the fight against the weeds. Properly and timely destruction of the weeds guaranteed obtaining high yields of this crop.

Registered in Bulgaria a large number of herbicides in cereals with a different spectrum of activity and changes in weed infestation requires a study of the problem of the efficiency of the herbicides and herbicide combinations, and the sensitivity of the crop to them as well as to propose a cost-effective and efficient scheme for chemical contol of weeds under certain conditions. (Georgiev 2015).

In Bulgaria barley are weeding of approximately 160 weed species, of which 80 are permanent. Distributed by biological groups, they are in the following order: ephemera - 18; early-springs - 26; winter-springs and winter - 30 perennials - 9 species (Kolev, 1963; Andreeva -Fetvadzhieva and Dechkov, 1973; Tityanov, 2006).

Saldzhiev (2002) reported a decrease in yield in the experimental areas of barley by 20.9% to 58.3% depending on the degree of weed infestation. The negative impact of individual species weed in cereals is determined by the combination of its features: period of germination, growth rate, size of the overhead mass, height and branching of stems, shape, size and position of leaves, levels of photosynthetic activity ecological plasticity coefficient of reproduction and others (Haigh, 2000).

In Australia, the yield of barley redused by 30%-50% when rhe density of wild oats exceed 100 plants per m^2 (Chancellor and Peters, 1976)

According to several authors (Tityanov, 2006; Chhokar et al., 2008; Scursoni et al., 2011) wild oats is economically the most important weed in winter cereals including barley both in Bulgaria and around the world

According to Bell and Nalewaja (1968) multiplication of wild oats in barley, the yield is decreased by 6.5% at a rate of 70 plants per m^2 and 25.9% in density 160 plants per m^2.

In the cultivation of winter barley crop rotation unit corn-barley deep soil and sowing treatments against corn leads to a significant reduction in specific winter cereal weeds: annual dicotyledonous (*Lithospermum arvense* L., *Galium tricorne* Whit., *Anthemis arvensis*

L.) and annual monocotyledonous (*Alopecurus myosuroides.* Huds., *Avena fatua L.).* In the continued cultivation of winter barley behind after wheat, the dynamics of weed infestation depends on the continued use of herbicides from the same group when are manifested compensation processes (Atanasova and Zarkov, 2007) Similar results obtained and (Bazitov and Bazitov, 2011) in barley in super intensive crop rotation.

Bazitov et al. (2014) reported a significant increase in weed infestation in experimental areas of barley grown under irrigation.

O'Donovan et al. (2001) in field trial found that barley seeded with 25-50% higher sowing rate strongly inhibited seed formation in wild oats.

Using chemical means to weed contorl weeds in the production of barley in modern agriculture is a very important. The herbicides are the main factor in modern integrated technologies for weed control. Obtaining high yields of barley is unthinkable without their use.

According to Galla (1989) the using of herbicides in crops of barley free of weeds reduces the yield, when the weed infestation is intense - efficiency is high, and the yield can be increased to 64% (Benkov Pochekanska, 1990)

Gruzdev et al. (1989) found an increase in the yield of barley by 15% to 39% when the using modern herbicides.

The results of experiments in barley by the use of reduced doses of herbicides are indicative. It has been found that with increased seed sowing standards and the use of low doses of herbicides are effective strategy for the control of grass weeds in Australia (Wallker et al. 1998).

The herbicide Axial (pinoxaden) has high efficacy against grass weeds and good selectivity to barley (Campagna and Rueegg, 2006)

Sikkema et al. (2008) tested the tolerance of springs wheat, barley and oats to herbicide developed by BASF *saflufenatsil* for weed control in the corn. The data from the experiment showed good tolerance of the crop to the herbicide when it is applied after sowing and before emergence of the crop. Applications vegetation saflufenatsil leads to a decrease in the yield in the three crops.

There have been manifested resistance to pinoxaden forms of wintering wild oat (Avena ludoviciana L.) (Uludag et al., 2008; Sasanfar et al. 2009) and Polish foxtail (Alopecurus myosuroides Huds.) (Henriet and Marechal, 2009; Petit et al. 2010; Delye, 2011).

In a study conducted by Russian scientists establish some sensitivity to certain varieties of barley to fenoxaprop-P-ethyl (Ilyin et al. 2007).

Chhokar et al. (2008), Ellis (2009), Yadav et al. (2009), Dhawan et al. (2010) and Dixit et al. (2011), tested a *pinoxaden* against grass weeds in barley. The results show that it is a perspective herbicide which can control weeds in crop successfully thereof.

In the barley the herbicides must be applied at some point in their development. Crops have specific enzymes responsible for the rapid elimination of herbicide impact of imported products. These enzymes are most active at a particular stage of plant development. This phase is barley is a tillering, through in this phase, the plants are most stable against chemical influences. Treatment in earlier or later stages of crop development, the enzymatic activity is not so high and plants are inhibited by the impact of the herbicide. (Murzagaliev, 2007)

The use of herbicides to destroy unwanted vegetation in crops is a major factor for increasing productivity (Georgiev, 2015).

The relationship herbicides - barley`s yield is not always stable and many authors give divergent results. Spasov and Spassova (1995) reported that preparations based on 2,4-D applied in phase second leaf acting positively on the yield of grain cereals. Late treatment of winter cereals including barley with herbicides, the reduction in the yield of the crop is appreciably (Wick, et al, 1987; Mohan et al, 1988; Martin et al, 1988).

In field experiments with treated and whitout herbicides spring barley, Boatman (1992) found increasing grain yield of 0,5 to 1,2 t / ha in the variants where they used chemical means to destroy weeds

Tralkoxydim, studied at different rates than recommended doses against wild oats in barley in the United States shows the following results: the importation of 100; 75 and 50% of the dose of the herbicide, the barley is not influenced by the negative effect on wild oats. Only lower yields are obtained by depositing 25% of the recommended dose (O` Donnovan et al., 2001)

Semenov and Vasilyev (2010) reported an increase in yield and grain quality in barley to 26% of the variants treated with herbicides from the sulfonylurea group.

Dimov (1974) found that the germination capacity of barley treated in the spring with 2,4-D did not exceed 89%

The use of sulfonylureas have a negative effect under the metabolism of the plants and appreciably to decrease the quality of seeds. (Shneider, 1974; Kravchenko, 1991)

Atanasova (2005) and Atanasova (2007) studying the selectivity of antibroadleaved herbicides in several varieties of barley in optimal and double doses reported that a significant varietal susceptibility. Variation in yields in most varieties is largely determined by the weather conditions during the years of cultivation and to a lesser extent by the treat

Belanovskaya et al. (2006) found, that in the treatment of barley with herbicide glyphosate 10-12 days before harvest, the protein content of grain increased by 0.54%.

CONCLUSIONS

Presented literature review and opinions of cited authors suggest that chemical control is the most efficient method of controlling weeds. Combinations of herbicides are more effective than self-administration in barley. Often when co-administered produces a high synergistic effect on yield. A number of authors export data from which it is clear that the barley differs from ordinary wheat in its response to some herbicides, herbicide combinations and herbicide tank mixes.

Data relating herbicides to effectively control certain weeds in winter cereals are scarce even globally. The serious problem with them is due to their resistance to most anti-cereal herbicides.

The serious problem is an effect of some herbicides used in their predecessors on succeeding crops, which is in direct relation to weather conditions during the degradation.

Stated in the literature review gives an idea that a lot of questions are published opposing views due primarily to the different conditions under which they have conducted experiments and the biological characteristics of the tested varieties. A serious problem emerged resistance and compensatory processes in weeds. In the literature there is growing consensus that periodically have to make a new mapping of crops and to seek new solutions to chemical control with changing weed associations.

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MEDICINAL PLANT CROPS - IMPORTANT SOURCE OF HIGH VALUE-ADDED PRODUCTS

Alice GRIGORE[1], Lucia PIRVU[1], Corina BUBUEANU[1], Svetlana COLCERU-MIHUL[1], Carmen IONITA[2], Lucian IONITA[2]

[1]National Institute for Chemical-Pharmaceutical R&D, 112 Vitan St., Bucharest, Romania
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, Bucharest, Romania

Corresponding author email: alicearmatu@yahoo.com

Abstract

Medicinal and aromatic plants play a central role, not only as traditional medicines used in many cultures but also as raw materials for other bio-based products.
Economical feasibility is the main interest to bring a species in cultivation but it is also a substantial limitation as long as sufficient raw material can still be obtained at a lower price from wild-harvest. The number of medicinal and aromatic plant species currently in formal cultivation for commercial production does not exceed a few hundred world-wide (FAO). Cultivation can also have conservation impacts, as some wild species are being over-exploited. Medicinal plant production through cultivation, for example, can reduce the extent to which wild populations are harvested, but, on the other hand, it also may lead to environmental degradation and loss of genetic diversity. A limiting factor for starting new crops is represented by climate changes which already causes major environmental effects. The selection of a vegetal species to be introduced into cultivation should be justified by the growing requirements correlated to the trends in climate change, multi-purpose potential of the plant - a variety of products based on current uses and future projections, various types (herb, seeds, fruits, leaves, flowers, roots) of raw material for industrial use and an important market demand.
In this review are presented the main biologically active herbal constituents, applicative potential (as medicines, cosmetics, insecticides, allelochemicals, food additives and dyes), prospects to widen the range of the feedstock for understudy industrial uses, restricting factors that inhibit broader industrial use of the biomass feedstock, prospects and recommendations to use bio-based products.

Key words: *medicinal plants, cultivation, biomass, bio-based products.*

INTRODUCTION

In the last years there was recorded an increasing need for industrial products from renewable resources. Many farmers are interested in adding value to their existing crops by utilizing agricultural waste material or by converting crops to new uses. The international market for herbal products is estimated to be of US$ 62 billion, and it is estimated to grow to US$ 5 trillion by the year 2050 (Purohit and Vyas, 2004).
The largest global markets for medicinal and aromatic plants (MAPs) are China, France, Germany, Italy, Japan, Spain, the UK and the USA. Japan has the highest *per capita* consumption of botanical medicines in the world.
Within the EU, Germany is by far the largest importer with 235,644,913 $ trade value in 2013 (9.2% out of total imports) and also the largest exporter with 550,141,676 $ (5.5% out of total exports). (COMTRADE)
Herbal/traditional self-treating remedies are increasingly popular in Romania, due to consumers' increasing awareness about the possible harming effects of long-term self-medication using standard OTC drugs. In 2013, value growth reached 14%, after a 20% rise in 2012 (Euromonitor International, 2014).
For successful large scale cultivation of MAPs, high quality raw material should be produced using low input cultivation methods so that it can compete in the international market and with plants collected in the wild (Lubbe and Verpoorte, 2011).
Scientists widely agree that global climate change is already causing major environmental effects, such as changes in the frequency and intensity of precipitation, droughts, heat waves

and wildfires; rising sea level; water shortages in arid regions; new and larger pest outbreaks afflicting crops and forests. Phenological changes will alter growing seasons, ecosystem production, population-level interactions and community dynamics. Projections (for 2071–2100) show a general reduction in summer soil moisture over most of Europe, significant reductions in the Mediterranean region, and increases in the north-eastern part of Europe. Soil degradation, together with prolonged drought periods and increased numbers of fires, leading to marginalisation and even land abandonment, is already contributing to an increased risk of desertification. Current trends and future scenarios depict an increase in the demand for water in agriculture, potentially increasing competition for water. Crop management will have to be adapted in order to try to avoid crucial development stages sensitive to water-stress (flowering, grain filling, etc.) occurring during generally dry periods.(Impacts of Europe's changing climate — 2008 indicator-based assessment, European Environment Agency)

The selection of a herbal species to be introduced into cultivation should be justified by the growing requirements correlated to the trends in climate change, multi-purpose potential of the plant - a variety of products based on current uses and future projections, various types (herb, seeds, fruits, leaves, flowers, roots) of raw material for industrial use and an important market demand. Cultivation provides a more stable production base and greater control over quality, but requires investment in management, training, equipment and labour, which makes financing an issue. Cultivation provides an option to regenerate endangered species and is more able to become certified organic as they can better control production, provide traceability and input supply records.

A key issue in manufacturing herbal products and medicines is standardization, the process of producing herbal extracts or phytochemicals in which product potency is guaranteed through consistency in active compound content level. This process requires high knowledge in phytochemical analysis and process technology to ensure the quality assurance required.

Product value increases in the following order: fresh material < dried powder <non-standardized extract < freeze/spray dried extract < standardized extract <phytomedicine.

This review aims to present the applicative potential of MAPs, prospects to widen the range of the feedstock for understudy industrial uses, restricting factors that inhibit broader industrial use of the biomass feedstock, recommendations to use bio-based products.

MATERIALS AND METHODS

Literature review

Studies were identified by conducting electronic searches of PubMed, Science Direct and Scopus from 2000 to the end of 2015. More than 100 papers related to utilization of herbs, herbal extracts or herbal products in various industrial areas were consulted.

RESULTS AND DISCUSSIONS

Potential applications of herbal raw material

Plants produce an enormous variety of natural products with highly diverse structures. These products are commonly termed “secondary metabolites” in contrast to the “primary metabolites” which are essential for plant growth and development (Springob and Kutchan, 2009). A simple classification of secondary metabolites includes tree main groups: terpenes (such as plant volatiles, cardiac glycosides, carotenoids and sterols), phenolics (such as phenolic acids, coumarins, lignans, stilbenes, flavonoids, tannins and lignin) and nitrogen containing compounds (such as alkaloids and glucosinolates) (Agostini-Costa et al., 2012).

In addition to their physiological function in plants, natural products also have a strong impact on human culture and have been used throughout human history as condiments, pigments, and pharmaceuticals (Springob and Kutchan, 2009). Many herbal species can be used for multiple purposes and discovery of new and valuable compounds is in progress.

For example, aromatic plants not only serve as condiments and as important resources in the perfume and cosmetic industries, but have gained wide popularity now in aromatherapy

(Bakksli et al., 2008; Perry and Perry, 2006). Many spices, seasonings, condiments, and perfumes are made using essential oils that function as insect toxins in plants but are relatively harmless to humans. Examples include peppermint and spearmint (*Mentha* spp.), basil (*Ocimum* spp.), oregano (*Origanum* spp.), rosemary (*Rosmarinus* spp.), sage (*Salvia* spp.), savory (*Satureja* spp.), thyme (*Thymus* spp.), black pepper (*Piper* spp.), cinnamon (*Cinnamomum* spp.), and bay leaf (*Laurus* spp.). Citronella, an essential oil isolated from lemon grass (*Cymbopogon citratus*) also contains high limonoid levels and has become a popular insect repellent in the United States due to its low toxicity in humans and biodegradable properties. Although it is toxic in large quantities, it has been used medicinally by humans in small amounts as a pupil dilator and antidote for some nerve gas poisonings. Capsaicin and related capsaicinoids produced by members of the genus *Capsicum* are the active components of chili peppers and produce their characteristic burning sensation in hot, spicy foods (Adeyemi, 2011).

Celery (*Apium graveolens* L. var. *dulce* DC.; Apiaceae) is an important vegetable crop. Apigenin, a flavone isolated from celery which has been used to dye wool, has been shown to possess remarkable anti-inflammatory, antioxidant and anti-carcinogenic properties (Patel et al., 2007).

It is worthy to mention the various applicative potential of terpene compounds. Farnesene is a sesquiterpene widely used by perfume industry due to its beautiful smell, mainly in cosmetics preparation such as masks and powders. In addition, this molecule is utilized during beer brewing since contributes significantly to their aroma. Aldehydes comprise another group of compounds with commercial applications either as precursors for the production of oxo-alcohols (used in detergents), or are produced in a small scale (less than 1000 tons/year) in order to be used as ingredients by perfumes and flavors industries. In this respect, the sesquiterpenic aldehyde α-sinensal was identified as potential isolation target (Evergetis and Haroutounian, 2014).

The monoterpene cymene is widely used either as precursor for the synthesis of *p*-cresol or as important intermediate by the pharmaceutical, food and agrochemical industries for the production of various fungicides, pesticides and flavoring agents (Selvaraj et al., 2002).

Pharma industry

The importance of plants as a source of new drug molecules is illustrated by the fact that, in the past 20 years, 28% of new drug entities were either natural products or derived from them as semi-synthetic derivatives (Chin et al., 2006). New therapeutic strategies based on natural compounds are targeted to cardiovascular diseases, infectious diseases, diabetes, obesity, cancer and allergy. There are a wide range of medicinal preparations: tea (infusions or decoction), tinctures, glycerolates, medicinal oils, essential oils, compresses or plasters, eye washes, balsams, cataplasms, as well as a great number of pharmaceutical forms: tablets, capsules, syrups, ointments, hydrophilic gels, eye-drops (colliriums), nasal sprays and drops.

The herbal medicinal market in Europe is currently affected by changes of the regulatory environment. There are great differences between Member States in the definition and categorization of herbal medicines. A single medicinal plant may be defined as a food, a functional food, a dietary supplement or a herbal medicine in different countries, depending on the regulations applying to foods and medicines in each country. The general intention is to harmonize the regulation of medicinal products, food and other consumer goods at centralized European level but difficulties come from the heterogeneity of the starting material itself (chemical composition, natural variability, diverse sources), the heterogeneity of plant preparations (plant part used, type of preparation, manufacturing process), and the lack of accurate quality/safety data for often non-standardized low price products (Peschel, 2007).

Plants have also proven to be a major source for the discovery of modern drugs, particularly in the cancer field (Young, 2005). Of 155 small molecules developed as anti-cancer drugs worldwide from the 1940s to the present time, 72.9% are naturally-inspired, with 47% being either the natural products or semi-synthetic derivatives (Newman and Cragg, 2007).

Anti-tumor pentacyclic alkaloid camptothecin (CPT) from the wood and bark of *Camptotheca acuminata* Decne. (Cornaceae) (Li and Adair, 1994), the terpene paclitaxel (Taxol®) from the bark of Pacific yew (*Taxus brevifolia* Peattie) (Wani et al., 1971; Wall and Wani, 1995), vinblastine and vincristine, two well-known antimitotic cancer drugs used to treat Hodgkin's lymphoma and acute childhood lymphoblastic leukemia, respectively are isolated from *Catharanthus roseus* (also known as *Vinca rosea* L., family Apocynaceae); etoposide and teniposide, two semi-synthetic analogs of podophyllotoxin, an aryltetrainlactone cyclolignan isolated from *Podophyllum peltatum* rhizomes (Itokawa et al., 2008), are potent DNA TOPII cancer drugs used for small cell lung and testicular cancers and lymphomas/leukemias; likewise the water-soluble etoposide phosphate (also known as etopophos) is used for refractory testicular cancer and small cell lung cancer. Natural compounds are effective also in other medical areas: betulinic acid, a lupane triterpenoid isolated from *Syzygium claviflorum* (Roxb.) Wall. ex A.M. Cowan & Cowan (Myrtaceae) is used in the semi-synthesis of dimethyl succinyl betulinic acid currently used in anti-AIDS clinical trials (Itokawa, 2008); coumarin suksdorfin isolated from *Lomatium suksdorfii* J. M. Coult. & Rose (Apiaceae) is an anti-HIV (human immunodeficiency virus) compound, with semi-synthetic analogs currently being tested in clinical trials; the alkaloid galantamine (Razadyne®/Razadyne® ER,formerly known as Reminyl) from *Galanthus woronowii* Losinsk. (Amaryllidaceae) and related genera, including *Narcissus* L., (Cherkasov and Tolkachev, 2002) is used for the treatment of mild to moderate Alzheimer's disease; shikimic acid, a precursor for the antiviral drug Tamiflu® is isolated from the most common hardwood species in the southeastern United States, *Liquidambar styraciflua* L., known as sweetgum (Hamamelidaceae) (Li et al., 2005), making this species a promising pharmaceutical crop.

A new pharmaceutical niche was developed in the last years, drugs for veterinary use. Considering the potential harm of veterinary drug treatments on the environment and human health and in some cases their limited efficacy, disease management has to be concentrated on harmless, preventive and lasting methods. Recently, increasing attention is being paid to the use of plant products for disease control in aquaculture as an alternative to chemical treatments. Plant products have been reported to stimulate appetite and promote weight gain, to act as immunostimulant and to have antibacterial and anti-parasitic (virus, protozoans, monogeneans) properties in fish and shellfish aquaculture (Raverter et al., 2014).

Cosmetics

According to the *Organic Monitor*, a research and consulting company specialised in global organic and related-product industries, natural and organic products were estimated to account for 3% of all personal care products sales in Europe in 2009. While this is a relatively small percentage, it showed an annual growth rate of 20% (Antignac et al., 2011).

In the last years a new concept has developed – cosmeceutics -cosmetic products that include ingredients designed not only to enhance the appearance but to also have a positive physiological effect at the cellular level. The portfolio of new products is diversified: men's grooming products, anti-aging products, spa-at-home, detoxification products. A novelty in this area is the use of vegetal stem cells in antiaging formulation. A recent study shows that cosmetic industry based on natural products could be very profitable (Katsikis, 2009). Beyond this, the safety assessment of botanicals is more complex and associated with a higher degree of uncertainty than that of conventional ingredients. Given that novel botanical ingredients of personal care products may contain unknown substances with novel toxicological properties, new approaches to their safety assessment are needed (Antignac et al., 2011).

Dyes, colorants

There is an increasing development of new natural compounds able to substitute chemical additives for food and beverage industry. These compounds are used as antioxidants or colorants. For example, Naturex France has developed an extensive range of extracts which naturally protect food products against oxidation and therefore extend their shelf life as well as a wide range of special coloring formulations made by natural pigments like carotenoids, curcuminoids, chlorophylls and anthocyanins. Some of the most known natural dyes used worldwide are: alizarin and lawsone, which belong to quinones, the main chemical components of madder and henna, different catechin structures belonging to tannins found in green tea, delphinidine, quercetin and mercetin with anthocyanin structure, a subgroup of flavonoids, the main components of saffron dye and curcumin, a carotenoid, the main component of turmeric (approved naturally derived food colorant in European Union – E100) (Alihosseini and Sun, 2008).

Natural colorants used in textile industry are popular due to their softer color shades, naturalness, deodorizing/anti-cancer properties and harmonizing natural shades (Mirjalili et al., 2011). Moreover, they prove a strong antibacterial activity (Ghaheh et al., 2014).

Only a limited number of plant species exhibit the potential for large-scale production. Method for obtain and purify compounds and stability studies must be developed.

Insecticides

An analysis of more than 20000 papers on botanical insecticides from 1980 to 2012 indicates a major growth in the number of papers published annually (61 in 1980 to 1207 in 2012), and their proportion among all papers on insecticides (1.43% in 1980 to 21.38% in 2012) (Isman and Grieneisen, 2014) which reflects the increasing interest of scientists concerning this subject, correlated with market needs. More than 1500 species of plants have been reported to have insecticidal value, and many more exist. Although compared with modern synthetics the plant substances are relatively less effective, their relatively safe nature has resulted in the opening up of a new vision in plant insecticides research (Kumar et al., 2011).

They are often called "environmentally friendly" due to their reduced toxicity to humans, fast and complete degradation in the environment and low-risk for resistance and selective properties for non-target organisms (Schmutterer, 1995). The most known natural insecticides are pyrethrins which come from certain species of chrysanthemums, azadirachtin from neem tree and limonene and linalool which are volatile molecules obtained from some vegetal species.

Allelochemicals

Limited research on isolation/extraction, characterization/synthesis or formulation of allelochemicals and their use in pest management in medicinal plantations showed that plant-derived products can be effective alternatives to synthetic pesticides in existing cropping systems (Gahukar, 2012).

It was showed that 3-O-monoglucoside of oleanolic acid secreted to the soil by *Calendula* species possesses very strong allelophatic properties in relation to the dicotyledons and weaker activity to the monocotyledons (Ruszkowski et al., 2004).

Plant sesquiterpenes comprise a large class of natural products with a number of biological activities, including some with interesting herbicidal and allelopathic potentials (Abdelgaleil et al., 2009; Saad et al., 2012).Sorghum releases a substantial amount of phenolic lipids including sorgoleone, a 3-penta-decatriene benzoquinone that is the primary source of the allelopathy properties of sorghums (Netzly and Butler, 1986). Juglone is an allelochemical present in walnut (*Juglans* spp) and it represses the growth of many weed species.

Food additives

Addition of natural antioxidants and antimicrobials to meat and meat products is one of the important strategies in development of healthier and novel meat products. In this regard several studies utilizing herbs, spices, fruits and vegetable extracts, and have shown that addition of these extracts to raw and cooked meat products decreased lipid oxidation, improved color stability and total antioxidant capacities which are important characteristics for shelf stable meat products. The major active components/phytochemicals responsible for the antioxidant activity of plant derivatives are polyphenols, flavonoids, phenolic diterpenes and tannins (Zhang et al., 2010). Moreover, the essential oils of herbs and spices are widely known for their strong antioxidant, antimicrobial and antifungal activities in foods (Hygreeva et al., 2014).

There are very few natural antimicrobials that can be used as direct replacements for existing preservatives owing to their lower effectiveness, higher cost and product organoleptic quality deterioration. Further, if a natural antimicrobial with potential as a food preservative can be shown to be sufficiently effective in foods, it will need regulatory approval before it can be used as a food additive (Negi, 2012).

Some of them are already approved for use in EU countries: E392 – rosemary extract as antioxidant and by Food and Drug Administration (USA): Alfalfa extract, herb and seed**;** Arnica flower extract **i**n alcoholic beveragesonly**,** Damiana leaves,Dandelion root andfluid extract,Sage (Greek and Spanish),Savory (winter or summer)**,** Tagetes (marigold) oil**;** Psyllium seed husk for frozen desserts, etc

Prospects to widen the range of the feedstock for understudy industrial uses, restricting factors that inhibit broader industrial use of the biomass feedstock

Many herbal compounds still await to be discovered or to be applied in various directions. By biotechnology and molecular methods, the yield and quality of valuable compounds can be increased. The majority of medicinal plants have yet to be utilized on a large scale. One of the main reasons for this is the chemical variability inherent in plant-derived therapeutics (Gorelick and Bernstein, 2014). A good example would be the natural variation of *Echinacea* within a species which have a tremendous effect on final product quality. This diversity might be due to genetic and environmental differences including variety, cultivation regions, harvest time, and cultivation or processing conditions. Even in germplasm that has been in cultivation for many years, there is still considerable phytochemical variation between individual plants. It was proved that cloned plants derived by division of the roots of individual plants in cultivated populations are very uniform and are one method for selecting and producing high-performance cultivars from exceptional plants (Arnason et al., 2002).

Cultivation also opens up the possibility of using biotechnology to solve problems like species misidentification, genetic and phenotypic variability, variability and instability of extracts, toxic components and contaminants. Further, by biotechnology and chemical (semi)synthesis, some gaps are overcomed. For example, it is known that the early production of paclitaxel relied on the bark of Pacific yew, with a limited supply of this nonrenewable source. The yield of paclitaxel from the yew bark is tremendously low; with 3,000 yew trees being needed to harvest enough bark to produce 1 kg of paclitaxel (Elbehri, 2005). Currently, paclitaxel can be produced by semi-synthesis using 10-deacetylbaccatin III (10-DAB) (Newmann and Cragg, 2004) and other baccatins isolated from needles of European yew (*T. baccata* L.) and other yew species.

Controlled growth systems also make it feasible to manipulate of phenotypic variation in the concentration of medicinally important compounds. The aim is to increase potency, reduce toxin levels and increase uniformity and predictability of extracts. By bringing herbs into cultivation, traditional and biotechnological plant-breeding techniques can be applied at the genetic level to improve yield and uniformity, and to modify potency or toxicity (Canter et al., 2005).

Pharmaceutical and other specialty crops are the starting point for a wide range of products: essential oils, human and veterinary drugs, herbal health products, inks, colorants and dyes, perfumes, beauty products, novel plant protection products and also a range of intermediate products from which the above are manufactured.

If we are referring to the cultivation technology and management, there are some restricting factors that should be taken into account.

It is clear that feedstock and quality of raw material strongly depend on weather conditions. As regards crop management, there are some stages that require investments and special attention, especially as size of cultivated area increases: watering during dry season (especially in the case of *Mentha piperita*, irrigation is a limiting factor), weed and pest control, harvest (the crop must be harvest on the right time, in the case of essential oil production harvesting should not be carried out in too hot weather and very windy conditions as significant volumes of oil can be lost through evaporation and also the numbers of harvests per year greatly influence yield, and composition of oil). Moreover, the raw material has to be free of components that are toxic for animals and humans – mycotoxins, heavy metals or xenobiotics (pesticides and other chemicals) and these problems could be avoided if appropriate facilities for storage and drying are available and also if good cultivation practices are complied. Mechanized work in cultivation process, whenever is possible will increase productivity and diminish labor work (for example, peppermint harvesting can be done with special machines whose productivity is high, thereby reducing labor consumption per hectare from 20 workers to 1 ha to 0.5 ha / hour mechanized harvesting). The essential oils production requires highly focused farm practices, field maintenance and more technical support.

As regards processing methods, it is clear that a processed material will increase the value of the good.

Since herbal drugs, extracts and herbal medicinal products are multicomponent systems, they present difficulties in separating and analyzing the right compound. Contrary to most synthetic drugs, plant- and plant derived material involves the (quantitative) determination of one or two components, normally only present in small quantities against a huge background of others. In the case of detection of adulterated oils or extracts, analytical study is a must; that is why modern analytical methods should be developed.

Adequate processing methods conduct to herbal products of higher yield, lower operating costs, and faster production times. The separation of the interesting compound mostly leads to the high price of the compounds. Usually, vegetal active principles works together in a synergic way and there is no need to develop many extraction steps. Only in a few cases one compound is of interest (artemisinin, silymarin, etc). Innovative and efficient (both from economical and scientific point of view) methods such as Supercritical Fluid Extraction (SFE) where supercritical fluids such as carbon dioxide under high pressure need to be developed.

Herbal products can be sold in a variety of forms such as capsules, tablets, tea bags, extracts, essential oils, etc. and packaging plays an important role to attract consumers. Products diversity is an important issue for a company; new products come from new technologies and new equipment but also must be correlated to consumers needs and targeted marketing campaign. Volatile oil, capsules or tablets require very high and high production costs unlike tea which requires medium production costs and give high incomes. To extend the product portfolio, there is a need for investments in appropriate equipment for extraction, processing and packing herbal products.

As regards economical aspects, the import of cheap and poor quality products and raw materials (especially from countries with low labor costs such as China and India) is a very common issue; the product price (and not the product quality) is the most important factor that affects buying decision for many market segments. Sometimes medicinal herbs are purchased, refined, repackaged and re-exported to other EU member countries or some producers choose to use encapsulated dried and milled plants as selective extracts or some choose to sell adulterated essential oils. For example, lavender oil is often adulterated by acetylated lavandin, aspic, synthetic linalool, linalyl acetate; caraway oil is adulterated by addition of *d*-limonene obtained as by products from the extraction of carvone or from orange oil; synthetic compounds are also added into oils - synthetic linalool in coriander oil and synthetic citral in lemongrass oil (Singhal et al., 1997).

CONCLUSIONS

At present, of the 70,000 species of medicinal plants in the world still primarily harvested in the wild, most have not been cultivated as crops. For example, of the 3,000 species of medicinal plants being traded in the world, 70-80% originate from wild-collections (Schippmann et al., 2006), and only 900 have commercial cultivation underway or in development (Mulliken and Inskipp, 2006). Some 15,000 medicinal plant species may be threatened with extinction (Hawkins, 2008).

The strategy for sustainable use of MAP has two main components: regulation of collection of medicinal plants from the wild to protect biodiversity and promotion of cultivation to meet demand and provide new income opportunities to farmers.

There are several ways in which plant science can address future demand in this area, as it was stated by The European Plant Science Organization in 2005: first, this can be done by optimising the profile and possibly increasing the content of active components of the raw material itself. A second opportunity lies in the better preservation of these phytochemicals during crop maturation, post-harvest treatment and storage. Third, the factors that play a major role in bioactivity during processing should be at least maintained and possibly enhanced.

Consumers preferences has changed towards the use of 'natural' over synthetic products and the trend will remain; still, the consumers must understand that the quality is more important than price. A critical examination of bioactive plant products has to cover analytical aspects, absorption, bioavailability and molecular functionality. The industry should speculate this trend and diversify the product portfolio as well as ecological farming has an ascending trend.

New applications should be investigated; phytotherapy in veterinary medicine is a domain which needs further study as well as development of natural products for agriculture. Environmentally friendly alternative practices for crop protection is a key issue in modern agriculture. Utilizing allelopathic plants to suppress the weed infestation is the most cost-effective and environment-friendly method of weed control. Also, the domain of food preservatives based on medicinal plants should be deepened.

As regards MAPs for pharmaceutical purposes, it is important to develop stable molecular markers which assure without doubt the quality of herbal medicines and to conduct clinical trials in Europe in order to comply with regulatory requirements for product registration, especially in Germany and France which regulate botanical products mainly as drugs. Examples of companies that perform clinical trials are BionoricaArzneimittel, Dr.Willmar Schwabe Pharmaceuticals, Lichtwer Pharma AG, Madaus AG, Max Zeller Sohne AG, and Schaper & Brümmer GmbH.

The perspectives are encouraging, as in the past 20 years, completely new markets were created for herbal- based products upon scientific support.

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ASSESSMENT OF AQUACROP MODEL IN THE SIMULATION OF WHEAT GROWTH UNDER DIFFERENT WATER REGIMES

Sema KALE

Suleyman Demirel University, Agricultural Faculty, Agricultural Structure and Irrigation Department, East Campus, 32260, Isparta/Turkey

Corresponding author email: semakale@sdu.edu.tr

Abstract

The main purpose of deficit irrigation is high water productivity with lesser water supplies to optimum crop yield. Accurate crop development models are important tools in evaluating the effects of different water applications on crop yields. The FAO-AQUACROP model (Ver. 5.0) simulates attainable yields of several crops as a function of water consumption under rainfed, supplemental, deficit, and full irrigation conditions. The aim of this study; validation and testing of the AQUACROP model for winter wheat under full and rainfed conditions in semi arid condition such as Central Anatolia. Model prediction and actual results were compared. According to statistical evaluation; average deviation (α), standard error (RMSE) and modeling efficiency (E) for biomass and for crop yield was found as 1.16, 1.17 t ha-1 and 0.67 and 0.320, 0.326 t ha-1 and 0.83 respectively. Model predicted soil water content in root zone, canopy cover and grain yields with high accuracy but biomass were predicted higher than actual results.

Key words: *AquaCrop, wheat yield, water use efficiency.*

INTRODUCTION

Agriculture is the biggest consumer about 72% percent of available fresh water resources on global bases (Geerts and Raes, 2009; Andarzian et al., 2011). With the increase in population in many parts of the world, it has become a necessity for an increase in food production. Especially arid and semi arid regions production depends almost entirely on irrigation and irrigation is important factor to improve water use efficiency (Musick et al., 1994; Steven et al., 2009). A lot of studies have shown that one of the encouraging irrigation strategies might be deficit irrigation (Kipkorir, 2002; Debaek and Aboudrare, 2004; Fereres and Soriano, 2007; Ali and Talukder, 2008; Farre and Faci, 2009; Behera and Panda, 2009; Blum, 2009; Geerts and Raes, 2009), since less water than required is applied during the growing period. Investigating the plant response to different irrigation strategies in field and carried out experiments is difficult and expensive. Considering this kind of limitations, accurate crop development models are important tools in evaluating the effects of water deficits on crop yield or productivity and predicting yields to optimize irrigation under limited available water for enhanced sustainability and profitable production (Zairi et al., 2000; Kipkorir et al., 2001; Lobell and Ortiz-Monasterio, 2006; Benli et al., 2007; Heng et al., 2007; Lorite et al., 2007; Pereira et al., 2009; Blum, 2009). The FAO AquaCrop model is a useful model to simulate economic parts of the crops, and is responsive for design and evaluation of irrigation strategies, deficit irrigations scheduling, and rainfed systems subject to soil types, field management scenarios, soil fertility, and climatic conditions (Raes et al. 2009a; Abedinpour et al. 2012; Ahmadi et al., 2015). AquaCrop is user-friendly and maintains a balance between simplicity, accuracy, and robustness (Heng et al., 2009). While most sophisticated crop models, which are suitably developed for research and systems analysis needs intensive data, AquaCrop potentially requires fewer data inputs (Steduto et al., 2009).

AquaCrop crop water productivity model predicts crop yield, water requirement, and water use efficiency under water-limiting conditions (Raes et al., 2009b). This model has been tested for several crops (Hsiao et al., 2009; Heng et al., 2009; Farahani et al., 2009; Garcia-Via et al., 2009; Todorovic et al., 2009; Geerts et al., 2009) under different environmental conditions. The aim of this study was to calibrate and validate this model under full and deficit irrigation and to apply it for simulating the effects of rainfed and irrigated conditions on grain yield and water productivity of wheat in Central Anatolia region of Turkey.

MATERIALS AND METHODS

Study Area Characteristics

Study data were obtained from Ministry of Agriculture in the agricultural enterprise (39°30'N, and 33°17'E, elevation 930 m) in Central Anatolia Region of Turkey (Figure 1).

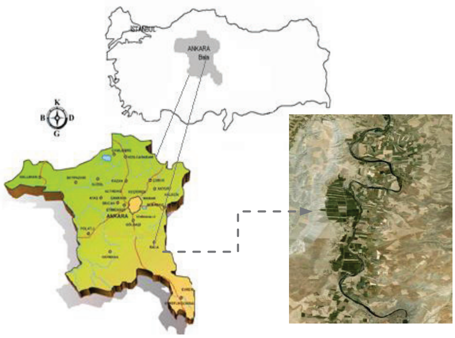

Figure 1. Location of experimental field

Annual average rainfall within the region 350 mm and annual evaporation is about 1250 mm as an average for the past 30 years. Almost no effective rainfall occurs during the summer. The main crops are corn, wheat, barley, beans and forage crops in experimental site.

The soil of the experiment area is mostly ranging in texture from silty clay loam for 0.30 m, clay loam for 0.30 - 0.50 m thick lying on the surface with a layer of clay texture roughly in 1.80 m below the surface. Field capacity on the volume basis of the top and following basement soil layer is described to be 41, 39 and 43 %, and wilting point, 22, 21 and 23 % respectively. Soil physical characteristics such as bulk density, texture, depth, field capacity, permanent wilting point and water content at saturation of the experimental sites were given in Table 1.

Table 1. Soil parameters

Depth (m)	Moisture content (vol. %)		Bulk density (g cm^{-1})	Texture
	Field capacity	Wilting point		
0-0.3	41	22	1.18	SiCL
0.3-0.50	39	21	1.15	CL
0.50-1.80	43	23	1.26	C

SiCL: silty clay loam, CL: clay loam, C: clay

Field Studies

For the purpose of evaluating the validity of the AquaCrop model, data were obtained from field studies conducted at the Agricultural Enterprise Farms for two cropping seasons, 2001-2002, 2002-2003. Winter wheat was planted at 15th of October for 2001-2002 and 18th of October for 2002-2003 cropping seasons. The seed rate was 300 seed m^{-2} with 1.8 cm row spacing. According to soil fertility analysis results commercial N fertilizers were applied in a band about 10 cm to the side of the seed row (200 kg ha^{-1} Ammonium sulfate (21%) were applied before sowing and 250 kg ha^{-1} Ammonium sulfate were applied at spring period). Sufficient phosphates were applied (160 kg ha^{-1} DAP 18-46-0) to ensure adequate P nutrition. Soil samples were taken each plot to make chemical and physical soil analysis. Winter wheat was grown under rainfed and irrigated conditions.

Weather data were obtained from local meteorological station which was within 1 km of the study fields (Table 3). The daily maximum and minimum air temperature (^{o}C), minimum air temperature (^{o}C), mean relative humidity (%), sun shine hours (cal cm^{-2}) and wind speed at a height of 2 m (u_2, m/s) weather data were used for calculation of referent evapotranspiration.

Table 3. Monthly average temperature, humidity, wind speed, sunshine hours, total rainfall

Months	Temperature (^{o}C)		RH %	Wind m/s	Sunshine hours h/day	Rainfall mm
	Max	Min				
October	20.8	4.5	56.5	0.8	8.2	0.5
November	11.5	1.4	72.0	1.2	4.7	76.2
December	5.6	-0.7	77.0	1.3	1.9	1.7
January	7.5	-2.1	72.5	0.8	4.1	3.0
February	9.6	-1.8	67.5	1.5	3.9	21.9
March	18.1	3.9	58.9	1.6	6.3	20.5
April	19.1	5.3	60.5	1.4	7.7	30.4
May	21.0	7.8	61.4	1.1	7.6	76.0
June	29.1	12.5	47.2	1.6	12.4	1.0
July	33.8	17.8	51.6	1.7	12.0	0.0

Soil water content was measured gravimetrically. Volumetric water content was obtained from gravimetric content and bulk density. Irrigation water was applied three times at sowing and stems elongation and stage of the crop. Wheat irrigated by basin method and soil moisture was reached to the field capacity. Irrigation date and applied water amount (mm) was given in Table 2.

Table 2. Irrigation dates and irrigation amount (mm)

Growing stage	Irrigation time		Irrigation amount	
	2001–2002	2002-2003	2001-02	2002-03
Sowing	17 Oct.	19 Oct.	92	90
Stem elongation	16 April	16 April	110	125
Grain filling	20 May	18 May	145	165

Crop inputs of the model such as plant density, grain and biomass yield, sowing, emergency, flowering, senecence and maturity date were collected for the growing period. Emergence date was considered when 90% of seedlings had been emerged. Senescence was assumed to be reached when canopy start to decline whereas maturity date was assumed when the canopy cover reached nearly zero (Raes et al., 2009a).

Soil physical characteristics initial soil water content, field capacity, permanent wilting points and saturated hydraulic conductivity at field site were measured in the Soil and Fertilizer and Water Resources Research Institute Laboratories. The soil water content in the root zone was measured by gravimetric methods throughout the season.

Description of AquaCrop (Version 5.0)

AquaCrop is the crop growth model developed by FAO deals with yield response to water. The model evolved from concepts of yield response to water as presented in Doorenbos and Kassam (1979) to a concept of a normalized crop water productivity (Steduto et al., 2009). The advantage of the model is accurate, robust and requires fewer data inputs (Hsiao et al., 2009; Steduto et al., 2009). Detailed description of the model was given by Steduto et al. (2009). One of the important key features of AquaCrop is the simulation of green canopy cover (CC) instead of leaf are index (LAI). AquaCrop calculates a daily water balance and separates its evapotranspiration into evaporation and transpiration. Transpiration is related to canopy cover which is proportional to the extent of soil cover whereas evaporation is proportional to the area of soil uncovered. The crop responds to water stress through four stress coefficients (leaf expansion, stomata closure, canopy senescence, and change in harvest index). The model reproduces the canopy cover from daily transpiration taking into account leaf area expansion and canopy development, senescence and harvest index (Steduto et al., 2009; Araya et al., 2010)

Wheat crop parameters in AquaCrop were presented in Tables 4 and 5. Some of them were assumed to be conservative (Table 3) according to AquaCrop manual appendix (Raes et al., 2009b). These parameters are presumed to be applicable to a wide range of condition and not specific for a given crop cultivar. In addition to conservative parameters, some crop parameters are cultivar-specific and some depending on management and environmental conditions and cannot be broadly applied. Those non conservative parameters were estimated using measured data of 2001–2002 cropping season experiment (Table 3). AquaCrop was run in growing degree day (GDD) calculated from temperature data.

Table 4. Conservative parameters used to simulation runs (Raes et al., 2009b)

Description	Value
Cut-off temperature	26
Canopy cover per seedling at 90% emerg. (CC_o)	6.46
Canopy growth coefficient (CGC) per GDD*	0.68 %
Maximum canopy cover (CC_x)	95 %
Crop coefficient for transpiration at CC = 100%	1.10
Canopy decline coefficient (CDC) at senescence	0.56 %
Water productivity	15
Leaf growth threshold p-upper	0.20
Leaf growth threshold p-lower	0.65
Leaf growth stress coefficient curve shape	5.0
Stomatal conductance threshold p-upper	0.65
Stomata stress coefficient curve shape	2.5
Senescence stress coefficient p-upper	0.70
Senescence stress coefficient curve shape	2.5
Reference harvest index (HI)	42

* GDD, growing degree days; HI, harvest index.

Model Calibration

Calibration is the process where the model's input parameters are changed to obtain the optimal agreement between the predicted and observed system variables (Singh et al., 2006). The model was calibrated using measured soil water content over the root depth data set for 2001-2002 growing season in AquaCrop.

Model Validation

Validation is an important step of model verification. It involves a comparison between independent field measurements data and output simulated by the model (Andarzian et al. 2011). Soil water content, dry biomass and grain yield were considered in this study for model validation. The performance of the calibrated model was evaluated against the independent data sets (experimental data of 2002–2003 growing seasons) which were not used for model calibration.

Table 5. Non-conservative parameters adjusted to simulate the response of the wheat

Description	Value
Latitude	39° 30'
Longitude	33° 17'
Altitude	930
Sowing rate	160
1000 seed mass	31.60
Germination rate	85
Cover per seeding	1.5
Plant density	430.4
Sowing	15 October
Time from sowing to emergence	13 (131)
Time to reach max canopy cover	177 (903)
Time from sowing to max. root depth	140(604)
Time to start senescence	224 (1546)
Time from sowing to reach maturity	269 (2415)
Time to reach flowering	184 (992)
Length Building up of HI	75 (1210)
Duration of flowering stage	16 (185)
Total period from emergence to maturity	257 (2284)
Minimum effective root depth	0.3
Maximum effective root depth	1.5
Base temperature	0

Data analysis

A statistical evaluation of model reliability was performed by comparing measured and simulated soil water content, dry biomass and grain yield. The agreement between predicted and measured values was quantified by calculating average absolute deviations (α), the root mean square error *(RMSE)* and coefficient of model efficiency *(E)*. The average absolute deviation was calculated for each test period as given in equation [1] (Janssen and Heuberger, 1995).

$$\alpha = \frac{\sum_{i=1}^{n}\left|O_i - S_i\right|}{n} \qquad [1]$$

The root mean standard error *(RMSE)* was calculated as in Equation [2] (Lyman, 1993).

$$\mathrm{RMSE} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(O_i - S_i)^2} \qquad [2]$$

The RMSE in Eq. 2 represents a measure of the overall, or mean, deviation between observed and simulated values, that is, a synthetic indicator of the absolute model uncertainty. In fact, it takes the same units of the variable being simulated, and therefore the closer the value is to zero, the better the model simulation performance. The coefficient of model efficiency *E* has been widely used to evaluate the performance of solute transfer models. Nash and Sutcliffe (1970) defined the coefficient of efficiency (*E*) as in Eq. [3]:

$$E = 1 - \frac{\sum_{i=1}^{n}(O_i - S_i)^2}{\sum_{i=1}^{n}\left(O_i - O_{avg}\right)^2} \qquad [3]$$

where *n* is the total number of observations; O_i is the observed value of the i^{th} observation; S_i the predicted value of the i^{th} observation; and O_{avg} the mean of the observed values (i = 1 to n). *E* values ranges from minus infinity to 1.0, with a value of 1.0 representing a perfect prediction, a value of 0 (zero) representing a prediction no better than using the mean of measured values, and lower values representing a progressively worse prediction. Values of *E* between 0.50 and 1.00 are considered acceptable.

Model application

After model validation, the model was used to evaluate the effects of irrigation on above ground biomass and grain yield The crop parameter values given in Tables 3 and 4 and the soil characteristics of Agricultural Enterprise and irrigation practices (Tables 1 and 2) were used for the simulation.

RESULTS AND DISCUSSIONS

Soil water content

The results show that the model performed very well for simulating water dynamics (Figures 2 and 3).

Average absolute deviations (α), the root mean square error *(RMSE)* and coefficient of model efficiency *(E)* were found 16.08 mm, 17.81 mm, 0.96 mm for rainfed and 21.23 mm, 25.39 mm and 0.81 for full irrigation treatment respectively.

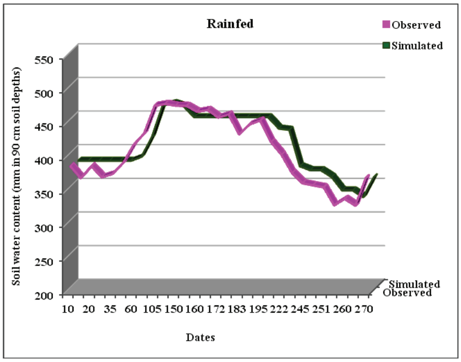

Figure 2. Simulated and observed soil water content for rainfed condition

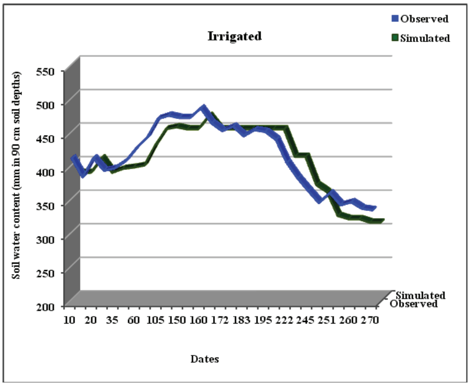

Figure 3. Simulated and measured soil water content for full irrigation

Canopy cover development

Potographs were taken from plots on the experimental field and were digitized with the processing programs (Greencrop of Tracker) to calculate canopy cover (Figure 4). Canopy cover development also were simulated by AquaCrop for irrigated and rainfed conditions.

The simulated canopy cover was close to the observed values from sowing to flowering over 2000–2001 growing season, but after flowering there was a slight mismatch in the last senesced CC measurement, with measured CC declining slightly faster compared with simulated CC (Figure 5).

According to statistical evaluation average absolute deviations (α), the root mean square error *(RMSE),* coefficient of model efficiency *(E)* and were found 9.00 mm, 11.08 mm and 0.95 for rainfed and 5.88 mm, 6.93 and 0.98 mm for irrigated condition respectively. Regression coefficients were also found 0.94 and 0.96 for treatments. Good agreement was found between the measured and predicted values.

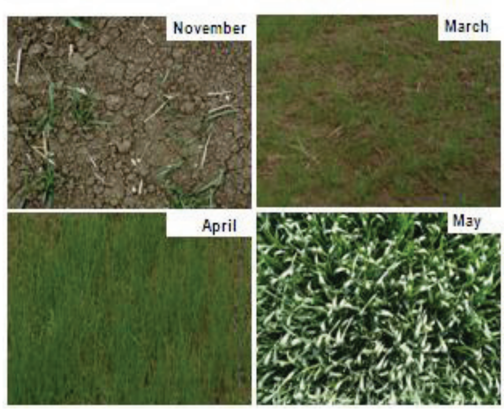

Figure 4. Observed canopy cover on the field

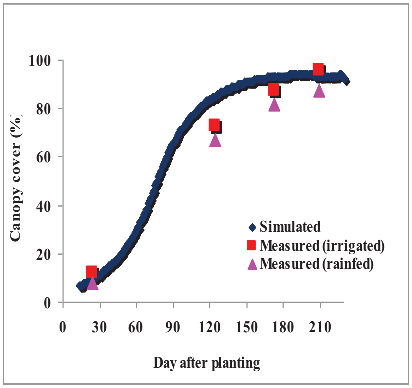

Figure 5. Simulated versus measured canopy cover of wheat under rainfed and full irrigation treatment during 2002–2003 growing season

Above ground biomass and grain yield

As shown at Figure 6 the simulated and observed dry biomass in rainfed and irrigated conditions there was very good agreement between observed and simulated values, even though a slight overestimation by the model. This discrepancies might have been caused by error in measured data and/or the manner which the model simulate crop growth (Andarzian et al., 2011).

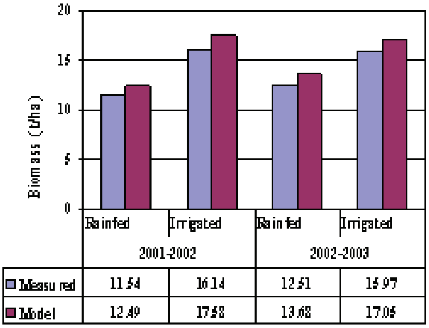

Figure 6. Simulated and measured biomass of winter wheat under irrigated and rainfed conditions

α, *RMS* and *E* were found 1.16 t/ha, 1.17 t/ha, 0.67 for biomass of winter wheat.

Grain yield were given at Figure 7. According to comparison of the simulated and measured grain yield results it could be said that model has acceptable performance to estimate yield.

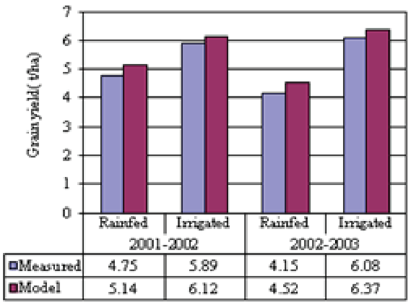

Figure 7. Comparison of simulated and measured grain yield of winter wheat

The simulated wheat yield varied from 5.1 t/ha to 6.1 t/ha, while the measured yield varied from 4.7 to 6.1 t/ha for rainfed and irrigated conditions. Statistical parameter *α*, *RMS* and *E* were obtained 0.32 t/ha, 0.33 t/ha, 0.83 respectively.

CONCLUSIONS

AquaCrop version 5.0 capable to simulate the soil water in the root zone, the above ground biomass and grain yield of winter wheat under rainfed and irrigated conditions. AquaCrop model can be used with a high degree of reliability in practical management, strategic planning of the use of water resources for irrigation.

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IDENTIFICATION OF PROSTIGMATID MITES ASSOCIATED WITH HAWTHORN TREES IN WEST OF IRAN

Masoumeh KHANJANI, Mohammad KHANJANI, Fatemeh AMINI

Bu–AliSina University, College of Agriculture, Department of Plant Protection, Hamedan, Iran

Corresponding author email: mh.khanjani86@gmail.com

Abstract

*Prostigmatid mite fauna of hawthorn trees, Crataegus monogyna Jacq. (Rosaceae), in Hamedan, Kurdistan and Kermanshah provinces were studied during 2009–2013. Mites specimens were collected from soil under trees and also aerial parts of hawthorn trees in hamedan, Kermanshah and Kurdistan and mounted directly in Hoyer's medium. In this study in total 17 species belonging to 13 genera and 9 families were collected and identified. Three species were new for the world Acari fauna and marked in the text by asterisk (*). The collected mites according to their families, genera and species are as follows: **Bdellidae**: Spinibdellacronini (Baker & Balock, 1944);**Pseudocheylidae**: Anoplocheylus sinai Bagheri 2013; **Caligonellidae**: Caligonella humilis (Koch, 1838), Molothrognathus **sp. nov**.*, Neognathus terrestris Summers & Schlinger, 1955,N. ueckermanni Bagheri and Haddad Irani-Nejad, 2010; **Cryptognathidae**: Favognathus alvandii Khanjani and Seeman 2014*; **Raphignathidae**: Raphignathus hecmataniensis Khanjani & Ueckermann, 2003, R. protaspus Khanjani & Ueckermann, 2002, R. collegiatus Atyeo and Crossley, 1961; **Stigmaeidae**: Eustigmaeus nasrinae Khanjani & Ueckermann, 2002; **Linotetranidae**: Linotetranus astragalusi Khanjani and Khanjani 2011;**Tenuipalpidae**: Cenopalpus bakeri Düzgünes, 1967, Cenopalpus crataegi Dosse, 1971,Colopalpus zahirii (Khanjani & Seeman 2013)*, Tenuipalpus euonymiKhosrowshahi, 1991; **Tetranychidae**: Tetranychus urticae Koch 1836. Among them family Raphignathidae with 3 species were found frequently, Colopalpus zahirii had high population and was first record from Iran and Spinibdellacroninialmost with wide distribution in these areas.*

Key words: *Raphignathidae, Tetranychoidae, predatory species, spider mites, cosmopolitan.*

INTRODUCTION

Suborder Prostigmata belongs to the order Trombidiformes and comprises 36 superfamilies. Supefmily Bdelloidea comprises a moderately assemblage of predatory species grouped in two cosmopolitan families: *Bdellidae* and *Cunaxidae* (Krantz and Walter, 2009). Members of the family Pseudocheylidae are thought to be predators, they are found under tree bark, in litter and moss (Ueckermann and Khanjani, 2004). Members of superfamily Raphignathoidea are important biological control agents of spider mites, eriophyid mites and scale insects in agriculture and forestry. They were found in various ecosystems: foliage, branches, trunks, moss and lichen, litter, soil, animal nests, stored products and even in house dust (Fan and Zhang, 2005). Superfamily Tetranychoidea are obligatory phytophagus mites assigned to five recognized families. Most of species that are of major economic importance are contained in two families, Tetranychidae and Tenuipalpidae (Krantz and Walter, 2009).Up to date, 18 species of genus *Eustigmaeus*, 12 species of genus *Raphignathus*, 7 species of the genus *Favognathus*, 10 species of the genus *Molothrognathus*, 15 species of genus *Linotetranus*, 9 species of genus *Tenuipalpus*, 18 species of *Cenopalpus*, 4 species of genus *Spinibdella*, 4 species of genus *Caligonella*,6 species of genus *Neognathus*, 8 species of genus *Tetranychus* and 6 species of genus *Anoplocheylus* have been recorded from Iran (Bayzavi et al., 2013; Khanjani et al., 2012; Khanjani et al., 2013; Ahmad Hoseini et al., 2014; Khanjani et al, 2014; Paktinat-Saeeji et al., 2015; Bagheri et al., 2013; Mahdavi et al., 2013 and Khanjani et al., 2014).

In this paper, we have reported 17 species belonging to 13 genera from 9 families: *Bdellidae, Caligonellidae, Pseudocheylidae, Cryptognathidae, Raphignathidae, Stigmaeidae*, *Linotetranidae*, *Tenuipalpidae* and *Tetranychidae* which were collected from west of Iran.

MATERIALS AND METHODS

Mites specimens were collected from hawthorn trees, *Crataegus monogyna* Jacq. (Rosaceae) in western parts (Hamedan, Kermanshah and Kurdistan) of Iran. In this order, samples were collected from soil under trees and also aerial parts of plants and taken into the laboratory for processing. Mites were removed from plant leaves with a No. 0 paint brush under a Wild M8 stereomicroscope and also Berlese funnel was used to extract the soil and litters specimens under hawthorn trees. The specimens were mounted directly on slides in Hoyer's medium. The collected specimens were identified by means of an Olympus BX51 differential interference contrast microscope under 1000X magnification.

RESULTS AND DISCUSSIONS

In this study, totally 13 genera and 17 species were recorded from west of Iran, three species were new for the world Acari fauna and marked in the text by asterisk (*). Identified species as follows:

Taxonomy

Superfamily Bdelloidea
Family Bdellidae Dugès, 1834
Genus *Spinibdella* Thor, 1930
***S.cronini* (Baker & Balock, 1944)**
Distribution: Three females collected from Marivan, Kurdistan, 3 September 2013; three females from Nahavand, Hamedan, 21 October 2013; one female from Sanandaj, Kurdistan, 10 July 2014 and one female from Sarv-Abad, Kurdistan, 5 May 2014.

Superfamily Cheyletoidea
Family Pseudocheylidae Oudemans, 1909
Genus *Anoplocheylus* Berlese, 1910
***A.sinai* Bagheri 2013**
Distribution: Two females collected from Tuyserkan, Hamedan, 29 September 2010 and one female from Hamedan, Hamedan, 23 October 2012.

Superfamily Raphignathoidea Kramer, 1877
Family Caligonellidae Grandjean, 1944
Genus *Caligonella* Berlese, 1910
***C. humilis* (Koch, 1838)**
Distribution: One female collected from Tuyserkan, Hamedan, 29 September 2010.

Genus *Molothrognathus* Summers & Schlinger, 1955
Molothrognathus* sp. nov.*
Distribution: Two females collected from Tuyserkan, Hamedan, 29 September 2010.

Genus *Neognathus* Willmann, 1952
1**. *N. terrestris* Summers & Schlinger, 1955**
Distribution: One femalecollected from Nahavand, Hamedan, 12 July 2013.
2. *N. ueckermanni* Bagheri and Haddad Irani-Nejad, 2010
Distribution: Four females collected from Tuyserkan, Hamedan, 19 October 2010.

Family Cryptognathidae Oudemans, 1902
Genus *Favognathus* Luxton, 1973
F. alvandii* Khanjani and Seeman 2014
Distribution: Five females collected from Tuyserkan, Hamedan, 11 October 2012.

Family Raphignathidae Kramer, 1877
Genus *Raphignathus* Dugès, 1834
1. ***R. hecmataniensis* Khanjani & Ueckermann, 2003**
Distribution: Nine females collected from Kermanshah, Kermanshah, 3 November 2013; six females from Salavat Abad, Kurdistan, 10 November 2013; two females from Marivan, Kurdistan, 10 November 2013.
2. ***R. protaspus* Khanjani & Ueckermann, 2002**
Distribution: Two females collected from Hamedan, Hamedan, 17 September 2013; three females and I males from Kermanshah, Kermanshah, 10 July and 17 September 2013; six females from Salavat Abad, Kurdistan, 10 July 2013.
3.*R. collegiatus* Atyeo and Crossley, 1961
Distribution: Eight females collected from Kermanshah, Kermanshah, 23 September 2013; one female from Marivan, Kurdistan, 15 July 2013.

Family Stigmaeidae Oudemans, 1931
Genus *Eustigmaeus* Berlese 1910
***E. nasrinae* Khanjani & Ueckermann, 2002**

Distribution: Five females collected from Hamedan, Hamedan, 4 September 2010.

Superfamily Tetranychoidea
Family Linotetranidae Baker & Pritchard, 1953
Genus Linotetranus Berlese, 1910
***L. astragalusi* Khanjani and Khanjani 2011**
Distribution: Two Females collected from Tuysekan, hamedan, 28 September 2010.

Family Tenuipalpidae Berlese 1913
Genus *Cenopalpus* Pritchard and Baker, 1958
1. *C. bakeri* Düzgünes, 1967
Distribution: Seven Females collected from Hamedan, hamedan, 18 September 2010 and 21 September 2013.
2. *C. crataegi* Dosse, 1971
Distribution: One Femalecollected from Hamedan, hamedan, 18 September 2010.

Genus *Colopalpus* Pritchard and Baker 1958
C. zahirii*(Khanjani & Seeman 2013)
Distribution: Twenty eight females collected from Simin, Hamedan, 10 October 2012.

Genus *Tenuipalpus* Donnadieu, 1875
T. euonymi Khosrowshahi, 1991
Distribution: Three females collected from Sanandaj, Kurdistan, 3 October 2009.

Family Tetranychidae Donnadieu, 1875
Genus *Tetranychus* Dufour, 1875
***T. urticae* Koch 1836**
Distribution: Nine females collected from Hamedan, hamedan, 12 September 2010 and 10 November 2013.

We have reported 17 species belonging to 13 genera from 9 families: *Bdellidae, Caligonellidae, Pseudocheylidae, Cryptognathidae, Raphignathidae, Stigmaeidae, Linotetranidae, Tenuipalpidae* and *Tetranychidae* which were collected from west of Iran.

Three species (*Colopalpuszahirii*, *Favognathusalvandi* and *Molothrognathu ssp.* nov.) were new for the world acari fauna**.**

Among them family Raphignathidae with 3 species was found frequently, *Spinibdellacronini* almost with wide distribution in these areas and *Colopalpuszahirii* was first record from Iran and had high population.

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EFFECT OF NUTRIENTS SUPPLY WITH FOLIAR APPLICATION ON GROWING DEGREE DAYS, PROTEIN AND FATTY YIELD OF CORN IN MEDITERRANEAN CONDITIONS

Yakup Onur KOCA

Adnan Menderes University, Faculty of Agriculture, Department of Crop Science, Aydın – 09100, Turkey

Corresponding author email: koca2002@hotmail.com

Abstract

Nutrients are essential for plant growth and soil that was found with high pH levels in alkaline character regions negatively affected the uptake of micronutrients (Zn, B, Mn, Cu, Co, Mg, Se, and Fe) with the exclusion of molybdenum. Current practices in attempts to solve this problem is to add nutrient fertilizers and natural hormone combinations via foliar. In this study nutrients and natural hormone combinations that could not be taken by roots were applied to the leaf and the effects on corn analyses. The experiment carried out in 2010 and 2011 was under in the field conditions in Aydın. Plant materials used in this experiment were: NK-Arma, 31G98, Kermes and 31D24 hybrid corn varieties which is cultivated commercially in Turkey. The fertilizer solutions included: a solution (1) containing auxin and zinc (Zn) foliar and a solution (2) containing boron (B) fertilizers were used. At the end of the final study it was determined that the yield of 168.8-260.0 g in cob had been obtained. Protein measurement revealed between 826-1505 kg.ha^{-1}, fatty yield was determined between 359-574 kg.ha^{-1} in the total yield. We observed that solution 1 (auxin and Zn) and solution 2 (B) applications positively affected both the corn yield and the quality in this study. Additionally it was found that foliar applications prolonged corn's vegetative period and increased GDD average values of the vegetative period with Auxin, Zn and B applications. The highest cob yield, protein yield and fatty yield values were found in 31D24 and this genotype stood out from all other genotypes in the research.

***Key words**: corn, foliar application, GDD, zinc, auxin, boron.*

INTRODUCTION

FAO estimations state that by 2050 the human population will have increased by 34% from today (Anonymous, 2011a). It is emphasized that to meet the expected increase in population, agricultural production must be increased by 70% (Anonymous, 2011b). This demand necessitates not only bigger cultivated areas, but more efficient sustainable usage of the cultivated areas already in production. Current agriculture practices have utilized non-arable fields (high pH, defective drainage, inadequate structure etc.). However high yield is only achieved when optimum conditions are put into practice (Fageria, 2002).

Corn's primary production is for human consumption that is utilized fresh and for processed products starch, flour, cooking syrup and crisp. Corn's secondary production is for animal feed and industrial uses such as ethanol (Remison, 2005). High corn yield is possible by providing sufficient water and nutrients during the short growing stage. We know that large cultivated areas of current agricultural soils are alkali characterized (pH up to 7 or more) and that this soil type negatively affects uptake of micronutrients by plants in Mediterranean areas (Cakmak et al., 1999). It is observed that there are decreases in uptakes of micronutrients (Zn, B, Mn, Cu, Co, Mg, Se, and Fe) with the exception of molybdenum at high pH levels (Basta and Tabatabai, 1992; Alcântara and Camargo, 2001; Fageria, 2002). These micronutrients are essential (Benett, 1993; Marschner, 1995) for many vital activities in plants from protein synthesis to carbohydrate and oil cycle, from photosynthesis and chlorophyll to chloroplast structures and energy cycle (Welch, 1995; Rodriguez et al., 2000; Ceylan et al., 2009). Insufficient presence of one or more of these elements negatively impacts on yield and quality (Genç et al., 2002; Yassen et al, 2010; Zayed et al., 2011). The relationship between micronutrient application on crops in terms of grain yield and quality of product is undeniable. (Hossain et al., 2008; Potarzycki and Grzebisz, 2009; Safyan et al., 2012).

Micronutrient deficiencies observed in plants in regions under the effect of Mediterranean climate have high alkaline characterized soil structure due to high pH and low organic substance (Cakmak, 2010). In these situations due to saltiness and high pH nutrient fertilizers can ensure uptake of micronutrients. The addition of Zn, Mn, Cu, Co and B treated from leaf increase grain yield and protein rates. It is observed that Zn has maximum effect especially on protein amount and fractions (Toma et al., 1973). B element has significant roles in carbohydrate and protein metabolism, tissue differentiation, auxin and phenol metabolism, membrane permeability, pollen germination and pollen tube growth (Marschner, 1995). It is also proven that B has positive effects in improving the ratio of K/Na (in favor of plant) which is a significant parameter in decreasing Na uptake, increasing K uptake of plants from soil and tolerance to salt (Muhammed et al., 1987; Maathuis and Altmann, 1999).

The plants response to auxin changes the effect on cell metabolism to coordination of the physical structure decreasing falling leaves and plant aging with cellular effects being inclusive of increase in proton exchange and membrane load (Marre, 1977). Numerous experimental results have indicated that cell expansion occurs in acid medium with auxins being considered as the promoter of this acidification (Mounla et al., 1980; Rayle and Cleland, 1992; Yang et al., 2000). The numerous experiments show that cereal yield is influenced positively with auxin (Ahmad et al., 2007: Ahmad et al., 2008a; Ahmad et al., 2008b; Karimi et al., 2012).

The importance of micronutrients in crop production with increase of population demands is for high yielding cultivars and intensive cropping systems (Ernani et al., 2002). Nutrient interaction in extern soil characteristics is the most important factor affecting yields (Fageria and Baligar, 1997). For example retention of Zn is strongly influenced by pH, the higher the pH the greater the retention (Alcântara and Camargo, 2001) influenced by the metal concentration in the soil, (Basta and Tabatabai, 1992) the organic matter content and by the soil mineralogical characteristics. Nutrient insufficiencies cause plants' ions to become unbalanced (Lewitt, 1980).

The aim of this study is to investigate nutrient mixture impact using leaf composted in the condition of Western Turkey (Mediterranean climate) agricultural activities with alkaline soil on the growth, development periods of corn plant, cob yield and protein yield and fatty yield.

MATERIALS AND METHODS

The research was carried out 2010 and 2011 during the main crop period for the region selected in what was considered a typical Mediterranean climate, hot summers and mild winters. Aydin, is located in west Turkey at 37° 44' N 27° 44' E and is 65 m above sea level. Initial results of soil analysis are shown in Table1.

The experimental soil of the studied field contained a sandy loamy structure with alkaline characteristic and it was mixed with quite low amounts of organic matter. In terms of the micronutrients, soil had a high P level.

Table 2 indicates the pattern of soil micronutrient levels in this experiment. As it is shown in this table, the highest levels of microelements were determined for Ca (2978 ppm) and Mg (594 ppm) of all investigated microelements. K with 176ppm and Na with 101ppm took the next place in the ranking. Further studies revealed Fe, Zn, Mn, Cu and B in lower amounts in the experimental soil respectively. Aydin region`s climate hot and dry in summers, warm and rainy in winters was selected and found to present the best average for a typical Mediterranean climate. Monthly temperature average and rainfall values were taken into account and these for the years 2010 and 2011 are presented in Table 3.

Monthly temperatures were recorded during the corn growth, April-August as shown in the data in Table 3. This data indicates that the temperature was higher in the first year of experiment in comparison to the second year during the corn growth period. The exception for the across the board lower temperature during the second year was the month of July

2011. Gathered precipitation data for both years, during the months January through July showed higher precipitation in the first year in comparison to the second year.

Experimental design

The experiment was based on 4 repetitions inclusive of two factors using a split plot experimental design plan. The area of the Parcel used was determined to be 28 m^2 for each genotype. In addition parcels were set up as a control feature and not applicable for treatment.

Table 1. Results of experimental soil texture and chemical analysis

Soil texture[1] (%)			pH[2]	Organic mater[3]	P[4]
Sand	Silt	Clay		(%)	(ppm)
72,0	16,7	11,3	8,4	1,2	21
[1] :Bouyoucos; [2]: 1:2.5 Saturasyon; [3]:Walkley-Black; [4]:Olsen					

(Bouyoucos G.J. 1962; Ayers and Westcot 1989; Walkley and Black 1934; Olsen et al. 1954).

Table 2. Some mineral content of soil.

K[5] (ppm)	Ca[5] (ppm)	Mg[5] (ppm)	Cu[6] (ppm)	B[7] (ppm)	Zn[6] (ppm)
176	2978	594	1.8	0.25	1.1
[5]:A. Asetat; [6]:DTPA; [7]:Azomethin-H					

(Li et all 2004; Lindsay and Norvell 1978; Sah and Brown 1997)

4 hybrid corn varieties were used as experiment material. The varieties nominated were 31G98, 31D24, Kermes and NK-Arma. We cultivated these varieties on 04/May/2010 and 20/May/ 2011. Our first seed emergence observation was conducted on: May 13th 2010 and the following year May 27th 2011. The irrigation plan considered and used (5 times) for the corn plants was based on the standard (5x100 mm) taking climate conditions and plant necessity into consideration. Standard fertilizer application for the soil was applied as 200 $kg.ha^{-1}$ pure nitrogen (80 $kg.ha^{-1}$ with 15-15-15 composite was applied immediately at the beginning of cultivation – 120 $kg.ha^{-1}$ with urea (H_2NCONH_2) before first water), 80 $kg.ha^{-1}$ phosphor (P_2O_5) and 80 $kg.ha^{-1}$ potassium (K_2O).

In this experiment the fertilization plan was carried out using foliar forms when 6-8 leaves where observed on each plant. Fertilizer was supplied using 0.150% of total mixed nutrients. Furthermore, actual leaves compost fertilizing was applied through the experiment. Fertilizer application was performed June 6th 2010 in the first year and June 28th 2011 the second year. Foliar fertilizers were used in the study. The utilized fertilizer in this study was procured from a local company: Biokim Company (Izmir, Turkey).

Table 3

Months	Temperature °C			Precipitation (mm)		
	2010	2011	Long term	2010	2011	Long term
Janua.	10.1	8.1	8.2	138.9	147.2	121.0
Februa	12.2	9.6	8.9	156.5	68.6	95.5
March	14.2	11.4	11.7	23.3	26.1	71.1
April	17.2	14.6	15.7	15.9	51.5	45.5
May	22.3	19.6	20.9	30.4	44.7	33.5
June	25.4	25.1	25.9	32.2	14.6	14.0
July	31.0	31.0	28.4	0.0	0.0	3.5
August	31.7	28.8	27.2	0.0	0.2	2.2
Septe.	26.7	26.2	23.2	0.8	32.2	14.4
Octob.	18.3	16.3	18.4	95.7	69.8	43.8
Nove	17.4	11.3	13.0	37.9	-	87.5
Dece	11.8	9.6	9.4	143.8	87.8	110.2

Fertilizer combinations:

Solution 1 (containing auxin (growth hormone) and 8% soluble Zn): Increases membrane permeability and promotes the uptake of nutrients. Additionally these conditions increase the resistance of plants to pests and diseases. The nutrient mixture has a positive effect on the plant enzyme system and was found to encourage amino acid and carbohydrate synthesis.

Solution 2 (containing 10% soluble B): It is recommended against boron deficiency in the soil. Boron deficiency can cause to reduction in spike and grain. It is suggested these nutrient mixture can use boron deficiency conditions in the soil.

Zachary (1999) noted that plant development subjected to stress of certain extreme temperature ranges either too high or too low results in stress during the period of development. It was reported that the value of temperature in the range of: 10°C and 30°C for corn plants created optimum conditions with rapid development of the plant at temperatures around 30°C. Many researchers have developed the following formula to calculate GDD values for corn and determined using the following equilibriums according to Cross and Zuber (1972) and in Germany et al. (1996) in their previous studies.

GDD = [(Tmax. + Tmin.)/2] – Tbase

Tmax.: Daily maximum temperature (up limit 30°C)

Tmin.: Daily minimum temperature (down limit 10°C), **Tbase**: for corn 10°C

In order to understand the interactive effects of daily temperature variations on plant growth we observed and recorded the temperature during the two years to better understand the relationship between corn plant growth and daily effective temperature, GDD values. These were calculated to clearly explain how the daily range of temperature of both upper and lower limits affects growth and ultimately yield.

Table 4. The number of days which temperatures down to 10°C and up to 37.5°C and 40°C

Months	2010			2011		
	10	37	40	10	37	40
May	-	-	-	2	-	-
June	-	4	-	-	1	-
July	-	13	-	-	12	1
August	-	12	7	-	9	-
September	-	-	-	-	2	-
Aggregate (total)	0	29	7	2	24	1

The number of days that temperature values exceeded the limit value for C4 plant (Stewart et al., 1998; Crafts-Brandner and Salvucci, 2002) is presented in Table 4. Data showed lower restricted pointed at10°C, whereas upper point indicated at 37.5°C and critical upper at 40°C.

Table 4 indicated of number of days that temperature exceeded the limit of range during the two years of this experiment. The lower limit in temperature of 10 °C, the upper limit of 37.5°C and 40°C is taken as the critical upper limit (Stewart et al, 1998; Crafts-Brandner and Salvucci 2002).

Per cob yield was measured by taking their average of 20 cobs from parcel. Protein and oil content of corn grain were analysed by using NIRS-FT (Bruker MPA) (Gislum et al., 2004). Plant samples were gathered by weighing (90 g) as uniformly as possible in mini sample cups with a depth of approximately 2.8 cm and a diameter of 9 cm. Samples were analysed and outcome results were used to calculate protein and oil yield by the following formulas.

Oil yield (kg ha^{-1}) = [Oil content (%) × Grain yield (kg.ha^{-1})]/100

Protein yield (kg ha^{-1}) = [Protein content (%) × Grain yield (kg.ha-1)]/100

Statistical Analyses of Data

All the plant data collected from all treatments were statistically analysed using the TARİST package software (Açıkgöz et al., 1994). Data was used in attempt to determine the interactive effects of foliar fertilizers on varieties.

RESULTS AND DISCUSSIONS

Least Square means of measured parameters was calculated through variance analysis for each. It was found that genotype and fertilizer application provided significant different results in all varieties. We observed however a significant difference in interaction effects between the individual genotype, fertilizer application and the interaction effects of years of application on protein yield. Data is separated according to years and evaluated in Table 6, 7 and 8. LSD values of the important ones among variation resources are presented under the Tables.

GDD values of corn varieties were calculated at the end of different foliar fertilizer applications and are presented in Table 5. It was found that averages of varieties were close to each other. 31G98 genotype was found to have 1904 varieties which make it the highest number of varieties. This is followed by NK-Arma (1874), 31D24 (1865) and Kermes (1854) varieties. It was found that Auxin and Zn addition (1894) application was higher than Control (1881) and Boron (1856) applications were found to be lower than control. Obtained values which were found to be higher than the values determined by Kara (2011), in accordance with the values determined by Koca et al. (2010), and lower than the values determined by Roth and Yocum (1997).

Based on results, we would suggest that only auxin and Zn addition extended vegetation period of corn in this study. Fertilizer impact increased both vegetative and generative periods of corn. Boron application only increased in vegetative period. Our data indicated that GDD in corn was related with some growth parameters in many researches (Teal et al., 2006; Warrington and Kanemasu, 1983a; Warrington and Kanemasu, 1983b; Warrington and Kanemasu, 1983c) directly with grain yield in many studies (Baez-Gonzalez et al., 2002; Bollero et al., 1996) and it can change dramatically with the effect of environmental factors (Koca, 2009).

Application of some nutrients and hormones from leaf ensured the reduction of stress conditions and reactions. To attain a more positive result a more optimum environment was attempted to be created. In some applications, the period for a plant to reach the growing stage was extended. This result is in parallel with the result obtained by Thomason et al. (2007). When the results are analysed in terms of years, it revealed that 2010 was warmer than 2011. Heat sum of all of the varieties were higher in the first year. However, we determined that the second year was cooler than the year before, temperature values presented in Table 4 supports these findings. While daily minimum temperature was never below 10^{o}C during application months, it fell below this level twice in 2011 and maximum temperature values were over limit values even more often.

Cob yield was analysed and it was indicated that the differences between first year varieties and applications were significant. 31D24 genotype products the highest yield value with Auxin, and Zn addition and B applications. There was also demonstrated the higher means values of solution 1 and solution 2 than control. Difference between these two applications was found to be insignificant. Therefore, the highest grain yield in the first year was obtained in 31D24 genotype, from B (260.0 g) application. This is followed Kermes genotype by auxin and Zn addition applications on (255.1 g).

Differences between varieties and applications were determined to be insignificant in the second year (2011). All applications provided greater cob yield than control in 31D24 genotype. Differences between the applications weren’t significant. The highest value was obtained from 31D24 genotype auxin and Zn addition (248.6 g) applications in the second year (2011). This is followed by B (232.9 g) applications. Results of the two years showed that 31D24 had high yield averages in comparison to the other studied genotypes.

In the first two years of the study, almost all of the applications resulted in high yields in control parcels. In particular B, auxin and Zn addition applications had significant positive effects on corn. It is stated that as a result of the soil analysis in the study, B element was deficient (Table 2). B deficiency is common in this soil. In terms of higher pH (8.4) plants are not able to uptake certain nutrients from these types of soil conditions despite sufficient nutrients being present in the soil. This decrease in ability to take in nutrients from soil through plant roots (Basta and Tabatabai, 1992; Alcântara and Camargo, 2001; Fageria, 2002) explains the reason why all the applications gave higher yields than control and it is in parallel with the results of the studies of Toma et al. (1973), Wojcik (2006), Usenik and Stampar (2007), Hossain et al. (2008), Potarzycki and Grzebisz (2009) and Safyan et al. (2012).

The GDD values indicated that fertilizer applications extended the plant’s vegetation period. However Auxin and Zn application ensured increase in both vegetative and generative periods, B application was found to increase only in vegetative period.

All these applications ensured yield values can be called high. It can be suggested that there is relationship between GDD values and grain yield (Bollero et al. 1996; Baez-Gonzalez et al. 2002). This obtained result is in parallel with the study of Bauder and Randall (1982) and Duchon (1986).

Both two years of the experiments were compared. It was found that the first year’s (2010) temperature values were higher than the second year (2011). It could be reason for the first year's GDD values (1885) being higher than the second year (1864). It can be suggested that the difference between the two years may be due to an emerged generative period. The first year average in yield value (222.4 g) was higher than the second year (212.5 g). These results were calculated to be due to increased temperature's effect on grain yield of corn (Fraisse et al., 2001).

Protein yield values of corn varieties after different foliar fertilizer applications are presented in Table 7. Almost all of the applications in the first year increased protein yield. 31D24 showed the highest value in auxin and Zn addition application. The value was found to be higher and statistically more significant than the other applications (solution 2 and control). Increase of protein yield by auxin and Zn application and amino acid application was an expected result. This result is in parallel with the studies of Toma et al. (1973), Ahmad et al. (1994), Tejada and Gonzalez (2003), Delfine et al. (2005).

31D24 showed the highest value similar with the first year. Genotype was found to be different from others. Whereas 31G98 genotype in the second line only auxin and Zn applications demonstrated high protein yield average in the second year. Auxin and Zn application had positive effects in both years. This result is in parallel with the results of Özer (1994) andCeylan et al. (2009).

Fatty yield values of different corn varieties, obtained from different foliar fertilizer applications are presented in Table 8. Generally all of the applied nutrient mixtures increased fatty yield of corn. But only genotype was determined to be significant on fatty yield. The highest yield value was showed from 31D24 genotype auxin and Zn applications.

31D24 genotype was determined as the genotype that had the highest fatty yield as well as the protein yield.

The second year all of the applications increased fatty yield. Auxin and Zn addition and B applications gave the higher than control values. In terms of varieties, 31G98 genotype produced highest fatty yield on average. However, all of the varieties except Kermes showed high fatty yield values. The Kermes genotype throughout the experiment suggested that application of B has a very positive effect on fatty yield in all genotypes. It was emphasized in many researches that B had positive effects on grain quality (Rerkasem and Jamjod 1997 and Soylu et al. 2004).

CONCLUSIONS

Regardless to cultivars auxin, added Zn and B have positive effects to grain yield and quality of corn. At the end of soil analysis, it was determined that B level was insufficient; this explains the positive effect of 10% water-soluble B (solution 1) on yield and quality. Zn contributed to increasing grain yield and quality values with auxin and Zn (solution 2).

Calculated GDD values showed that Zn only with auxin extends vegetation period. Application increased both vegetative and generative periods for a few days. Boron application increased vegetative period.

31D24 genotype became prominent in terms of grain yield (crop yield) and quality (protein and fatty yield). The genotype gave positive reactions to almost all of the applications. It especially gave high values in auxin, Zn addition and B applications. The genotype showed high values in control application which indicates their quick and positive responses to given nutrients.

We noted however that especially in quality parameters, varieties gave different reactions to applications in different years. It is clear that many environmental, physiological, cellular, metabolic and molecular processes contribute to the relative deposition of protein and fatty in the developing corn kernel (Douglas and Robert, 1991). Obtained results were in accordance with this.

As a result, it can be said that increase in soil pH has negative effects on plant's taking nutrients. It was seen that even though nutrients (Zn, B, Mn, Cu, Co, Mg, Se and Fe) exist in soils that have high pH, they cannot be taken up by the plant. It can be said that, application of nutrients that cannot be taken from soil that application to the leaf has a positive effect.

Table 5. Result of GDD (Growing Degree Days) value for different nutrient application in 2010 and 2011

	Year	NK-Arma			31G98			Kermes			31D24			Average		
		Veg	Gen	WGP	Veg	Gen	WGP	Veg	Gen	WGP	Veg	Gen	WGP	Veg	Gen	WGP
solution (1)	2010	732	1203	1935	705	1244	1949	732	1173	1905	695	1180	1875	716	1200	1916
	2011	740	1172	1912	697	1215	1912	740	1145	1885	692	1175	1867	717	1177	1894
Average		736	1188	1924	701	1230	1931	736	1159	1895	694	1178	1871	717	1189	1905
solution (2)	2010	718	1128	1846	732	1244	1976	680	1152	1832	695	1184	1879	706	1177	1883
	2011	740	1080	1820	756	1240	1996	681	1167	1848	700	1188	1888	719	1169	1888
Average		729	1104	1833	744	1242	1986	681	1160	1840	698	1186	1884	713	1173	1886
Control	2010	718	1172	1890	718	1231	1949	692	1170	1862	692	1184	1876	705	1189	1894
	2011	723	1139	1862	697	1215	1912	681	1153	1834	697	1165	1862	700	1168	1868
Average		721	1156	1876	708	1223	1931	687	1162	1848	695	1175	1869	703	1179	1881
	2010	723	1168	1890	718	1240	1958	701	1165	1866	694	1183	1877	709	1189	1898
	2011	734	1130	1865	717	1223	1940	701	1155	1856	696	1176	1872	712	1171	1883
Year average		729	1149	1878	718	1232	1949	701	1160	1861	695	1179	1875	711	1180	1891
Veg.: Vegetative period, Gen.: Generative period, WGP: Whole growth period																

Table 6. Result of cob yield (g) value for different nutrient application in 2010 and 2011

	2010					2011				
	NK-Arma	31G98	Kermes	31D24	Average	NK-Arma	31G98	Kermes	31D24	Average
solution (1)	225.6	231.3	255.1	246.6	239.7	208.7	213.5	230.2	248.6	225.3
solution (2)	237.4	231.8	207.9	260.0	234.3	228.4	211.5	206.9	232.9	219.9
Control	201.6	191.2	199.1	211.4	200.8	188.1	168.8	185.0	197.9	185.0
Average	221.5	218.1	220.7	239.3	224.9	208.4	197.9	207.4	226.5	210.0
LSD (0.05)	Genotype*Application: 12,7									

Table 7. Result of protein yield ($kg.ha^{-1}$) value for different nutrient application in 2010 and 2011

	2010					2011				
	NK-Arma	31G98	Kermes	31D24	Average	NK-Arma	31G98	Kermes	31D24	Average
solution (1)	943	1174	1223	1505	1211	1000	1232	1131	1387	1188
solution (2)	1076	1264	1041	1218	1150	1086	1113	961	1236	1099
Control	1075	1080	862	1303	1080	1092	1126	1004	1138	1090
Average	1031	1173	1042	1342	1147	1059	1157	1032	1254	1126
LSD (0.05)	Genotype x Application: 164,0									

Table 8. Result of fatty yield ($kg.ha^{-1}$) value for different nutrient application in 2010 and 2011

	2010					2011				
	NK-Arma	31G98	Kermes	31D24	Average	NK-Arma	31G98	Kermes	31D24	Average
solution (1)	507	520	483	566	519	515	568	489	570	536
solution (2)	515	574	453	491	508	519	534	449	553	514
Control	490	462	359	508	455	497	498	450	488	483
Average	504	519	432	522	494	510	533	463	537	511
LSD (0.05)	Genotype: 39,0									

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EFFECT OF NITROGEN ON THE TRANSLOCATION OF DRY MASS AND NITROGEN IN BARLEY

Svetla KOSTADINOVA[1], Galia PANAYOTOVA[2], Lyubena KUZMANOVA[1]

[1]Agricultural University – Plovdiv, 12 Mendelleev str., 4000 Plovdiv, Bulgaria,
[2]Trakia University, Faculty of Agriculture, Student campus, 6000 Stara Zagora, Bulgaria

Corresponding author email: klyubena@yahoo.com

Abstract

A pot experiment was carried out to determine dry mass and nitrogen accumulation until anthesis and at grain filling period, and dry mass translocation and utilization in grain filling of Bulgarian barley genotype Krami. The plants were grown on four levels of nitrogen nutrition – 0, 100, 200 and 300 mg N/kg soil. It was established that plants were synthesized 3-61% more dry biomass at pre-anthesis than at post-anthesis. Nitrogen fertilizing was diminished the relative amount of dry mass accumulated at pre- and post-anthesis and pre- to post-anthesis nitrogen uptake. The highest NHI/HI ratio was established at unfertilized plants – 1.67 and its values were slightly depended on the nitrogen levels. Pre- to post-anthesis N uptake was decreased with increasing N levels from 6.1 (at unfertilized plants) to 3.4 (at N_{300}). Nitrogen fertilizing was decreased the relative part of nitrogen in the grain. Dry mass translocation efficiency ranged from 18.8% in unfertilised plants to 22.4% at applying N_{100}. The mean nitrogen translocation efficiency was 60% and significant differences were obtained between unfertilized plants and those grown at N_{200}.

Key words: *dry mass; nitrogen; translocation efficiency; spring barley.*

INTRODUCTION

The supply of assimilate to the grain of barley may originate from current assimilation and matter assimilated before anthesis and is stored temporarily in the leaves, culms, chaff, and other vegetative plant parts (Van Sanford and MacKown, 1987). Accumulation of reserves before anthesis and their storage in the vegetative parts depend on the growing conditions and genotype (Przulj and Momcilovic, 2001; Blum, 1998). Pre-anthesis reserves contributed up to 74% to the grain yield of barley (Gallagher et al., 1975). According to Austin et al. (1980) the total dry mass of the aboveground vegetative parts of barley usually decreased after anthesis. The contribution of pre-anthesis assimilates to grain filling and grain weight depend on the amount of mass that is mobilized between anthesis and maturity and the efficiency of conversion of the mobilized mass in the grain (Gebbing et al., 1999). The N requirement of the growing grain can be supplied by the mobilization and utilization of N assimilated prior to anthesis (pre-anthesis N) and by the utilization of N assimilated during grain filling (post-anthesis N). Pre-anthesis accumulated nitrogen seems to be the predominant source of nitrogen during grain growth and development (Van Sanford and MacKown, 1987). The amount of nitrogen at anthesis in the aboveground wheat parts can be as high as 90-100% of total plant nitrogen at maturity (Clarke et al., 1990; Heitholt et al., 1990). For barley plants these values were established from 55 % up to 91 % (Przulj and Momcilovic, 2001). The precise amount of pre-anthesis N that is used for grain filling is difficult to estimate because it is necessary to know N losses and the role of the root in N balance (Rroco and Mengel, 2000). In cereals, research on N accumulation and utilization has been carried out mainly on wheat (Dachev, 1999; Papakosta and Gagianas, 1991; Cox et al., 1984; Austin, 1977). Studies have shown that grain N in wheat mainly represents N accumulated in the vegetative parts until anthesis and translocated to the grain during the reproductive phase. N distribution showed that 60-92% of the N accumulating in the wheat grain originates from the translocation from vegetative tissue after anthesis. In barley, 10-100% of grain N is taken up during vegetative growth and translocated during grain filling period (Carreck and Christian, 1990). After anthesis, plants continue the assimilation of N, and significant quantities of N can be assimilated during grain filling. The importance of both N sources has been emphasized by Van Sanford and MacKown (1987), who have found that variation in final spike N can be associated with variation in total N uptake. Environmental conditions during the pre- and post-anthesis periods are likely to have different effects on N accumulation. N uptake is influenced by available water, degree of association between the roots and the soil, the supply of nitrate, genotype requirements and efficiency of N use, and other properties of the genotype and conditions of growing (Clarke et al., 1990). Bulman and Smith (1994) found genotypic variation in N accumulation and translocation to the grain during the process of filling. The aim of this study was to assess contribution of pre- and post-anthesis assimilation for grain production at barley in dependence of nitrogen fertilization.

MATERIALS AND METHODS

The pot experiment with Bulgarian barley variety Krami (15 plants/pot) was conducted under greenhouse conditions. The plants were grown in plastic pots (5L volume) on four levels of nitrogen – 0, 100, 200 and 300 mg N/kg soil. Applying of NH4NO3 as water solutions created the different nitrogen levels. The soil reaction in water solution was 6.7 and content of Nmin – 43.2 mg N/kg. The content of available phosphorus and potassium per 100 grams of soil were 24 and 48 mg, respectively. Four pots of each variant at about mid-anthesis and the rest four pots of each variant at maturity were collected for analyses. These samples were separated in two components at anthesis (leaves+stems and chaff-flowered spikes) and at maturity [grain and straw (leaves+stems+chaff)]. The samples were weighed, oven-dried at 70 °C for 48 h and then weighed again. The nitrogen content was determined according to the Kjeldahl method (Walinga et al., 1995).

The following parameters related to dry mass and nitrogen accumulation and translocation within the barley plant are discussed in this paper:

1. Pre-anthesis and post-anthesis dry mass (DM) and nitrogen accumulation (g/pot);
2. Dry mass translocation (DMT) (g/pot) = dry mass at anthesis-dry mass (straw) at maturity;
3. Dry mass translocation efficiency (DMTE) (%) = dry mass translocation / dry mass at anthesis × 100
4. Contribution of pre-anthesis assimilates to the grain (CAVG) (%) = dry mass translocation / grain yield × 100 (Papakosta and Gagianas, 1991).
5. N translocation from vegetative tissues at anthesis to the grain was calculated as:

N translocation (NT) (mg N/pot) = N uptake at anthesis – N uptake at maturity (straw) (Cox et al., 1986).

6. Proportion of pre-anthesis N that was translocated to the grain:

N translocation efficiency (NTE) (%) = (N translocation / N content at anthesis) x 100

7. Proportion of N in grain in relation to the total above-ground N at maturity:

Nitrogen harvest index (NHI) (%) = (Grain N / total N in above-ground parts at maturity) x 100

Biomass and nitrogen increase during the grain filling period were estimated as the difference between total DM and nitrogen at maturity and the total DM and nitrogen at anthesis. For the estimation parameters of N translocation, it was assumed that all N from the vegetative parts was translocated to the grain during their filling. N losses due to dead leaves falling off before the harvest and root contribution were assumed to have been zero. This approach was used of other researchers (Przulj and Momcilovic, 2001).

An overall analysis of variance (ANOVA) was performed to evaluate the effect of the experimental treatments on the referred variables, and Duncan (1955) multiple range test (□ = 0.95) was used in order to establish the difference among the means.

5. Phosphorus translocation (kg $N.ha^{-1}$) = P_2O_5 content at anthesis− P_2O_5 content of straw at maturity.

6. Phosphorus translocation efficiency (%) = (P_2O_5 translocation/ P_2O_5 content at anthesis) x 100

7. Phosphorus harvest index (PHI) = grain P_2O_5 at maturity/total P_2O_5 content of aboveground biomass at maturity.

RESULTS AND DISCUSSIONS

The obtained results showed significant effect of the N fertilizing (ranged from 0 to 300 mg N/kg soil) on the above ground dry mass at anthesis and maturity (Table 1). Dry mass of leaves+stems, spikes and their sum was increased up to a level 200 mg N/pot. Growing of barley plants at higher level of nitrogen fertilizing (300 mg N/pot) let to decreasing of dry mass at anthesis. The similar result was obtained for grain production at maturity. Vegetative plant parts (leaves+stems+chaff) and total DM at maturity were no significantly decreased with increasing N fertilizing to 300 mg N/pot. Unfertilized plants had the lowest grain harvest index. This parameter was slightly depended on nitrogen fertilizing from 100 up to 300 mg N/pot.

Table 1. Above-ground dry mass at anthesis and maturity, (g/pot) and harvest index, (%)

Variants	Anthesis			Maturity			
	Leaves+stems	Spikes	Total	Grain	Straw	Total	HI
N_0	19.0 d	4.4 c	23.5 c	13.3 d	24.7 c	38.0 c	35.0 b
N_{100}	24.1 c	7,0 b	31.1 b	23.0 c	31.9 b	54.9 b	42.1 a
N_{200}	35.0 a	8.3 a	43.4 a	36.2 a	44.3 a	80.5 a	44.1 a
N_{300}	29.6 b	6.8 b	36.4 b	31.7 b	41.9 a	73.6 a	43.2 a

Table 2. Nitrogen concentration at anthesis and at maturity, (mg N/g DM)

Variants	Anthesis		Maturity	
	Leaves+stems	Spikes	Grain	Straw
N_0	15.2	10.2	17.4	6.4
N_{100}	18.6	15.4	19.0	7.1
N_{200}	20.9	17.7	20.7	7.5
N_{300}	22.1	19.8	21.8	7.9

Under field experiment with twenty barley genotypes Przulj and Momcilovic (2001) were established the mean N concentrations of leaves+stems and flowred spikes 19.2 and 16.4 mg N/g DM, respectively. Our results (Table 2) at anthesis showed that N concentrations of unfertilized plants were 15.2 mg N/g DM (leaves+stems) and 10.2 mg N/g DM (spikes). These values were increased to 22.1 and 19.8 mg N/g DM, respectively at applying N300. Nitrogen fertilization showed the positive effect on the N concentrations of all plant parts at anthesis and at maturity. Nitrogen fertilizing (N200) increased total N uptake of barley at anthesis by 2.6 times, in comparison to unfertilized plants (Table 3). The highest nitrogen level (N300) decreased total N uptake, because it was negatively affected dry mass accumulation. At maturity it was not established significant difference of N uptake between plants grown at N200 and N300.

Table 3. Nitrogen uptake at anthesis and at maturity, (mg N/pot) and NHI, (%)

Variants	Anthesis			Maturity			
	Leaves+stems	Spikes	Total	Grain	Straw	Total	NHI
N_0	289.4 d	45.1 c	334.5 d	231.8 c	157.8 c	389.6 c	59.5 b
N_{100}	449.0 c	107.3 b	556.3 c	437.8 b	226.2 b	664.0 b	65.9 ab
N_{200}	731.9 a	147.4 a	879.4 a	748.9 a	332.1 a	1081.0 a	69.3 a
N_{300}	653.7 b	134.6 a	788.4 b	690.6 a	331.3 a	1022.0 a	67.6 a

Nitrogen harvest index represents the ability of the plant to mobilize and translocate nitrogenous compounds from the leaves, culm, and chaff into the grain. The values of NHI were varied from 59.5 % (unfertilized barley plants) up to 69.3 % at applying N200 (Table 3). The NHI/HI ratio gives approximately estimation of relative parts of the nitrogen and carbohydrates in the grain (Hay, 1995). The highest NHI/HI ratio was established at unfertilized plants – 1.67 and its values were slightly depended on the N levels (Table 1 and 2). These data were corresponded with a viewpoint of Gooding and Davies (1997) for existing of strong genetical control of the NHI/HI ratio.

Table 4. Post-anthesis dry mass (PADM) and nitrogen (PANU) accumulated by barley plants and ratio of pre- to post-anthesis DM accumulation (ADM/PADM), and pre- to post-anthesis N uptake (AN/PANU)

Variants	PADM g/pot	PANU mg N/pot	ADM/PADM	AN/PANU
N_0	14.5 c	55.1 d	1.61	6.1
N_{100}	23.8 b	107.6 c	1.31	5.2
N_{200}	37.2 a	201.7 b	1.17	4.4
N_{300}	37.2 a	233.6 a	1.03	3.4

Nitrogen fertilization was positively affected post-anthesis dry mass (PADM) and post-anthesis N uptake (PANU) (Table 3). PADM accumulation of barley plants grown at N200 and N300 was increased 2.55 times, compared to the control plants. Nitrogen taken up by plants after anthesis (PANU) was significantly increased up to fertilizing N300 (more five-folds, in comparison with unfertilized plants). The relative amount of DM accumulated at pre- and post-anthesis was presented as the ADM/PADM ratio, which was higher than 1 for all variants. Nitrogen fertilizing was diminished ADM/PADM ratio. In dependence of applied N plants were synthesized 3 - 61% more DM at pre-anthesis than at post-anthesis. The ratio of nitrogen taken up pre-anthesis to that taken up post-anthesis (AN/PANU) was strongly depended on the genotype and the year conditions and it was varied from 0.78 up to 16.87 (Przulj and Momcilovic, 2001). We were established that pre- to post-anthesis N uptake was decreased with increasing N levels from 6.1 (at unfertilized plants) to 3.4 (at N300).

Dry mass translocation (DMT) and efficiency (DMTE) of barley plants were increased with N levels up to N200 (Table 5). Dry mass translocation efficiency (DMTE), the parameter that shows the percentage of translocated dry mass, ranged from 18.8 % in unfertilised plants to 22.4 % at applying N100. Nitrogen translocation, estimated as the difference between total amount of nitrogen at anthesis and vegetative nitrogen at maturity, was the highest (547.3 mg N/pot) in plants grown at N200. NT was decreased at higher nitrogen level (N300). The increased accumulation of nitrogen from anthesis till maturity indicated a continued uptake of nitrogen from the soil and a possible translocation from the root. Acording Przulj and Momcilovic (2001) nitrogen translocation efficiency of field grown barley widely varies in dependence of genotype (from 27 to 66 %) than years (from 47 to 52 %). The authors suppose that the ratio of translocated N to grain N can be an indicator of growing conditions during vegetation, i.e. a higher ratio indicates good growing conditions throughout both vegetative and generative phases. In present investigation NTE was high (mean value 60 %) and significant differences were obtained between unfertilized plants and those grown at N200 - 55 % and 64 %, respectively.

Table 5. Dry mass and N translocation and translocation efficiency

Variants	DMT g/pot	DMTE (%)	NT (mg N/pot)	NTE (%)
N_0	4.42 c	18.8 b	176.7 d	52.8 b
N_{100}	6.97 b	22.4 a	330.1 c	59.3 ab
N_{200}	8.33 a	19.2 ab	547.3 a	62.2 a
N_{300}	6.80 b	18.7 b	457.0 b	58.0 ab

CONCLUSION

Bulgarian barley cultivar Krami was synthesized 3 – 61 % more dry biomass at pre-anthesis than at post-anthesis. Nitrogen fertilizing was diminished the relative amount of dry mass accumulated at pre- and post-anthesis and pre- to post-anthesis nitrogen uptake. The highest NHI/HI ratio was established at unfertilized plants – 1.67 and its values were slightly depended on the nitrogen levels. Pre- to post-anthesis N uptake was decreased with increasing N levels from 6.1 (at unfertilized plants) to 3.4 (at N300). Nitrogen fertilizing was decreased the relative part of nitrogen in the grain. Dry mass translocation efficiency ranged from 18.8 % in unfertilised plants to 22.4 % at applying N100. The mean nitrogen translocation efficiency was 60 % and significant differences were obtained between unfertilized plants and those grown at N200.

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IRRIGATION SCHEDULING AND THE IMPACT OF IRRIGATION ON THE YIELD AND YIELD COMPONENTS OF SWEET CORN

Milena MOTEVA[1], Nelly GADJALSKA[2], Viktoria KANCHEVA[2], Todor TASHEV[2], Veska GEORGIEVA[3], Natalia KOLEVA[4], Ivan MORTEV[2], Vesela PETROVA-BRAHICHEVA[2]

[1]University of Architecture, Civil Engineering and Geodesy,
1 Hr. Smirnenski, Blvd.,1046 Sofia, Bulgaria
[2]Institute of Soil Science, Agrotechnologies and Plant Protection "N. Pushkarov",
3 Shose Bankya Str., 1331 Sofia, Bulgaria
[3]National Institute of Meteorology and Hydrology – BAS,
66 Tzarigradsko Shose, Blvd., 1784 Sofia, Bulgaria
[4]Forestry University, Faculty of Agronomy, Department Agriculture and Herbology,
10 Kliment Ohridski, Blvd., Sofia, Bulgaria

Corresponding author email: milena_moteva@yahoo.com

Abstract:

The goal is to establish the features of the irrigation scheduling of sweet corn for two irrigation technologies – drip irrigation and sprinkling and to establish their impact on the yield and yield components. A two-factorial field experiment with irrigation of Super Sweet 71,12 R hybrid was carried out in Sofia region. The main-plot factors were A - irrigation technology: A_1- sprinkling; A_2- drip irrigation; B - irrigation depth: B_1 – rainfed; B_2 – 50% of the maximum irrigation depth (MIrD); B_3 - 75% of MIrD; B_4 - irrigation with MIrD, which was relative to 80% of field capacity. The following productionelements were established – total ear fresh yield, marketable ear fresh yield, total ear number, marketable ear number, single marketable fresh ear mass, marketable ear row number, one row kernel number of a marketable ear, marketable ear fresh kernel mass. Plant characteristics were taken as plant height, leaves number per plant, ear legth, tassel length. Analysis of varience was applied to all data obtained. It was established that in conditions of a very dry and very warm growing season, sweet corn needs 3 irrigation applications and 180 mm net irrigation depth by sprinkling, and 5 irrigation applications and 75 mm net irrigation depth by drip irrigation. Drip irrigation creates better conditions for the green biomass development, while sprinkling creates better conditions for the productivity. The yield of the marketable ears under the impact of sprinkling was 11.4 Mg/ha and 62080 pieces, while under drip irrigation it is 9.5 Mg/ha and 57080 pcs. Irrigation had significant impact on the yield and the components of the yield. The irrigation depth had significant impact on the total ear fresh yield, marketable ear fresh yield, single marketable ear fresh mass and marketable ear kernel fresh mass. In terms of the yields obtained, sprinkling prevailed over drip irrigation.

Key words: *sweet corn, sprinkling, drip irrigation, irrigation scheduling, yield, yield components*

INTRODUCTION

Sweet corn (*Zea mays saccharata* Korn.) has gained popularity in Bulgaria over the past 10 years. Nowadays the consumers' demand for fresh sweet corn is strong. The crop is attractive because of its excellent taste and nutritional value due to the high content of sugars. Though the crop is profitable and easily marketed, Bulgarian market of sugar corn is still underdeveloped.

Due to the fact that sweet corn is consumed in a fresh condition, it is often recognized as a vegetable crop. Two circumstances are important for growing sweet corn in Bulgarian climate conditions – it has to be grown like the early conventional corn hybrids and has to be irrigated like the vegetable crops. Further, the already registered tendencies to climate warming and drought in our geographical region evoke special attention to irrigation as a stabilizing factor for obtaining high yields and high market prices in general (Kazandjiev et al., 2014). As to Pereira et al. (2009), with the increasing water scarcity nowadays there is a need to optimize water use in irrigation.

The countries, which traditionally grow sweet corn, apply irrigation. Sweet corn has a relatively shallow root system and requires an inch of water per week. Adequate watering is particularly critical during silking, tasseling and ear development. Dry hot weather during pollination, results in ears with "skips" in the kernels and poor tip fill (Jett, 2006).
The irrigation technologies practiced to sweet corn are furrow irrigation, gun irrigation system, solid set sprinkler systems, center pivot machines, and drip tape irrigation – on a bare soil or subsurface that makes irrigation and fertigation relatively easy (Smith et al., 1997; Growing Guide, 2005; Jett, 2006; Sweet Corn, 2010). The contemporary tendency in the irrigation technologies is to apply drip tape irrigation, which ensures maximum water use efficiency. Drip systems are best adapted to the contemporary shortage of water and energy. They are also most efficient in fertilizers' utilization and have the highest environmental performance among the other irrigation technologies. Deficit irrigation also gains more popularity. Oktaem et al. (2003), Oktem, (2008) and Oktem & Oktem, (2009) have established that the allowable for sweet corn irrigation water deficit is up to 20%, which doesn't cause serious disruptions in productivity. As to Rodrigues (2013), who compares drip irrigation with sprinkler irrigation of corn, drip irrigation systems lead to higher water use performance in terms of beneficial water use and water productivity but deficit irrigation is generally not economically feasible.
Irrigation of sweet corn in our soil and climatic conditions allows its cultivation as an alternative marketing crop and as a row crop in the crop rotations. Because of the economic and market conditions in our country, the production of sweet corn needs a production technology that provides maximum return and meets the environmental principles of sustainable production.
The goal of the paper is to establish the features of an irrigation scheduling of sweet corn of two irrigation technologies – drip irrigation and sprinkling and to establish their impact on the yield and yield components of the crop.

MATERIALS AND METHODS

A field experiment with irrigation of Super Sweet 71.12 R hybrid was carried out in 2015 in the region of Sofia, Bulgaria. The site is situated at 42.6^o N and 550 m a.s.l. The climate is temperate-continental and the region is one of the coldest and most humid in Bulgaria.
The experiment was two-factorial and was put in a randomized complete block design as a split-plot factorial arrangement in three replications. The main-plot factors were: *factor A - irrigation technology:* A_1 - Sprinkling; A_2 - drip irrigation; and *factor B - irrigation depth:* B_1 – rainfed; B_2 – 50% of the maximum irrigation depth (MIrD); B_3 - 75% of MIrD; B_4 - irrigation with MIrD, relative to 80% of field capacity (FC). The following variants were tested: A_1B_1 (control 1), A_1B_2, A_1B_3, A_1B_4, A_2B_1 (control 2), A_2B_2, A_2B_3, A_2B_4.
Land preparation and weed control were applied according to the standard agricultural practices in the region. The fertilizers were applied conventionally at sprinkling and as fertigation at drip irrigation.
The soil was chromic luvisols (FAO classification) with total water content TWC=327 mm, total available water content TAWC=165 mm, and bulk density α=1.5 g/cm^3. Soil moisture was determined by the gravimetric method, by taking soil samples in each 10 cm down to 1-m depth of the soil profile. Once soil moisture reached 80% of FC, an irrigation application was appointed.
The net application depth for sprinkling was calculated as: $m = 10H\alpha\left(\sigma_W^{FC} - \sigma_W^{80\%FC}\right)$, where: m – irrigation application depth, mm; H – thickness of the soil layer, m; α - bulk density of the soil, Mg/m^3; σ_W^{FC} - water content at FC, weighing %; $\sigma_W^{80\%FC}$ - water content, which is relative to 80% of FC, weighing %. The irrigation application depth for drip irrigation was calculated as: $m = 10H\alpha\left(\sigma_W^{FC} - \sigma_W^{80\%FC}\right)K$, where: K – the ratio between the actual irrigated area and the total sawn area (K =0.40) (Zhivkov, 2013).
The following production features were established – total ear fresh yield, marketable ear fresh yield, total ear number, marketable ear number, single marketable fresh ear mass, marketable ear row number, one row kernel

number of a marketable ear, and marketable ear fresh kernel mass. Plant characteristics were taken as plant height, leaves number per plant, ear legth, and tassel length. Analysis of varience was applied to all data obtained.

The meteorological characteristics of the growing season May-August 2015 were estimated in a 40-year statistical row 1976-2015. It is seen from Table 1 that it has been dry, with rainfall total 215.2 mm and 70% probability of exceedance. The period of seed filling was very dry with 87.5% probability of exceedance, while the wetness condition in June and July were average. The monthly values were generally under the normals – especially those of May and July (Table 2). The rainfall totals of these months were 38.7 mm and 15.8 mm respectively, with residuals -45.7% and -76.2%. Unlike these months, May rainfall total was 105.2 mm, which was 41.3% higher than the 40-year normal. The distribution of the daily rainfalls, which is illustrated on Figure 1, shows that there has occurred an uninterrupted drought period from the first decade of July till the second of August.

As to the air temperature, the growing season May-August was very warm, with 15.0% probability of exceedance, while the period July-August was extremely warm - with 5.0% probability of exceedance (Table 1). The least stressing temperatures were observed in the period May-June, which probability of exceedance of the air temperature total was 32.5%. May, July and August had positive residuals of 11.0%, 15.5% and 8.1% from the relevant normals, while June had a negative one of -4.1% (Table 2 and Figure 2).

Table 1. Probability of exceedance of the totals of the meteorological elements in 2015, %

Index	*May-August*		*May-June*		*June-July*		*July-August*	
	mm; °C	%	mm; °C	%	mm; °C	%	mm; °C	%
Rainfall totals	215.2	70.0	143.9	55.0	121.0	57.5	71.3	87.5
Air Temperature totals	2477.5	15.0	1064.2	32.5	1259.1	17.5	1413.3	5.0

Table 2. Monthly values of the meteorological elements

Month	*Air temperature totals*			*Rainfall totals*		
	°C	Residuals, %	1976-2015 normals, °C	mm	Residuals, %	1976-2015 normals, mm
May	524.7	11.0	472.8	38.7	-45.7	71.2
June	539.5	-4.1	562.7	105.2	41.3	74.5
July	719.7	15.5	622.9	15.8	-76.2	66.5
August	693.7	8.1	641.7	55.5	-4.5	58.1

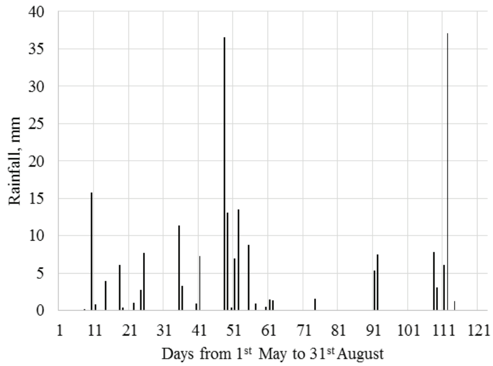

Figure 1. Distribution of the daily rainfalls in the period May-September 2015 г.

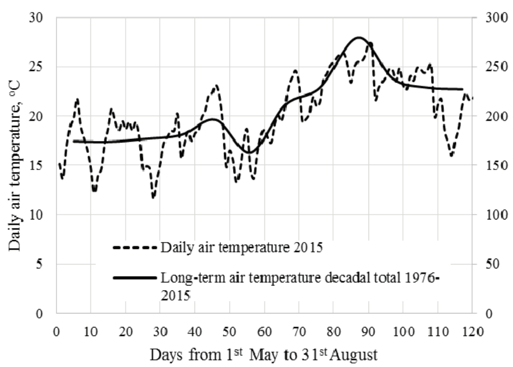

Figure 2. Dynamics of the daily air temperature in the period May-September 2015 г.

RESULTS AND DISCUSSIONS

Corn plants are large and fast-growing, so they need regular feeding and watering. Water management is very important, especially during the critical growth stages when any stress imposed on the plant can affect the yield. Particular care needs to be taken to avoid stress around pollination as poor tip fill will result if the plant is stressed. In accordance with the dynamics of the meteorological conditions in 2015 and the peculiarities of the irrigation technologies, several irrigation applications were given to the crop. By sprinkling were given 3 applications with maximum application depth of 60 mm in A_1B_4. A 25% reduction of the irrigation application depth was implemented in A_1B_3, where it was 45 mm, and 50% reduction in A_1B_2, where it was 30 mm (Table 3). The total seasonal water given to the crop by sprinkling was 180 mm, 135 mm and 90 mm respectively. The necessity of irrigation occurred during stem elongation, tasseling and silking. Irrigation by dripping was more frequent – 5 applications were given with average application depth – 15.0 mm in A_2B_4, 11.3 mm in A_2B_3 and 7.5 mm in A_2B_2. The relating irrigation depths were 75.0, 56.3 and 37.5 mm. The applications were given during stem elongation - 2, tasseling – 1, silking - 1, and ripening – 1. The irrigation depth in our conditions of a temperate-continental climate appeared to be lower than in more arid climates (Growing Guide, 2005), where the seasonal irrigation amount by sprinkling used to be 400-800 mm and by dripping – 350-400 mm. In our region, this is due to the fact that the period of high temperatures is shorter but there is also lack of precipitation. However, this period of the year is the period of the critical to water growing stages of sweet corn and irrigation is inevitably needed.

Table 3. Features of the irrigation scheduling

Variants	*Number of applications*	*Applications dates*	*Application depth, mm*	*Irrigation depth, mm*
		Sprinkling		
A_1B_1	-	-	-	-
A_1B_2	3		60	180
A_1B_3	3	9-10.07, 21-22.07, 4-5.08	45	135
A_1B_4	3		30	90
		Drip irrigation		
A_2B_1	-	-	-	-
A_2B_2	5	11.07, 16.07, 23.07, 31.07, 5.08.	15.0	75.0
A_2B_3	5		11.3	56.3
A_2B_4	5		7.5	37.5

The results from the analysis of variance of the main-plot factors impact are presented in Table 4. It is seen that the irrigation technologies – *factor A* – performed statistical differences mostly for the biometrical features of the plant. Under drip irrigation, the crop developed higher plant height, leaves number per plant, tassel length and ear length. Both technologies had the same impact on the total ear yield, total ear number and the marketable ear number per hectare (Table 4). Under the impact of drip irrigation, plant height was 127.8 cm but under the impact of sprinkling it was 119.0 cm. Leaves number per plant was 7.4 and 6.9 respectively, tassel length was 35 and 32 cm, ear length – 17.8 and 16.0 cm. As to the features of the marketable ear: the single marketable ear mass - didn't show statistical differences between both irrigation technologies, the single fresh ear mass was 188.2 and 177.3 g, the marketable ear row number – 12.5 and 11.8, the one row kernel number of a marketable ear was 26.2 and 27.2, the marketable ear fresh kernel mass was 92.3 and 84.4 g. The total ear fresh yield, the marketable ear fresh yield, the total ear number and the marketable ear number under drip irrigation and sprinkling were 13.6 and 15.4 Mg/ha, 9.4 and 11.4 Mg/ha, 90000 and 99580 pcs./ha, and 57080 and 62080 pcs./ha respectively, without any statistical differences. Only the marketable ear fresh yield under drip irrigation was statistically lower at probability P=0.05.

The irrigation depth – *factor B* - had statistically significant impact on all indices except for the row number of a marketable ear. Irrigation proved its impact for all the tested levels of soil moisturizing (Table 4). The total ear fresh yield increased from 10.1 Mg/ha under rainfed conditions to 14.4 Mg/ha under 50% irrigation deficit, to 15.0 Mg/ha under 25% irrigation deficit and to 18.5 Mg/ha under full irrigation. The marketable ear fresh yield increased more than twice (216.6%) at full irrigation, compared to that under rainfed conditions – from 6.5 Mg/ha to 14.1 Mg/ha. The marketable ear number increased from 5333 to 7083 respectively, which comprised 32.8%. The plant height increased from 109.9 to 132.3 cm (with 18.7%), the leaves number per plant – from 5.9 to 8.2 (with 38.7%), the tassel length – from 31 to 37 (with 19.8%), the ear length – from 12.9 to 17.2 cm (with 33.2%). Further, the single marketable fresh ear mass increased from 108.9 g to 245.4 g (with 25.3%), the marketable ear row number didn't increase statistically, one row kernel number of a marketable ear – from 22.2 to 31.0 under 25% irrigation deficit (with 39.3%), and the marketable ear fresh kernel mass – from 56.3 g to 104.8 g (with 86.1%).

Table 4. Main impacts of the tested factors

Indices Variants	*Total ear fresh yield, Mg/ha*	*Marketable ear fresh yield, Mg/ha*	*Total ear number, pcs./ha*	*Marketable ear number, pcs./ha*
Factor A – irrigation technology				
A_1 - sprinkling	15.388	11.438	99580	62080
A_2 – drip irrigation	13.654	9.463^{o}	90000	57080
Factor B – irrigation depth				
B_1 - rainfed	10.100	6.533	76670	53330
B_2 - 50% of MIrD	14.425^{++}	9.925^{++}	105000^{++}	51670
B_3 – 75% of MIrD	15.008^{+++}	11.192^{+++}	98330^{+}	62500^{+}
B_4 – MIrD (at 80% of FC)	18.550^{+++}	14.150^{+++}	99170^{+}	70830^{+++}

1st continuation of Table 4

Indices Variants	*Plant height, cm*	*Leaves number per plant*	*Tassel length, cm*	*Ear length, cm*
Factor A – irrigation technology				
A_1 - sprinkling	119.0	6.9	32	16.0
A_2 – drip irrigation	127.8^{+}	7.4^{+++}	35^{++}	17.8^{++}
Factor B – irrigation depth				
B_1 - rainfed	109.9	5.9	31	12.9
B_2 - 50% of MIrD	123.9^{++}	6.8^{+++}	32^{+}	18.5^{+++}
B_3 – 75% of MIrD	127.4^{+++}	7.7^{+++}	36^{++}	19.0^{+++}
B_4 – MIrD (at 80% of FC)	132.3^{+++}	8.2^{+++}	37^{+++}	17.2^{+++}

2nd continuation of Table 4

Indices Variants	*Single marketable fresh ear mass, g*	*Marketable ear row number*	*One row kernel number of a marketable ear*	*Marketable ear fresh kernel mass, g*
Factor A – irrigation technology				
A_1 - sprinkling	188.2	12.5	26.2	92.3
A_2 –drip irrigation	177.3	11.8	27.2	84.4
Factor B – irrigation depth				
B_1 - rainfed	108.9	12.4	22.2	56.3
B_2 -50% of MIrD	174.1^{+++}	12.0	28.6^{++}	96.8^{+++}
B_3 – 75% of MIrD	202.8^{+++}	11.9	31.0^{+++}	95.6^{+++}
B_4 – MIrD (at 80% of FC)	245.4^{+++}	12.4	25.1	104.8^{+++}

$^{o, +}$ significant at 5% level; $^{++}$ significant at 1% level; $^{+++}$ significant at 0.1% level

These differences, including the results from the variants of the irrigation depth, were statistically significant on all probability levels. These results correspond to those obtained by Oktem (2008), who announces for the highest fresh ear yields - 14.76 and 14.17 Mg/ha at an irrigation scheduling, which is based on 100% E_{pan}, whereas minimum fresh ear yields - 9.15 and 8.84 Mg/ha - on 70% of E_{pan}.

Sprinkling and drip irrigation had statistically significant impact on the ear yield – total and marketable ears (Table 5). This impact was significant at deficit drip irrigation with 75% of MIrD and with MIrD, while at sprinkling it was significant at irrigation with 75% and 50% of MIrD. Under the impact of sprinkling, the total ear fresh yield increased maximum with 102% and the marketable ear fresh yield – with 151.8%. Actually, these yields changed from 10.1 Mg/ha to 20.4 Mg/ha and from 6.5 to 16.4 Mg/ha. Analogously for drip irrigation, these two kinds of yield changed from 10.1 to 16.7 Mg/ha (an increase of 65.7%) and from 6.5 to 11.8 Mg/ha (an increase of 81.4%). These results were significant and P=0.001.

The ear number – either total or only marketable ears - also increased. Sprinkling had significant effect by all levels of the irrigation depth, while drip irrigation contributed to the ear number formation only by full irrigation (Table 6). The maximum total ear number under sprinkling was 105000 pcs./ha, while under drip irrigation – 93330 pcs./ha. The maximum marketable ear numbers were 75000 pcs./ha and 66670 pcs./ha respectively. The increase of the total ear number under full irrigation by sprinkling was 37.0% and by drip irrigation - 21.7%. The increase of the marketable ear number was 40.6% and 25.0% respectively.

Sprinkling had a significant effect on the biometric features of the plants only under full irrigation, while drip irrigation had statistical effect at all levels of irrigation – either full or deficit (Table 7). Under full irrigation, plant height increased up to 130 cm by sprinkling and 134 by drip irrigation, which was 18.7% and 22.2% respectively as compared to that under rainfed conditions (110 cm). The leaves number per pant increased from 5.9 under rainfed condition up to 7.8 (with 32.1%) and 8.6 (with 45.3%) under sprinkling and drip irrigation respectively. The tassel length was also significantly impacted by full irrigation at sprinkling and by all irrigation levels at drip irrigation. Its maximum length reached 36.1 cm and 37.9 cm at both irrigation technologies respectively. Sprinkling contributed for 16.9% increase and drip irrigation – for 22.7% increase as compared to the rainfed conditions (30.9 cm). Finally, the marketable ear length was 16.2 cm at full irrigation by sprinkling and 18.1 cm at full irrigation by dripping – with 25.9 and 40.5% more than under rainfed conditions (12.9 cm). It is notable that no marketable ears, more than 14 cm long, were formed under rainfed conditions. The deficit irrigation demonstrated better effect on the ear length. The latter reached an increase of 36.2% by 50% deficit irrigation, while the increase by 25% deficit drip irrigation was 61.2%.

Table 5. Impact of the irrigation depth on the fresh yield

Indices	*Total ear fresh yield, Mg/ha*		*A marketable ear fresh yield, Mg/ha*	
Variants	A – Sprinkling	B – Drip irrigation	A – Sprinkling	B – Drip irrigation
B_1 – rainfed	10.100	10.100	6.533	6.533
B_2 - 50% of MirD	15.617^{++}	13.233	11.517^{++}	8.333
B_3 – 75% of MirD	15.433^{++}	14.583^{++}	11.250^{++}	11.133^{++}
B_4 – MirD (at 80% of FC)	20.400^{+++}	16.700^{+++}	16.450^{+++}	11.850^{+++}

$^{+}$ significant at 5% level; $^{++}$ significant at 1% level; $^{+++}$ significant at 0.1% level

Table 6. Impact of the irrigation depth on the ear number

Indices	*Total ear number, pcs./ha*		*Marketable ear number, pcs./ha*	
Variants	A - Sprinkling	B - Drip irrigation	A - Sprinkling	B - Drip irrigation
B_1 - rainfed	76670	76670	53330	53330
B_2 - 50% of MIrD	106670^{+}	103330^{+}	53330	50000
B_3 – 75% of MIrD	110000^{+}	86670	66670^{+}	58330
B_4 – MIrD (at 80% of FC)	105000^{+}	93330	75000^{+++}	66670^{+}

$^{+}$ significant at 5% level; $^{++}$ significant at 1% level; $^{+++}$ significant at 0.1% level

As far as the yield components were concerned, the greatest impact of irrigation was observed on the single marketable ear fresh mass and on the marketable ear kernel fresh mass. Both components demonstrated great sensitivity to water. They reacted in to the smallest irrigation depths with around 60% and 80-90% increase.

The mass of a single fresh marketable ear increased with 140.4% under full sprinkling and with 110.2% under full drip irrigation. It reached 262 g and 229 g, respectively. The kernel fresh mass of a marketable ear was maximum 109 g and 101 g at 50% deficit irrigation by both technologies. These differences were statistically significant at P=0.001. The row number of a marketable ear didn't react to irrigation, and the number of the kernels in a row demonstrated scattered results under the impact of the irrigation depth.

Table 7. Impact of the irrigation depth on the plant characteristics

Indices	*Plant height, cm*		*Leaves number/plant*	
Variants	A - Sprinkling	B - Drip irrigation	A - Sprinkling	B - Drip irrigation
B_1 - rainfed	110	110	5.9	5.9
B_2 - 50% of MIrD	119	129^{++}	6.4	7.2^{+++}
B_3 – 75% of MIrD	117	138^{+++}	7.4^{+++}	7.9^{+++}
B_4 – MIrD (at 80% of FC)	130^{++}	134^{++}	7.8^{+++}	8.6^{+++}

$^{+}$ significant at 5% level; $^{++}$ significant at 1% level; $^{+++}$ significant at 0.1% level

Continuation of Table 7

Indices	*Tassel length, cm*		*A marketable ear length, cm*	
Variants	A - Sprinkling	B - Drip irrigation	A - Sprinkling	B - Drip irrigation
B_1 - rainfed	30.9	30.9	12.9	12.9
B_2 - 50% of MIrD	29.3	33.1^{+}	17.6^{++}	19.4^{+++}
B_3 – 75% of MIrD	32.8	38.8^{+++}	17.2^{++}	20.8^{+++}
B_4 – MIrD (at 80% of FC)	36.1^{++}	37.9^{+++}	16.2^{+}	18.1^{+++}

$^{+}$ significant at 5% level; $^{++}$ significant at 1% level; $^{+++}$ significant at 0.1% level

Table 8. Impact of the irrigation depth on the yield components

Indices	*A single marketable ear fresh mass, g*		*A marketable ear row number*	
Variants	A - Sprinkling	B - Drip irrigation	A - Sprinkling	B - Drip irrigation
B_1 - rainfed	109	109	12	12
B_2 - 50% of MIrD	176^{+}	172^{+}	12	12
B_3 – 75% of MIrD	206^{+++}	199^{++}	13	11
B_4 – MIrD (at 80% of FC)	262^{+++}	229^{+++}	13	12

Continuation of Table 8

Indices	*One row kernel number of a marketable ear*		*A marketable ear kernel fresh mass, cm*	
Variants	A - Sprinkling	B - Drip irrigation	A - Sprinkling	B - Drip irrigation
B_1 - rainfed	22	22	56	56
B_2 - 50% of MIrD	26	31^{++}	109^{+++}	101^{+++}
B_3 – 75% of MIrD	30^{++}	32^{+++}	105^{+++}	86^{++}
B_4 – MIrD (at 80% of FC)	27	24	100^{+++}	94^{+++}

$^{+}$ significant at 5% level; $^{++}$ significant at 1% level; $^{+++}$ significant at 0.1% level

CONCLUSIONS

1. In conditions of a very dry and very warm growing season of a temperate continental climate, sweet corn needs 3 irrigation applications and 180 mm net irrigation depth by sprinkling, and 5 irrigation applications and 75 mm net irrigation depth by drip irrigation
2. Drip irrigation creates better conditions for the green biomass development, while sprinkling creates better conditions for the process of productivity. The yield of the marketable ears under the impact of sprinkling was 11.438 Mg/ha and 62080 pcs./ha, while under drip irrigation - 9.463 Mg/ha and 57080 pcs./ha The difference was statistically significant, while none of the technologies showed statistical advantage in the number of marketable ears.
3. Irrigation has a significant effect on the yield, the yield components and the biometric plant features. The marketable ear fresh yield increased from 6.533 Mg/ha and 53330 pcs./ha under rainfed conditions to 9.925 Mg/ha and 51670 pcs./ha under 50% irrigation deficit, 21.192 Mg/ha and 6250 pcs. under 25% irrigation deficit and 14.150 Mg/ha and 70830 pcs./ha under full irrigation.
4. The irrigation depth by both irrigation technologies had significant impact mostly on the total ear fresh yield, the marketable ear fresh yield, the single marketable ear fresh mass and the marketable ear kernel fresh mass. The irrigation depths of deficit sprinkler irrigation had no significant effect on the biomechanical features of plants.
5. In terms of the yields obtained, sprinkling prevail over drip irrigation.

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INFLUENCE OF BASIC TILLAGE DEPTH ON SOIL HUMIDITY RESOURCES AND SUNFLOWER YIELDS

Angelina MUHOVA, Stefka DOBREVA, Ivan SALDZHIEV

Field Crops Institute, Georgi Dimitrov Blvd. Nr. 2, 6200 Chirpan, Bulgaria

Corresponding author email: muhova.angelina@gmail.com

Abstract

In the period 2002-2005 it was studied the effect of the soil ploughing depth for sunflower on soil humidity regulation and yields. It was tested two ploughing tillad on depth 23-25 cm and 31-33 cm. The results present that the deeper ploughing on 31-33 cm increases total water supplay quantity of water productivity in soil and yields of sunflower. The effect of ploughing tillage on depth 31-33 cm with respect to water productivity continues to flowering phase. Yields are increased with 165 kg/da.

Key words: *sunflower, soil tillage, soil humidity.*

INTRODUCTION

A lot of researches are made in regards to the soil moisture under the influence of the tilth. The results obtained are highly controversial due to the soil differences, the technological production and the purposes of the researches (Borisov and Simeonov, 1979; Borisova and Dimitrov, 1996; Shopov et al., 1965, Kluchnov, 1986, Baumhardt et al., 1993: Yoo and Touchton, 1989). The results are mostly in regards to the moisture containment in weight percentage. There are very few researches that give a perspective about the total and productive moisture stock in the tilth layer and under the tilth layer (Borisova and Nikolova, 2006; Saldzhiev and Stoilova, 2007; Stoimenov et al., 2007).

The purpose of the research was to determine the impact of the basic tillage depth on the moisture reserve, the amendment of the total water reserve and the productive moisture throughout the vegetation of the sunflower and their impact on the level of yield.

MATERIALS AND METHODS

In a field test held in the field of the Field Crops Institute Chirpan it was studied the influence of two types of basic tillage depth (23-25 and 31-33 cm) over the moisture reserve and the amendment of the quality of the productive moisture during the vegetation of the sunflower. The culture was grown in non-irrigated conditions in Pellic vertisols with humus horizon-70-115 cm, humus content of 3.5-3.7 %. The soil is of heavy mechanical constitution with mainly clay fraction of 65%, low in moving nitrogen and well stocked with potassium. The approximate weight of the plowing layer is 2.45 g and the bulk density of the layer from 0 to 50 cm varies between 1.24-1.28 g/cm^3. The wilting humidity point is between 19.5-22.5 %. FMC for layer 0-50 cm was 34.2 %, 51-100 cm was 31.6 % and 101-200 cm-28.7 %. The soil moisture was determined by the weight method at 100 cm depth. The total water supply was determined by the percentage of moisture and the bulk density. The productive moisture was calculated by the difference from the total water supply and the quantitative productive moisture. These indicators are determined during the basic phases of the development of the sunflower – germination, fifth-eight leave, budding forming of the disk, flowering and ripening. The dates of the reading of the moisture reserve are as follows: 17.03, 17.04, 17.05, 17.06, 7.07, 17.07 and 17.08. The sowing was in the period 20-25.03. The yields is equated to 10 % moisture of the seeds. The sum of the temperatures during the experimental period is within the norms. The rainfall during the vegetation period is described in Table 1.

Table 1. Raifall distribution in vegetation period of sunflower

Years	Mounths						Sum
	IV	V	VI	VII	VIII	IX	
2002	66.6	28.9	17.2	176.4	35.4	49.7	374.2
2003	55.1	73.1	33.2	105.6	10.3	27.9	305.2
2004	17.6	93.3	135.8	36.8	72.8	39.5	395.8
2005	18.1	50.1	72.5	158.1	51.6	91.8	442.2
2006	67.2	19.2	32.9	66.6	48.6	39.9	274.4
2002-06	44.9	52.9	58.3	108.8	43.7	49.8	358.4
1928-07	44.9	62.4	65.7	54.0	41.5	34.4	302.9

In 2006 was reported considerably lower rainfall, 2003 is equal to the average yearly, and the rest three years 2002, 2004 and 2005 are with considerably higher rainfall. Despite the overall ascertainment, the distribution of the rainfall is not even during the most important phase for the sunflower – flowering – start of filling the seeds. In 2002, from 10-25 July there was no rainfall and the disks were small in diameter which led to lower yield. The excessive rainfall during this period had little impact over the sunflower. In July 2004 and 2005 there was no considerable rainfall for 22 days – from 1/07 until 22/07 for the first, and form 15/07 until 05/08 for the second. Due to the good water reserve from the previous month the drought did not led to considerable decrease of the yield. 2006 was considerably low in rainfall and with drought from 15/07 – 06/08. The best year for the sunflower was 2003, when there was considerably even rainfall.

RESULTS AND DISCUSSIONS

The data for the influence of the tillage depth over the water reserve of the soil, gathered before sowing are shown in Table 2. The analysis shows that for tillage depth of 31-33 cm average for the period, there is considerably high water reserve in the layer 0-30 cm and 0-50 cm. For the horizons 0-10 cm and 0-20 cm the total reserve, as well as the quantity of the productive moisture, at both depths is equal. Early the most variable results in the quality moisture are in the layer 0-10 cm. The growth and development of the sunflower during the vegetation is implemented with different content of productive moisture in the soil and depends on the depth of the basic tillage (Table 3). Average for the period, there are no big differences in the content of productive moisture in the layers 0-10 and 10-20 cm. This can be explained with the excessive rainfalls during the months of April, May and June in 2002, 2003 and 2004, which equalized the content of the total water reserve of the soil in these layers. Because of the better physical condition of the soil and the creation of more powerful water-accumulating layer during plowing in 31-33 cm, the productive moisture for the layers 0-30 and 0-50 cm is higher than this during plowing in 23-25 cm with respectively 5 m^3/ha in phase 5-8 leaves and 2 m^3/ha in the buttoning phase (total for the layer 0-30 cm). For the soil layer 0-50 cm
for the phases mentioned above the differences are 17 m^3/ha and 10 m^3/ha respectively. During the period between the phases buttoning-flowering there is fast gaining of biomass and the plants grew in height with 1 cm daily average. During this period the quantity of the absorbable moisture is used up, as well as this in the in the 50-100 cm layer. Regarding this, it is safe to say that the impact of the plowing is exhausted in the "beginning of the flowering" phase. The productive moist in the layer 0-30 cm then decreases to 2-3 cm^3/ha and the yield depends only on the quantities and distribution of the summer rainfalls. The higher content of productive moisture in the layers 0-30 and 0-50 cm leads to accumulating of larger biomass, forming of more seeds in the disks.

The formation of the yield to great extend depends on the rainfall quantities during the summer months. In three of the cases (2002, 2003 and 2005) we have demonstrated higher yield when the basic tillage is deeper – Table 3. In two of the years there is no prove but, average for the multi-annual period with the deeper tillage variant there is higher yield with 16.5 kg/ha or 57%.

Table 2. Water supply for sunflower pre-sowing time (mm)

Soil layer, cm	2002		2003		2004		2005		2006		Average	
	TWS	WP	TWS	WP	TWS	WP	TWS	WP	TWS	WP	TWS	WP
Tillage of 23-25 cm depth												
0-10	33	10	27	5	29	6	29	7	40	17	32	9
10-20	36	11	35	10	36	11	36	11	39	14	36	11
20-30	39	13	38	12	38	12	38	12	42	16	39	13
0-30	108	34	100	27	103	29	103	30	121	47	107	33
0-50	187	63	182	59	181	57	185	62	211	87	189	66
0-100	370	120	404	155	380	130	407	158	431	181	399	149
Tillage of 23-25 cm depth												
0-10	36	14	28	6	29	6	28	6	40	17	32	10
10-20	38	13	38	12	36	11	37	12	40	15	38	13
20-30	39	13	41	15	40	14	39	13	45	19	41	15
0-30	113	40	107	33	105	31	104	31	125	51	111	38
0-50	192	68	190	66	188	64	190	65	220	96	196	72
0-100	386	136	420	170	396	146	411	161	472	192	411	161

TWS-total water supplay; WP-water productivity

Table 3. Yield of sunflower (kg/da) on the period 2002-2006

Depth of plowing (cm)		Years					Average		
		2002	2003	2004	2005	2006	mg/da	D	%
23-25 cm		160.7	384.5	345.4	305.3	242.5	287.7	-	100
31-33 cm		192.1***	406.7***	339.1	327.4***	255.8	304.2	16.5***	105.7
GD	5.0%	6.4	9.6	7.7	11.8	14.0	10.0	10.0	3.5
	1.0%	8.6	12.8	10.2	15.8	18.7	13.3	13.3	4.6
	0.1%	11.2	16.8	13.4	20.7	24.5	17.3	17.3	6.0

CONCLUSIONS

The tillage with depth 31-33 cm for the sunflower improves the physical condition of the soil, which results in better water reserve in the soil, compared to the tillage with depth 23-25 cm. The deeper tillage increases the quantity of productive moisture in the soil, and the effects are limited in the phase of mass flowering of the sunflower. These better conditions help the higher average yield of the plants – 16.5 kg/da more.

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STUDY REGARDING ORGANIC AGRICULTURE AND CERTIFICATION OF PRODUCTS

Paula Ionela NASTASE, Maria TOADER

University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, 011464, Bucharest, Romania

Corresponding author email: nastase_paula23@yahoo.com

Abstract

In this paper, authors collective present statistical data provided by various organizations and institutions involved in organic agriculture movements in the world and in Romania, in order to characterize the particularities of organic farms and organic products certification. Organic agriculture is an integral part of sustainable development strategies and as a viable alternative to conventional agriculture. At the end of 2013, the total organic area in the world means 43.1 million ha and there are approximately two million organic farmers. The commerce of organic food sells 60 billion dollars every year. In Romania, it were recorded a surface of over 288 thou ha in 2014 and around 15,000 operators. Each EU Member State accredits certification and inspection bodies for control of organic farms and products. In this context, the farm/unit also is inspected at least once a year to ensure that you meet the EU-wide organic standards. Only then can products legally be labelled and marketed as "organic". The EU organic logo and labelling is a quick and simple way for consumers to recognise organic produce, and an important step in guaranteeing that organic produce is always of the same high standards. According to last research performer by EU, more than 70% of Europeans say they trust organic products. However, nearly 60% of them would favour an improvement of the control system. Consumer trust is about more than just quality. It's also about protecting the environment, providing good conditions for animals, and boosting rural development.

***Key words**: organic farms, certification, food quality, consumer's behaviours.*

INTRODUCTION

Organic production systems are based on specific standards specifically formulated for food production and aims to produce them in a sustainable way both in terms of social and material. This system should be regarded as an integral part of sustainable development strategies and as a viable alternative to conventional agriculture.

The organic production method plays a dual societal role, because on the one hand provides for a specific market responding to consumer demand for organic products, and on the other hand delivers public goods contributing to environmental protection and animal welfare and rural development (www.ec.europe.eu).

Organic farming is one of the broad spectrums of production methods which supports and protects the environment (Behera et. al., 2011).

Demand for organic products is growing in both developed countries and developing countries, with an average annual growth of 20-25%. At the end of 2013, the total area means 43.1 million ha. According to a United Nations Conference on Trade and Development (UNCTAD, 2013), nowadays there are approximately two million organic farmers, about 80% of them in developing countries.

Organic production aims to be free of pollutants and substances not allowed in organic production such as GMOs, pesticides and fertilizers, by not using these substances for environmental and health reasons. However, focusing on threshold levels as a key organic certification tool would undermine both the organic principles and process quality approach of inspection and certification in organic production (IFOAM EU Group, 2014).

Farmer, grower, food processor, storage provider and/or an importer of organic food from a non-European Union (EU) country, or trader of organic products must registered with an approved organic inspection and certification bodies. Organic farmers, processors and traders, must comply with strict EU requirements if they want to use the EU organic logo or label their products as "organic". In this context, the farm/unit also be inspected at least once a year to ensure that you meet the EU-wide organic standards. Only then can products legally be labelled and marketed as “organic”.

Farm products under conversion are grown without chemicals, but the land where they grow still has to be cleaned up of the previously used pesticides and fertilizers; the ecological certification is possible only after a conversion period of 2 or 3 years.

The prices of the products in the conversion process are approximately 5 percent higher than in conventional farming, while organic certificated products further add 5 to 10 percent.

The EU organic logo and labelling is a quick and simple way for consumers to recognise organic produce, and an important step in guaranteeing that organic produce is always of the same high standards.

According to last research performer by EU, more than 70% of Europeans say they trust organic products. However, nearly 60 % of them would favour an improvement of the control system. Consumer trust is about more than just quality. It's also about protecting the environment, providing good conditions for animals, and boosting rural development.

MATERIALS AND METHODS

In order to characterize the particularities of organic farms and organic products certification it used statistical data provided by various organizations and institutions involved in organic agriculture movements in the world and in Romania. The data presented were selected from journals, scientific articles, statistical data collections, legislation and media information regarding organic agriculture.

Also studied data on the organic products and monitoring reports of pesticide residues carried out international level by the laboratory for residues control of pesticides in plants and plant products.

The data have been processed into the following indicators: organic surfaces and crops, mains countries involved in organic agriculture, organic market size, consumers attitude and different reports regarding pesticide residues of yield.

RESULTS AND DISCUSSIONS

Statistical data. Organic farming undoubtedly is one of the fastest growing sectors of agricultural production. Lately, organic farming has grown rapidly globally, being practiced in over 164 countries and organically cultivated areas are increasing (Willer, 2016).

Australia is the country with the largest organic agricultural area (17.2 million hectares, with 97% of that area used as grazing), followed by Argentina (3.2 million hectares) and the United States of America (2.2 million hectares) (Figure 1).

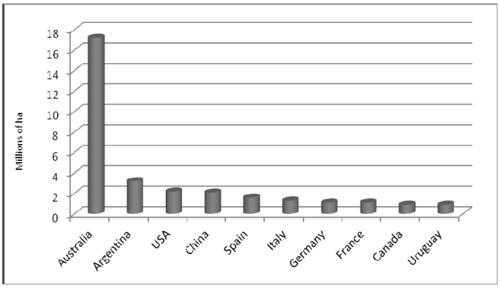

Figure 1. Organic surface by countries, in 2013 (FiBl and IFOAM, 2016)

40% of the global organic agricultural land is in Oceania (17.3 million hectares), followed by Europe (27%; 11.5 million hectares), and Latin America (15%; 6.6 million hectares) (Figure 2).

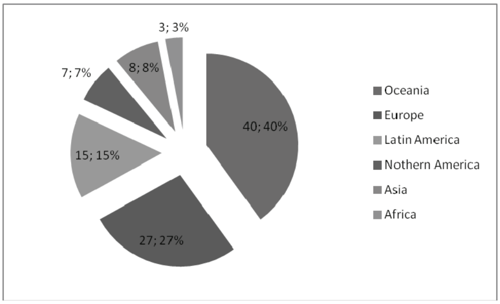

Figure 2. Percentes of organic surface by continents, in 2013 (FiBl and IFOAM, 2016)

According to a United Nations Conference on Trade and Development (UNCTAD, 2013), nowadays there are approximately two million organic farmers, about 80% of them in developing countries. The commerce of organic food sells 60 billion dollars every year.

Organic retails sales value by countries in 2013 is present in figure 3. Main market country is USA with 26.7 billion $, followed of Germany with 8.3 billion $ and France with 4.8 billion $.

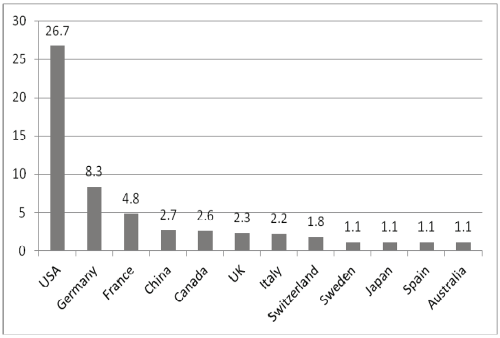

Figure 3. Organic retails sales value by countries, in 2013 (FiBl and IFOAM, 2016)

In Romania, it were recorded a surface of over 288 thou ha in 2014 and around of 15,000 operators (Figures 4 and 5).

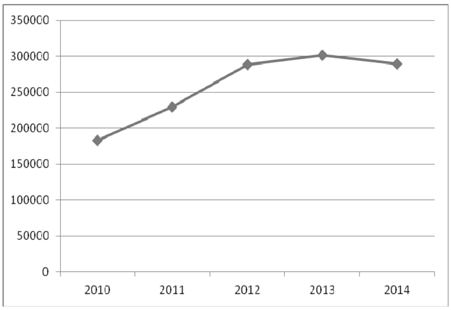

Figure 4. Evolution of organic area in Romania (MARD, 2016)

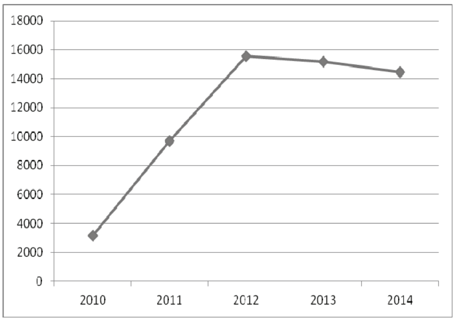

Figure 5. Evolution of oprganic operators in Romania (MARD, 2016)

The most important crops are cereals (105 thou ha) and oil seeds (45 thou ha) (Table 1).

Table 1. Surfaces of organic mains crops in Romania (MARD, 2016)

Species	2011	2012	2013
Berries	240.0	327.0	327.0
Cereals	79,167.0	105,148.0	105,148.0
Dried pulses and protein crops for the production of grain	3,147.0	2,764.0	2,764.0
Grapes	842.0	1,649.0	1,649.0
Industrial crops	2.0	112.0	112.0
Nuts	184.0	597.0	597.0
Oilseeds	46,046.0	43,923.0	43,923.0
Root crops	1,075.0	1,125.0	1,125.0
Strawberries	3.0	3.0	3.0
Tobacco	29.0	1.0	1.0

In 2013, the trade with organic products in Romania was around 80 mil. Euros for imports and 120 mil. Euros for exports (MARD, 2016).

Certification of organic farms and products. Regarding certification of organic farms, European Union (EU) standards cover crop, livestock and processing. Farm and handling plans are required, as well as detailed record keeping and detailed livestock feed standards. Specific standards are included for aquaculture, seaweed, yeast, bees, and mushrooms (Global Organic Trade Guide, 2015).

Each EU Member State accredits certification bodies. The EU requires an equally strict control system with checks carried out at every stage of the organic chain. Every operator (farmer, processor, trader, importer or exporter) is checked at least once a year, or more often on the basis of risk assessment.

In addition to the European Commission organic regulations for certification and accreditation procedures, the requirements of EN 45011 and ISO Guide 65 for accreditation must be met.

The name or code number of the control authority or body in the EU which checked the operator should also be on the label.

In Romania, monitoring and certification of organic products is currently provided by private certification and inspection bodies. They are approved by the Ministry of Agriculture, Forestry and Rural Development, based on criteria of independence, impartiality and competence established by Order No.

181/2012, approving the „Rules of organizing the inspection and certification system, approval of the certification and inspection bodies, surveillance of control body's activity".

MARD's approval of inspection and certification bodies is preceded mandatory by their accreditation in accordance to European standard EN ISO 45011, issued by a competent body for this purpose.

In Romania, in 2016, 14 of inspection and certification bodies are operating, approved by MARD to conduct the inspection and certification of organic products.

In Romania, according to organic legislation (EC Regulations 834/2007 and 889/2008), the operators before beginning their activity must register at the County Agriculture Departments from the area where they operate, by filling in the standardized registration in organic agriculture**.** He must choose and contact an Inspection and Certification Body approved by MARD and sign with them a contract for inspection and/or certification of the farm in the purpose of compliance with the legislation on organic production control. The organic surfaces must be separated from the conventional surfaces used into by access roads, irrigation canals, shelterbelts; the crop does not require herbicide or other treatment of plant protection and must be known its history of diseases, pests and weeds specific for the area. Growing, in organic farming, a different crops or varieties from other crops managed at the farm in a conventional system. Use of certified organic seed or, if it is not on the market such seed, it is used untreated seed, only with the approval of inspection and certification bodies. Any inputs must be approved prior, by the inspection and certification bodies. During conversion period, obtained products cannot be sold as organic. In compliance with EU Regulations, is permissible to use the logo and marketing since two years for annual crops and three year for the perennial.

Behaviour of consumers. Regarding the attitude of consumers, they searching for organic food on the market. According to studies, the people who buy organic food are mainly women, families with children and the elderly (Hughner et al., 2007). These groups are linked mainly by their concern for their own or their relatives' health, due to a particular physiological condition and the associated awareness of the importance of healthcare.

Hughner et al. (2007) also mentioned the reasons why consumers are interested in the purchase of organic products. A key motive, given by many consumers of organic food – both so-called 'regular' and 'occasional' ones – as the most important, is concern about health, i.e. the conviction that organic products are healthier and safer than conventional ones

On the other hand, comparisons between organic and conventional products are usually inconclusive. The cultivation procedure and the location where the planting is done are factors commonly more important than the cultivation system. This theme is one of the most common ones in different studies on organic markets and production (Guthman, 2008; Lotter, 2003; Siderer et al., 2005; Torjusen et al., 2001).

The evidences of significant environmental improvement due to the organic agriculture are truly huge. The pesticides were practically vanished and the pollution caused by nutrients was drastically reduced. Erosion and biodiversity losses were reduced, as well as the use of water and fossil fuel. These changes diminished the impacts related to global warming in comparison to conventional agricultural systems (Lotter, 2003).

Matt et al. in the Report about Quality of Organic vs. Conventional Food and Effects on Health (2011) stressed that surveyed consumers mentioned such organic food characteristics as: better taste (sensory properties), care for the natural environment, greater food safety, animal welfare, social factors (supporting local market and traditions). To sum-up, consumers prefer organic food for its greater nutritional value, its better taste, its safety for health, and because its production does not endanger the environment (Matt et al., 2011).

Also, this report find out what restrictions exist on pesticides, fertilisers, and antibiotics and how organic farmers create good quality produce through crop rotations and cultivating in season. Only half of Europeans know that all organic operators must be controlled at least once per year. Discover the control process from start to finish. Organic farming means that the time and distance from the farm to kitchen is greatly reduced (http://ec.europe.eu).

Organic foods, which feature production methods that reject synthetic materials and compounds, have gained a fair amount of media attention in recent years, and with good reason: they are popular with 40% of survey respondents, particularly shoppers in Asia Pacific where 47% said they buy organic, Latin America at 45% and Middle East/Africa/Pakistan at 43%. North America falls well below the global average, with only 24% of consumers saying they actively buy organic. Thirty-five percent of Europeans say they actively buy organic products (Nielsen Global Online Survey, 2011).

People prefer organics for a host of reasons, including: the belief that they are healthier, pesticide-free, more nutritious, environmentally-friendly, taste better, not genetically-modified (GMO), supportive of small farmers and rural communities, the right thing to do ethically, and a vote against modern farming methods (Matt et al., 2011) (Figure 6).

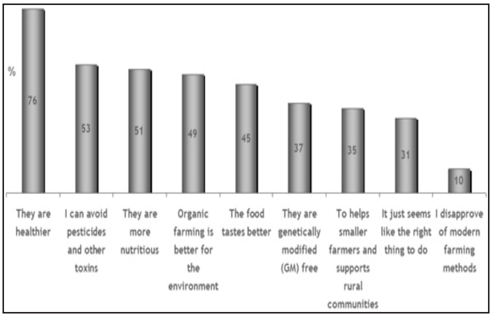

Figure 6. Reasons consumers to by the organic products (The Nielsen Company, Global Online survey, 2011)

Growth in the market can be attributed to growing health concerns among consumers and increasing awareness with regard to health benefits of organic food. Other factors driving organic food sales across the globe include increasing income levels, improving standard of living, and government initiatives aimed at encouraging widespread adoption of organic products. Consumers across the globe are becoming increasingly health conscious, which has resulted in a change in their tastes and preferences. A growing number of consumers are moving towards consumption of organic food in place of conventional food, to avoid adverse health effects caused by chemical preservatives or genetically modified ingredients present in inorganic food. Moreover, the increasing popularity of organic products has significantly expanded the availability of organic food across the globe. With organic food becoming easily accessible, global organic food market is expected to witness remarkable growth over the forecast period (Nielsen Global Online Survey, 2011).

Residues in organic products. In the scientific literature on pesticide residues in organic foods, evidence indicates that conventional foods are more likely than organic foods to contain (single and multiple) synthetic pesticide residues (Smith-Spangler et al., 2012). An annual monitoring report of European Food Safety Authority (EFSA) found traces of pesticides in organic food products, challenging public perceptions that organic products are free of synthetic plant protection products. Maximum Residue Levels (MRLs) are generally-acceptable limits of pesticide deposits, which remain after fruit or vegetables are cleaned up and above which consumption in large quantities could present a risk for human health. The control activities related to pesticide residues in food carried out in 2011, in 27 Member States. 4,117 organically produced food products (5.8% of the total number of samples) were analysed by the reporting countries except Bulgaria, Hungary and Iceland. Compared to conventionally grown food products, for organic samples a lower MRL exceedance rate was observed 0.5% for organic products versus 2.6% for conventional products. The presence of synthetic pesticides in organic food may arise from environmental pollution. Although organic farming does not permit the use of synthetic pesticides, it can involve the use of a limited number of biopesticides, which are types of pest management interventions based on micro-organisms or natural products (e.g. copper, sulphur).

In Romania, recent survey by Mednet Marketing Research Center (2015) shows that only a third of respondents trust bio products as being healthier than conventional ones, half of them consider them expensive and a quarter believe that everything is a marketing invention. However, once they get over this barrier, Romanians tend to choose imported brands, rather than local ones. Over 60% of consumers associate a organic product with a "product that does not harm in any way the environment" and a "product that contains no chemicals, E and artificial additives".

CONCLUSIONS

Organic agriculture is an integral part of sustainable development strategies and as a viable alternative to conventional agriculture.

At the end of 2013, the total organic area in the world means 43.1 million ha and there are approximately two million organic farmers.

The commerce of organic food sells 60 billion dollars every year.

In Romania, it were recorded a surface of over 288 thou ha in 2014 and around of 15,000 operators.

Each EU Member State accredits certification and inspection bodies. The EU requires an equally strict control system with checks carried out at every stage of the organic chain.

Every operator (farmer, processor, trader, importer or exporter) is checked at least once a year, or more often on the basis of risk assessment.

Organic farmers, processors and traders, must comply with strict EU requirements if they want to use the EU organic logo or label their products as "organic".

According to various reports, consumers mentioned such organic food characteristics as: better taste (sensory properties), care for the natural environment, greater food safety, animal welfare, social factors (supporting local market and traditions).

Consumers prefer organic food for its greater nutritional value, its better taste, its safety for health, and because its production does not endanger the environment.

In 2011, in 27 Member States, from 4,117 organic food samples (5.8% of the total number of samples) was observed only 0.5% present the pesticides residues versus 2.6% for conventional products).

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IDENTIFICATION AND CHARACTERIZATION OF MUTANTS INDUCED BY GAMMA RADIATION IN WINTER WHEAT (*Triticum aestivum* L.)

Mykola NAZARENKO

Dnipropetrovsk State Agrarian and Economic University, 25a Voroshilova str., 49600, Dnipropetrovsk, Dnipropetrovsk region, Ukraine

Corresponding author email: nik_nazarenko@ukr.net

Abstract

Mutation breeding is one of the breeding methods used successfully in durum wheat for selecting lines with increased agronomic values. This study was carried out to determine gamma rays effect and interaction between gamma-rays and the genotype of treated variety of winter wheat in mutations induction. We used physical mutagens: gamma-rays in doses 100, 150, 200, 250 Gy.
Seeds of eight winter wheat varieties were exposed with gamma-rays. Insensitive and most sensitive for mutagen actions varieties have been developed. Thirty-six different types mutated traits were observed. Among them there were seven valuable for breeding process. Mutations rate was waved from 0,4 to 30 %.
Medium dose of gamma rays (100 Gy) is recommended for winter wheat mutation breeding and high dose (200 Gy) for obtaining genetic-value mutants (parent components for crossbreeding with some valuable traits like as semi-dwarf, early-heading and other). For high-productivity lines were identified. Positive desirable mutants will be selected and be incorporated in future breeding programs.
We have shown that varieties obtained by gamma radiation are less sensitive to this mutagen. Their re-exposure is inappropriate by same mutagen. However, the varieties which obtained by field hybridization or treatment by mutagens of another nature (chemical agents, temperature) indicate a higher level of mutation rate and variability of traits.

Key words: *gamma-rays, winter wheat, mutation breeding, mutation rate.*

INTRODUCTION

Induce of mutations in crop plants contribute by increasing genetic variability and enrich plants germplasm for direct selection and cross-breeding. In wheat, chemical and ionizing radiation mutagenesis have been universally used to generate genetic variations for breeding researches and genetic studies (Cheng et al., 2015). In total, 274 mutant varieties of wheat were developed by physical or chemical mutagens from 1930 to 2014 (IAEA, 2015).
New forms such as semi-dwarfism, early maturity, disease resistance, etc met immediate market demands and were often released directly as commercial varieties without recourse to refinement through cross breeding (Si1ngh, Balyan, 2009). Mutation breeding gave a initial material for green revolution (Ahloowalia et al., 2004).
Wheat is the top food crop in Ukraine as well as in the whole world and the biggest part of grain is obtained primarily from winter wheat. Wheat is the stable food of millions of people globally. This crop is widely adapted to wide range of climatic conditions. The total area for winter wheat cultivation in Ukraine covers 6.8 mil. ha with actual productivity of 24 mln tons and average capacity of 2.8 t/ha (Morgun, Logvinenko, 1995; Nazarenko, 2012).
High doses are more successful in obtaining large quantity and a wide range of mutations. Gamma rays is the most important and frequently used mutagens well known for their effect on the plant growth and development and the appearance of morphological, cytological and physiological changes in cells and tissues; they are also traditional in breeding (van Harten; 1998; Nazarenko, 2015). Most commercial varieties are obtained by means of gamma irradiation (Ahloowalia et al., 2004).
The development of direct mutants into commercial varieties is still a common practice in seed propagated crops (Shu et al., 2011).

MATERIALS AND METHODS

Seeds (approx. 14% moisture content) of Favoritka, Lasunya, Hurtovina, Kolos Mironovschiny Sonechko, Kalinova, Voloshkova varieties and line 418 of winter wheat (Triticum aestivum L.) were subjected to 100,150, 200, 250 Gy gamma irradiation. Each treatment was comprised of 1000 wheat seeds. These doses are trivial for the breeding process that has been repeatedly established earlier (Ukai, 2006). Non-treated varieties were used as a check.

M_1 plants grown after mutagenic treatments were propagated based on the spike progeny method. The M_2 seeds obtained from each spike were sown to rows. The M_1 and M_2 generations were grown in DSAEU science-educational center, Aleksandrovka, Dnepripetrovsk region, Ukraine in 2010 and 2011. Selection of mutants was carried out in the M_2 and M_3 generations. M_2 plants showing a difference from the check (untreated mother varieties were also planted after every twenty rows for comparison with the M_2) and plants with desired phenotypes were harvested individually. Then M_3 progeny from selected M_2 plants according to the pedigree selection procedure were grown (Morgun, Logvinenko, 1995). The mutants were identified by visual screening for differences and were confirmed at M_3 generations by measuring for single spike yield and single plant grain yield in the M_2 and M_3 generations. Population sizes of M_1 was 500 in each case (total extent of examinations was 19 300 families in M_2), excepted varieties Lasunya and Kalinova (200 and 250 Gy)/

In 2013 – 2015 M_4 – M_6 generations genetic-valuable mutations were hand sown using a randomized complete block design in two-row plots of 1,5 m long row with 0,3 m spacing between the rows with tree replicates as a breeding collection (Albokari, 2014). Breeding-value lines were sown using a randomized complete block design in ten-row plots of 10 m^2 square size with 0.15 m spacing between the rows for 2-3 replications. After every 10 plots national standard Podolyanka was sown.

Selected mutant lines were evaluated for plant height, spike length, the number of grains per spike, single main spike yield, plant yield and 1000 grains weight (were recorded using 30 plants (10 random plants from each replication) before harvest) and general grain yield by comparison with national standard Podolyanka.

The level of variability was calculated using the formula: $P\nu = \alpha \times \gamma$

Where $P\nu$ - level of the variant variability;
α - the ratio of the total number of mutations to the total number of families in the variant;
γ – the number of modified traits types in the variant (Nazarenko, 2012; Nazarenko, 2015).

Mathematical processing of the results was performed by the method of analysis of variance; the variability of the mean difference was evaluated by Student's t-test. Factor analyses were conducted by module ANOVA. In all cases standard tools of the program Statistica 6.0 were used.

RESULTS AND DISCUSSIONS

As we can see from the table 1, the highest rate of mutations is observed in variety Kolos Mironovschiny (30%) at a dose of 250 Gr. However, for the most varieties the reducing of the mutation rate at a given dose and a higher value of rate at a dose of 200 Gr is observed. The greatest level of variability was also in the variety Kolos Mironovschiny. And we can see again that the highest dose of 250 Gr causes more narrow variability for the most varieties. That limits our ability for the selection of genetically-valuable mutations. The usage of the 200 Gr dose was more optimal. The less stable among the represented varieties Voloshova was the one obtained by exposure of low temperatures during vernalization. It is generally characteristic of such varieties.

Varieties Favoritka, Lasunya, Hurtovina (obtained by gamma rays) showed a significantly lower mutations rate and variability.

Mutations rate and variability increases linearly at doses of 100, 150 and 200 Gr, at a dose of 250 Gr. in most cases, on the contrary, there is a decrease to the level of 150 Gr dose or lower. However, we can not say that the use of this dose does not make sense. For two varieties mutations rate was highest at this dose.

Thirty-six traits were totally sorted out on which the change occurred under the influence of the mutagen. For analysis, they were classified in the following groups (Morgun, Logvinenko, 1995):

1. Mutations in the stem and leaf structures (all types of mutants by stem height and thickness were presented, mutants by waxy bloom);

2. Mutations of color and ear structures (only nine types by structure);
3. Mutations by grains color and structure (large in dimensions grain);
4. By physiological traits of growth and development of mutations (sterility, earliness, lateness, resistance to main pathogens);
5. Systemic mutations (like wild wheat relatives by spike shape);
6. Productivity and high quality mutations.

Table 1. Winter wheat mutations rates

Variant	Number of mutants	Rate, %	Variability level
Check (Kolos Mironivschini, water)	2	0,4	0,01
Kolos Mironivschini, gamma-rays, 100 Gy	46	9,2*	1,10
Kolos Mironivschini, gamma-rays, 150 Gy	67	13,4*	3,22
Kolos Mironivschini, gamma-rays, 200 Gy	83	16,6*	4,48
Kolos Mironivschini, gamma-rays, 250 Gy	90	30,0*	7,50
Check (Kalinova, water)	6	1,2	0,05
Kalinova, gamma-rays, 100 Gy.	39	7,8*	1,01
Kalinova, gamma-rays, 150 Gy	84	16,8*	3,53
Kalinova, gamma-rays, 200 Gy	83	23,7*	5,93
Kalinova, gamma-rays, 250 Gy	50	14,3*	2,43
Check (Voloshkova, water)	9	1,8	0,07
Voloshkova, gamma-rays, 100 Gy.	32	6,4*	0,90
Voloshkova, gamma-rays, 150 Gy	51	10,2*	2,14
Voloshkova, gamma-rays, 200 Gy	79	15,8*	3,63
Voloshkova, gamma-rays, 250 Gy	104	20,8*	4,99
Check (Sonechko, water)	4	0,8	0,02
Sonechko, gamma-rays, 100 Gy.	59	11,8*	1,89
Sonechko, gamma-rays, 150 Gy	90	22,5*	4,28
Sonechko, gamma-rays, 200 Gy	84	33,6*	6,38
Sonechko, gamma-rays, 250 Gy	23	23,0*	3,68
Check (Favoritka, water)	3	0,6	0,01
Favoritka, gamma-rays, 100 Gy.	28	5,6*	0,50
Favoritka, gamma-rays, 150 Gy	38	7,6*	1,06
Favoritka, gamma-rays, 200 Gy	43	9,6*	1,82
Favoritka, gamma-rays, 250 Gy	45	11,3*	2,03
Check (Hurtovina, water)	4	0,8*	0,02
Hurtovina, gamma-rays, 100 Gy.	34	6,8*	1,09
Hurtovina, gamma-rays, 150 Gy	40	8,0*	1,44
Hurtovina, gamma-rays, 200 Gy	51	10,2*	2,14
Hurtovina, gamma-rays, 250 Gy	50	12,5*	2,38
Check (Lasunya, water)	7	1,4	0,07
Lasunya, gamma-rays, 100 Gy.	26	5,2*	0,57
Lasunya, gamma-rays, 150 Gy	27	5,4*	0,86
Lasunya, gamma-rays, 200 Gy	43	9,6*	1,73
Lasunya, gamma-rays, 250 Gy	40	11,4*	1,94
Check (Line 418, water)	4	0,8	0,02
Line 418, gamma-rays, 100 Gy.	57	11,4*	2,05
Line 418, gamma-rays, 150 Gy	78	15,6*	3,28
Line 418, gamma-rays, 200 Gy	102	25,5*	4,59
Line 418, gamma-rays, 250 Gy	84	21,0*	4,20

* - difference is statistically significance from preliminary variant at $t_{0.05}$

Rates of genetically (short-stem plants, semi-dwarf plants, a large spike, large grain, earliness) and breeding-value mutations are included (productive mutants) were low (0.2-0.6% for the variant) and usually derived forms carried the additional negative qualities. Totally it was received (selected as genetically-valuable): short-stem plants 35 (especially a lot of forms from variety Voloshkova), semi-dwarf plants 11, with a large spike 41, with a large grain 14, earliness 40.

Mutant lines with the high grains productivity were induced primarily at the dose of 100 Gr. Their number is varied from 0 to 0.4 % in the variant (as an exception in the Hurtovyna variety), preferably – 0.2-0.4%. However, almost all these mutations have negative traits such as high stem or little resistance to pathogens, low drought resistance and winter hardiness. They represented a very limited interest.

After three year field estimation 4 lines with the productivity above national standard were allocated. All these lines were obtained by radiation of 100 Gy dose (Tables 2).

These three lines are derived from Sonechko variety, one line from the Kalinova variety. These varieties also showed a higher sensitivity to gamma-rays compared with others in the first generation (died of plants was high at 200 and 250 Gy doses (Nazarenko, 2015).

The usage of gamma rays in a 100 Gy dose was the most effective for the mutation breeding on the varieties obtained by chemical mutagenesis. Varieties, which showed even greater mutation rate and the level of variability in this dose, do not give anything.

Table 2. Grain productivity of winter wheat mutants lines after three years of estimation (2013 -2015)

Number of mutant line	Yield 2013	Yield 2014	Yield 2015	average yield	+/- to standard
			t./he		
Podolyanka	5,772	10,878	9,761	8,804	--
130	8,436	11,766	11,39	10,531*	1,727
133	5,195	11,033	10,71	8,979*	0,176
157	6,078	17,316	10,27	11,221*	2,418
157-1	6,078	11,5	11,12	9,566*	0,762
$LSD_{0,05}$			0,14		

* - difference is statistically value at $t_{0.05}$

Higher productivity of these lines was formed due to the increasing (in comparison with the standard) of the weight of thousand grains, weight of grain per spike and plant, more number of grains in the spike.

CONCLUSIONS

Thus, the most optimal for obtaining of breeding-value mutations is the usage of 100 Gy dose. For the most promising genetically-value mutations it makes a sense to use higher doses - 200-250 Gr.

We have shown that varieties obtained by gamma radiation are less sensitive to this mutagen. Their re-exposure is inappropriate by same mutagen. However, the varieties which obtained by field hybridization or treatment by mutagens of another nature (chemical agents, temperature) indicate a higher level of mutation rate and variability of traits.

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THE RESPONSE TO STOMATAL CONDUCTANCE AND CHLOROPHYLL VALUE OF GROUNDNUT GROWN UNDER SALT STRESS IN DIFFERENT DEVELOPMENT STAGES

Berkant ÖDEMİŞ

University of Mustafa Kemal, Faculty of Agriculture Department of Biosystem Engineering, Hatay, Turkey

Corresponding author email: bodemisenator@gmail.com

Abstract

In this study its response to salinity over different development periods (blooming, ginofor formation and fruit formation and maturation) was determined in the Eastern Mediterranean Region. The experimental design was split plot in a randomized complete block with three replications and was conducted in a total of 180 pots. In the irrigaton of groundnut, saline water with electrical conductivity (ECw) 0.19 dS m^{-1} ($T_{0.19}$), 3.54 dS m^{-1} ($T_{3.54}$), 7.12 dS m^{-1} ($T_{7.12}$) and 12.86 dS m^{-1} ($T_{12.86}$) were used. It was determined that Ginof formation stage was the most sensitive stage to salinity than the other developmental stages. Yield parameters were affected at p <0.001 level from development stage, irrigation water salinity and the development stage x irrigation water salinity interaction. Chlorophyll values at different salinity levels of stoma conductivity was show that different. The highest and lowest stomatal conductance were realized in $T_{3.54}$ (356.025 mmol m^{2}s^{-1}) and $T_{12.86}$ (238.25 mmol m^{2}s^{-1}) issues. Stomatal conductivity showed differences at different salinity levels. The highest and the lowest stoma conductivity monitored at $T_{3.54}$ (356.025 mmol m^{2}s^{-1}) and $T_{12.86}$ (238.25 mmol m^{2}s^{-1}). It was observed that the at the plots where the highest stoma conductivity determined had the higest yield.

Key words: *groundnut, salinity, development periods, stomatal conductance, chlorophyll.*

INTRODUCTION

Drought problems arising in the arid and semi-arid regions makes almost mandatory to use of marginal quality water in irrigation (brackish, reclaimed, drainage and waste water). Salt water usage causes the salinization to about 830 million hectares of worldwide (Martinez-Beltran and Manzur, 2005). This situation becomes necessary to determine in detail to the salt water yield function in salinity field (especially the plants that play an active role in human nutrition). One of the peanut plant species rich in oil, protein, carbohydrates, vitamins and mineral substances (Arıoğlu et al., 2010). Worldwide, about 24.7 million hectares in 100 countries, the production plant grown shelled 34.1 million megagram (Mg/ha), average efficiency 1.38 Mg/ha (FAO, 2002). Yield losses due to drought may vary with time associated with temperature and high stress factors, such as region-specific irradiance. About 3/2 in arid regions where crop production potential limitation of production consists, depending on the seasonal rainfall. In these areas productivity changes between 0.7-0.8 Mg/ha. But even with that limited water efficiency in commercial areas are level of 2.0-4.0 Mg/ha (Smartt, 1994). Lack of soil moisture in peanut farming and irrigation water quality are considered to be the most important factors limiting the yield. Growth period changes from about 120 to 150 days. precipitation of 500-700 mm is sufficient for the cultivation of peanuts during the growth. But this fall should be distributed to the growing period. Peanut maximum daily water consumption that occurs in flowering and pod-linking and maturation. The highest water consumption in July-August, August-September of about 6.0-8.5 mm/day was measured. In starting period (germination) when the peanut requesting adequate soil moisture it must be inserted into a small amount of water stress during the vegetative period. Flowering period is the period in which the most sensitive to water shortages. In general, extreme water shortages in the vegetative period causes to delay of flowering, the product formation, development and harvest. Water shortages of the flowering period lead to loss of the flowering and poor of the flower pollination.

Studies conducted in response to the saltwater applications of peanuts is almost negligible. Revealing different stages of plant development functions of salt-yield research was not found in a literature search. In this research, during that three different development of peanut aim to determine the different irrigation water salinity effects of yield, vegetative and physiological parameters.

MATERIALS AND METHODS

Research was conducted in greenhouses sheltered from rain, between May and October 2012, NC-7 variant of the Virginia group (leaning early). The plants were grown in 43 cm diameter and 47 cm high plastic pots., each pot filled with sandy-clay loam soil (42.0% sand, 35.3% clay, 22.7% loam) which is volume weight 1.38 gr cm^{-3}, salinity C_1S_1.

The experiment was conducted according to the split plot in a randomized complete block design in three different growth period (Flowering, Ginof formation, The formation and maturation of fruits periods), 4 different salinity in irrigation water (ECw) (0.19 dS m^{-1} (T_0), 3.54 dS m^{-1} ($T_{3.5}$), 7.12 dS m^{-1} (T_7) ve 12.86 dS m^{-1} (T_{13})), three replications and In each replications will take place the 5 pots, a total of 180 pots. NaCl salt and pure $CaSO_4$ salt sources were used in the experiment. Na and Ca values take care in the irrigation water must be kept between 0.1 and 0.7 (Grattan ve Grive, 1999). Determining the amount of irrigation water, prior to each watering (everything subject extra 3 pots) the observation of the subject pot is determined by measuring the required amount of irrigation water needed to field capacity. 20% of washing water is applied at each irrigation witness subject to issues outside (T_0). Irrigation water salinity (dS m^{-1}) was measured by portable EC meter (Orion 3 Star, USA), soil moisture content (cm^3 cm^{-3}) and soil salinity was measured by ΔT marka HH-2 moisture meter. Before the experiment starting, calibration equation is determined for the soil salinity y= 0.0127x + 0.91, (r^2=0.96**).

Evapotranspiration was determined by in every treatment of the weight of the 3 pot weighing the time between two irrigation and and summing the wanting. Plants in pots removed and collected in the harvest peanuts and eliminating all land in the pot tried to prevent the possible loss of peanut grain. The resulting grain, In every treatment that peanuts were determined to width (mm), length (mm), the average grain weight (gr) and numeral (number m^{-2}). Plant height were measured to determine the vegetative response before each irrigation. In this research, stomatal conductance and chlorophyll content were read a total of 6 times in 2 pots out of every replication before irrigation In order to determine the effects of irrigation water salinity on plant physiology. Stomatal conductance was measured by porometer (Model SC-1. LPS0881) and chlorophyll content was measured by Minolta SPAD 502. Stomatal conductance and chlorophyll content were measured in the middle of parcel, the full-blown fresh leaf which see the sun, In outdoor conditions between times of 12:00-14:00, once a week and before irrigation.

RESULTS AND DISCUSSIONS

Soil Moisture Content, Soil Salinity and Evapotranspiration: In this research, the plants were irrigated by fours in blooming and ginof period and in the during fruit ripening 3 times. Unsalted water for irrigation has been applied to all issues from planting to exit from to soil period. Salt water applications have started blooming period and continued until the harvest period. Soil salinity has increased significantly depending on irrigation practices (outside of T0 issue). 0.19 dS m^{-1} irrigation water is even did not cause a significant reduction in salinity level in the next period of saltwater applications in blooming and ginof periods. This situation is due to Na ions present in the soil is heavily complex and the high hydration diameter not impede the full realization of the washing process (Frenkel ve ark. 1978). Evapotranspiration (Et) decreased overall by increasing salinity (Table 1).

Table 1. The average values of evapotranspiration and soil salinity in the growth period

Issues	Blooming Period		Ginof Formation Period		Fruit Formation and Maturation Period		Seasonal Average	
	Et (mm)	ECe (dS m^{-1})	Et (mm)	ECe (dS m^{-1})	Et (mm)	ECe (dS m^{-1})	Et (mm)	ECe (dS m^{-1})
$T_{0.19}$	813.00	1.15	744.00	1.62	714.33	0.62	757.11 a	1.13
$T_{3.54}$	738.00	3.36	716.67	2.45	757.33	1.67	737.33 a	2.48
$T_{7.12}$	677.67	6.88	704.33	4.38	630.00	2.88	670.67 b	4.69
$T_{12.86}$	628.67	12.61	613.33	8.25	586.67	4.57	609.56 c	8.42

The highest Et was measured in witnesses issue in blooming and ginof formation periods and it also was measured in $T_{3.54}$ issue in during fruit ripening period. Significant relationship was found like that ($y=-14.307x+799.15$ $r^2=0.95^{**}$) in blooming period between Et and average Ece, and also in ginof formation periods ($y=-10.081x+754.35$, $r^2=0.93^{**}$) and insignificant relationship was found like that ($y=-12.357x+745.34$ $r^2=0.74$ns) during fruit ripening. Increased salinity dS m^{-1} of 1 causes a decrease 14.3 mm of BST in blooming period and also in ginof formation period it causes a decrease 12.35 mm.

Stomatal conductance, Chlorophyll Fluorescence: Irrigation water salinity increased, decreased stomatal conductance (Figure 2). Average of stomatal conductance was measured respectively in T_0, $T_{3.5}$, T_7 and T_{13} like that 307.476, 356.025, 268.187, 223.056 mmol m^{-2} s^{-1} . Stomatal conductance values of $T_{3.5}$ and T_{13} were took place separate groups and also T_0 ve T_7 were same group of statistical analysis. The stomatal conductance of $T_{3.5}$ was determined higher than the T0 (witness). It evaluated as a result of salinity given a final effort to recover from the stress of the plant itself has become stressed. Between stomatal conductance and soil salinity the regression coefficient is obtained different linear relationships in the blooming period as ($y=-2.43x+340.163$ $r^2=0.12$ ns), in ginof formation period (*$y=-34.484x+418.56$ $r^2=0.96$***), also in fruit formation and maturation period ($y =-18.417x+310.3$ $r^2=0.37$ns). Ginofor formation of stomatal conductance to be effective during the land 96% salinity be considered as an indication that more important than other periods of water movement and photosynthesis from the leaves in this period. The highest and lowest stomatal conductance in growth period were measured in blooming (326.053 mmol m^{-2} s^{-1}) and fruit formation periods (265.440 mmol m^{-2} s^{-1}). ECe average values were measured between 5.99 dS m^{-1} and 2.43 dS m^{-1} in the same period. Despite the increased stomatal conductance reduction of soil salinity may be a result to cause aging of salinity stress in plants during the growth period.

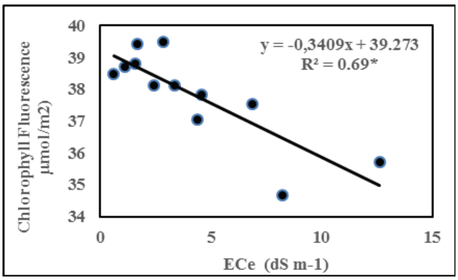

Figure 1. The relationship between chlorophyll content and soil salinity

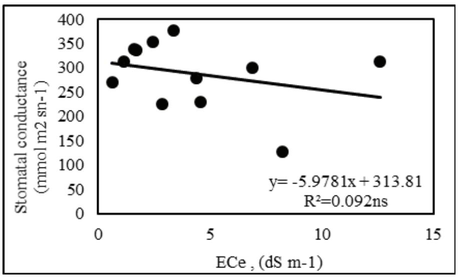

Figure 2. The relationship between stomatal conductance and soil salinity

The effects of soil salinity on stomata conductance ($p<0.01$) is the more efficient than growth periods has been determined in statistical analysis (Table 2). But from 8 August to 10 October (Harvest time) before watering measurements, the highest regression coefficients were determined in the ginof formation period regression analysis between stomatal conductance and ECw ($p<0.05$).

Table 2. Variance analysis of the efficiency parameter

Variation Source	Stomatal conductance (mmol m^{-2} s^{-1})			Chlorophyll Fluorescence (µmol m^{-2})		
	dF	MS	F	dF	MS	F
ECe	3	260406.817	3.357*	3	151.341	7.469**
Growth stages (Gs)	2	125428004	1.617ns	2	111.210	5.489**
ECe* Gs	6	58409.788	0.753ns	6	22.327	1.102ns
Error	344					

Gs: Growth stages, ECe: electrical conductivity of soil paste (dS m^{-1}), dF:Degree of Freedom, MS: Mean Square

Chlorophyll Fluorescence: Chlorophyll values decreased due to the increase in salt concentration (Figure 3). However, this reduction was not statistically significant (r^2=0.89ns, $p<0.05$). Chlorophyll values of witness issue ($T_{0.19}$) was measured 38.674 µmol/m^2, and also in $T_{13.86}$ 36.080 µmol/m^2. Chlorophyll values of $T_{3.5}$, T_7 were determined respectively, 38.569 µmol/m^2 and 38.038 µmol/m^2. $T_{0.19}$, $T_{3.5}$, T_7 issues were included in the same group, $T_{12.86}$ was icluded in the different group. Chlorophyll lowest value during the period was measured in $T_{12.86}$ by 35.193 µmol/m^2 and also the highest value was measured in $T_{0.19}$ by 39.491 µmol/m^2. The effect of soil salinity to chlorophyll value of each development cycle has been different. In regression analysis between soil salinity and chlorophyll content is obtained equations as $y=-0.2588x+39.084$, $R^2=0.99^{**}$ in blooming period, $y=-0.61x+39.721$ $R^2 = 0.99^{**}$ in ginof formation period and $y=-0.1948x+39.29$ $R^2=0.17^{ns}$ in fruit formation and maturation period. As it is seen from equation plants closer to the time of harvest chlorophyll values became more erratic than the other periods. In addition to weakening towards the end of the synthesis of chlorophyll in the plant's life cycle and entering senescence salinity stress is a major cause of this condition. Statistically chlorophyll value is significantly affected by developments periods and soil salinity (*$p<0.01$*, Table 2). While chlorophyll measured values in blooming an ginof formation periods located in the same group (37.531 µmol/m^2 ve 37.174 µmol/m^2), fruit formation and maturation period has been involved in a different group (38.815 µmol/m^2).

The Relationship Between Physiological Characteristics and Yield: Peanut of the efficiency parameters response to the irrigation water salinity analysis of variance are given in Table 3. The analysis of variance shows that efficiency parameters are affected at the level of *$p<0.001$* of *their growth period, irrigation water salinity and interaction of growth period x irrigation water salinity.* When the average value of the yield parameter in the development period analyzed, highest values were obtained from fruit formation and maturation periods. This situation shows that if the saline water implemented closer to harvest in the growth period, it would be relatively lower average yield reduction.Stomatal conductance and chlorophyll values at each growth period were not effective at the same level. When regression relationships are examined, both physiological properties were determined to be most effective in ginof formation (Table 3).
The relationship between the efficiency of both features (stomatal conductance and chlorophyll) were more important than other periods as both linear and polynominal. Chlorophyll values were effective on a greater number of yield parameters according to the stomatal conductance.

Table 3. The stomatal conductance and Chlorophyll fluorescence parameters relationships with yield (Regression Equations)

		Lineer regression					Polynomial regression				
		Number of peanut (number/m^2)	Grain W.(gr)	Width (mm)	Length (mm)	Plant Height (cm)	Number of peanut (number/m^2)	Grain W.(gr)	Width (mm)	Length (mm)	Plant Height (cm)
Sc (mmol m^{-2} s^{-1})	Blo	y=-0.0144x +84.31 R^2 = 0.001	y=0.1009x+60.706 R^2 = 0.16	y=0.0606x +76.164 R^2=0.24	y=0.0446x+82.675 R^2=0.37	y=0.1797x +31.156 R^2=0.23	y=-0.023x^2 +15.9x-2615 R^2=0.60	y=0.0083x^2- 5.5449x+1015.6 R^2=0.36	y=0.0066x^2- 4.44x+837.36 R^2=0.77	y=0.0035x^2- 2.32x+483.06 R^2=0.80	y=0,0068x^2- 4.447x+813.7 R^2 = 0.29
	GNF	y=0.369x -27.985 R^2=0.81	**y=0.2955x-1.3599 R^2=0.99****	**y=0.1385x +52.67 R^2=0.97****	**y=0.0997x+65.818 R^2=0.99***	y=- 0.0097x +100.86 R^2=0.53	**y=-0.0034x^2 +1.9957x- 187.081 R^2=0.99**	**y=-0.0006x^2 +0.5752x- 28.714 R^2 = 0.99****	**y=-0.0005x^2 +0.37x +29.817 R^2=0.99****	**y=-0.0002x^2 +0.1776x+58.20 R^2=0.99****	y=0.0002x^2- 0.0845x + 108.18 R^2 = 0.89
	FFM	y=0.0668x +76.202 R^2=0.14	y=0.0918x +68.836 R^2=0.37	y=0.0289x +90.638 R^2=0.33	y=0.0132x+95.051 R^2=0.15	y=- 0.0312x +104.54 R^2 = 0.27	y=-0.0013x^2 +0.7786x- 20.952 R^2=0.17	y=0.0005x^2- 0.1909x+107.42 R^2=0.38	y=-0.0006x^2 +0.364x+45.382 R^2=0.43	y=8x$10^{-5}$$x^2$- 0.033x + 101.39 R^2=0.15	**y=-0.0018x^2+ 0.9642x- 31.325 R^2 = 0.93***
Chll Fluor. (µmol m^{-2})	Blo	y=5.054x -110.07 R^2=0.20	**y=6.489x -149.93 R^2 = 0.90***	y=2.4099x +5.49 R^2=0.52	y=1.4074x+4.384 R^2=0.51	**y=9.910x -282.1 R^2= 0.95****	**y=12.278x^2 -906.9x+16806 R^2 = 0.99****	**y=-2.5579x^2 +196.47x-3673.9 R^2=0.99****	**y=-2.6925x^2 +202.39x- 3704 R^2 = 0.94***	y=-1.4382x^2 +108.2x – 1937 R^2=0.86	**y=-1.3126x^2+ 107.4x- 2090.5 R^2 = 0.96***
	GNF	y=21.055x- 709.35 R^2 = 0.74	**y=16.742x - 542.58 R^2 = 0.96***	**y=7.6992x -195.51 R^2 = 0.90***	**y=5.646x-116.7 R^2=0.96****	y=-0.595x +120.31 R^2=0.59	**y=-8.3659x^2 +634.34x- 11927 R^2 = 0.94***	**y=-3.2268x^2 +253.3x-4869.2 R^2 = 0.99****	**y=-2.3225x^2 +177.9x-3309.6 R^2 =0.99****	**y=-1.037x^2 +81.6x - 1507.1 R^2 = 0.99****	y=0.2266x^2 -17.21x + 424.19 R^2 = 0.69
	FFM	y=9.671x -281.45 R^2 = 0.69	y=9.0227x -257.02 R^2=0.87	y=2.394x +5.3736 R^2=0.54	**y=2.1102x+16.652 R^2=0.90**	**y=- 1.1442x +140.68 R^2=0.09**	**y=-15.516x^2 +1210.7x- 23516 R^2=0.97**	**y=-7.7912x^2 +612.13x-11925 R^2=0.98**	**y=-5.5544x^2 +432.3x-8312.4 R^2=0.99**	**y=-1.6864x^2 +132.6x- 2508.8 R^2= 0.99****	y=-6.1588x^2 +475.6x- 9082.3 R^2 = 0.48

** Blo: Blooming stage, GNF: Ginofor Formation Stage, FFM: Fruit Formation and Maturation Stage

In particular, grain weight, grain width, grain size were an important relationship with stomatal conductance and chlorophyll levels as both of poynomial and linear regression. The effect of stomatal conductance only creating important relationships with plant height has been shown to influence more output parameter values of chlorophyll. The effect of stomatal conductance fruit formation and maturation period creating important relationships with plant height It has been shown to influence more output parameter values of chlorophyll.

CONCLUSIONS

Accurate detection of plant water sensitive and tolerant period is crucial. The information obtained from research done before show that determining the mentioned period for many plants. As with drought stress, salinity stress is caused the low yield by the approximately same mechanism in plant. In areas where water is scarce, in plant physiology is an important option to use saline water for irrigation is causing serious problems. This information we have are showed that plants are more tolerant or more sensitive approximately in the same period of the plant drought-salinity stress. It is important to know the response of the estimated yield physiologically plant occurred during periods of stress. The findings from this study, indicates that the most sensitive period to salinity is ginof formation period among the blooming, ginof formation and fruit formation periods. Increased salinity stress caused a . . decrease evapotranspiration. It was determined that the stomatal conductance significantly reduced, depending on the salinity and chlorophyll content. The yield on the changes in chlorophyll content rather than changes in stomatal conductance is determined to play a more important role. The plant get older, impact of changes in stomatal conductance yield was insignificant. However, the chlorophyll content was determined to be of a more significant impact on the plant's final stage.

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ANTIFUNGAL ACTIVITY OF *Liquidambar orientalis* L., and *Myrtus communis* L. AGAINST SOME PLANT PATHOGENIC FUNGI

Abdurrahman ONARAN[1], Yusuf BAYAN[2]

[1]Gaziosmanpaşa Universty, Faculty of Agriculture, Department of Plant Protection, 60250, Tokat, Turkey
[2]Ahi Evran University, Faculty of Agriculture, Deparment of Plant Protection, 40100, Kirsehir, Turkey

Corresponding author email: abdonaran@hotmail.com

Abstract

As a result of the negative effects of pesticides used in the agricultural field, studies to find alternative methods have to be developed. In this study, Liquidambar orientalis L. (leaf and resin) and Myrtus communis L. (leaf) of methanol extracts of antifungal activities were determined against plant pathogens such as Fusarium oxysporum f. sp. lycopersici (FOL) (Sacc.) W.C. Snyder and H. N. Hans, Alternaria solani (Ell. and G. Martin), Botrytis cinereapers.:Fr, Rhizoctonia solani Kühn, and Sclerotinia sclerotiorum Lib De Bary which are caused intensive yield loss on tomatoes, strawberries, potatoes and cucumbers both in Turkey and in the world, In order to examine the used plant extracts, percentages of mycelium inhibition (MGI) values were calculated to compare with the positive control (80% Thiram), which is a standard fungicide. Also, the antifungal activities of plant extracts were evaluated statistically. 50 mg, 100 mg, 200 mg and 400 mg/mL of plant extract doses were used. L. orientalis and M. communis were shown distinguished antifungal activity. Plant extract of M. communis showed a strong antifungal effect against the tested fungi when compared with L. orientalis. As a result, nowadays the natural bio-pesticides used are cheap and eco-friendly; therefore they have potential in the control against plant pathogens.

***Key words**: plant pathogens, plant extracts, antifungal activity, Liquidambar orientalis, Myrtus communis.*

INTRODUCTION

The chemical control of plant diseases have caused severe problems, so that, has been accelerated to work on new effective alternative control methods , particularly in the developed countries. As a result of using pesticides, natural environment was affected, as well as human health (Delen and Tosun, 1997). There are many studies on the fungicide, herbicide and insecticidal effects of components and essential oils within the plants and their biological activities (Dudai et al., 1999; Gören et al., 2002; Cavanagh and Wilkinson, 2002; Dulger and Hacıoğlu, 2008; Almedia et al., 2010; Kalkışım, 2012; Kordali et al., 2013).

L. orientalis is an endemic tree from Altingiaceae family which grown in Fethiye and Mugla, Turkey (Anonim, 2015a). *M. communis* is aplant from *Myrtaceae* family, also named as Mersin or Murt and it is in the form of bush. It is commonly seen in places where Mediterranean climate is dominant, especially in coastal areas (Anonim, 2015b).

Fusarium oxysporum f.sp. *lycopersici* (FOL), *B. cinerea*, *R. solani*, *A. solani* and *S. sclerotiorum* are responsible for plant diseases that cause significant yield losses both in Turkey and worldwide. *FOL* is known as crown and root rot disease in tomato (Can et al., 2004). *B. cinerea* causes significant yield loss of fruit on strawberry (Williamson et al., 2007). *S. sclerotiorum* is known as white mold on more than 400 plant species. It causes diseases on stems, fruits and roots of cucumbers (Yanar and Onaran, 2011). The known as early blight disease of *A. solani* is widely seen on tomatoes (Yazıcı et al., 2011). One biotic factor that causes significant yield losses in potato crops is *R. solani*, responsible for soft decay of roots and bumps (Yanar et al., 2005).

In this study, the antifungal activities of the methanolic plant extracts from different parts of *L. orientalis, M. communis* against five different plant pathogens of were determined.

MATERIALS AND METHODS

Plant Materials. Plant species of *L. orientalis* and *M. communis* were collected from Muğla and Antalya province in Turkey 2014 (Table 1). The plant parts were air-dried at room temperature for three weeks in dark conditions. The dried plant parts were milled to a fine powder in a mill.

Table 1. List of plant species

Scientific name	Family	Part used
Liquidambar orientalis L.	*Altingiaceae*	Leaf, Resin
Myrtus communis L.	*Myrtaceae*	Leaf

Fungi Cultures. The plants pathogenic fungi (Table 2) tested in this research were obtained from the stock cultures of laboratory of phytoclinic, Department of Plant Protection, Faculty of Agriculture, University of Ahi Evran, Turkey. Plant pathogens were grown on Petri dishes on PDA and incubated at 25±2ºC for 7 days.

Table 2. List of plant pathogens

Plant pathogens	Origin
Fusarium oxysporum f. sp. lycopersici (Sacc.) W.C. Snyder and H.N. Hans	Tomato
Botrytis cinerea pers.:Fr	Strawberry
Rhizoctonia solani Kühn.	Potato
Alternaria solani (Ell. And G. Martin)	Tomato
Sclerotinia sclerotiorum (Lib.) de Bary	Cucumber

Plant Extracts. Powdered plant materials (100g each one) were extracted with methanol by incubated on orbital shaker (Lab. Corporation Group, Model-SI-300) at 120 rpm for 72 h (30^{o}C). After that it was evaporated to dryness in a rotary evaporator (Heildolph Group, Model-Hei-Vap Presicion). The concentrate was then diluted with 50% Acetone. Each plant extract was used at 50, 100, 200 and, 400 mg/ml (Kadıoğlu et al 2004).

In vitro Antifungal Activity. Plant extracts were added to PDA at 40^{o}C to give the final concentrations of 50, 100, 200 and 400 mg/mL for each extract. Seven-day-old agar discs (5 mm in diameter) bearing the desired fungus was transferred in the Petri plates. These fungus cultures were incubated at 25±2^{o}C for 7 days. Mycelial growth was recorded daily (Onaran and Yılar, 2012). Commercial fungicide [Thiram 80% (Hektaş, group)] was used as a positive control. 50% Acetone was used as a negative control. Experiment was set up in four replications and repeated twice.

The percentage of mycelial growth inhibition was calculated accordingly the formula mentioned by Pandey et al. (1982):

I=100×(dc□dt)/dc

I: Mycelial growth inhibition

dc: the mycelial growth in control

dt: the mycelial growth in treatment

Statistical Analysis. The data were analyzed by using Analysis of Variance (ANOVA) test. Differences between means were determined by the TUKEY test (at the 0.05 probability level). The software SPSS 13.0 was used to conduct all the statistical analysis.

RESULTS AND DISCUSSIONS

The antifungal activity of plant extracts against *FOL, B. cinerea, R. solani, A. solani* and *S. sclerotiorum*, expressed as Mycelial growth inhibition (MGI) (Figures 1-3 and Table 3).

No 100% inhibition was observed in any of the plant extracts used. But, compared to control, inhibition of mycelial growth occurred in generally, as the concentration increased. No activity was observed in all tested concentrations of *L. orientalis* leaf extracts against *FOL* and *S. sclerotiorum* (Figure 1). On the other hand, antifungal effect was observed in *L. orientalis* leaf extract against *B. cinerea, R. solani* and *A. solani* with different MGI values. *B. cinerea* was exposed to inhibition at 72.96-80.65%. The effect of plant extracts against *R. solani* was shown the lowest values (MGI between 10.61 and 28.32%). MGI values for *A. solani* were between 27.91 and 48.8% (Figure 1).

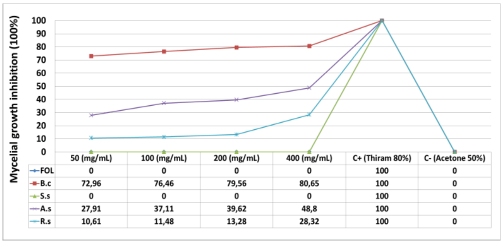

Figure 1. The effect of *L. orientalis* leaf extract on the mycelial growth inhibition of plant pathogenic fungi

Against FOL; *L. orientalis* resin extracts of 200 mg/ml and 400 mg/ml, were found between 27.93% and 39.75% values respectively (Fig. 2). The dose of 400 mg/ml of *M. communis* leaf extracts against *FOL* was observed value of 23.31% antifungal activity. Similarly, *M. communis* leaf extract at 400 mg/ml dose was determined against *S. sclerotiorum* rate of 82.40% antifungal activity (Figure 3). The dose of 400 mg/ml of *L. orientalis* resin extract against *S. sclerotiorum* was found value of 59.50% (Fig. 2). Other used plant extracts against *FOL* and *S. sclerotiorum* did not indicate any effects on doses (Figures 2-3).

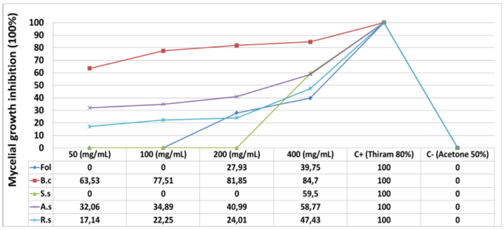

Figure 2. The effect of *L. orientalis* resin extract on the mycelial growth inhibition of plant pathogenic fungi

B. cinerea was the most affected pathogens from plant extracts in all pathogenic fungi species. This was followed by *A. solani*, *R. solani*, *FOL* and *S. sclerotiorum* respectively. The highest antifungal activity against *B. cinerea* was found in *L. orientalis* resin extract (84.70%) and of the same plant in leaf extract value was observed at 80.65%. This was followed by *A. solani* of *M. communis* leaf extract (60.71%), *R. solani* with 55.74% (*M. communis* leaf extract) and 47.43% (*L. orientalis* resin extract) respectively (Figures 1-3).

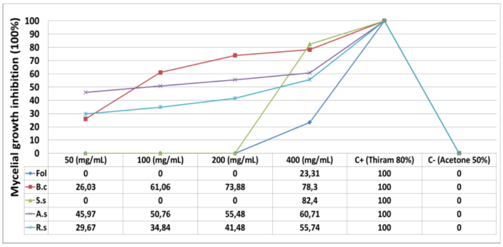

Figure 3. The effect of *M. communis* leaf extract on the mycelial growth inhibition of plant pathogenic fungi

Generally, antifungal activity of tested plant extracts varies with plant part and concentration. The antifungal effect increased with concentration. Different parts of the same plant have shown different antifungal effects. In the study, the commercial fungicide Thiram 80% was used as a positive control and showed 100% MGI against all pathogens. Acetone 50% was used as a negative control and had no effect on mycelial growth for all pathogens.

The antifungal activity of tested plant extracts were shown from the highest to the lowest were *M. communis* leaf extract, *L. orientalis* resin extract and *L. orientalis* leaf extract respectively (Table 3).

The plant extracts were evaluated in vitro conditions, on pathogens mycelial growth. The least effected was found the mycelial growth on *FOL* between 60.00 and 36.15 mm. Mycelial growth in the other plant diseases, for *S. sclerotiorum* between 60.00 and 24.32 mm, for *R. solani* between 45.64 and 22.60 mm, for *A. solani* between 38.97 and 21.24 mm and for *B. cinerea* between 44.38 and 9.18 mm were determined at different levels (Table 3).

Mycelial growth inhibition was observed at 200 mg/ml of resin extract of *L. orientalis* against *FOL* at 43,24 mm, and in 400 mg/ml doses against *FOL* at 36,15 mm and *S. sclerotiorum* at 24.32 mm. The leaf extract of *M. communis* was shown the mycelial growth inhibition in 400 mg/ml doses against *FOL* at 40.01mm and *S. sclerotiorum* at 10.59 mm. The mycelial growth inhibition was displayed similar values for *FOL* and *S. sclerotiorum* at other all plant extracts. But for *B. cinerea, R. solani* and *A. solani*; different antifungal activity values were exhibited by all plant parts and doses (Table 3).

Tablo 3. The antifungal activity of plant extract on the mycelium growth of plant pathogenic fungi

Plants	Parts	Concentration (mg/mL)	[1]Plant Pathogens				
			FOL	**B.c**	**S.s**	**A.s**	**R.s**
C+	Thiram	80%	0.00[2]$\pm$0.00^{e}[3]	0.00 ± 0.00^{j}	0.00 ± 0.00^{e}	0.00 ± 0.00^{v}	0.00 ± 0.00^{t}
C-	Acetone	50%	60 ± 0.00^{a}	60 ± 0.00^{a}	60 ± 0.00^{a}	54.06 ± 0.00^{a}	51.06 ± 0.00^{a}
[2]***L.o***	Leaf	50	60 ± 0.00^{a}	$16.22\pm1.26^{d-\imath}$	60 ± 0.00^{a}	$38.97\pm1.49^{c-\imath}$	$45.64\pm0.56^{a-f}$
		100	60 ± 0.00^{a}	$14.12\pm0.79^{d-\imath}$	60 ± 0.00^{a}	$34.00\pm0.73^{h-m}$	$45.20\pm0.82^{b-g}$
		200	60 ± 0.00^{a}	$12.26\pm0.68^{f-\imath}$	60 ± 0.00^{a}	$32.64\pm0.47^{\imath-o}$	$44.28\pm0.52^{b-\imath}$
		400	60 ± 0.00^{a}	$11.61\pm0.86^{g-j}$	60 ± 0.00^{a}	$27.68\pm0.89^{m-t}$	36.6 ± 1.14^{nop}
	Resin	50	60 ± 0.00^{a}	$21.88\pm3.51^{c-h}$	60 ± 0.00^{a}	$36.73\pm1.21^{f-k}$	$42.31\pm0.55^{d-m}$
		100	60 ± 0.00^{a}	$13.49\pm2.19^{e-\imath}$	60 ± 0.00^{a}	$35.20\pm1.97^{g-l}$	$39.70\pm0.41^{g-o}$
		200	43.24 ± 3.95^{bc}	$10.89\pm0.65^{h-j}$	60 ± 0.00^{a}	$31.90\pm1.10^{j-p}$	$38.80\pm0.57^{\imath-o}$
		400	36.15 ± 2.69^{d}	$9.18\pm1.22^{\imath-j}$	24.32 ± 9.24^{c}	22.29 ± 1.44^{stu}	26.84 ± 1.31^{rs}
M.c	Leaf	50	60 ± 0.00^{a}	44.38 ± 3.32^{b}	60 ± 0.00^{a}	$29.21\pm0.68^{l-r}$	35.91 ± 1.28^{op}
		100	60 ± 0.00^{a}	$23.36\pm5.70^{c-g}$	60 ± 0.00^{a}	$26.62\pm2.70^{n-t}$	33.27 ± 0.75^{pq}
		200	60 ± 0.00^{a}	$15.67\pm0.21^{d-\imath}$	60 ± 0.00^{a}	$24.07\pm0.55^{q-u}$	29.88 ± 1.17^{qr}
		400	46.01 ± 2.64^{b}	$13.02\pm0.40^{e-\imath}$	10.59 ± 0.50^{d}	21.24 ± 0.53^{tu}	22.60 ± 0.81^{s}

[1]Plant pathogens; *F. oxysporum f. sp lycopersici*=**FOL**, *B. cinerea*=**B.c**, *S. sclerotiorum*=***S.s***, *A. solani*=**A.s**, *R. solani*=**R.s**. [2]Plants . ***L.o*:** *Liquidambar orientalis;* **M.c***:Myrtus communis*. C+=Positive control, C-=Negative control
[3]Means in the same column by the same letter are not significantly different to the test of TUKEY.

In similar studies, other researchers have stated that the plant extracts used in our study were effective against the different plant pathogens at different values. Resin extract of *L. orientalis* $28x10^{-3}$ mg/mL air concentration had showed antifungal effect against *Phytophthora cactorum*, *Cryphonectria parasitica* and *Fusarium circinatum,* and $17x10^{-3}$ mg/mL air concentration was effective on *P.cactorum* and *F.circinatum pathogens,* whereas 7x10-3 mg/mL and 3.5x10-3 mg/mL air concentrations were only effective against *P.cactorum* pathogen (Lee et al., 2009). Similarly, plant extracts of *L. orientalis* in different doses and parts antimicrobial activity values was determined (Özcan et al., 2005; Oksay and Sarı 2005). Another study has evaluated the *n*-hexane, methanol, ethanol, ethyl-acetate and water extracts of M. communis to be finding antibacterial and cytotoxic activities. The antibacterial activities of extracts were tested on bacteria *Escherichia coli ATCC 29998, E.coli ATCC 25922, E.coli ATCC 11230, Staphylococcus aureus ATCC 6538P, S. aureus ATCC 29213, S. epidermidis ATCC 12228, Salmonella typhimurium CCM 5445, Enterobacter cloacae ATCC 13047, Enterococcus faecalis ATCC 29212, Pseudomonas aeruginosa ATCC 27853* and on fungus *Candida albicans ATCC 10239*. *E. coli ATCC 29998, E. coli ATCC 11230, S. epidermidis ATCC 12228, S. typhimurium CCM 5445* and *P. aeruginosa ATCC 27853* were shown different antifungal activities. Only the methanol extract obviously displayed antibacterial effect on ATCC 25922. None of the extracts was effective on ATCC 13047 and ATCC 29212 (Mert et al., 2008).

CONCLUSIONS

The plant species used in our study were determined to have different levels of antifungal effect. These differences change between 84.70% and 0.00% depending on mycelium inhibition rates; different results appeared according to the plant species and in different parts of plants. The result obtained after using different parts of different plants have caused varied results in mycelium inhibition values. Antifungal activities against all test organisms have reduced mycelium growth at the level of observable in a dose dependent manner. Hopeful results were obtained from the use of plant extracts controls. According to these results, the antifungal activities of the extracts obtained from different parts of plants to be used against plant pathogens (*FOL, B. cinerea, S. sclerotiorum, A. solani* and *R. solani*) were revealed in our study. One of the most important results is provided alternative control methods by plant based bio pesticides against other commercial uses chemicals pesticides. In this manner, the disadvantages caused by chemical control will be minimized.

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DOWNY MILDEWS SPECIES ON THE WEEDS OF LENTIL FIELDS IN DIYARBAKIR IN TURKEY

Cumali ÖZASLAN

Dicle University, Faculty of Agriculture, Department of Plant Protection, 21280 Diyarbakır, Turkey

Corresponding author email: cumali.ozaslan@dicle.edu.tr

Abstract

The study was carried out to determine downy mildews species on the weed, which create problems on lentil fields of Diyarbakır province of Southeastern Anatolia Region of Turkey during 2013. As result of this study, 7 different downy mildews were detected on 7 different weed species in the lentil fields. These downy mildews species are following: *Peronospora aparines* (de Bary) Gäum., *Peronospora arborescens* (Berk.) De Bary, *Peronospora lamii* A. Praum., *Peronospora narbonensis* Gäum., *Hyaloperonospora parasitica* (Pers.) Constant., *Peronospora sisymbrii-officinalis* Gäum. and *Peronospora trifoliorum* de Bary were determined on the weeds *Galium aparine* L., *Papaver macrostomum* Boiss & Huet. ex Boiss, *Lamium amplexicaule* L., *Vicia narbonensis* L., *Myagrum perfoliatum* L., *Sisymbrium officinale* (L.) Scop. ve *Trifolium* sp. respectively.

Key words: *downy mildews, weed, lentil field, Diyarbakır, Turkey.*

INTRODUCTION

Lentil (*Lens culinaris* Medik.) is very low in saturated fat, cholesterol and sodium. It is also a good source of thiamin, iron, phosphorus and copper, and a very good source of vitamin C, folate and manganese. Lentil has a large dosage of folate (folic acid), which fights heart disease and prevents birth defects. Lentil contains 75 % carbs, 21 % protein and 4 % fats (Anonymous, 2016).

Lentil, occupying an important position in the human diet, is consumed in different forms. In India, lentil is consumed either in boiled form (locally known as dal) or in the bread (roti) made from either wheat or maize flour mixed with lentil. Another food name “Khichri” is also made from lentil (Williams et al., 1993; Coskuner and Karababa, 1998). It is generally consumed as soup in Turkey. Lentil soup is very popular because of its taste, nutritional value and high protein content. Moreover, quenelles, ready soups and flour are also made from lentil in the country (Coskuner and Karababa, 1998).

Turkey ranked 3rd in lentil production in the world after Canada and India (Anonymous, 2010). A huger portion of annual lentil production in the country comes from South Eastern Anatolia region where, only red lentil is cultivated. In the recent decades, possibilities of irrigation have been raised in the region and lentil cultivation has been shifted to irrigated agriculture. The shift in production practices, climatic factors, and weeds have been thought as the hurdles in sustainable production of lentil in the region.

Weeds compete with lentil plants for water, nutrients and aeration; impair growth and development of lentil, offer difficulties in harvesting and decrease the quality of produce through weed seed contamination. Additionally, weeds also serve as alternative hosts for a number of diseases thus negatively affect the lentil production.

The use of biological control agents for weed control has attracted increased attention recently. The diagnosis of host weeds and their natural enemies is the foundation stone of a successful biological control program.

Studies of phytopathogenic fungi and other microorganisms on weeds of agrophytocoenosis are important in terms of biological control of them. There are some reports in Turkey that interested with fungal plant pathogens on weeds (Göbelez, 1963, 1964; Erciş and İren, 1993; Uygur et al., 1993; Özrenk and Tepe, 1999; Bahçecioğlu and Gjaerum, 2003; Kavak, 2003; Sert and Sümbül, 2003; Kırbağ, 2004; Sert, 2009; Tunalı et al., 2009; Erdoğdu et al., 2010; Özaslan, 2011; Ekici et al., 2012; Özaslan et al., 2013, 2015; Erdoğdu and Hüseyin, 2013). However, new pathogen records are to be determined in the future, which will contribute to the biological control of weeds.

In this study downy mildew fungi infesting the weeds prevailing in lentil crop were identified.

MATERIALS AND METHODS

Specimens of the downy mildews were collected during periodical mycological excursions in lentil fields in Diyarbakır Province of Turkey, in 2013. Microscopic studies were carried out on slides prepared in distilled water. Microphotographs were captured by Olympus BX 53 research microscope supplied with Olympus DP 22 digi-CAM (Japan) and Axio imager 2 equipped with Nomarski differential interference contrast optics. The fungi were identified using the handbooks and other publications (Ellis and Ellis, 1987; Mayor, 1962; Sacc., Syll. 1881-1931; Uljanishchev 1985; Vanev et al., 1993). The host plants were identified using the "Flora of Turkey and East Aegean Islands" (Davis, 1965–1985). Taxa, families, and author citations are spelled according to Kirk and Ansell (1992), and Index Fungorum (2016). All specimens are deposited in the Mycological Collection of the Dicle University, Diyarbakir (Faculty of Agriculture, Department of Plant Protection).

RESULTS AND DISCUSSIONS

The list of downy mildews with their host plant, collection sites, coordinates, altitudes, dates and the numbers of the collector (CÖ = Cumali Özaslan) is presented below.

OOMYCOTA

Peronosporales

Peronosporaceae

1. *Peronospora aparines* (de Bary) Gäum.

Specimen examined: – In lentil field, on the living leaves of *Galium aparine* L. (*Rubiaceae*), TURKEY, Diyarbakır Province, Sur District, 37°53'24" N, 40°16'28" E, 668 m, 3 April 2012, CÖ 201211.

2. *Peronospora arborescens* (Berk.) De Bary

Specimen examined: – In lentil field, on the living leaves of *Papaver macrostomum* Boiss & Huet. ex Boiss (*Papaveraceae*), TURKEY, Diyarbakır Province, Silvan District, 38°08'24" N, 40°55'18" E, 806 m, 16 April 2012, CÖ 201212.

3. *Peronospora lamii* A. Praum.

Specimen examined: – In lentil field, on the living leaves of *Lamium amplexicaule* L. (*Lamiaceae*), TURKEY, Diyarbakır Province, Bismil District, 37°46'50" N, 40°45'49" E, 568 m, 18 September 2014, CÖ 201213.

4. *Peronospora narbonensis* Gäum.

Specimen examined: – In lentil field, on the living leaves of *Vicia narbonensis* L. (*Fabaceae*), TURKEY, Diyarbakır Province, Silvan District, 38°08'24" N, 40°55'18" E, 806 m, 16 April 2012, CÖ 201214.

5. *Hyaloperonospora parasitica* (Pers.) Constant.

Specimen examined: – In lentil field, on the living leaves of *Myagrum perfoliatum* L. (*Brassicaceae*), TURKEY, Diyarbakır Province, Ergani District, 37°53'09" N, 39°42'34" E, 1033m, 24 April 2012, CÖ 201215.

6. *Peronospora sisymbrii-officinalis* Gäum.

Specimen examined: – In lentil field, on the living leaves of *Sisymbrium officinale* (L.) Scop. (*Brassicaceae*), TURKEY, Diyarbakır Province, Çınar District, 37°48'24" N, 40°21'17" E, 623 m, 25 April 2012, CÖ 201216.

7. *Peronospora trifoliorum* de Bary

Specimen examined: – In lentil field, on the living leaves of *Trifolium* sp. (*Fabaceae*), TURKEY, Diyarbakır Province, Sur District, 37°53'24" N, 40°16'28" E, 668 m, 9 April 2012, CÖ 201217.

CONCLUSIONS

Weeds negatively affect the field crops in several was such as; increase input costs, serve as alternative hosts for many casual agents of several diseases, offer hurdles in harvesting, decrease production and lower the quality of produce (Özer et al., 2001).

Lentil occupies first position in the legumes' production of South Eastern Anatolia region. Seven different mildew fungi were identified on seven different weeds in this study conducted in lentil crop. The incidences of the identified fungi varied according to the vegetation period. Moreover, less frequency of the fungi were observed in the crops where weeds were managed through crop rotation and thin plantation. Whereas, the incidence of the fungi were severe in the fields where these practices were not opted.

In conclusion, the fungi observed on the weeds prevailing in lentil fields have been considered important. Moreover, the diagnosis of fungi will contribute in the future biological control programs for weed management. The increase in weed infestation due to the possibilities of irrigation is expected in South Eastern Anatolia region.

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INFLUENCE OF NITROGEN FERTILIZATION ON BULGARIAN COTTON CULTIVARS

Galia PANAYOTOVA[1], Svetla KOSTADINOVA[2], Neli VALKOVA[3]

[1]Trakia University, Faculty of Agriculture, 6000 Stara Zagora, Bulgaria
[2]Agrarian University, Faculty of Agronomy, Mendeleev 12, 4000 Plovdiv, Bulgaria
[3]Field Crops Institute, 6200 Chirpan, G. Dimitrov 2, Bulgaria

Corresponding author email: galia_panayotova@abv.bg

Abstract

The field experiment was conducted from 2011 through 2014, at the Field Crops Institute, Chirpan, to evaluate the influence of nitrogen rates of 0, 60, 120 and 180 kg.ha^{-1}. The response of four Bulgarian cultivars - Chirpan 539 and Boyana (G. hirsutum L.), Darmi (G. hirsutum x G. barbadense) and Helius (developed by experimental mutagenesis) was studied. Various indices were determined: the total seedcotton yield (t.ha^{-1}), number of bolls per plant, boll weight (g), 1000 seeds weight (g), plant height in maturity (cm), fibre length (mm). The soil type was Pellic Vertisols, with neutral soil reaction, with poor to middle nitrogen supply, low content of mobile phosphates and well provided with available potassium. The results demonstrated that the N rates affected greatly all the studied indices except fibre length, and caused largest differences to plant height, boll weight, and 1000 seeds weight. The cultivar led to the greatest significant differences in fibre length, lint percentage, 1000 seeds weight, September and lint yield, while they were not significantly different in boll weight and plant height. The total seedcotton yield ranged from 1.18 t.ha^{-1} in 2011 to 2.50 t.ha^{-1} in 2013. The N rates increased the yield with 21.7- 28.8% in comparison with the unfertilized. The optimal effective N rate for yield was 120 kg.ha^{-1}. The agronomic efficiency of N was 3.87 kg seedcotton at 80 kg N.ha^{-1} and decreased to 3.33 and 2.56 kg at 120 and 160 kg N.ha^{-1}, respectively. The studied cultivars had similar demands to the levels of N treatment. N fertilization at different rates had a positive impact on the cotton yield components. After 120 kg N.ha^{-1}, boll weight increased with 3.5% compared to the unfertilized, harvested bolls per plant - with 15.0%, plant height- with 32.5%. Seeds per boll and fibre length were variable and we could observe no consistent trends.

Key words: *cotton, nitrogen, cultivar, yield.*

INTRODUCTION

Nitrogen is an essential nutrient for cotton that affects plant growth, fruiting and yield. Without adequate amounts of this element at each growth stage, the maximum potential of cotton cannot be achieved. Nitrogen plays a major role in defining the expression of a wide range of plant variables including plant size, fruiting intensity, boll retention rate, boll size and total boll number per plant (Gerik et al, 1998). Optimizing yield and earliness of cotton varieties with nitrogen fertilization is an ongoing concern of cotton producers. Nitrogen fertilization rate was the only factor that affected seedcotton yield (Alagudurai et al., 2006; Ansari and Mahey, 2003; Anwar and Afzal, 2003; Clawson et al., 2006; Khan et al., 2005; Panayotova and Kostadinova, 2003; Prasad, 2000; Stavrinos et al., 2002). Optimal nitrogen rate is determined by many environmental variables, including weather, soil type, residual fertility, insect pressure etc. (Stoilova and Nicolov, 2002).

Seilsepour and Rashidi (2011) reported that N application significantly increased boll number, boll weight, seed cotton weight of boll, seed cotton yield and lint yield. Results of study also showed that the highest seed cotton yield was obtained in case of 200 kg N.ha^{-1} rate and this application rate resulted in 19.6% increased seed cotton yield.

The foreign cultivars in Bulgaria have late maturity and fail to manifest their yield and quality potential. Highly actual are the results on the reaction of the Bulgarian cotton varieties to applied nitrogen fertilization. According to some authors cotton varieties manifest specific requirements to fertilization (Fritschi et al., 2003; Karamanidis et al., 2004; Clement-Bailey et al., 2007), but according to others (Kostadinova and Panayotova, 2003; McConnell et al., 2003; Panayotova and Videva, 2006; Pettigrew et al., 1996) cotton varieties with similar origin have similar N fertilizer requirements.

Sustainable cotton production requires new effective technologies and new cotton varieties, new and innovative solutions to cotton problems.

Therefore, the objectives of this research were to determine the (i) variability of productivity among cotton cultivars and (ii) response of cotton cultivars to nitrogen rates in years with different meteorological conditions.

MATERIALS AND METHODS

The experiments were carried out on the testing field of the Field Crops Institute, Chirpan, situated in a major cotton-growing region of Bulgaria. From 2011 through 2014, under non-irrigated conditions was investigated the influence of four nitrogen rates - 0, 60,120 and 180 $kg.ha^{-1}$ on cotton yield, yield components and some growth and quality indices. Nitrogen as ammonium nitrate was applied preplant on background of 60 kg $P_2O_5.ha^{-1}$ for all plots. The cotton was planted in crop rotation with durum wheat.

The response of four Bulgarian cotton cultivars to N was studied. Chirpan 539 and Boyana which originated from *G. hirsutum* were early, high yielding cultivars (Bojinov et al., 1996; Valkova and Bozhinov, 2010). Cultivar Darmi was with longer fibre, created by interspecies hybridization (*G. hirsutum x G. barbadense*) (Stoilova and Saldzhiev, 2008). Helius was developed by experimental mutagenesis method (Valkova, 2009). The Chirpan 539 cultivar grown without N fertilization was accepted as a standard in the trial.

The experimental design was a randomised split plot design with cultivars as main plots, and N levels as sub plots, in four replications. Individual plots consisted of six 8.33-m rows spaced 0.60 m apart with a net plot size of 50 m^2. There were two harvests made by hand from four middle rows (20 m^2). The plant population reached as much as 160,000 $plants.ha^{-1}$, approximately. Cotton seeds were sown within 20-30 April. Weeds were controlled by preplant and preemergence herbicides, interrow cultivation and hand chipping. Defoliants were not applied. The applied agrotechnical practices were complied with the technology established for the region (Saldzhiev et al., 2005; Saldzhiev et al., 2006).

At maturity the seedcotton yield from each plot was weighed and ginned on a rollergin. The following were determined: total seedcotton yield ($t.ha^{-1}$); number of bolls per plant by accurate count; boll weight (g), which was determined as seed cotton weight per plant/number of bolls per plant; 100 seeds weight (g); plant height in maturity (cm); fibre length (mm) measured by hand by the "butterfly" method. Ten plants from each replication were analyzed.

Analysis of variance (ANOVA) was applied to determine differences and interaction among N rates, cultivars and years.

The soil type was classified as *Pellic Vertisols* (FAO), defined by the sandy-clay composition, with high humidity capacity and small water-permeability. The soil has a high-powered humus horizon (70-100 cm), it has a compact zone of the profile (united horizon). Soil analysis of the experimental field indicated bulk weight of the plough soil layer 1.0-1.2 $g.cm^{-3}$, specific gravity – 2.6-2.7. The cation exchange capacity ($T_{8.2}$) was 41.0-46.1 meq/100 g soil, total acidity (exchangeable $H_{8.2}$) was 3.6 meq/100 g soil, no damage soil acidity and exchangeable aluminum were established. Despite the long-term use of physiologically acid mineral fertilizers the degree of the bases saturation was very high – 93.4-98.8 %.

The soil had neutral soil reaction in the 0-60 cm soil layer, medium supplied with organic matter, with poor to middle nitrogen supply, with low content of phosphates and well provided with available potassium (Table 1).

The experimental field of the Field Crops Institute, Chirpan, is located at Latitude N 42°12'58", Longitude E 25°17'00" and Altitude 175 m. For the region are typical low winter temperatures and warm summers. The average annual temperature sum is 4317°C. The coldest month is January with daily average temperature of -0.3°C and the warmest is July with an average temperature of 23.2°C. The annual average rainfall is 567 L/m^2, with a maximum in June - an average of 70.0 L/m^2. The annual minimum precipitation is in September.

Table 1. Agrochemical properties of the soil, Chirpan

Parameters	Depth, cm	
	0-30	30-60
pH $_{KCl}$	6.7	6.2
Humus, %	2.80	2.55
Total N, %	0.100	0.090
$N\text{-}NH_4^+$, kg.ha^{-1}	50	53
$N\text{-}NO_3^-$, kg.ha^{-1}	47	30
Total N_{min}, kg.ha^{-1}	97	83
Available P_2O_5, mg.kg^{-1}	51	39
Exchangable K_2O, mg.kg^{-1}	230	160

In meteorological aspect the studied years had higher temperatures and less precipitation during the cotton vegetation period (May-October) compared to the average values of the 85-year period (Table 2).

With regard to temperature, 2012 was hot, 2011 and 2013 – very warm, 2014 was moderately cool - the temperature sum was lower with 23°C. As for rainfall supply, 2011, 2012 and 2013 were very dry, and 2014 was very humid in comparison with the long 85-year period.

In 2011 and 2014 the cotton was harvested in adverse temperature and humidity conditions.

Table 2. Meteorological data during the vegetative period of cotton

Year	Temperature sum, Σ t°C			Rainfall sum, mm		
	IV-IX	V-VIII	V-X	IV-IX	VI-VIII	V-IX
2011	3791	2160	3256	255	113	209
±	+315	+107	+123	-45	-45	-46
2012	3859	2305	3447	185	33	171
±	+383	+252	+314	-115	-125	-84
2013	3735	2134	3319	218	153	177
±	+259	+81	+186	-82	-5	-78
2014	3480	2059	3110	593	168	509
±	+4	+6	-23	293	10	254
1928-2013	3476	2053	3133	300	158	255

RESULTS AND DISCUSSIONS

Table 3 shows the mean squares of differences for the studied parameters. For an easier comparison the absolute values of square sums for the different sources of variance were replaced with their share in the total variance.

It is obvious that all studied parameters showed significant differences. The greatest and most significant of all indices appeared to be the influence of the uncontrollable environment factors, summarised here as factor years. The year impact took the largest part of the total variance; forming both seedcotton yield (92.73%) and lint yield (90.77%).

The rates of N fertilization affected greatly and significantly ($p<0.001$) all studied indices except fibre length. It was statistically determined that N fertilization led to largest differences to plant height, boll weight, and 1000 seeds weight. Although it was proved at $p<0.001$, N fertilization had moderate influence on the total seedcotton and lint yield (2.55-2.65% from total variance), and minimum (0.58%) on lint percentage and earliness, manifested in September yield (0.61%).

Cultivar, the third factor, led to the largest significant differences at $p<0.001$ on fibre length, lint percentage, 1000 seeds cotton weight, September and lint yield. Its influence on bolls per plant was low but significant, while the studied cultivars were not significantly different in respect to boll weight and plant height.

The year-to-year differences in growing conditions led to effect variation of cultivar and N rate on the total cotton yield. However, N manifested greater influence across all years. The N x C interaction was not proven, which statistically showed that the created and grown Bulgarian cultivars had similar needs for N fertilization rates in respect to yield. The analysis identified the strongest significant influence of YR x C, YR x N, C x N and YR x C x N interactions to lint percentage.

As far as the degree of variance was concerned, received through the variation coefficient, lint percentage and 1000 seeds weight were the most stable studied indices, while number of bolls per plant, plant height and cotton yield were the most variable. The total cotton yield ranged less (VC = 5.77 %) in comparison with September harvest (VC = 7.94 %).

The differences between years affected the total seed cotton yield, which ranged from 1.18 t.ha^{-1} in 2011 to 2.50 t.ha^{-1} in 2013 (Table 4). The significant differences between yields were caused by the meteorological differences between years, especially the amount and distribution of precipitation. The higher yield values in 2013 were caused mainly by the favourable conditions in July and August altogether. In this year, which had adequate seasonal rainfall distribution, the plants grew faster, produced more vegetative and reproductive growth, they were higher and had more biomass.

The total yield in 2012 exceeded the yield of the most unfavourable year 2011 with 40.1 %, in 2014 - with 29.5 % and in 2013 - more than two times (112.0 %).

Table 3. Effect of factors on cotton yield and yield components (mean squares - % of total)

Source of variance	df	September harvest, $kg.ha^{-1}$	Total seed cotton yield, $kg.ha^{-1}$	Lint yield, $kg.ha^{-1}$	Lint, %	Boll weight, g	Harvested bolls per plant, number	1000 seeds weight, g	Plant height, cm	Fibre length, mm
Replicate	3	0.02**	0.53***	0.53***	0.01	1.08	0.54	0.37	1.22	0.78
Year (Y)	3	97.05***	92.73***	90.77***	48.77***	32.24***	72.70***	71.42***	43.58***	16.59***
N rate (N)	3	0.61***	2.65***	2.55***	0.58***	5.09***	2.34***	4.47***	13.91***	0.47
Cultivar(C)	3	0.39***	0.24**	1.24***	28.18***	0.31	0.64*	8.21***	0.27	33.09***
Y x N	9	0.42***	0.63***	0.62***	1.48***	5.38***	2.32***	0.58	1.38	1.09
Y x C	9	0.33***	0.39**	1.13***	11.42***	7.84***	6.20***	3.82***	3.69*	8.73***
C x N	9	0.05	0.08	0.14	1.13***	2.01	0.31	0.39	1.31	1.32
Y x Cx N	27	0.09	0.12	0.28	6.26***	10.14**	1.52	1.19	2.36	1.45
Error	198	1.03	2.64	2.76	2.17	35.90	13.42	9.57	32.29	36.47
VC, %		7.94	5.77	5.75	0.66	4.69	9.86	1.92	8.88	4.43

*, **, *** - significant at p<0.05, p<0.01 and p<0.01, respectively

Table 4. Effect of nitrogen fertilization on the total seed-cotton yield, average of four Bulgarian cultivars

Fertilization	Year				Average		
	2011	2012	2013	2014	$t.ha^{-1}$	%	AE
$N_0P_0K_0$	1.04	1.53	2.09	1.08	1.44	100.0	-
N_{80}	1.17	1.71	2.49	1.62	1.75*	121.7	3.87
N_{120}	1.28	1.71	2.64	1.73	1.84**	127.9	3.33
N_{160}	1.24	1.68	2.80	1.69	1.85**	128.8	2.56
Average - kg/da	1.18	1.66	2.50	1.53	1.72	-	-
- %	100.0	140.1	212.0	129.5	-		

*, ** - significant at p<0.05 and p<0.01, respectively

The applied N rates - 80,120 and 160 $kg.ha^{-1}$ led to increase in yield with 21.7; 27.9 and 28.8 %, respectively, in comparison with the unfertilized. In all the years, the treatment exerted positive effect on cotton production. Results demonstrated that the difference between the yields at 120 and 180 $kg.ha^{-1}$ N rates was insignificant and the optimal effective N rate for yield was 120 $kg.ha^{-1}$. McConell et al. (1993) investigated the interaction of cotton genotypes with varying levels of N fertilization and reported that N rates above 112 $kgN.ha^{-1}$ did not significantly increase the seedcotton yield. The agronomic efficiency of nitrogen was 3.87 kg of seedcotton at 80 $kgN.ha^{-1}$ and decreased to 3.33 and 2.56 kg of seedcotton at 120 and 160 $kgN.ha^{-1}$, respectively.

Additional realised yield at N_{180} in comparison with N_{120} was insignificant and this treatment was ineffective. Data revealed that because of the late vegetative period and cotton growth at dry conditions the plant could form greater boll number and be higher, even at N_{180} application. In spite of this, cotton growth was sensitive to N supply. The delay in maturity due to excessive N and heavy rainfall was detected in 2014.

Discussing the response of the studied cultivars to levels of N treatment (Table 5), it was indicated that all cultivars had similar demands. This was also confirmed by the manifested insignificance of differences at N-by-C interaction (Table 2). A tendency was observed for Chirpan 539 and Boyana to increase their yield after N_{120} treatment and these cultivars were more effective. At this N rate, Chirpan 539 improved cotton yield with 26.0% in comparison with the unfertilized. The productivity of cultivars Darmi and Helius increased up to N_{160} and reached 1.92 $t.ha^{-1}$ for Darmi and 1.76 $t.ha^{-1}$ for Helius. Chirpan 539 and Darmi manifested high productivity at all N levels.

The yield increase in all cultivars was caused by the higher number of bolls per plant and boll weight with the increasing of N rates. The advantage of Chirpan 539 was manifested in the highest lint percentage, the bigger number of harvested bolls per plant and boll weight. Good combination of fibre length and lint percentage was found for the varieties Darmi and Boyana.

Table 5. Effect of nitrogen fertilization on total seedcotton yield of four Bulgarian cotton cultivars, average for 2011-2014, $t.ha^{-1}$

Cultivar	Fertilization				Average for cultivars	
	N_0	N_{80}	N_{120}	N_{160}	t/ha	%
Chirpan 539	1,50	1,82	1,90	1,88	1,78	100,0
Darmi	1,47	1,77	1,87	1,92	1,76	98,87
Boyana	1,43	1,72	1,85	1,85	1,71	97,15
Helius	1,36	1,69	1,75	1,76	1,64	93,18

Nitrogen fertilization at different rates had a positive impact on the cotton yield components (Table 6). At an effective N rate for yield of 120 $kg.ha^{-1}$ the boll weight increased with 3.5% compared to the unfertilized, harvested bolls per plant - with 15.0%, plant height- with 32.5%, etc. Boll size and seeds weight were larger in the first September harvest. Seeds per boll and fibre length were variable and we could observe no consistent trends.

Table 6. Effect of nitrogen fertilization on cotton yield components, average for 2011-2014

Treat ment kgN/ha	Boll weight, g	Harvested bolls per plant, number	1000 seeds weigh t, g	Plant height, cm	Fibre length by "butterfly, mm
N_0	4.24	4.07	103.0	52.96	24.48
N_{80}	4.33	4.36	104.1	55.74	24.62
N_{120}	4.39	4.68	105.5	70.16	24.81
N_{160}	4.42	4.96	106.0	76.35	24.53
LSD 0.05	0.07	0.14	0.07	1.43	0.44
LSD 0.01	0.09	0.19	0.09	1.89	0.58
LSD 0.001	0.12	0.24	0.12	2.43	0.75

High N rates led to decrease in lint percentage. The differences in fibre length were found to be insignificant for all N rates. However, the effect of increased N rate treatment on fibre length was slightly negative at 180 kg $N.ha^{-1}$. Other authors (Nikolov, Stoilova, 1999; Seilsepour and Rashidi, 2011) also confirmed this.

CONCLUSIONS

Results demonstrated that on *Pellic vertisols* soil type the total seedcotton yield of studied cultivars ranged from 1.18 $t.ha^{-1}$ in 2011 to 2.50 $t.ha^{-1}$ in 2013 under typical production practices in Southern Bulgaria. The applied N rates - 80,120 and 160 $kg.ha^{-1}$ led to increase of yield with 21.7; 27.9 and 28.8 %, respectively, in comparison with the unfertilized. The difference between cotton yields at 120 and 180 kg $N.ha^{-1}$ was insignificant and the optimal effective N rate for yield was 120 $kg.ha^{-1}$.

The agronomic efficiency of nitrogen was 3.87 kg of seedcotton at 80 kg $N.ha^{-1}$ and decreased to 3.33 and 2.56 kg of seedcotton at 120 and 160 kg $N.ha^{-1}$, respectively.

The studied cultivars had similar demands to the levels of N treatment. A tendency was observed that Chirpan 539 and Boyana increased their yield after N_{120} treatment and these cultivars were more effective.

N fertilization at different rates had a positive impact on the cotton yield components. At 120 kg $N.ha^{-1}$ the boll weight increased with 3.5% compared to the unfertilized, harvested bolls per plant - with 15.0%, plant height- with 32.5%. Seeds per boll and fibre length were variable and we observed no consistent trends.

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HERBAGE YIELD AND QUALITY OF WHEAT STUBBLE AND SORGHUM SUDAN-GRASS PASTURES

Altıngül Özaslan PARLAK[1], Ahmet GÖKKUŞ[1], Fırat ALATÜRK[1], Hülya HANOĞLU[2], Cemil TÖLÜ[3]

[1]Çanakkale Onsekiz Mart University, Faculty of Agriculture, Department of Field Crops, 17100, Çanakkale, Turkey
[2]Sheep Breeding Research Institute, Bandırma, Balıkesir, Turkey
[3]Çanakkale Onsekiz Mart University, Faculty of Agriculture, Department of Animal Science, 17100, Çanakkale, Turkey

Corresponding author e-mail: gulozaslan@yahoo.com

Abstract

Summers are hot and dry and winters are cool and precipitated in regions with dominant Mediterranean climate. Since the pastures totally dry out during hot-dry period, sheep usually graze over wheat stubble in Turkey. The present study was conducted to investigate the herbage yield and quality of wheat stubble and Sorghum Sudan-grass pastures during summer dry periods and to compare live weight gains of the sheep grazed over these pastures. In sorghum Sudan-grass pastures, sheep (4 Karacabey merino race sheep x 3 replications) freely grazed in each plot for two-and-a half month (July-August-September) when the plants had 50-75 cm heights. Similar grazing treatments were also performed over wheat stubble. Dry herbage yields of wheat stubble and sorghum sudan-grass pastures were respectively observed as 2.82 ton/ha and 10.0 ton/ha. Considering the herbage quality of the wheat stubble, crude protein was 6.28 %; NDF was 66.54%. ADF was 37.88%, ADL was 4.37%, DMD was 60.25%, ME was 2.18 Kcal/kgKM. The same values were respectively observed as 11.33%, 61.13%, 31.58%, 2.99%, 67.27%, 2.43% in sorghum sudan-grass pasture.Traditional sheep grazing can be performed over wheat stubble pastures, but supplementary energy feed with CP should be provided. Sorghum sudan-grass can also be cultivated as an alternative to traditional stubble grazing. In this case, there is no need for supplementary feeds.

Key words: *wheat stubble, sorgumsudan grass, herbage yield, herbage quality, sheep grazed.*

INTRODUCTION

Cereal cultivation is implemented over the entire country in Turkey except for eastern Black Sea region. Cereals are cultivated over 117.132.230 da land area in Turkey and wheat is cultivated over 67% of these lands corresponding to 78.668.874 da land area (Tuik, 2016). Sheep are traditionally grazed on wheat stubble after grain is harvested from June to September. The sheep usually graze without supplements. The nutritional quality of stubble is low, owing to low nitrogen content and digestibly (Landau et al., 2000). However, stubble lands sometimes have increasing feed quality because of quite high grain losses during the harvest. As an alternative to traditional stubble grazing, sorghum-sudan grass pastures can be established in dry summer periods. The characteristicity of sorghum hybrids include fast establisment and vegetative growth, low soil fertility demand, as well as cutting and grazing management facilities. Sorghum hybrids have been used in rotation a grazing on summer annual grass for decades (Rodrigues, 2000). High forage production, 14.6Mg/ha of the dry mass with high nutritive value forage (7.5% crude protein) in 4 to 6 cuttings is observed in the experiments (Bean et. al.,2013). The present study was conducted to investigate the herbage yield and quality of wheat stubble and sorghum sudan-grass pastures during summer dry periods.

MATERIALS AND METHODS

The study was conducted at the July to mid October at the Bandırma Sheep Breeding Research Institute, located in northwestpart of Turkey. Bandırma has a typical Mediterranean climate: the mean annual precipitation 684.6 mm falls mainly in winter and spring. The rainy season typically begins in October and ends in

May, while summers are dry and hot. The mean annual temperature is 15.0^{o}C.

The soil at Bandırma is generally neutral, unsaline and has clay or clay-loam texture with low or medium lime content, medium organic matter content, low or sufficient phosphorus content, sufficient or high potassium and magnesium contents, high calcium content, sufficient copper and manganese, high iron and low or sufficient zinc contents.

Summer pasture was established with sorghum-sudan grass hybrid in June. In sorghum sudan-grass sowing, 30 kg/ha sowing rate and 50x10 sowing spacing were used. Together with sowing, 80 kg/ha nitrogen was applied once to the soil (Beyaert and Roy, 2005). Plants were grazed when they reached to a height of 50-75 cm (Lewandowski et al., 2012). Wheat fields are harvested in June in the region. Over wheat stubble and sorghum sudan-grass pastures. 4 fences (2.5 x 2.5 = 6.25 m^2) were surrounded and prevented from grazing. Free grazing was performed over each plot with 4 Karacabey merino race sheep (4 sheep x 3 replications). Grazing was initiated on July 29. 2015 and plant samples were taken from the grazing plots on August 21, September 17 and October 9, 2015. Then the fence replaced to another place.

Collected samples were dried at 60^{o}C for 48 h, and ground in a mill to passt hrough 1 mm screen priorto analyses. All analyses were carried out on duplicate samples and results reported on DM basis. Nitrogen content was measured by the Kjeldahl method (AOAC, 2000). Crudeprotein wascalculated as Nx6.2, NDF, ADF and ADL were measured using the procedure described by Van Soest et al.,(1991).

Data were analyzed by analysis of varianceusing MINITAB program, and meand were compared using Duncan's multiple range test at the $P \leq 0.05$ level.

RESULTS AND DISCUSSIONS

Grazing was initiated over sorghum sudan-grass and wheat stubble on July 29. 2015. Plant samples were taken from each plot in 20 day intervals. The greatest dry herbage yield (10.0 ton.ha^{-1}) was observed in sorghum sudan-grass pasture and the value was observed as 2.82 ton.ha^{-1} in wheat stubble pasture. Since sorghum sudan-grass height was quite low when the grazing was initiated, the lowest yield was also observed in this date. Yield increased in the other four periods but placed in the same statistical group (Table 1). Since sorghum sudan-grass has regrow ability, plants regrew after grazing and thus produced high herbage yields in each sampling period. Sapıtmaz and Özaslan Parlak (2015) in a study in a region with dominant Mediterranean climate grew sorghum sudan-grass as the second crop and reported total dry herbage yield (as 3 cuttings) as 33.69 ton.ha^{-1}.

While low crude protein levels were observed in wheat stubble pasture, the values were quite high in sorghum sudan-grass pasture. The crude protein contents were at the highest levels at the beginning of grazing period and the values decreased throughout the grazing period. NDF, ADF and ADL ratios were higher in wheat stubble pasture. NDF and ADL values were lower at the beginning of grazing period. However, increasing NDF values were observed in the other periods, but the difference between them was not significant. The greatest ADL ratio was observed in the last periods.

While sorghum sudan-grass pasture had high digestible dry matter content (67.27%), the value was lower (60.25%) in wheat stubble pasture. Significant differences were not observed in digestible dry matter contents of different periods. The case for metabolic energy was similar digestible dry matter (Table 2). Guessous (1992) reported after 30-day grazing that crude protein content decreased by 30% and digestibility decreased by 12%. While grazing over wheat stubble, sheep initially graze the grains, and then graze leaves and stems. Therefore, decreasing nutritional components were reported for stubble (Guessous et al., 1989). A decrease was also seen in protein ratio of the present study, but a quite low decrease was observed in digestibility. An increase was observed in crude protein ratio of the samples taken on September 17. It rained before sampling period and foliation was observed, thus a slight increase was observed in crude protein ratio. Landau et al., (2000) reported low nutritional quality and digestibility for stubble. In present study, crude protein and digestibility of stubble were lower than sorghum sudan-grass.

Table 1. Dry herbage yields of wheat stubble and sorghum Sudan-grass pastures in different periods throughout the grazing season (ton/ha)

Pastures	Day of Sampling				
	07.29.2015	**08.21.2015**	**09.17.2015**	**10.06.2015**	**Means**
Wheatstubble	2.33	2.72	3.29	2.94	2.82**a**
Sorgum-sudangrass	3.37	11.92	11.61	13.09	10.0**b**
Means	2.85**b**	7.32**a**	7.45**a**	8.02**a**	6.41

$P_{Pastures}$: 0.000.$P_{Day\ of\ sampling}$: 0.000.P_{PxD}:0.000

Table 2. Herbage quality of wheat stubble and sorghum sudan-grass pastures in different periods throughout the grazing season (CP, NDF, ADF, ADL,DMD, ME)

Pastures	Day of Sampling				
	07.29.2015	**08.21.2015**	**09.17.2015**	**10.06.2015**	**Means**
	CP (%)				
Wheatstubble	5.79	6.19	7.04	6.09	6.28 **a**
Sorgum-sudan grass	15.94	9.15	9.71	10.52	11.33 **b**
Means	10.87 **a**	7.67 **b**	8.38 **b**	8.31 **b**	
	$P_{Pastures}$: 0.000.$P_{Day\ of\ sampling}$: 0.001.P_{PxD}: 0.000				
PasturesNDF (%)					
Wheatstubble	65.07	67.00	68.96	65.15	66.54 **a**
Sorgum-sudan grass	55.36	60.13	62.96	66.10	61.13 **b**
Means	60.21 **b**	63.56 **a**	65.96 **a**	65.62 **a**	
	$P_{Pastures}$: 0.000.$P_{Day\ of\ sampling}$: 0.000.P_{PxD}: 0.002				
Pastures	**ADF (%)**				
Wheatstubble	36.98	37.85	39.39	37.29	37.88 **a**
Sorgum-sudan grass	30.07	30.67	32.26	33.31	31.58 **b**
Means	33.52	34.25	35.82	35.30	
	$P_{Pastures}$: 0.000.$P_{Day\ of\ sampling}$: 0.075.P_{PxD}: 0.236				
Pastures	**ADL (%)**				
Wheatstubble	4.47	4.17	4.64	4.22	4.37 **a**
Sorgum-sudan grass	2.43	3.03	2.92	3.57	2.99 **b**
Means	3.45 **b**	3.60 **ab**	3.78 **ab**	3.89 **a**	
	$P_{Pastures}$: 0.000.$P_{Day\ of\ sampling}$: 0.040.P_{PxD}: 0.001				
Pastures	**DMD (%)**				
Wheatstubble	61.26	60.29	58.57	60.91	60.25 **b**
Sorgum-sudan grass	68.95	68.28	66.52	65.34	67.27 **a**
Means	65.10	64.29	62.54	63.13	
	$P_{Pastures}$: 0.000$P_{Day\ of\ sampling}$: 0.075.P_{PxD}:0.236				
Pastures	**ME (Kcal/kgKM)**				
Wheatstubble	2.21	2.18	2.12	2.20	2.18**b**
Sorgum-sudan grass	2.49	2.47	2.40	2.36	2.43**a**
Means	2.35	2.32	2.26	2.28	
	$P_{Pastures}$: 0.000. $P_{Day\ of\ sampling}$: 0.075.P_{PxD}: 0.236				

CONCLUSIONS

Dry herbage yield, crude protein content, NDF, ADF, ADL, DMD and ME values of wheat stubble were significantly lower than sorghum sudan-grass. Cereals are cultivated over large areas in Turkey. Traditional sheep grazing can be performed over wheat stubble pastures, but supplementary energy feed with CP should be provided. Sorghum sudan-grass can also be cultivated as an alternative to traditional stubble grazing. In this case, there is no need for supplementary feeds.

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APPLYING OF MANURE TO WINTER WHEAT ÎN BESSARABIA

Gheorghe PRIPA

State Agrarian University of Moldova, 44 Mircesti, 2049, Chisinau, Republic of Moldova

Corresponding author email: gheorghe.pripa@gmail.com

Abstract

In the Republic of Moldova for a long time was considered, that manure applied to winter wheat in recommended doses (40-60 t/ha) contains too much nitrogen and leads to lodging of plants, lower production and its quality. Therefore the winter wheat is incorporated only chemical fertilizers. At the same time, in neighboring countries (Romania, Ukraine) for fertilization of wheat, frequently are using organic fertilizers at lower doses (10-20 t/ha). The dates obtained in long-term experiments demonstrate, that to this crop can be used manure in the autumn, at the dose 20 t/ha. In the case, when the manure is applying to the forerunner of wheat, the dosage may be increased up to 40-60 t/ha. Wheat, fertilized with manure is relatively low: content of crude protein and crude gluten is only 23.1 and 13.12% respectively when we incorporated into the soil 20 t/ha manure. To increase quality indicators is necessary to incorporate foliar nitrogen.

Key words*: manure, winter wheat, crude protein, crude glutein.*

INTRODUCTION

Currently, intensive agriculture can't be exploited without applying of mineral or organic fertilizers. The share of fertilizers in the crop formation of cereals yields in Moldova is about 25-30% (Zagorcea, 1990). In recent years, cost of fertilizers, agricultural machinery, petroleum products rose sharply, but the prices of agricultural products have remained quite low. As a result, the farmers procure and applied a low doses of fertilizers, gaining small profits and decreases soil fertility. In this situation increase the role of local fertilizer, containing all necessary nutrients for plants,, increasing the humus content and improving the physical properties of the soil. They have a very low cost and applied in equivalent doses (based on content of NPK) ensure obtaining the same yield increase as the mineral fertilizers. Meanwhile, the local fertilizers are voluminous, require significant expenditure for transporting in the field, have relatively low nutrients content (NPK 13-15 kg per 1 ton), can't be applied to all crops and at all stages of plants development.

In Moldova, for winter wheat are recommended to apply only mineral fertilizers (Recommendations on use of fertilizers in Moldova, 1994). Manure is using often to maize, sugar beet, fodder beet, most vegetables. With manure, applied at recommended doses (40-60 t/ha), is administered relatively much nitrogen (200-300 kg/ha), contributing to the fall of wheat plants, reducing yields and quality of production. From this cause, manure should not be used for spiked crops, including and winter wheat. However, other countries are applying the manure to the winter wheat. For example, in Romania condition doses of manure, applied for wheat is only 15-20 t/ha, increase of yield is exceed 1500 kg/ha (http://www.agricultor.ro/article/36901/Graul/7). Other authors from Romania (http://agroromania.manager.ro/articole/diverse /gunoiul-de-grajd-un-ingrasamant-universal-13423.html) recommended for wheat only 10-15 t/ha manure. În forest-steppe zone of Ukraine for winter wheat recommended to administrate 20 t/ha manure, which ensures a harvest addition of 4.9 q/ha on podzolic and at 4.8 to 6.6 q/ha on the typical chernoziom soils (http://fermerland.com/rastenievodstvo/zernovye-kultury/pshenitsa/353). Popov (2011) studied the growing influence of different doses (1.8, 3.6 and 5.4 t/ha) dry and granulated poultry litter for winter wheat, on the chestnut soils, in irrigation conditions. The author has established, that the crop growth was 0.3; 0.98 and 1.68 t/ha corresponding. In Moldova, there are a few data about of the manure application for winter wheat. Therefore, the problem of winter wheat fertilization with organic fertilizers is less studied in our country, and the available data are often conflicting.

MATERIALS AND METHODS

The studies were conducted in long stay experience at Experimental Station "Chetrosu", of State Agrarian University of Moldova. The soil is calcareous chernoziom, which containing in arable layer: 3.2% humus, mobile phosphorus approximately 1.5 mg/100 g dry soil, exchangeable potassium 18 mg/100 g dry soil. Scheme of experience included variants with different annual dose of manure (3.3, 6.6, 9.9 and 20t/ha), that corresponds to 20, 40, 60 and 120 t / ha, applied for one rotation. Studies have been conducted in 6-rotation fields with following crop rotation: silage corn - winter wheat - winter wheat - corn / beans - spring barley - sunflower. Fertilizers were applied in the first culture. Only one variant included the application of manure at a dose of 20 t/ha each year (direct action for each crop in rotation, including and winter wheat). The experiment was conducted in 3 replicates. The total area of the plots was 220-440 m2. We had use semi-fermented manure, obtained from cattle and the total content of nitrogen, phosphorus and potassium was - 0.5; 0.25 and 0.6% respectively. The results were statistically enterpreted by Dospehov (1979).

RESULTS AND DISCUSSIONS

În the Republic of Moldova conditions, it is recommended to use only mineral fertilizer (autumn in plowing), while seeding and during the growing season). The very high price of mineral fertilizers and rather small profits of farmers, requires us to seek other sources of plant nutrients, much cheaper as manure. This organically fertilizer is not recommended to apply to winter wheat in the Republic of Moldova, but in long-term experience, which including and winter wheat, we study the residual action of manure (in the second and third years after its incorporation). Only in one version was incorporated the manure each year, at a dose of 20 t/ha.

The data obtained show us that in the second year after incorporation 3.3; 6.6; 9.9 to 20 t / ha of manure were obtained corresponding to 480, 660, 820 and 1430 kg/ha grains, compared to control (Table 1). The dose of manure was higher, much higher it was the grain harvest. Ît is explained by the fact, that we have incorporated different dozes of nitrogen, phosphorus and potassium - N100P50K120, N200P100K240, N300P150K360 and N600P300K720 respectively, with increasing dose of manure (20, 40, 60 and 120 t/ha). Increasing the dose of manure at 20 to 40 t/ha lead to increased the yield by 280 kg/ha more grains, compared to control, but increasing the dose of manure at 40 to 60 t/ha - only to 160 kg/ha grain, compared with previous dose. Therefore, increasing the dose of manure at 40 to 60 t/ha is not profitable, because does not contribute to a significant increase of wheat harvest. Application of 20 t/ha manure every year, including and winter wheat, helped to achieve the highest yield added -1430 kg/ha. The effect of applied manure in this variant is not observed only in winter wheat, but to also of previous crops.

Incorporated of different doses of manure in forerunner winter wheat was not contributed to the lodging of plants, due to excess of nitrogen. It is explained by the fact, that approximately 20-30% of the nitrogen was used for working culture (corn silage). A part of nitrogen migrated to the lower layers of the soil. But even the version where each received annually 20 t/ha manure obtained about 1.5 t/ha yield increase, fall of plants was not observed. Similar yield increases have been achieved in Romania (http://www.agricultor.ro/article-/36901/Graul/7). Perhaps this can be explained by a using of a significant portion of nitrogen (20-30%) by corn silage. Part of the nitrate nitrogen migrated into below layers of the soil, during of the vegetation season. Therefore, manure can be incorporated in the soil, on nearby fields of livestock farms, in doses at 10-20 t/ha, without fear that the winter wheat plants will fall.

Manure is considered as slow-acting fertilizer that slowly decomposes, releasing gradually certain amount of NPK. In some stages of plant development (twinning, taxidermy, grain formation), N requirement of the plants is higher, relative to the amount of released from manure. In this case appear the symptoms of nitrogen deficiency in plants and grain quality is low.

Zagorcea (1990) mentions, that in the second year after application of manure, plants using only 10-15% of NPK and 5-7% in the third year. Therefore, the application of 20, 40 and 60 t/ha and 120 t/ha manure, wheat plants will be used in the second year 10-15, 20-30, 30-45 and 60-90 kg/ha nitrogen properly. Such amounts of nitrogen can´t cause the fall of wheat plants, but do not contribute to obtaining high - quality productions. The data of crude gluten and crude protein content in wheat grains demonstrates (Table 1), that these indices on control variant were 23.6 and 12.41% respectively. Action retained of the increasing doses of manure (20, 40 and 60 t/ha), applied in the preceding culture did not change significantly the production quality (crude gluten - 20.1, 23.0 and 21.8% and crude protein - 10.81, 11.69 and 11.64% respectively). Probably, it is obvious, that the decomposition of the organic fertilizer gradually releases a small amount of nitrogen, comparatively with plant requirements, especially during grain formation, which had a negative impact on grain quality. Only annual administration of 20 t/ha manure, increased crude protein content (13.12%), but not exceeded the requirements standart (14%). Therefore, when winter wheat fertilization with manure appears urgent need to administrate (foliar) a small doses of nitrogen, to improve grain quality.

Table 1. The influence of anthropic-impact level on soil plasticity

Average annual dose of manure, t/ha	Dose of manure appled in previous culture, t/ha	The average harvest of grain, kg/ha	The yield increase		Content, %	
			kg/ha	%	Crude protein	Crude glutein
Control (without fertilize) 3.3 t / ha	-	1760	-	-	12.41	23.6
6.6 t/ha	20	2240	480	27.2	10.81	20.1
9,9 t/ha	40	2420	660	37.5	11.69	23.0
	60	2580	820	46.6	11.64	21.8
20 t/ha	**20	*3190	1430	81.2	13.12	23.1

*Average of 5-years experience, direct action of manure
**Manure 20 t/ha applied every year

În the soil with manure fertilization incorporating not only NPK, but and all other nutrients (macro-, micronutrients such as calcium, magnesium, sulfur, iron, manganese, molybdenum, zinc, boron, iodine). If we had fertilizate the wheat with manure it is not practical to apply foliar complex fertilizer în the vegetation. They are more expensive compared to the price of urea which provides aproximativly the same effect on the grain quality. Relatively low concentration of nutrients (approx. 13 kg/t NPK) and relatively high dose of manure applied on 1 hectare (10-20 t), leads to increased the transporting costs of manure in the field. To reduce the costs, the manure is applied to land near the farms. Another method of reducing the costs is composting the manure with phosphorus fertilizer (1-3% by weight). In this case ammonia nitrogen from manure, interacts with phosphorus, forming a stable substance - Amofos or Diamofos. The use of poultry manure, especially in the dry form, reduce the doses approximativly to 5 t / ha. This dose is practically equivalent (after NPK content) with 40t wet manure produced by cattle. In the regions, where it operates poultry plants, poultry manure is a "Divine gift" for all nearby farmers.

Relatively low concentrations of nutrients (about 13 kg NPK to 1t), and the too high volume of manure used per hectare (40-60 t), necessary to find new ways to increase the nutrients concentration and reduction the

application dose of this organic fertilizer. One of these methods is processing livestock waste with California's red earthworms. The obtained product (viermicompost) is administered at a dose 10 times smaller (4-6 t/ha), compared to traditional manure (40-60 t/ha), has a higher content of nutrients. Vermicompost, obtained in different countries from different animal waste is different. For example, viermicompost obtained by E. Miorzlaia G., (2004) in Russia, has the following content of nutrient: 0.6-1.4% N, P 0.4 - 2.7%, K 0.5-1.9%. Viermicompost produced in Germany has a much higher content of nutrients: N – 4%, P – 5%, K – 2. 5% (Melzer R., 1988) because, in the processing with earth worms, have been used various additions - bone meal, flour, phosphate, blood meal and doses of incorporation in soil - much smaller. Obtained viermicompost in Moldova contains far fewer nutrients: N - 0.8%, P - 1.4% K - 1.2% (Cremeneac, 2003) and applied doses can' t be 4-6 t/ha. So then, the chemical content of viermicompost, obtained from different species of animals, and dosage of administration are less studied in the Republic of Moldova.
Experiments performed with different types of processing manure with Red California's, earthworms demonstrates, that viermicompost nitrogen content decreases slightly, but phosphorus and potassium content increase, as compared with the initial amount (Table 2).

Table 2 Chemical composition of viermicompost, obtained from manure of different animal species in 2007-2010

Moisture,%	Dry matter, %	Natural mass content, % in mass		
		N	P	K
Vermicompost from Cattle manure				
45.1	54.9	0.34	0.51	1.11
Vermicompost from Swine manure				
41.7	58.3	0.59	0.72	0.76

Processing of manure with California red earthworms not significantly increased the content of nutrients, but increased the cost of viermicompost. The data obtained allow us to conclude, that this technology is relatively difficult, with many problems, and the obtained vermicompost is quite expensive. Currently it is not widespread in the country and is´t used by many farmers.

CONCLUSIONS

The Republic of Moldova has not recommendations on the application of organic fertilizer to winter wheat. But the data, obtained in long-term experiments in Moldova and recommendations from neighbors country demonstrate, that for this crop can be used the manure, autumn plowing in dose 20 t/ha. Increase harvest was 1430 kg/ha. When applying manure under forerunner of winter wheat, doses may be increased to 40-60 t/ha. Wheat grain quality is relatively low in the fertilization with manure: the crude gluten and crude protein content in wheat grains were 23.6 and 12.41% respectively. To increase wheat production quality is recommended to applie foliar nitrogen fertilizer, during grain formation. Processing of animal waste with California red worms considerably reduces the volume of organic fertilizers, but not the content of NPK, increase the cost of viermicompost. In Moldova Republic conditions it is not rational to process the manure with California red worms.

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OLD AND REGIONAL VARIETIES OF PEAR TREES IN THE TERRITORY OF CZECH SILESIA

Radim LOKOČ[1], Maria TOADER[2]

[1]Natura Opava - Czech Republic, non-profitable organization, Edvarda Beneše 30, 747 05 Opava, Czech Republic
[2] University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăşti Blvd, District 1, 011464, Bucharest, Romania

Corresponding author email: info@natura-opava.org

Abstract

This article is aimed to present the some old and regional varieties of pear in the territory of Czech part of Silesia; it means the north-eastern part of the Czech Republic. It is a border area (larger part of Silesia region stretches in the territory of Poland) which is characterized by slightly wavy and lowland part of the territory which belongs to areas with mild climate and then also by the mountains of "Nízký Jeseník" and "Hrubý Jeseník" which belongs to cold areas. The average annual temperature in Silesia is about 7.6°C of the long-term usual level.
The following pages will be aimed to emphasize the some aspects of specific pomological information based on research carried out in various parts of the region during recent years, to preservation of biodiversity of natural associations occurring on its area.

Key words: *conservation, biodiversity, old pear varieties, traditional cultivation.*

INTRODUCTION

The genus *Pyrus*, which contains 21-26 species, is highly diverse (Bell and Hough, 1986). The species differ in morphological and phenological traits (Shen, 1980; Westwood, 1982). For characterization and identification of plant species, polygenic morphological traits serve as markers (Simmonds, 1979). Widely distributed and extensively grown pear genotypes show variability in leaves and fruits traits, partially due to hybridization, sexual propagation, bud mutation and diverse agro-ecological conditions. Therefore, characterization for all existing variation within genotypes is needed (Zagaja, 1970; Terpo, 1985). However, characterizations of wild genotypes will provide base for further evaluation, conservation and to bridge information 25 differences for the genus *Pyrus*. Both types of study i.e. qualitative and quantitative are necessary to evaluate variability in pear genotypes in relation to polygenetic and environmental factors.
The pears are important both for the wildlife supported by traditionally managed orchards and for the many varieties of fruit which exist, often with traditional local, culinary and seasonal uses. At the same time as the destruction of orchards, there has also been a concentration on production of fewer varieties of pears.
The pear tree has higher climate and soil requirements than the apple tree. It is cultivated in countries with a warm climate, such as Italy, Spain, China, Argentina, and Chile (Mohan Jain et al., 2009).
According to the Central Institute for Supervising and Testing in Agriculture, Czech growers harvested 3,758 MT of pears in year of 2015. This year commercial production reached 9,372 MT of pears.
On the other hand, traditional orchards are valuable habitats for wildlife and their loss has an important negative impact on nature conservation. These orchards are a vital and characteristic feature of our rural landscape and heritage. A more varied orchard floor in terms of structure and plant communities will support a greater diversity of insects, small mammals and birds.

MATERIALS AND METHODS

In order to characterize the particularities of old varieties of pear from Silesia region, it was considered the cultivars' determination and description in the different regions of the Czech Republic.
The list shows the varieties whose cultivation was recorded by pomologists in exhibitions and during the process of mapping from the second half of the 20th century to the present times.
The variety composition which was recorded during the process of mapping and pomological determination in the period of 2010-2015 is significantly more modest while compared to the list specified.

RESULTS AND DISCUSSIONS

Statistical data. A total 21,347 ha of fruit orchards were registered in the Czech Republic, in 2015. By comparison with year of 2012 (17,568 ha), area increased with 3,779 ha.
The age structure of pear orchards is 26% for old orchards and 24% of new out planting (Figure 1).

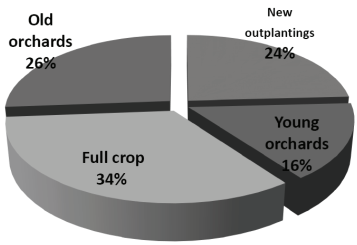

Figure 1. Age structure of pear orchards (after Roman Chaloupka, 2013)

The most frequently planted varieties of pear trees belonged to groups Conference (21.8% of the total pear orchard area) and William (7.1%). The age structure of pear orchards was found to be favourable. There were 37.1% of pear trees in young plantations up to 4 years (by 6.8% more than in 2007) and old plantations over 25 years shared 23.7% (by 11.1% less than in 2007). Pear orchards were planted with their average density of 891 trees per hectare; their prevailing share (83.3%) belonged to the density class of 1 600 trees/ha. Density up to 400 trees/ha prevailed among orchards up to 4 years newly planted in 2012 while in 2007 orchards of the same age class belonged mainly in the density class of 400–1 599 trees per hectare. The main varieties of pears in Czech Republic are present in figure 2.

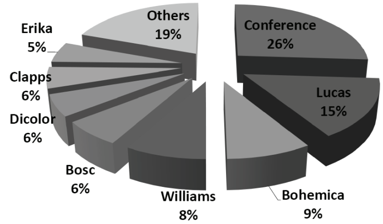

Figure 2. Pear varieties in Czech Republic (after Roman Chaloupka, 2013)

Historical context. In the Czech part of Silesia, pear trees belong to traditional cultivated fruit types, together with apple trees, plum trees and cherry trees. The group of pear trees is not present in the region in such numbers or in such varietal diversity like it is in case of apple trees. However, we can still find very interesting varieties in the local orchards, gardens and alleys.
It is caused by the approach of our ancestors to fruit farming. To provide supply of fruit throughout a year, farmers were growing a wide variety of fruit types and varieties - the first cherries ripened in June; then came the summer pears that ripened already around the feast of St. James and then the first varieties of apples ripened at the times of harvesting. The first plums also ripened at that time. And the harvest works in the orchards were busiest in autumn. In addition to processing the autumn varieties of apples, pears and plums, farmers had to harvest the winter varieties of apples and pears at the right time in order to keep them until spring months.
Growing pear trees has currently been associated almost exclusively with providing the fruits for table use. In some cases, surpluses are used to make compotes or prepare yeast which is then used for making pear drinks ("Hruškovice"). However, we have to realize that in the past the pear trees were grown much more for other methods of processing. They were used for food (soups, porridge, meat sauces, ingredient in fasting and festive meals); they were used for plum jams or dried. Powdered dried pears, called "*pracharanda*" in Silesia, were replacing sugar until the times of boom related to growing sugar beet.

There is no wonder that growing pears had a very important role in economies in the countryside and in towns of Silesia, as well as in other regions. The fact that the importance of pears used to be much greater in the past is obvious in some old gardens where number of pear trees exceeds number of apple trees. Reducing numbers of pear trees is partly connected with new sweeter apple varieties as well as worse usability of fruits which get mostly mellow in bulk amounts during short period of time and they are often not easy for current consumers due to information of adequate storage methods of winter varieties.
We could see the pear trees in any types of planting, in the past. This fruit type was traditionally planted in farmers' orchards where it often played significant role in type composition; it could not miss in the field orchards and gardens of smaller farms where at least one or two pear trees were present. More or less preserved field orchards can be found in many local villages; some orchards of this type are maintained and planted in traditional ways; others were grassed; we often find only the last remnants of the plantations once involved. Some of these orchards had to give the way to construction of family houses; the entire new streets emerged in the *peripheries*.
In many cases, pear trees were planted in the yards of peasant farms where they can be found even nowadays. In some municipalities, when allowed by the urban area layout, they were planted on the village green or other public place. Due to their powerful and majestic tree-tops, many age-old pear trees have become real dominants and they enriched the countryside of our villages with a significant landscape element. However, such examples are very rare now in this area.
We can still find several varieties of pear trees in the alleys around main and rural roads; they have been planted in thousands of kilometres since the 50s years. Unfortunately, due to old age, permanent lack of care or due to the care inappropriately performed, a major part of plantings are in very bad condition, endangered by gradual disappearance.
Diversity of Old Varieties. Although the pear trees are nowadays, and have been from a historical perspective, less numerous than the apple trees, this type is viewed as very important in the fruit orchards in Silesia from pomological perspective.
Unlike the apple trees in which the economically most significant old and regional varieties are among the winter varieties, we can find large part of pear varieties and most representatives of them among summer and autumn varieties. In addition to the already mentioned methods of use, this fact is closely linked with greater demands of pear trees in relation with heat. Within the regions of Opava, Hlučín or Osoblaha there are suitable conditions for fruit farming (classified in the second degree in the Czech Republic). However, the earlier varieties of pear trees usually surpass the later ones in terms of flesh quality and aroma. In the higher regions of Krnov, Bruntál and Těšín, some late varieties have problems with ripening. Relatively trouble-free fruit type in the past is now suffering from heavy pear rust attacks, which is associated with the current fashion trend of planting ornamental conifers some varieties of which are its hosts.
Regarding the old varieties, especially the varieties with high fertility, broad utility of fruits, good health, resistance to freezing temperatures and diseases have been preserved. Or also the varieties which remained in the product range of fruit nurseries or those spread among gardeners and small growers. Due to nostalgia, clinging to tradition and family assets, we managed to preserve many old and regional varieties which are deemed as rare in terms of occurrence and significance. We have to note that we have not yet managed to save a major part of the varieties related to the list.
The process of mapping conducted in recent years indicates that the skeletal old varieties of pear trees grown in our area include the old widespread varieties: summer varieties: *Clappova máslovka, Williamsova čáslavka, Špinka, Solanka*; autumn varieties *Charneuská*, *Hardyho máslovka, Boscova lahvice, Konference, Merodova, Salisburyho*; winter varieties: *Pařížanka, Pastornice, Madam Verté*. Furthermore, we have also found a few old pear tree varieties which are not frequent in terms of the existence in the wider region or republic. In this group, the following summer varieties are quite interesting: *Nagevicova, Kozačka štuttgartská, Muškatelka letní, etc.; then the*

autumn varieties: Amanliská, Avranšská, Kongresovka, Lucasova, Thirriotova, Ministr doktor Lucius, Hájenka, Pitmastonská, Děkanka Robertova, Marrilatova, Esperenova máslovka, etc.; and the winter varieties: *General Le Clerc, Fulvie* and *Mechelenská* which is more usual in the region of Hlučín - it is very rare in other regions.

Only a single piece of that variety has often been found. Also for this reason, the varieties deserve great attention and particularly the consistent and timely rescue.

Now we can have some presentation of the most interesting discoveries of recent years:

-*Nagevicova.* Interesting old summer variety; probably French or Italian variety has been grown since the 16th century. It was particularly grown in the region of Českomoravská Vrchovina (Czech-Moravian Highlands) under the names *Piksla, Piksálka, Blanketka*. In the region of Slezsko (Silesia) there were the names *Šídélko* and *Vínovka*, which is associated to very pleasant taste. The trees are lush and healthy. They are suitable for worse, colder and higher altitudes.

The fruit is small; it has a bulbous oblong shape; fruits grow in clusters. The crust is straw-yellow; the stem is long and curved. The flesh has butter colour, medium-firm consistency; it is juicy and very sweet, with muscat aroma. It shall be harvested from the beginning of August; the shelf life is very short. It is suitable for direct consumption but also for drying and preservation.

Figure 1. Nagevicova variety
(Silesia region, 2015)

-*Mechelenská.* Old winter variety originated in Belgium. We can also see the name 'Malinská Zimní'. The variety got here probably thanks to handy farmers and merchants who met it in Prussia where they have often travelled. The local farmers find it popular due to good quality. The tree grows in medium-lush tempo; it has a spherical and less structured habitus. The densely growing flagelliform thin twigs are very typical. It is not very demanding in terms of soil or conditions; it tolerates windy positions. Fruits have medium size and roundish bulbous shape. The cup is open, located in shallow and bowl-shaped hole; the stem is strong, woody, pressed into the small hole, often bent aside. The skin is smooth, green, then yellow, reddish on the sunny side, covered with rusty dots, sometimes rusty. It has a high-quality buttery and very soft, juicy and sweet flesh with muscat flavour. It is harvested in mid-October, ages around Christmas; it can last until March when stored in a good cellar.

Figure 2. Mechelenská variety
(Silesia region, 2015)

Regional and Local Varieties. Situation related to the regional and local varieties of pear trees is equally interesting. It is also similar in such the way that the varietal diversity significantly fades down. And only a fraction of regional and local varieties has been preserved, those grown by our ancestors. The situation was complicated by historical development; part of the territory called Sudetenland was expatriated. Compared to the denizens, the new residents and newcomers could not pass information about the names and use of these varieties. They were often cutting the trees down, since they often had no idea about suitability of their fruits. Another problem of regional and local varieties is also that they have not been described in the pomological literature. We can take the only information from a few local publications, particularly the oral history, which means the memory of the local people. However, the lists with brief descriptions are exceptional. Priest František Myslivec included them in his book called "*Starý způsob hospodářství na Opavsku*" (old ways of farming in Opava region). Large part of these varieties is included in the summer and autumn varieties; these are often the farming pears which were not directly consumed. Instead, they were used for drying, production of plum jams, cooking or making brandy. Now we can have some presentation of the most interesting discoveries of recent years:

- *Žňuvka.* Summer local variety. It is apparently named after the harvest period. 'Žňuvka' located in the yard of a farmhouse in Markvartovice is associated with a story. The harvesters were having a rest by it when they returned from the field, taking some fruits for their further journey. The majestic trees, which belong to the largest fruit trees in Silesia region, have broad pyramidal tree-tops reaching the height of 15 m. A medium to large fruit (9 cm) has egg, bergamot shape; it is pointed at the stem. The stem is long, moderately strong, curved. It remains green. The cup is ajar, with their free parts angled to each other; it is set in a flat and slightly rounded hole. The skin is greenish and yellow; it is straw yellow with numerous soft light brown lenticels when ripened. The flesh is yellowish, drier and almost loose; it is fine-grained, sweet and slightly spicy. It matures at harvest time - in the second half of July and early August; it decays at maturity times.

Figure 3. Žňuvka variety
(Silesia region, 2015)

- *Cebula.* Early local winter variety of interesting onion shape, named after that. It is resistant to diseases. The trees have widely pyramidal habitus; the leaves are larger and more elongated. The fruit is medium-sized, spherical, resembling an onion with its shape. The stem is long, thick, brown. The cup is open, embedded in a shallow hole. The skin is rough and green. It has often numerous dots and also rust around the cup and stem. The taste is characteristic, very pleasantly sweet. It ripens in October.

Figure 4. Cebula variety
(Silesia region, 2016)

- *Plaskarka.* The summer local variety which was named after the condition in which it was after falling down from a high tree-top on the ground. It has a high and spread tree top. The fruit is smaller to medium sized, bulbous to spherical. The stem is moderately thick, long and straight; the cup is ajar, continuous underneath; it has an erected crown. The skin is green before maturity, later partly yellow. On the surface there are fine and little noticeable green-brown dots and rust dispersed. Light yellow flesh has a coarser grain; it is sweet - without spiciness. It decays after mellowing. It matures in early August. Fruits were traditionally used for drying and production of plum jams.

- *Ovesninka*. This is the summer regional variety, also named as *Ovšinka*. Previously, the trees with this name were well-known in the regions of Hlučín, Opava and Poodří. The fruits of 'Ovesninka' found in obroslavice village can be used for the pomological description. It creates massive trees; the tree top is broad in the height; the branches are overhanging. The fruit is small to medium sized; it has a bulbous shape, the widest in the middle; it is slightly bulged at the place of cup. The stem is moderately thick, long and straight; it is usually set aside. The cup is open and continuous at the bottom. It is shaped as broad crown. The skin is green; it is brownish when ripened, covered with brown lenticels, especially at the place of cup and stem; having dots of rust. The flesh is yellowish, drier; the flavour is slightly aromatic and sweetish. These fruits ripen in the summer harvest season - hence the name (according to harvest of oats). It was also used for drying.

Figure 5. Ovesninka variety
(Silesia region, 2015)

- *Jakubinka.* Regional variety which once belonged to the most grown and popular varieties in the Opava region. It is one of the earliest varieties; even the name is derived from the maturation period, around the feast of St. James (July 25); it matures gradually within the period of 3 weeks. We do not know anything about its origin. It is very fertile and resistant to diseases. It is also suitable for compotes. Big and vital trees have broadly pyramidal tree-top with plenty of fruit bearers. There were two different types of fruits widely used in the past.
- *Type I.* The fruit is small, oval, and widest in the middle; it is slightly elongated towards the stem, having dull end. The stem is fairly long and thin; the cup is ajar; it is positioned on a slightly protruding peak. The skin has lemon-yellow colour; it turns to yellow-brown after ripening; barely noticeable tiny light brown lenticels are on the surface. The flesh is whitish, juicy and sweet with typical mild aroma. It gets floury very quickly after over-maturing.

Figure 6. Type I variety
(Silesia region, 2015)

- *Type II.* The fruits are small; they are pear-shaped or ovoid-shaped, slightly elongated towards the stem. The stem is long and thin; the cup is open, having long and pointed free parts (lobes) spread around the peak. The skin is straw yellow to brown-yellow. Flesh of buttery colour is juicy and sweet, having typical aroma. It nearly does not decay; taste is quite good.

Figure 7. Type II variety,
(Silesia region, 2015)

-*Margetinka.* Regional variety of Opava region, also called *Margetky, Svatojánské*. After 'Jakubinka', it is the second local earliest variety of which the last exhibit has been found. The tree is moderately vigorous; it lives long and is very vital. Habitus is spherical, similar to the variety 'Solanka'. The fruit is small, oblong; the green skin turns yellow after maturing. At the stage of decay, taste is sweet, quite good. It matures at the end of July; the ripened fruits decay.

Figure 8. Margetinka variety,
(Silesia region, 2015)

-*Cukrůvka.* The autumn regional variety of Opava region; very popular in the past. There are also synonymous names *Medůvka, Cukerinka*. Trees are medium in height; they are vital. They form pyramidal tops. Fruits are small to medium, more elongated and pear-shaped. The skin is green-yellow, more or less rusty. The fruits mature in September, the fruits turn yellow when fully ripened - and they decay. The flesh is soft, very sweet and juicy; it has delicious slightly spicy taste. The fruits have traditionally been used for drying; their infusions were used for feeding bees.

Figure 9. Cukrůvka variety
(Silesia region, 2015)

Unspecified Varieties. There are some pear trees whose names, however, have not been preserved. They are worth attention for their varietal diversity and also for very interesting fruits and also the appearance of the trees. We are mentioning some of them. In the past, they certainly had some nicknames. However, we did not find them out during the process of mapping.

-*Autumn Pear from Darkovice.* This is apparently a local variety of autumn. The tree grows up to the medium size; it has narrow pyramidal habitus. The fruit is small-to-medium sized; it is bulbous and ovoid, slightly asymmetric. The stem is moderately thick, having longer length; it is embedded in a small hole; the cup is open with long lobes (free parts), spread and terminated with a tip. The skin is light green to light yellow; it has numerous tiny brown lenticels; it is partially covered with rust, mostly near the cup. White-yellow flesh is crunchy, reeled, very tasty. It ripens in September.

Figure 10. Autumn Pear from Darkovice variety,
(Silesia region, 2015)

- *Autumn Brownish Fruit from Píšť.* Unspecified autumn, probably local, variety of an interesting tree called Hnilička (Brownish Fruit). The last tree grows up in Píšť village. The tree is huge; the top has high and broad structure; leaves are smaller; it contains thin annual shoots. Fruits are somewhat unbalanced, they are small to medium in size; they are pear-shaped, somewhat bulbous at the bottom, flatter by the cup. The stem is long and thinner; it is curved; the cup is smaller and ajar, located in the wider and flat hole. The skin is yellow-green, having numerous small brown spots; it is rusty by the cup. The flesh is fine-grained, very juicy; it decays when ripening; the taste is very good and reeling sweet. It ripens in September; it is not able to last long. Fruits suffer from scabbing; yet the crops are huge.

- *Summer Brownish Fruit from Strahovice.* Unspecified, late summer Hnilička (Brownish Fruit) which grows in Strahovice village. The big tree has habitus similar to poplar. The tree is huge and has a broad pyramidal top. The fruit is medium-sized; it has elongated pear-like shape. The stem is very long and thin; the cup is smaller and ajar; it has unfolded top with pointed lobes. The skin is yellow-green; it is yellow when maturing; the area around the cup is lightly covered with rust. Soft and medium juicy flesh has sweet taste. The fruit ripens at the turn of August and September; the fruits decay after ripening.

- *Autumn Krvavka from Lhota.* It is a very valuable and unique local autumn pear tree variety, having reddish flesh. It is the only Krvavka found with green skin. The tree is huge and has a broad spread habitus. The fruit has medium size and pear-like shape; the skin is rough and green; it is yellow-green when ripened - having a fine reddish blush. The flesh is soft and has butter colour; it is red-streaked from the central point. The taste is very good and sweet reeled. It decays after mellowing.

Figure 11. Autumn Krvavka from Lhota variety,
(Silesia region, 2015)

- *Summer Pear from Krasov.* Local late-summer variety; it belongs to so-called drier hnilička trees (brownish trees). The tree is huge; the top is high and wide. Very large and beautifully bright green leaves are typical. The fruit has medium size and pear-like elongated and bulbous shape; the skin is yellow, similar to lemon. The flesh has a yellowish colour; it is drier and has pleasant rum-like aroma.

- *Autumn Pear from Burkvíz.* Autumn local variety; interesting farming pear. Medium-sized fruits have oval shape. They are relatively low. The flesh is drier; it is surprisingly juicy after decaying. Trees are small to medium sized. The local variety; taste is typical for Hnilička (brownish fruit); it is sweet, having no special aroma.

CONCLUSIONS

The pears are important both for the wildlife supported by traditionally managed orchards and for the many varieties of fruit which exist, often with traditional local, culinary and seasonal uses.

Czech growers harvested 3,758 MT of pears in year of 2015, and commercial production reached 9,372 MT of pears.

In Czech Republic, the age structure of pear orchards is 26% for old orchards and 24% of new out planting.

The most frequently planted varieties of pear trees belonged to groups Conference (21.8% of the total pear orchard area) and William (7.1%).

In the Czech part of Silesia, pear trees belong to traditional cultivated fruit types.

The group of pear trees is not present in the region in such numbers or in such varietal diversity like it is in case of apple trees.

Growing pear trees has currently been associated almost exclusively with providing the fruits for table use.

The process of mapping conducted in recent years indicates that the skeletal old varieties of pear trees grown in our area include the old widespread varieties: summer varieties: *Clappova máslovka, Williamsova čáslavka, Špinka, Solanka*; autumn varieties *Charneuská*, *Hardyho máslovka, Boscova lahvice, Konference, Merodova, Salisburyho*; winter varieties: *Pařížanka, Pastornice, Madam Verté*. Also for this reason, the varieties deserve great attention and particularly the consistent and timely rescue.

In conclusion, traditional orchards are valuable habitats for wildlife and their loss has an important negative impact on nature conservation. These orchards are a vital and characteristic feature of our rural landscape and heritage.

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CONTRIBUTIONS TO THE ESTABLISHMENT OF THE FERTILIZATION SYSTEM WITH MINERAL NITROGEN FOR AUTUMN CROPS RAPE AND WHEAT - IN THE SPECIFIC ENVIRONMENT OF BULBUCATA GIURGIU

Luxița RÎȘNOVEANU[1], Liviu DINCĂ[2], Emil Igor Vlad GEORGESCU[3], Mariana Carmen BURTEA[4]

[1] Dunarea de Jos" University of Galati, Engineering and Agronomy Faculty of Braila-Agronomy Center for Research and Consultancy and Environment „Lunca", Agricultural Research Development Station Braila, Romania
[2]Agronomy Center for Research and Consultancy and Environment „Lunca"
[3]NARDI Fundulea, Plant Protection Laboratory
[4]Dunarea de Jos" University of Galati, Engineering and Agronomy Faculty of Braila-Agronomy Center for Research and Consultancy and Environment „Lunca"

Corresponding author email: dinca_liviu84@yahoo.com

Abstract

The experiment was initiated in the crop year of 2013 – 2014 and analysed the influence of the commercial product on winter wheat and autumn rape on the final crops. It was used the Glosa C1 wheat variety and Extec rape hybrid; the used mineral fertilizers were as follows: D.A.P., 15:15:15, EUROFERTIL TOP 38, UreeEgipt (Egypt Urea), Nitrocalcar (ammonium nitrate), Sulfammo 30 N-PROCESS. During the fall, it was provided a general background of P_{60} *and part of the nitrogen and in the spring, the nitrogen was applied in a fractionated manner. Following the climatic conditions in the crop year of 2013 - 2014, it was noticed that the rainfall favourably influenced both the crop productions of rape and winter wheat and the phytopathogenic agents and pests' multiplication that had a more aggressive manifestation than in the years with normal conditions. The highest rape crops were obtained by applying a dose of* $N_{150}P_{60}K_{60}$*with a production of 44.20q/ha,and the application of* $N_{150}P_{60}$ *dose to the winter wheat resulted in the production of 79.0 q/ha.*

Key words: *climatic conditions, fertilizers, rape, winter wheat.*

INTRODUCTION

Setting up the fertilization system in modern technology farming for field plants has been a major concern for scientists and practitioners. Some of these very important field plants are rape and wheat. The differentiation of fertilizer dose issues from Liebig`s theories (mineral nutrition and the law of the minimal)and becomes more conclusive after the works of: Barlog et al., 2004; Bell, 1970; Bilsborrow et al., 1993; Borlan et Hera, 1973, 1984, 1996; Davidescu et Hera, 1964; Hera et al., 1994.
A modern approach of the soil`s fertility state in the system will contribute to the rise of its productive ability, to obtaining safe and stable production of high quality performance and of great economic efficiency (Hera, 1980; Walker et Booth, 2001).
Optimizing the supplying state with fertilizing elements intends to satisfy the autumn rape`s requirements to a higher degree against the presence of nutrient substances of certain concentration and proportion which amplifies the growth and development of this plant and this proves that applying nitrogen to rape fields has brought a harvest increase as compared to those which are not chemically fertilized (Hera, 1964; Grant et Bailey, 1990; Plank, 2000; Risnoveanu, 2011; Dincă et al., 2012). Aimed at highlighting the difference in autumn crops, rape and wheat production influenced by fertilizer, the necessary fertilization and capitalization of the current kind of fertilizers by plants.
The main goals were: determining the dose and range of commercial products, the influence it has over efficiency and elements of efficiency (productivity elements) in pedo-climatic areas of Bulbucata, west of Romanian Plain, on chromic luvisoil and, in perspective establishing commercial product influence on

the production of rapeseed, of knowledge and correlation between applying mineral nitrogen fertilizers, NPK imbalance in the soil, soil acidity and organic matter.

MATERIALS AND METHODS

The research was conducted by experiments performed under field conditions, the land belonging to the company "AgroMads Crop SRL", the Bulbucat avillage, Giurgiu County.
Placing experiences in the field was done by randomized block method and experimental data processing was done by analysis of variance. When fitting experience in the field, samples of soil were collected and agrochemical analyzes were done using methods practiced in specialized laboratories for analysis series. The type of soil that was experimented on is typical of Bulbucata, Giurgiu area, chromic luvosoil and the pedo-climatic conditions of the area are favorable for autumn crops studied, wheat (Glosa C1) and rape (Extec).
Production unit requirement were considered in establishing experimental variants, the current fertilizer assortment was used and applied in autumn and in the beginning of spring.
Variety of fertilizer used:
In autumn complex fertilizers were used, respectively DAP(18:46:0) or 15:15:15 and Eurofertil Plus PHOS 38 which contains 8%N, 30%P_2O_5, 8%SO_3, 15%CaO, 2%MgO, 0.15%Br, 0.15%Zn.
During the growing period were used: uree, NAC nitrocalcar, Sulfamo30 (NPK 30:0:0) which contains 30% N, 15%SO_3, 7%CaO, 3% MgO.
Fall fertilizer application was made on the background of P 60 kg/ha and the remaining doses were administered to prepare the ground for seeding by incorporating with schemer.
The doses of commercial product given in fall were differentiated at experimental variants, namely 130 kg/ha for 18:46:0; 400 kg/ha and 200 kg 15:15:15 /ha for EurofertilPlus 38 PHOS.
Fertilization for vegetation was done with differentiated doses at experimental variants, namely urea 100 kg/ha and 160 kg/ha, NAC 100 kg/ha and 185 kg/ ha and Sulfamo 30 doses of 122 kg/ha, 150 kg/ha and 280 kg/ha.
The number of variants was 10 with the same differentiation .in both crops as much for the doses as for the range of commercial products used.

RESULTS AND DISCUSSIONS

Preliminary results of production in the crop year 2013-2014.
Results on the development of vegetation in the given climatic conditions, treatments and interventions in crop technology.
Climatic conditions, namely the average monthly temperature of ^{o}C and monthly rainfall recorded since 2013 to 2014 and the annual average of the area are presented in Figure 1 and Figure 2.
The agricultural year of 2013-2014 can be considered favorable for winter crops wheat and rape. Annual average rainfall exceeding 90 mm over the entire crop year and higher temperatures satisfied the requirements of a good vegetation development.
In autumn, during the third decade of October, the vegetation went so well that rape plants had around 2-3 leaves per plant and by mid November they had 5-7 leaves per plant and they were prepared for winter. Wheat plants have also vegetated normally providing a number of normal wheat ears.

Table 1. Comments upon the phases of vegetation up to entry in the winter at the rape of autumn (Extec)

Dose kg/ha	Fertilizer	Kg/ ha N a.s.	Kg/ ha P_2O_5	Kg/ ha K_2O	Date					
					26 -X- 2013		2 –XI- 2013		16-XI- 2013	
					Plants/ m^2	Leaves/ Plant	Plants/ m^2	Leaves/ Plant	Plants/ m^2	Leaves/ plant
0	-	-	-	-	33	2.82	33	4.31	29	5.76
130	D.A.P. (18:46:0)	23.4	60	0	26	3.60	26	5.08	26	7.37
200	Eurofertil Plus PHOS 38	16	60	0	27	2.15	33	3.31	33	4.58
400	15:15:15	60	60	60	27	3.19	27	4.28	26	6.65

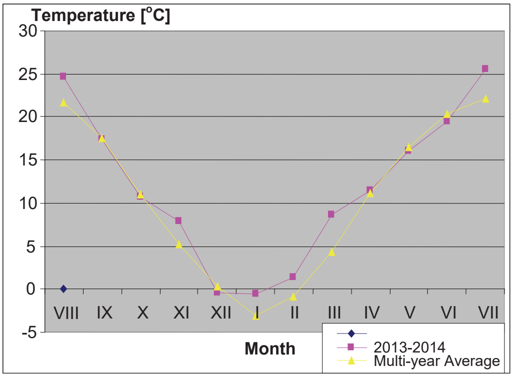

Figure1. Climatic conditions - temperature 2013-2014

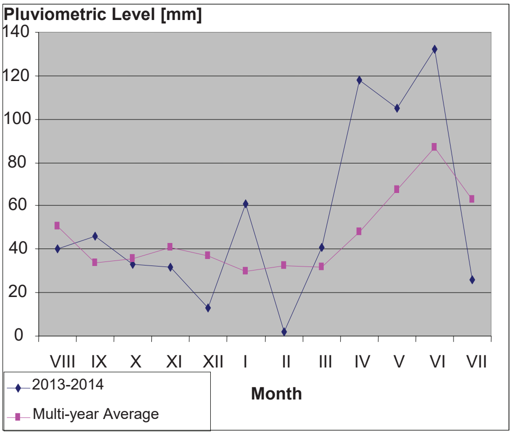

Figure 2. Climatic conditions- rainfall 2013-2014

An earlier beginning of spring allowed an early resumption of the vegetation, the application of fertilizers, with differentiated assortment and doses according to the graduation of experimental variants. This happened on 13 February 2014 and for wheat on February 27, 2014.

From the point of view of the attack by pests at the two crops, wheat and rape in the autumn array may be presented as follows:

Wheat has been found for the presence of the pest *Zabrus tenebrioides*, but the attack was filed under the PET (pest economic threshold) both in the autumn of 2013 and in the spring of 2014. but

Because of unfavorable climatic conditions from May 2014, average level of sun pest (*Eurygaster* spp.) adults from wheat crops were low, between 0.25 and 1.0 insect/sqm.

At rape crop (colza) it has recorded rodents attack. Higher attack intensity was observed, especially in first two decades of November (first 20 days of November). Rodents activity start again in second decade of January, as result of the high temperatures registered in that period.

As result of unfavorable climatic conditions from autumn of the year, flea attack (*Phyllotreta* spp. and *Psylliodes chrysocephala)* has low values.

It has ascertained moderate attack of the *Athalia rosae* larvae when colza plants are at 3-4 leaf stage (BBCH 13-14).

Results regarding the efficiency of autumn crops rapeseed the Exrec hybrid, and wheat, Glosa variety under the influence of nitrogen fertilizers from 2013 to 2014 year in Bulbucata-Giurgiu.

Preliminary production results from the experimental field located on a red preluvosoil from Bulbucata-Giurgiu, for rape and winter wheat crops in the year 2013-2014 are summarized in Tables 4, 5 and 6. An overview of these results show a fairly high level of production from both studied crops and significant differences between the versions.

Generally, favorable climatic conditions allowed a better use if this area`s potential, of the soil and hybrid used, of technology and nutrient elements from fertilization adapted to the plants` needs.

It also highlights the importance of nitrogen applied in substance P (s.a. P_2O_5 60 kg/ha), pointing out the great influence of nitrogen dose and the assortment over production - commercial product adapted to the specific climatic Bulbucata-Giurgiu area.

Therefore, at autumn crops from 2013-2014 productions of over 70 q/ha for wheat and over 40 q/ha for rape were carried out which was increased as compared to the unfertilized one with over 50% more for wheat and over 100% for rape and a production increase for both crops, 7-14 kg/ha for wheat or rape/kg. NPK fertilizer applied.

These preliminary results point to the importance of fertilization for winter crops wheat and rapeseed and the need to continue the research which started in 2013/2014.

Results on the influence of nitrogen fertilization on rapeseed crops Extec hybrid, in 2013-2014.
From this table it can be seen that in all the 9 variants with doses and assortment of fertilizers –commercial products – significant increases were recorded for the unfertilized one as well as between variants with different doses of nitrogen or different kinds of fertilizer used.
Production increases between 9.50 and 29.10 q/ha respectively 62 to 192% were recorded as Compared to unfertilized variant and a rise 7.92 to 14.56 kg per kg rape brought s.a. NPK fertilizer used.
The contribution of nitrogen on rapeseed crop is remarkable, the productions was significantly increased as the dose increased from 60 kg/ha N et al Up to 100 kg/ha et al the fund to P60 and N150 kg/ha et al P60K60 the fund.
On P60 fund and dose increasing from N to 100 led to average significant increases of 11.9 q/ha, and increasing the dose to N150 kg/ha has not led to increased production, it actually decreased it with 4.50 q/ha very significantly from N100.
Very significant increases were obtained on P60K60 fund when dose of N N100-N150 was increased. The recorded production increase is 9.80 q/ha compared to N60 to N100 and reaches 14.30 q/ha for N150 dose compared to N100, meaning rapeseed production increase with N150 compared to N100 is significant, being 4.50 q/ha.
On average the differences in production is similar to that of fertilization with different doses of N on a P60 fund.
Potassium has a significant effect on P60K60 fund with the biggest productions for all levels of N. Potassium contribution to increasing rapeseed production is very significant, it is in average 6.19 q/ha compared to fertilization on P60 fund. Compared to P60 without K, P60K60fertilization obtains increases of 3.90-5.30 q/ha with N60P60K60 doses, 1.30-3.70 q/ha with N100P60K60 and reaches 8.80-14.20 q/ha with N150P60K60 doses, showing best rapeseed production in 2013/2014.
The variety of fertilizer used (commercial product) significantly influenced the rapeseed production, regardless of the N dose applied at sowing in autumn or in spring on vegetation, as outlined in Table 4.
In autumn, before planting, PK fund was secured using 3 types of fertilizers. Complex fertilizers like DAP; N18, P46, K0 and N15, P15, K15 as well as Eurofertil Plus 38 PHOS fertilizer were used before sowing.
Table 4 shows the biggest productions for all N doses used at fertilization in autumn with NPK complex fertilizers with a ratio of 15:15:15 (400 kg/ha of commercial product) which provided the P60K60 fund (the remaining N was completed in spring).
The production has diminished significantly when fertilizers that do not contain EurofertilPlus PHOS 38 or when complex NP complex fertilizers with N16:P48:K0 were used as compared to using 15:15:15 fertilizers. The losses recorded were 4.76 q/ha DAP 18:46:0 and 7.73 q/ha Eurofertil Plus 38 PHOS as compared to NPK 15:15:15 complex fertilization in autumn.
To reach the doses of each experimental variants, during spring vegetation, at the beginning of spring, the variant of nitrogen fertilizer consisted of three commercial products Urea, Sulfamo 30 and NAC, all of which proved very effective in 2014.
Therefore, the urea applied to the vegetation to complete the nitrogen dose to N100 kg/ha, with the use of complex fertilizers during autumn, led to high yields of 39.70 q/ha with NPK 15:15:15 and 38.40 q/ha NPK 18:46:0.
With these yields with no significant difference between them the increase in production reached more than 23-24 q/ha (23.30-24.60 q/ha) or 154-162% compared to the unfertilized one.
It is noted that compared to N60P60K60 variant, when applying urea in vegetation, there has been a very significant growth 9.60 q/ha and on complexes without K (NPK 18:46:0), using urea in total doses of N100 also brought a significant increase of 12.4 q/ha compared to N60P60 dose version with the use in vegetation of the commercial product Sulfamo 30.
The Sulfammo commercial product applied in vegetation for the fertilized variant with N60P60 led to equal productions for autumn fertilization with Eurofertil Plus PHOS 38 (24.60 q/ha) or complex type DAP 18:46:0 (26.0 q/ha). But Sulfammo 30 applied in autumn to fund of Eurofertil in order to raise the dose of N to N100P60 led to production of

36.0 q/ha, with a very significant increase of 11.4 q/ha compared to N 60P60 and 20.9 q/ha, respectively 138 % compared to unfertilized.

Urea and NAC applied together on NPK fund from NPK 15:15:15 complex was best harnessed allowed capitalization of high N doses up to N150P60K60.

The Maximum production for Rapeseed, of 44.20 q/ha, in fact, occurs at fertilization with N150P60K60 kg/ha variant dose, using NPK 15:15:15 complex fertilizer, 400 kg/ha, commercial product (kg N60P60K60 /ha) and at the beginning of spring with nitrogen fertilizers to complete the N dose to N150 kg N /ha using commercial products urea 135 kg/ha and 100kg NAC /ha commercial product.

One could say that the dose of N150 could be exploited by plants only in the presence of potassium K60 with phosphorus P60 from complexes with NPK 15:15:15.

With this method of fertilization a normal state of vegetation was ensured which allowed such production in Bulbucata area, Giurgiu.

Results related to wheat production are summarized in Table 2.

From this table one can see that all the 9 variants with doses and types of fertilizers – commercial products- have recorded significant increases in production compared to the unfertilized variant but also between variants with different doses of N or different kinds of fertilizers used.

The contribution of nitrogen on wheat crops is considerably good, production significantly increasing with increasing dose from 60 kg/ha N a.s. to N100 kg/ha-150 kg/ha a.s. on P60K60 fund.

On a P60 fund increasing the dose from 60 kg N/ha a.s. to 100 kg/ha s.a. brought very significant production increases of 4.00-7.00 q/ha and on P60K60 fund increases of 6.00 q/ha.

Increasing the dose of N to 150 N a.s. in regard to N100 led to very significant increases of 4-9 q/ha, only for the autumn fertilization with complexes.

As for potassium with wheat compared to rape did not bring any increase in production regardless of the level of fertilization with N.

Table 2 The influence of the fertilizing purposes with nitrogen on the production of rape EXTEC hybrid in the year 2013-2014 on chromic luvisoil from Bulbucata-Giurgiu

Variant	Dose kg/ha			Yield q/ha	Difference			Increase Yield/kg a.s.
	NPK s.a	Commercial product			q/ha	%	Semnification	
		Autumn kg/ha	Spring kg/ha					
V1	N0P0K0	Unferilized		15.10	Blank			-
V2	N60P60	130kg DAP	122kg Sulfa-mo30	26.00	10.90	72	xxx	9.08
V3	N100P60	130 kg 18:46:0	160 kg Uree	38.40	23.30	154	xxx	14.56
V4	N150P60	130 kg 18:46:0	160kg Uree and 185kg NAC	35.40	20.30	134	xxx	9.67
Average				33.27	18.17	120		11.10
V5	N60P60K60	400kg 15:15:15	-	29.90	14.80	92	xxx	8.22
V6	N100P60K60	400kg 15:15:15	100kg Uree	39.70	24.60	162	xxx	11.18
V7	N150P60K60	400kg 15:15:15	100kg NAC and 135 kg Uree	44.20	29.10	192	xxx	10.78
Average				37.93	22.83	151		10.06
V8	N60P60	200kg Eurofertil Plus PHOS 38	150kg Sulfamo 30	24.60	9.50	62	xxx	7.92
V9	N100P60	200kg Eurofertil Plus PHOS 38	280kg Sulfamo 30	36.00	20.90	138	xxx	13.06
V10	N150P60	200kg Eurofertil Plus PHOS 38	100kg Uree and 280kg Sulfamo 30	30.00	14.90	98	xxx	7.09
Average				30.20	15.10	100		9.36

LSD 5% = 2.02 q/ha LSD 1% = 2.74 q/ha LSD 0.1% = 3.66 q/ha

Table 3. The influence of the fertilising purposes with nitrogen on the production of durum wheat , Glosa variety in the year 2013-2014 on chromic luvisoil from Bulbucata-Giurgiu

Variant	Dose kg/ha			Yield q/ha	Difference			Kg/kg s.a Increase production	Yield	
	NPK s.a	Commercial product			q/ha	%	Sem.		Nr. heads/ m^2	MH Kg/hl
		Autumn kg/ha	Spring kg/ha							
V1	N0P0K0	Unfertilized		47.80	Blank			-	450 Mt.	79.6
V2	N60P60	130kg DAP 18:46:0	122kg Sulfa-mo30	66.0	18.20	38	xxx	15.16	770	78.4
V3	N100P60	130 kg 18:46:0	160 kg Uree	70.0	22.20	46	xxx	13.87	774	80.8
V4	N150P60	130 kg 18:46:0	160 kg Uree and 185kg NAC	79.0	31.20	65	xxx	14.86	786	80.0
Average				71.67	23.87	50		14.63	776	79.7
V5	N60P60K60	400kg 15:15:15	-	62.00	14.2	30	xxx	7.89	724	78.8
V6	N100P60K6(	400kg 15:15:15	100kg Uree	68.0	20.2	42	xxx	9.18	668	79.2
V7	N150P60K6(	400kg 15:15:15	100kg NAC and 135 kg Uree	72.0	24.2	51	xxx	8.96	650	79.2
Average				67.33	19.53	41		8.68	680	79.1
V8	N60P60	200kg Eurofertil Plus PHOS 38	150kg Sulfamo 30	63.80	16.00	33	xxx	13.33	554	77.2
V9	N100P60	200kg Eurofertil Plus PHOS 38	280kg Sulfamo 30	71.00	23.20	48	xxx	14.5	660	80.8
V10	N150P60	200kg Eurofertil Plus PHOS 38	100kg Uree and 280kg Sulfamo 30	60.50	21.70	45	xxx	10.33	620	77.6
Average				68.10	20.30	42		12.72	611	78.5

LSD 5% = 1.65 q/ha LSD 1% = 2.09 q/ha LSD 0.1% = 2.67 q/ha

Of fertilizer – commercial product used for wheat and rapseed has significantly influenced the production, regardless of the dose of N applied before sowing or in spring on vegetation in the beginning of spring.

Urea and NAC in vegetation at the version with fund from complexes, the version with N150P60K60 or N150P60K0 doses (without K) were the best productions with the best increases over the unfertilized.

For the versions with N150P60K60 doses (fund 400 kg/ha complex 15:15:15) out of which in vegetation 135 kg/ha urea and 100 kg/ha NAC, the production of 72.0 q/ha ensure over the unfertilized an increase of 24.20 q/ha, meaning 51% and wheat 8.96 kg/kg of fertilizer each.

But the largest production of 79 q/ha was achieved on the version with N150P60 dose, with fund provided from autumn fertilization with 130 kg/ha complexes NPK 18:46:0 and in spring in vegetation completed the dose of nitrogen with 60 kg/ha urea together with 186 kg NAC. At this version compared to the unfertilized one there is an increase of 31.20 q/ha meaning 65% and 14.86 kg wheat per kg s.a. NP fertilizer used.

Fertilization in vegetation for wheat and rapeseed, the combination of urea and ammonium nitrate proves most suitable for the pedo climatic weather conditions in Bulbucata, Giurgiu.

CONCLUSIONS

Rape uses the nitrogen in large doses (N100 and N150), with K60 and P60.

At rape, Sulfammo 30 applied in autumn to fund of Eurofertil in order to raise the dose of N to N100P60 led to production of 36.0 q/ha, with a very significant increase of 11.4 q/ha compared to N60P60 and 20.9 q/ha, respectively 138 % compared to unfertilized.

Urea and NAC applied together on NPK fund from NPK 15:15:15 complex was best harnessed allowed capitalization of high N doses up to N150P60K60.

The mximum production for Rape, of 44.20 q/ha, in fact, occurs at fertilization with N150P60K60 kg/ha variant dose, using NPK15:15:15 complex fertilizer, 400 kg/ha, commercial product (kg N60P60K60 /ha) and at the beginning of spring with nitrogen fertilizers to complete the N dose to N150 kg N /ha using commercial products urea 135 kg/ha and 100kg NAC /ha commercial product.

One could say that the dose of N150 could be exploited by plants only in the presence of potassium K60 with phosphorus P60 from complexes with NPK 15:15:15.

With this method of fertilization a normal state of vegetation was ensured which allowed such production in Bulbucata area, Giurgiu.

As for potassium with wheat compared to rape did not bring any increase in production regardless of the level of fertilization with N.

The type of fertilizer – commercial product used for wheat and rapeseed has significantly influenced the production, regardless of the dose of N applied before sowing or in spring on vegetation in the beginning of spring.

Fertilization in vegetation for wheat and rapeseed, the combination of urea and ammonium nitrate proves most suitable for the pedo climatic weather conditions in Bulbucata, Giurgiu.

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EFFECTS OF DIFFERENT PHOSPHORUS LEVELS ON UREIDES CONTENTS AND NODULATION OF SOYBEAN (*Glycine max L.*) IN RELATION TO SOIL MOISTURE REGIME

Vladimir ROTARU

Institute of Genetics, Physiology and Plant Protection, Moldavian Academy of Sciences
20 Padurii str., MD 2002, Chisinau, Republic of Moldova

Corresponding author email: rotaruvlad@yahoo.com

Abstract

Soybean is a legume crop and it may fix efficiently atmospheric nitrogen (N) if an adequate amount of phosphorus (P) is present in the soil. The main product of nitrogen fixation in soybean root nodules is ureides. A greenhouse experiment was conducted on a low soil P silly clay soil- sand mixture to evaluate the effect of P application and water regimes in a factorial combination on ureides contents and nodulation of soybean (Glycine max L. cv Zodiac). Soybean plants were grown in a soil very low in available P. Seeds were inoculated with bacteria Bradyrhizobium japonicum at sowing. The P application significantly increased ureides concentration and dry weights of nodules irrespective of water soil regime. In general, low amounts of ureides in nodules were found in watered plants, but those levels were significantly increased in stressed plants. Maximum dry weight of nodules and plants was obtained at 100 mg P kg^{-1} soil under normal water regime of soil (70% WHC). The same trend of P influence was denoted in plants subjected to drought stress (35% WHC) but its effect was reduced by insufficiency water supply. Hence, the adequate P supply raised DM accumulation and chlorophyll contents but decreased level of ureides in roots of soybean plants. This research indicates that the ureides concentrations in plant tissues are more sensitive to P deficiency and drought than chlorophyll contents in leaves. The obtained results demonstrated that the adequate P nutrition of soybean significantly increases nodulation and ureides production in comparison to unfertilized treatment.

Key words: *drought, nodulation, phosphorus, soybean, ureides.*

INTRODUCTION

Legumes are an important component of the agroeosystems in many countries due to their capacity to produce significant quantities of protein-rich seed and to improve soil quality by inclusion of organic matter and biological nitrogen fixation (Vance et al., 2003, Vance, 2001). They are grown in a range of environments and nutrient deficiency and water supply are considered the major ecological factors limiting growth and yield. Worldwide, at least 45% of the total agricultural land area, some 5,8 billion hectares suffers from phosphorus deficiency (Batjes, 1997). Therefore, P deficiency is a common problem in many soils and it is considered a major constraint for the production of legumes also in the Republic of Moldova (Andrieş, 2007). Phosphate fertilizer application remains the most effective way to increase crop productivity in soils with low levels of plant-available phosphates. Soil moisture plays a critical role in both nodule formation and N2 fixation. Low soil moisture during the early stages of the plant growth decreases nodule formation (Gan et al., 2008), and low moisture during late vegetative to early flowering period decrease efficiency of N2 fixation. In general, drought stress strongly inhibits plant growth and development, but the application of suitable fertilizers can alleviate these effects (Zhu et al., 2009).

Although P deficiency and drought are extremely important in cropping systems, however, in majority of cases they have been studied separately. It is well documented that the ureides allantoin and allantoate are major forms of nitrogen transported from root nodules to shoots in tropical legume. Assimilation of atmosphere nitrogen has a higher demand of P nutrition because nitrogen fixation required considerable sources of energy.

Ureides synthesized in the nodules are transported to the shoots where they should be degraded and their N content re-assimilated.

The activity of symbiotic system *Glycine max-Bradyrhizobium japonicum* is estimated by ureides production and partitioning within soybean parts. The objective of this study was to evaluate the effects of different levels of fertilizer P on ureides partitioning between leaves, roots and nodules as well as on nodule growth in relation to water soil regime in soybean.

MATERIALS AND METHODS

A pot experiment was conducted in a glasshouse at the Organic Plant Production and Agroecosystems Research in the Tropics and Subtropics Department, University of Kassel, Germany. Treatments included the factorial combination of four P fertilization levels, two soil water regimes (control and water stress) and a soybean (*Glycine max.* L. Merr) cultivar namely Zodiac. There were four P application rates namely as 0, 10, 20 and 100 mg P kg^{-1} soil which were termed as P deficiency (P0), low phosphorus (P10), moderate low P (P20), and higher P (P100). All pots with P application received potassium (K) as KCL to equivalent potassium level. Each pot was filled with 6 kg soil of P deficient soil that was sieved before. The content of available phosphorus was 4,4 mg kg^{-1} (CAL) and 11,5 mg kg^{-1} by Olsen method (Olsen and Sommers, 1982), pH ($CaCl_2$) 7,74, total N - 0,04% and C - 1,42. At 5 days after emergence plants were thinned to three ones per pot.

The water treatments were 70% water holding capacity (WHC) as normal level and 35% WHC as insufficient moisture. The all plants were grown during 4 weeks at normal water regime (70% WHC). Drought was imposed 4 weeks after sowing by withholding water from pots until 35% of soil water holding capacity. Suboptimal moisture of soil was imposed for 2 weeks. Normal and low water supplies were maintained by weighing the pots every day and on the basis of weight loss, re-watering them to corresponding weights. Mean night temperature ranged from 18-20 C and mean day temperature varied 26-28 C. Relative humidity varied between 60-65%. The pots were placed on tables and rotated every 2 days for random distribution in a greenhouse. Chlorophyll content readings were taken with a handheld dual wavelength meter (SPAD 502, Chlorophyll meter, Minolta Camera Co., Ltd., Japan). The instrument stored and automatically averaged these readings to generate one reading per plot (Richardson et al., 2001).

Ureides in plant tissues were determined by basic hydrolysis of allantoin to allantoic acid, acid hydrolysis of allantoic acid to glyxoylate and urea, and spectrophotometrically determination of glyoxylate after its reaction with phenylhydrazine and ferric cyanide (Vogels and Van der Drift, 1970).

Data in figures represent the average value of the results of chemical analysis of plants in three replications. The experimental results were analyzed statistically, determining significant differences at the level of P = 0,05. In figures are presented means of 3 replicates ± standard deviations. The STATISTICA (version 7) package was used for statistical analysis.

RESULTS AND DISCUSSIONS

The ureides have been identified as the export products of N_2 fixation of many tropical legumes in particular soybean (McClure and Israel, 1979). Although the effects of P nutrition on early growth, nodule activity of soybean plants are known (Sa and Israel, 1995), information is not available in the literature on the pattern of ureides-N allocation within the soybean plant in relation to soil moisture regime. In this experiment ureides concentration and partitioning within plants of soybean were altered by both abiotic factors water regime and P supply. Ureides content in leaves and nodules are shown in figures 1 and 2. It was observed a low concentration of ureides in leaves and nodules of soybean under low P supply (treatment without fertilization). These trends were revealed in both water regimes. Adequate P nutrition (100 mg P kg^{-1} soil) stimulated the production of ureides in nodules which was associated with decreasing of these compounds in roots. These metabolites of nitrogen fixation in leaves changed not so much under normal water regime. However, the supplemental P nutrition increased ureides level in leaves. Probably, improvement of mineral nutrition stimulated canopy development and in consequence increased demand for nitrogen compounds to maintain good growth. Similar trends were observed in plants of *Phaseolus vulgaris* (Vadez et al., 1999).

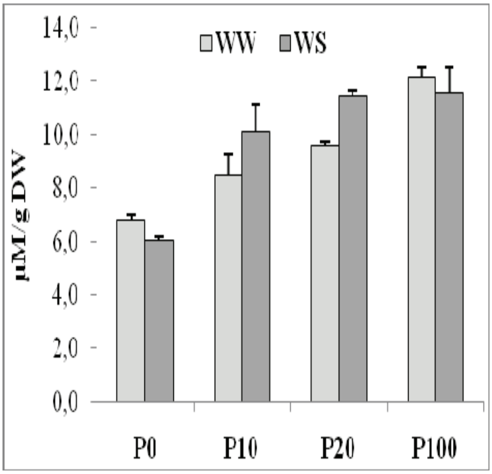

Figure 1. Effect of phosphorus application on the ureides concentrations (µM/g DW) in leaves of soybean in relation to soil water regime

Our study also showed that the negative effect of moisture stress on nodule efficiency was reduced when the plants were supplied with P fertilizer. Decreased ureides N concentrations in leaves tissues demonstrate, as has been reported previously (Israel, 1987), that P low supply imposed some degree of N deficiency on symbiotically soybean plants. Soybean plants are sensitive to soil moisture regime. The experimental data have shown that water deficit induced accumulation of these N metabolites in tissues irrespective of P supply. In particular, under water stress conditions there was a higher accumulation of ureides in nodules in comparison to well-watered plants (Figure 2).
Increased concentrations of ureides were observed in the leaves and nodules when increasing the level of P in the soil (Figure 1 and 2). The opposite effect of phosphorus supply was observed in the roots. The increase of P dose decreased the ureides concentrations in soybean roots. Probably, the improvement of phosphorus nutrition facilitated the transport of metabolites in the shoots. In general, dry weights of roots were higher under P supplemental nutrition than in control treatment (data are not shown).
The proportion of coarse roots increased under fertilization of phosphorus; therefore this in turn could increase the translocation of ureides

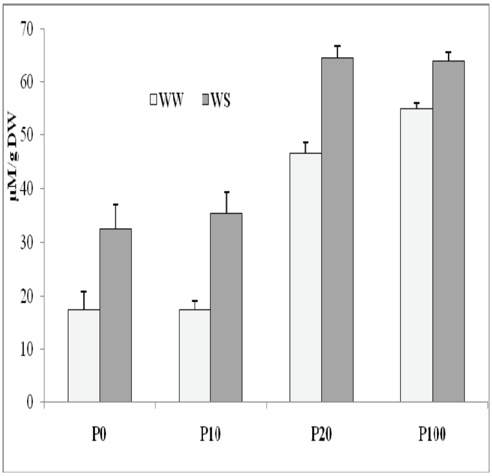

Figure 2. Effect of phosphorus application on the ureides concentrations (µM/g DW) in nodules of soybean in relation to soil water regime

The lowest P level was clearly limiting the capacity of N2 fixation by nodules. Likewise, it is necessary to note that the low soil moisture had a negative effect on the translocation of N compounds from nodules to aboveground parts in the forms of ureides. Reduction in symbiosis efficiency due to low water regime and P deficiency has also been reported by other researchers (Gan et al., 2008). Sa and Israel (1995) observed a decreased flux of ureides and other N constituents in the xylem sap of P-deficient soybean plants grown hydroponically. It is known that grain legumes transporting fixed N as amides, such as chickpea, faba bean and lupine are less sensitive to water stress than those transporting ureides, such as soybean. Hence, low soil moisture restricted ureides translocation out of the nodules. The experimental data are consistent with the observations reported in *Medicago sativa* cultivated under P insufficiency (Suleiman et al., 2013). However, the P application increased this physiological trait under normal water regime. Such findings were observed in common bean (Vadez et al., 1999) and in lupine (Shulze et al., 2006).

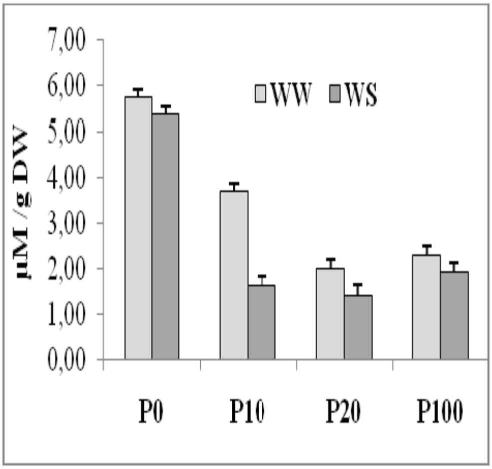

Figure 3. Effect of phosphorus application on the ureides concentrations (µM/g DW) in roots of soybean in relation to soil water regime

The fertilization with P in moderate and high rates decreased significantly ureides concentrations in roots (Figure 3).

The development of N-fixing nodules on legumes roots upon invasion of *Bradyrhizobium* bacteria is subjected to regulation by environmental factors. In particular, the extent of nodulation is restricted by water deficit and low P supply.

There is a realtionship between ureides production and nodule growth. Changes in ureides concentration paralleled the change in nodule mass produced by increasing P levels in the medium (Figure 4).

It is well documented that P supplementation had significant impact on nodulation of legumes. However, little is known about the effect of P on nodules developmnet in relation to soil moisture conditions.

Our results for nodule dry weight are presented in figure 4. The P supplementation had great influence on nodule dry weight. There was a significant interaction ($P < 0.05$) among abiotic factors and location in nodule dry weight. Highest mean nodule dry weight was recorded in treatments with higher levels of P fertilization compared to non treated control in both water soil regimes.

Also, there was found a large difference in nodule dry weight between watered and stressed plants irrespective of P nutrition level, but P supplementation attenuated the negative influence of drought (Figure 4). Therefore, the results of this study were shown that with application of phosphorus up to 100 mg kg^{-1} soil dry weight of nodules per plant was increased. So it was stated that the P application had beneficial impact on nodules formation and plant biomass in soybean. The experimental results demonstrated that the nodulation was improved by P supply at both soil moisture levels, but its effect was more pronounced under not limiting water regime. This effect suggests that P limited nodule formation and growth whereas shoot and root growth were less affected (data are not presented). Drought conditions had a very negative impact on nodulation and their growth (Figure 4). Therefore, we conclude that inhibitory impact of water deficit on nodulation could be partially reversed by increased P availability as suggested by a previous report (Tsai el al., 1993).

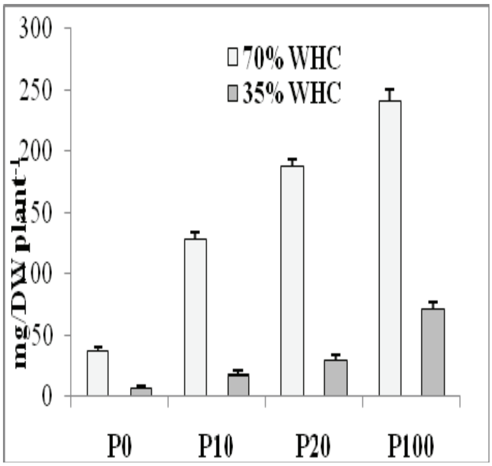

Figure 4. Mean nodules dry weight (g) of soybean in relation of P supply and moisture of soil

The growth and activity of nodules depends on assimilates supply. Chlorophyll maintenance and consequently photosynthesis durability in stressful conditions are among physiological indicators of stress resistance (Zhang et al., 2006). The photosynthetic intensity is determined by chlorophyll concentration in leaves and has significant effects on nodules supply with resources.

Phosphorus supply affect the leaf chlorophyll contents, which influences the leguminous plant to manufacture its own food through photosynthesis process, which ultimately

increases yields and uptake of important nutrients in different soybean plant tissues (Imsande, 1988). Phosphorus plays a very important function in almost every plant process that involves energy transfer. High-energy phosphate, detained as a part of the chemical structures of adenosine diphosphate (ADP) and adenosine triphosphate (ATP), is the source of energy that drives the huge number of chemical reactions within the plant.
Results presented in figure 5 shows significant effect of phosphorus supplementation on the leaf chlorophyll content for glasshouse experiment. The experimental results demonstrated an increase of the chlorophyll value in treatments with higher dose of P compared with unfertilized control.
The lowest SPAD value was obtained at P0 treatment. Based on obtained data, there was a positive correlation between number of nodules per plant and SPAD value.

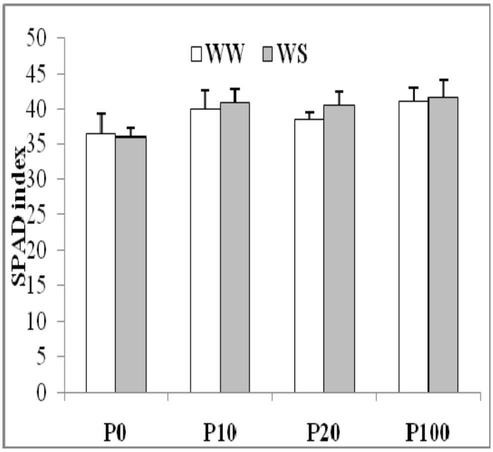

Figure 5. The influence of P supplementation on SPAD values of soybean leaves in relation to soil water regimes (5 days after dry soil imposition)

The results of leaf chlorophyll analysis showed that P fertilizer significantly increased the total chlorophyll contents relative to the control treatment at 5 and 10 days after water deficit imposition in the green house experiment (Figure 5 and 6).
The application of P fertilizers generally improved total chlorophyll content in soybean leaves relative to the control treatment for both soil moisture levels.

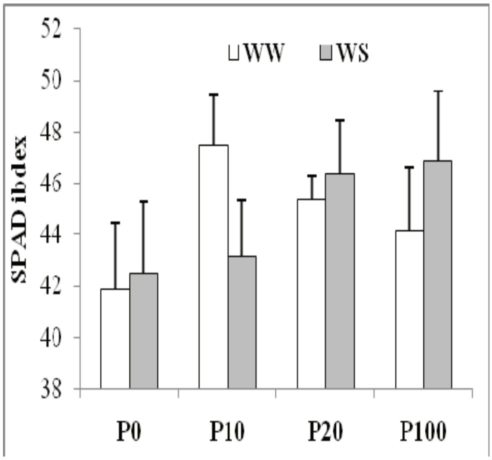

Figure 6. The influence of P supplementation on SPAD values of soybean leaves in relation to soil water regimes (10 days after dry soil imposition)

Hence, the experiment results revealed the positive role played by P fertilizer on chlorophyll contents of the soybeans as it significantly increased total chlorophyll content by 14 % and 6 % for the reading taken after one week after subjected plants to low water supply (35% WHC). It seems that P could partially counteract the detrimental effect of P deficiency and drought on photosynthetic activity of leaves which in turn affect the N_2-fixation capacity of soybean.
In addition, experimental results of this study confirm that the metabolites production of the N_2-fixation process is the stage in the nitrogen assimilatory pathway of nitrogen fixing plants that is sensitive to phosphorus deficiency as well as to water deficit.
Therefore, the fertilization with phosphorus of soybean plants grown at a low accessible phosphates increased nodulation, photosynthetic pigments concentrations and ureides metabolism compared to unfertilized control plants.

CONCLUSIONS

The present study indicated that the P application reduced adverse effects of low water regime on ureides production and nodulation of soybean. Greater nodules growth under low water supply could play an important role in acquisition of N from atmosphere. Results showed that there were significant growth and ureides partitioning responses to P supply in relation to soil moisture level. In general, nodule growth was enhanced by supplemental phosphorus nutrition under optimal soil moisture conditions, demonstrating the requirement of adequate soil moisture for better growth.

However, it should be noted that these results came from greenhouse investigations; therefore, it would be necessary to carry out further experiments under field conditions which would be quite important research for sustainable crop production under unfavorable environmental conditions.

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DETERMINATION OF OPTIMUM ROW-SPACING AND PLANT DENSITY IN GOLDASHT1 SAFFLOWER VARIETY

Mohammad SHARIF MOGHADDASI[1], Amir Hasan OMIDI[2]

[1]Islamic Azad University /Saveh Branch, Felestin esq. 39137-366, Saveh, Iran
[2]Seed and Plant Improvement Institute (SPII) IRAN, Karaj, Iran

Corresponding author email: memo1340@yahoo.com

Abstract

In this study optimum row-spacing and plant density of new safflower cultivar, Goldasht were evaluated during a two-year period (2007-2009) in Saveh University in Iran. The experimental design was set up as strip-plot in a randomized complete block with four replication Rows were arranged at varying spaces of 25,30,50,60 cm while the plants were adopted horizontally at 5,10 and 15 cm .In this way, plants density ranged from111111 to800000 plant/ha. Combined analysis of two years, demonstrated that a significant effect on the seed and oil yields due to an decrease in row spacing from50-25cm and inter-row spacing from 15 to 5 cm .This decrease in row spacing from 50 to 25 cm and inter-row spacing from 15 to 5 cm could also increase 100SW from 27 g to 31 g, and seed and oil yields from 1010 and 361 kg/ha to 1399 and 422 kg/ha respectively. Moreover, an increase in plant spacing from 50 to 25 cm and inter-row spacing from 15 to 5 cm caused decreasing in the number of head/plant from 15 to 5, number of branches from 19 to 9. Correlation among the traits showed that the grain yield is significantly correlated with oil yield, number of heads and number of secondary branches. It can be concluded that the higher number of heads per plot caused more seed yield, comparing with high number of heads per plant.

***Key words**: safflower, row spacing, plant density, variety.*

INTRODUCTION

Safflower, *Carthamus tinctorius* L., is a member of the family *Compositae* or *Asteraceae*, cultivated mainly for its seed, which is used as edible oil and as birdseed (Ashri, 1976). Traditionally, the crop was grown for its flowers, used for coloring and flavoring foods and making dyes, especially before cheaper aniline dyes became available, and in medicines. Safflower is a highly branched, herbaceous, thistle-like annual or winter annual, usually with many long sharp spines on the leaves (Li and Mündel, 1996).

Plants are 30-150 cm tall with globular flower heads (head) and, commonly, brilliant yellow, orange or red flowers. Achenes are smooth, four-sided and generally lack pappus.

The plant has a strong taproot which enables it to thrive in dry climates. Depending on condition varieties grow from about 0.75 to 1.5 m tall. Some have spiny, others do not.

In China, safflower is grown almost exclusively for its flowers, which are used in treatment of many illnesses as well as in tonic tea. Safflower has a bitter herbal taste, but the Institute of Botany of the Chinese Academy of Sciences in Beijing has developed a non bitter, sweet-smelling tea which contains amino acids, minerals and vitaminsB1, B2, B12, C and E. Safflower preparations should be stored in light-resistant containers (Weiss, 1971)

India is the biggest safflower producing country, following by the USA and Mexico (Li and Mündel, 1996). Safflower has tolerance to drought and is suitable for growing in dry and marginal areas.

Safflower has been cultivated in Iran for centuries on limited areas for dye extraction from its florets. Its importance as an oil seed crop has only been realized since 1970 in Iran. (Ahmadi and Omidi, 1997).Iran is one of the richest germplasm sources of safflower. For instance, out of the 2042 safflower genotypes deposited at the Western Regional Plant Introduction Station, Pullman, WA, USA, 199 are from Iran (De Haro et al., 1991).

Safflower is being grown in over 60 countries but India is contributing about 50% of production. In Iran the area safflower cropped area has increased over the last few years

reaching about 7500 ha in 2001 whereas in 1997 it was 200-300 ha (Omidi, 2001).
The recommended range of planting density for spring and winter types is from 200 to 400 thousand plants per hectare; this will vary depending on germination rate, soil type and availability of irrigation. (Omidi et al, .2009)
Omidi (2000) concluded that in winter safflower type seed number per head, head number per plant showed a decrease against increasing of plant density from 111 thousand to 800 thousand plants per hectare.
Salera (1996) conducted an experiment on safflower cultivars for best plant density in 25, 30, 50 and 60 cm.Results showed a remarkable rise in the seed yield against plant density which rose from 25 to75 cm.
Uslu (1997) had run an experiment on two safflower over 3 varying plant rows spacing of 20, 40 and 60cm. His conclusion revealed that the highest seed yield was belonging to 20 cm row space.
Evaluating yield components and their interrelationships and detecting suitable selection indexes is also very important in safflower breeding programme,
Omidi (1994) reported that the number of seeds per head is associated with the increase of seed yield in safflower. Uslu et al. (1994) concluded that selection for number of head per plant was effective for the improvement of the yield. Consentino et al. (1980) showed that the number of head per plant and seeds per head were significantly and positively correlated.
Yazdi-Samadi and Abd-Mishani (1989) grouped all 1618 Iranian and American safflower genotypes into 5 clusters according to their similarities and reported that the of lines from USA and Iran and other eastern countries were classified into same cluster, as they had similar genetic base.
Zongwen Zhang (2001) in a classification of 89 accessions of safflower reported that accessions from India possessed high diversity and accessions from Turkey were closely related to those from the other Middle East countries.
Bagawan and Ravikumar (2001) studied 10 safflower population from F2 and M2 generation and reported that the number of head per plant is the most important character contributing to grain yield per plant and the number of head recorded the highest positive correlation with grain yield.
Johnson et al. (2001) indicated that grain yield was positively correlated with seed weight, and plant height.
Thus this study was planned to evaluate Determination of optimum row-spacing and plant density for safflower varieties

MATERIALS AND METHODS

This experiment was carried out over a two – year period in Saveh university at 48°, 26’’and 32°, 16’’ with an altitude of 1000 m above sea level. Based on meteorological statistics , the annual rainfall is 350 mm, mean annual air temperature are +35°C, maximum and minimum absolute annual temperature are +35°c and -9°c respectively. The pilot farm indicated a silty clay loam texture, the table 1 shows to the soil farm trial characters.

Table 1. Soil farm trial characters at two depth

Soil depth Cm	N %	p %	K %	PH	EC Ds/cm	Soil Texture
0-30	0.77	14.1	111	7.1	2.2	Silty clay Loam,
30-60	0.70	11.3	99	7	3.1	Silty Loam

The experiment was conducted in four replications using statistical strip plots. The vertical plots were arranged in rows at 25, 30, 50 and 60 cm and plant intervals of 5, 10 and 15 cm. Table 2 shows the various densities in different cultivation patterns. Each plot was composed of four lines of 10 m long. The new safflower variety Goldasht was planted in October 2008. After emergence, manual thinning was used to obtain normal density. For the experiment, 70 kg/ha of P_2O_5 as ammonium phosphate and 25 kg/ha of nitrogen as urea were supplied prior to sowing and 30 kg/ha of nitrogen as urea at the start of stem elongation. Weeds were controlled by manual weeding before stem elongation. Irrigation was applied at 7 stages: After emergence, stem elongation, bud formation, beginning of flowering, 50% of flowering, finishing of flowering and seed filling. Data on yield per plant and yield components and other agronomic traits were recorded on plants randomly selected from the two middle rows. The harvesting areas for determination of seed yield, after deletion of the plot sides, were from two middle rows. The data for each experiment were analysed by MSTATC software for comparison of the mean values by the Duncan test at the 1% level.

Table 2. Plant numbers per square meter at different row spacing and plant distances

Plant distance (cm) / Row spacing (cm)	5	10	15
25	800	400	266
30	666	333	222
50	400	200	133
60	333	166	111

RESULTS AND DISCUSSIONS

In this investigation the impact of plant density over 12 growing patterns, ranging from 111111 up to 800000 plants per unit area were monitored on the seed and oil yields and their components. After homogeneity test for error variances, combined analysis of variance was performed. F.test of different sources of variation revealed that the effect of row space x year, plant distance x year and row space x plant distance x year interaction were not significant. Analysis of the grain and oil yields and some traits showed significant difference for the main effects of row space, plant distance and row space x plant distance (Table 3).

There were significantly different results values between plant heights on the rows spacing treatments but, as well as plant distance being increased, plant height became decreased, it means that inter-plant competition was decreased.

The results of Yield and yield components comparison for different row spacing and densities are shown in table 4 and 5.The highest plant height belong to 25x5 cm, because in this situation, relative humidity is high and there is no direct sun shine, and also there is desirable temperature ,they cause to Auxin reduction especially in some parts of stem in shadow, Auxin as a class of plant growth substance that have an essential role in coordination of many growth and behavioral processes in the plant life cycle.

Also , the results showed that , by spacing the rows more widely from 25 to 60 cm, and by distancing the plants from 5 to 15 cm led to increase in number of head from 13 to 20 cm and 11 to 14.5 respectively.

The average head number per plant in interaction effects between row spacing with plant distance was also significant and revealed that widening distance between the plants, which caused competition decrease among the variety, also increased the head number of plant. The greatest number of plant heads was recorded as 19 in 60x15 cm pattern. Whereas the least, recorded as 8 was detected in 5x25 cm pattern. The seed number of the head as another component of yield was effected by the plant distance applied. Although no significantce was identified between the seed number of the heads at varying plant spacing. The significant interaction effects of row and plant spacing were indicated that in increasing plant distance each row spacing would increase the seed content of the head. The least quantity of the head seeds at 10 was seen in its highest density in 25x5 cm pattern, while the greatest content was reported equal to 16 in the 60x15 cm growing arrangement.

Significantly effect of the number of branches trait was observed in different row spacing. The highest number of plant branches was recorded as 19 in 60 cm .Study of plant row spacing and plant distance interaction showed the highest number of branches (21) was belonging to 60x15 cm pattern. High plant density produced more biomass compared to low plant density. The thousand seed weight was also affected by the above spacing, so that the greatest weight was yielded at 60 cm wide. The mean seed weight interaction effects significant different. The range of thousand seed weight in the treatments was 37 to 42 grams. It is because of high Net photosynthetic rates, in this case, the leaves and seeds work as source and sink respectively. The highest seed and oil yields were obtained at the highest plant density .The 25 and 5 cm row and plant spacing possibly due to excessive competition , and the row and plant spacing of 60 and 15 cm, for their lower plant density per unit area , demonstrated less yield .Also , the planting density of 800000 plant per unit area resulted in the highest seed yield .Having the higher the all treatments at a 25 cm row spacing , as well as with the preferred 5 cm, plant distance for all row spacing, a growing pattern of 25x5 cm is therefore recommended. The pattern is available easily, by planting two lines in 50 cm row spacing, prepared by seed planter.

CONCLUSIONS

It can be concluded that the higher number of heads per plot caused more seed yield, comparing with high number of heads per plant.

The relationship between seed yield and row spacing, plant distance and plant density represented a linear character and followed the equation y=-9.79 x +1692.5, y=-4.99. x +1324.5 and y=0.0007 x +1040.5 respectively, which means a falling trend of seed yield against row spacing, plant distance and plant density .According to the above equations, the highest seed yield was obtained in the highest plant population. The planting density of 111111 to 800000 plants per unit area resulted in the highest seed yield (Figures 1-3).

The results of phenotypic correlations showed that the grain yield is significantly correlated with oil yield (0.84), biomass (0.71) coefficient and number of head per plant (0.97).

Table 3. Mean squares for yield and yield component

S.OV	df	ms							
		Seed yield Kg/ha	Oil yield Kg/ha	Head per plant	Seed per head	Thousand Grain weight	Number of branches	Biomass Kg/ha	Height Cm
Year	1	13380.22 ns	7440 ns	221.88 ns	847.87 ns	724.1 ns	933.5 ns	144506 ns	9855.8 ns
E1	6	8920.33	3270.32	401.77	422.8	499.8	577.8	111158.1	7039
R.S	3	18960.66**	5611.47**	398.38**	998.11**	395.88**	407.11**	104409.1**	5877.46**
Rs×Y	3	964.33 ns	3981.01 ns	100.06 ns	411.40 ns	222.2 ns	99.77 ns	9999.8 ns	1510.5 ns
E2	18	2106.33	561.42	36.88	155.8	88.79	37.3	9494.33	839.8
P.d	2	8222.0. ns	1165.78 ns	81.2 ns	101.63 ns	108.68 ns	99.68 ns	13254.88 ns	1741.6 ns
P.d×Y	2	1478.66 ns	1121 ns	88.87 ns	107.11 ns	111.2 ns	88.87 ns	25688.2 ns	1054.10 ns
E3	12	7475.33	604.21	31.4	95.11	88.8	58.99	17839.8	1456.55
R.S×Pb	6	27084.77**	2599.77**	774.568**	2010.02**	477.47**	659.7**	132547.8**	9984.98**
R.S×Pb×Y	6	4129.33 ns	911.33 ns	99.90 ns	233.11 ns	100.2 ns	147.17 ns	98.74.9 ns	990.8 ns
E4	36	2608.88	256.66	59.61	313.48	53.11	99.55	12801.57	1426.14

Table 4. Yield and yield components comparison for different row spacing and densities

Treatment		Seed yield Kg/ha	Oil yield Kg/ha	Head per pant	Seed per head	Thousand Grain weight	Number of branches	Biomass Kg/ha	Height Cm
Row spacing	25	1477 a	315 a	13 a	11.3 b	42.6 a	13.3 a	6530 a	147 a
	30	1362 ab	295 b	13 a	12.3 b	39.6 b	15.6 b	6110 ab	131 a
	50	1210 b	266 b	12.3 a	12.3 b	38 b	15.3 b	5629 b	126 a
	60	1036 c	234 b	20.6 b	15.3 a	37.6 b	19 b	4710 c	117 b
Plant distance	5	1351 a	300 a	11 a	12 a	39.5 a	13.75 a	5893 a	128 a
	10	1252 a	271 a	13.5 a	13.5 a	38.75 a	12.75 a	5653 a	127 a
	15	1211 a	262 a	14.75 a	13 a	38.7 a	16 a	5688 a	127 a

Means followed by similar letters in each column for each main row or plant distance are not significantly different at the 1% level

Table5. Yield and yield components comparison for different row spacing and densities

Row spacing Cm	Plant distance(Cm)	Seed yield Kg/ha	Oil yield Kg/ha	Head per plant	Seed per head	Thousand Grain weight	Number of branches	Biomass Kg/ha	Height Cm
25	5	1605 a	353 a	8 b	10b	42 a	11 b	7295 a	139 a
	10	1421 a	298 a	15 a	13a	40 a	18 a	6178 a	135 a
	15	1407 a	295 a	9 b	11b	40 a	11 b	6117 a	139 a
30	5	1390 a	319 a	9 b	11b	40 a	11 b	5791 b	121 b
	10	1376 a	275 a	17 a	14a	39 a	20 a	6254 a	119 b
	15	1320 b	290 a	13 a	12a	40 a	16 a	6258 a	117 b
50	5	1300 b	286 a	13 a	12a	38 b	16 a	5652 b	128 a
	10	1212 b	278 a	11 a	12a	38 b	14 a	5637 b	138 a
	15	1120 b	235 b	13 a	13a	38 b	16 a	5600 b	135 a
60	5	1112 b	244 b	14 a	15a	38 b	17 a	4833 c	115 b
	10	1000 b	230 b	16 a	15a	38 b	19 a	4545 c	119 b
	15	998 b	229 b	19 a	16a	37 b	21 a	4752 c	120 b

Means followed by similar letters in each column for each main row or plant distance are not significantly different at the 1% level

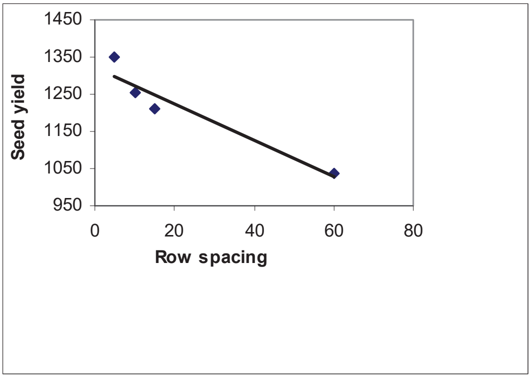

Figure 1. The relation between row spacing and seed yield which follows the linear equation: of y=-9.79 x +1692.5 representing yield decrease yield decrease against row space increase

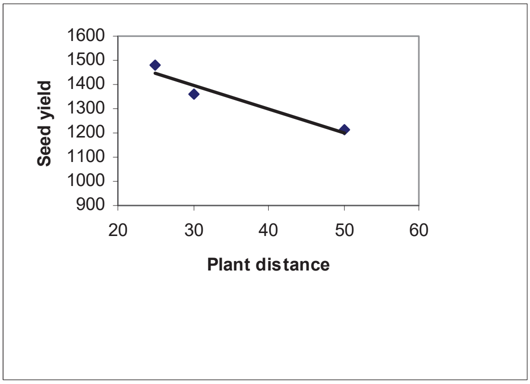

Figure2. The relation between plant distance and seed yield which follows the linear equation: of y=-4.99. x +1324.5 representing yield decrease yield decrease against plant distance increase

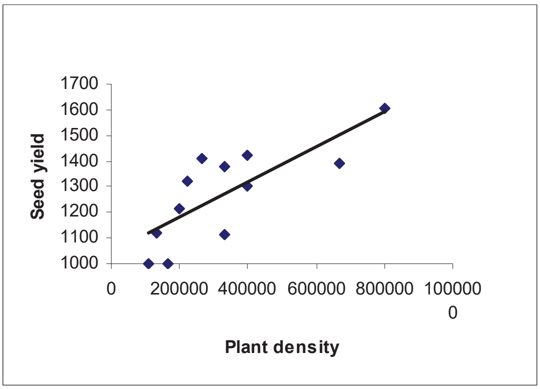

Figure3. The relation between plant density and seed yield which follows the linear equation: of y=0.0007 x +1040.5 representing yield decrease yield decrease against plant distance increase

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THE STUDY OF THE DROUGHT TOLERANCE OF CANOLA (*Brassica napus* L.) CULTIVARS BY USING STRESS TOLERANCE INDICES

Seyed Habib SHOJAEI[1], Khodadad MOSTAFAVI[2], Pooria MAZLOOM[3], Peyman KERMANI[1], Sajjad SHOJAEI[1], Seyede Mitra SADATI[1]

[1]Technical and Vocational University, Damavand College of Agriculture, Damavand, Iran
[2]Islamic Azad University, Karaj Branch, College of Agriculture, Department of Agronomy and Plant Breeding, Alborz, Iran
[3]Islamic Azad University, Chaloos Branch, Department of Agronomy, Chaloos, Iran

Corresponding author email: habib2784@yahoo.com

Abstract

To study the drought tolerance of the different canola cultivars by the evaluation of drought tolerance indices, fourteen canola cultivars were planted and studied in the research farm of Karaj area under both normal and stress conditions. For this purpose, the randomized complete block design (RCBD) with three replications was employed. The results indicate that SML046 and Sarigol cultivars have the mean seed yield respectively. The results of the combined analysis of variance showed that seed yield had had significant difference. The analysis of correlation between drought tolerance indices showed that there is a positive significant correlation between most indices. In addition, the analysis of the components shows that the first two factors explain approximately 99.93% of the variance. The cultivars were studied by the analysis of the data using drought tolerance indices. According to the indices TOL and SSI, the cultivars Talaye 13 and Hyola401 were the most tolerant cultivars to drought stress. According to the indices GMP and MP, the cultivars Licord and SLM046 were the most tolerant ones. Based on Harm index, the genotypes Sarigol and SLM046 were the most tolerant ones and finally, according to the STI index, the cultivar Sarigol had the highest tolerance for drought stress. The results of the study of correlation between the indices of drought stress tolerance indicate that there is a positive significant correlation between most indices. According to the results obtained from the bi-plot depicted from the two main components, the indices MP, GMP, and TOL are the best indices.

***Key words**: canola, drought stress, combined analysis, factor analysis, tolerance indice.*

INTRODUCTION

At least one third of the entire world is classified as arid and semi-arid regions. Drought is the most common environmental stress that restricts almost 25 percent of the productions of the lands of the world (Bates et al., 1973). 40 % of the canola (*Brassica napus* L.) is seed oil and protein in meal and therefore, it is considered as one of the main seed oils of the world during the recent decades (Raymer, 2002). In addition, this plant is economically the fifth top plant after rice, wheat, barley, and cotton (Cardoza & Stewart, 2003). Fischer and Maurer (1978), Rosille and Hambilin (1981), Fernandez (1992), and Kristin et al. (1997) have introduced respectively stress sensitivity index (SSI), tolerance index mean productivity index (Mp), and geometric mean productivity (GMP). The cultivars, which have identical or are to some extent different in yield under stress or stress-free conditions, have relative tolerance for drought. One of the important factors used for the evaluation of the drought tolerance of cultivars is the quantitative measurement of drought tolerance criteria (Clark et al., 1992). By the study of the genotype yield in the normal condition and stress condition, Fernandez classified into four groups in terms of their reactions to these two conditions: Group A: Genotypes with high yield in both normal and stress environment; Group B: Genotypes with high yield only in normal condition; Group C: Genotypes with high yield only in stress condition; Group D: Genotypes with low yield both in normal and stress conditions.

The genotypes with high yield in both conditions are appropriate for improvement purposes (Fernandez, 1992). The results of the studies conducted by Qifuma et al. (2006) on canola showed that water scarcity stress has a negative impact on seed yield in flowering and seed filling. The purpose of this study is to study and identify the genotypes that are tolerated for drought in canola cultivars, and study the reaction of the cultivars to drought stress.

Some researchers suggest selecting the cultivars with high yield in ideal conditions (Bertan et al., 2003) and some others recommend selecting those that produce high yields under stress conditions (Ceccareli & Grando, 1991). However, there are reports indicating that the selection of the cultivars with high seed yield under both stress and stress-free is more effective in the identification of resistant cultivars (Clark et al., 1992; Fischer & Maurer, 1978;Rajaram and Ginkle, 2001; Fernandez, 1992)

To study the drought tolerance of the cultivars, the following indices have been employed:

Stress Susceptibility Index: this index (SSI) was suggested by Fischer and Maurer. The low value of SSI is the indication of minor changes in genotype yield in both stress and stress-free conditions.

$$SSI = \frac{1-(Y_S/Y_P)}{SI}$$

Tolerance Index: TOL was introduced by Rosille and Hambilin (Rosille & Hambilin, 1981). The high value of TOL is an indication of genotype sensitivity to stress.

$$TOL = Y_P - Y_S$$

Arithmetic mean:

$$\mathbf{MP} = \frac{Y_P + Y_S}{2}$$

Stress Tolerance Index: STI was introduced by Fernandez (Fernandez, 1992). The genotypes with high STI based on this index are more stable.

$$\mathbf{STI} = \frac{(Y_P)(Y_S)}{(Y_P)^2}$$

Geometric Mean: another index, which was introduced by Fernandez, is the Geometric Mean Productivity. In comparison to MP, this index is more effective in terms of the separation of genotypes.

$$GMP = \sqrt{}\, Y_s \times Y_P$$

Harmonic Mean:

$$\mathbf{Harm} = \frac{2Y_pY_s}{Y_P+Y_S}$$

MATERIALS AND METHODS

To study the drought tolerance in canola cultivars by evaluating tolerance indices, fourteen canola cultivars (Table 1) were farmed and evaluated in the research farmland of Karaj branch of the Islamic Azad University in 2010-2011 under both normal and stress drought conditions. The test was conducted in form of a randomized complete block design with three replications. The tested cultivars included Modena ،Okapi ،Hyola401 ،Licord ،Opera ، Zarfam ،RGS003 ،SLM046 ،Sarigol ، Hyola308،Hyola330 ،Talaye 13 ،Hyola6, and Option 500.

All tillage land leveling and grading were done completely. Each experimental plot was divided into four rows 50 centimeters distant from each other and in a length of 2 meters. The phases of stress were gone through after flowering stage. To eliminate marginal effects and reduce errors, sampling was conducted only from the middle rows of each plot. The analysis of variance (ANOVA) was conducted on the quantitative value of indices in form of randomized complete block design (RCBD). Moreover, the correlation between tolerance indices and seed yield was calculated in both stress and stress-free conditions. SAS and Minitab software programs were used to analyze the obtained data.

RESULTS AND DISCUSSIONS

The results of combined ANOVA obtained in both normal and stress conditions at the probability levels of 0.01 and 0.05 indicate a significant difference in the trait seed yield. The lack of significant difference in replication effects indicates the uniformity of test conditions. In addition, no significant difference was observed in genotype effect, genotype, and environment. The significance of genotype effect and genotype by environment interaction indicates the adaptability of the different genotypes with the different regions. The results of this analysis have been presented in the Table 2.

The data were analyzed based on the drought tolerance indices including TOL, MP, Harm, GMP, STI, and SSI. According to TOL index, the cultivar Talaye 13 (1.92) and Hyola 401 (1.97) are the most tolerant cultivars and SLM 046 (6.4) and Hyola 60 (5.8) have the least drought tolerance.

Contrary to TOL index, lower value of MP index indicates the higher sensitivity of genotypes to stress conditions. In this regard, the cultivars Licord (3.23) and SLMO46 (3.2) are the most tolerant genotypes than others. By contrast, the cultivars Talaye (0.96) and Hyola 401 (0.98) are more sensitive to drought in comparison to other genotypes.

In addition, the higher Harm, GMP, and STI indices are, the more tolerate the genotypes are for stress conditions. According to Harm index, the genotypes Sarigol (4.86) and SLM046 (4.03) have the highest resistance to stress conditions. According to this index, the most sensitive cultivars include Okapi (1.59) and Hyola 330 (1.77). Based on GMP index, the cultivars Licord (2.54) and SLM 046 (2.52) have the most tolerance for stress conditions, and the cultivars Hyola 401 (1.4) and Talaye 13 (1.38) have the least tolerance towards stress conditions. According to STI index, the cultivar Sarigol (9.85) is the most resistant cultivar to stress conditions and the cultivars Hyola 330 (2.27) and Okapi (2.13) are the least tolerant cultivars to stress conditions. Just like the TOL index, the high SSI index indicates the sensitivity of genotypes to stress. Therefore, any selection based on this index leads to the selection of genotypes with low yield under ideal conditions and by contrast, high yield under stress conditions. The cultivars Okapi (1.17) and Hyola 60 (1.18) are the most sensitive genotypes and the cultivars Talaye 13 (0.61) and Hyola 401 (0.74) are the most resistant to stress conditions. The results of this analysis have been have been provided in the Table 3.

The results of the correlation between the indices of drought tolerance indicate that seed yield in normal condition (Y_p) is in positive significant relation with all indices excluding SSI index. In addition, the trait seed yield in stress conditions (Y_s) is in positive significant correlation with the indices Harm and STI and in a negative significant correlation with the index SSI. TOL and MP indices are in positive and significant correlation with GMP and SSI. It is understood that any index with a high and identical correlation with the seed yield in both stress and stress-free condition is considered as the best index (Rosille & Hambilin, 1981). The correlation coefficients of the different indices with the yields in both stress and normal conditions show that Harm and STI indices that are in high correlation with the seed yield in stress and normal conditions can be used to identify fertile cultivars in both environmental conditions. In 1992, Fernandez concluded based on the results of the correlations of TOL, MP, and SSI with Y_s and Y_p that STI is the potential yield index and stress tolerance and it can separate the genotypes of the group A from those of other groups (Fernandez, 1992). In addition, the indices Harm is in positive significant correlation with STI and the index MP in the same correlation with SSI index. The results of this study have been provided in the Table 4.

Factor analysis has been employed to explain the correlation between many variables in the framework of low number of independent factors (Mohammadi & Rasanna, 2003). In addition, this statistical method is one of the oldest multivariate methods used to reduce data volume. Such reduction is carried out for describing multivariate data. This method is improved ideally when there is a significant linear correlation between the main variables (Johnson & Wichern, 1988). According to the factor-analysis conducted on 14 genotypes based on 6 indexes and two stress and non-stress conditions and presented in the table 5, the two first components (totally equal to 99.93%) explained the total changes in the data. In this test, the first component called stress tolerance index explains 63.68 % of the total changes in the data, and it had a high positive correlation with Y_p (0.44), as well as the indices TOL (0.41), MP (0.41), and GMP (0.40). The second component explains 37.25 % of the total changes in the data, and is in high positive correlation with the yield in stress condition (0.49) and negative correlation with the yield under non-stress condition (-0.008). In addition, the second component had a negative correlation with the indices TOL (-0.22), MP (-0.22), GMP (-0.23), and SSI (-0.52), and positive correlation with the indices Harm (0.41) and STI (0.38). This second one is called harmonic component.

In Figure 1, the results of the factor analysis, the genotypes G1, G8, G4, G6, and G7 have been put in the potential, yield stability, and drought tolerance area. In addition, the genotypes G14, G5, G11, and G13 have been put in the lower part and close to the sensitivity indices. This indicates the genetic diversity of genotypes in responding to drought conditions. According to the results shown in the Table 5, five genotypes G1, G8, G4, G6, and G7 located in the potential, yield stability, and drought tolerance, and having high MP, GMP, and TOL values are the most tolerance cultivars, and the genotypes G14 and G5 located on the border of two high and low potential, yield stability, and drought stress were identified as the semi-tolerant cultivars.

According to the results, the indices MP, GMP, and TOL acted identically in terms of the separation of the cultivars that are tolerant for drought, and identical genotypes were identified. Therefore, they are called the most appropriate indices for the identification of cultivars.

Table 1. The name and the origin of Canola genotypes evaluation in the experiment

Row	Genotypes	Origin	Row	Genotype	Origin	Row	Genotype	Origin
1	Modena	Russia	6	Zarfam	Iran	11	Talaye 13	Germany
2	Okapi	France	7	RGS003	Germany	12	Hyola 60	Canada
3	Hyola401	Canada	8	SLM046	Germany	13	Option 500	Germany
4	Licord	Germany	9	Sarigol	Germany	14	Hyola 330	Canada
5	Opera	Sweden	10	Hyola308	Canada			

Table 2. Combined analysis of variance of seed yield under normal and stress conditions

S.O.V	Df	SS	MS
Env	1	384.34	384.34**
Block(env)	4	1.51	0.37ns
Genotype	13	98.2	7.55**
G×E	13	48.95	3.76**
Error	52	53.52	1.02
CV			25.04

Table 3. the mean drought tolerance indices in both normal and stress conditions in Canola Cultivars

Cultivars	Yp	Ys	STI	SSI	GMP	Harm	Mp	TOL
Modena	7.62	2.17	6	1.03	2.33	3.38	2.72	5.45
Okapi	5.03	0.95	2.13	1.17	2.03	1.59	2.04	4.08
Hyola 401	3.81	1.84	3.6	0.74	1.4	2.48	0.98	1.97
Licord	8.46	2	5.81	1.1	2.54	2.23	3.23	4.46
Opera	5.34	1.7	3.92	0.98	1.9	2.57	1.82	3.64
Zarfam	6.64	1.86	4.81	1.04	2.18	2.91	2.39	4.78
RGS003	7.79	2.04	5.71	1.06	2.39	3.24	2.87	5.74
SLM046	9	2.6	7.8	1.02	2.52	4.03	3.2	6.4
Sarigol	7.75	3.54	9.85	0.78	2.05	4.86	2.1	4.21
Hyola 308	3.71	1.35	2.6	0.92	1.53	1.97	1.18	2.36
Hyola 330	3.91	1.15	2.27	1.02	1.66	1.77	1.38	2.76
Talaye 13	4.51	2.58	5.48	0.61	1.38	3.28	0.96	1.92
Hyola 60	7.1	1.29	3.44	1.18	2.4	2.18	2.9	5.8
Option 500	5.94	1.64	4	1.04	2.07	2.57	2.15	4.3

Ys is the genotype yield in environmental stress conditions, Yp the genotype yield in ideal conditions, TOL, MP, Harm, GMP, SSI, and STI are tolerance index, mean productivity, harmonic mean, geometric mean productivity, stress susceptibility index, and stress tolerance index respectively.

Table 4. The correlation between drought tolerance indices in stress and non-stress conditions

	YP	YS	TOL	MP	HARM	GMP	SSI	STI
YP	1	0.51*	0.92**	0.92**	0.69**	0.92**	0.39ns	0.72**
YS		1	0.15ns	0.15ns	0.97**	0.14ns	-0.56*	0.95**
TOL			1	1**	0.37ns	0.99**	0.69**	0.42ns
MP				1	0.37ns	0.99**	0.69**	0.99**
HARM					1	0.36ns	-0.35ns	0.99**
GMP						1	0.71**	0.41ns
SSI							1	-0.29
STI								1

ns, * and ** mean non-significant, significant at 5% and 1% levels respectively.

Table5. Linear combination principal components of drought tolerance indices

Component	Eigen-value	Variance Cumulative (%)	YP	YS	TOL	MP	HARM	GMP	SSI	STI
1	5.01	62.68	0.44	0.23	0.41	0.41	0.33	0.40	0.17	0.33
2	2.93	99.93	-0.008	0.49	-0.22	-0.22	0.41	-0.23	-0.52	0.38

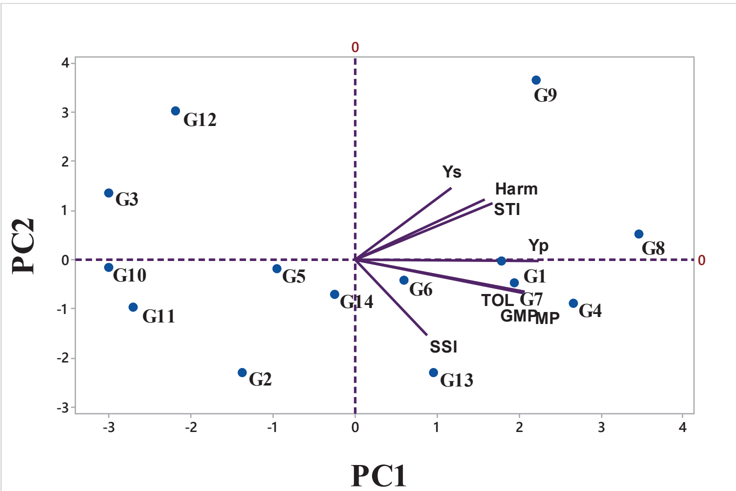

Figure 1. The bi-plot scheme of 14 canola cultivars based on the first and second main components (pc1 and pc2) obtained from 8 indices of drought tolerance and sensitivity

G1:Modena ‹G2:Okapi ‹G3:Hayola401 ‹G4:Licord ‹G5:Opera ‹G6:Zarfam ‹G7:RGS003 ‹G8:SLM046 ‹G9:Sarigol ‹ G10:Hyola308 ‹G11:Hyola330 ‹G12:Talaye13 ‹G13:Hyola60 ‹G14:Option500.

CONCLUSIONS

According to the indices TOL and SSI, the cultivars Talaye 13 and Hyola401 were the most tolerant cultivars to drought stress.

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EFFECT OF SOWING TIME ON PEANUT (*Arachis hypogaea* L.) CULTIVARS: I. YIELD, YIELD COMPONENTS, OIL AND PROTEIN CONTENT

Tahsin SOGUT, Ferhat OZTURK, Suleyman KIZIL

[1]Dicle University, Faculty of Agriculture, Field Crops Department, 21280, Diyarbakir, Turkey

Corresponding author email: tsogut@dicle.edu.tr

Abstract

The objectives of this research were to investigate the effects of sowing time and cultivar on pod yield, yield components, oil and protein content of peanut crops under irrigated condition in south-eastern of Turkey. Three peanut cultivars, Halis Bey, Osmaniye-2005 and Sultan developed by Cukurova University were grown at the experimental area of Agricultural Faculty, Dicle University, Diyarbakir, Turkey in 2010 and 2012 with two sowing times (15 April as early sowing and 25 June as late sowing). Treatments were arranged in split plot design replicated three times with sowing time in the main plots and cultivars in the subplots. Sowing time affected pod yield, pod number plant^{-1} and oil content in both years. Early sowings resulted in higher pod yields, pod number plant^{-1} and oil content compared to late sowing for all cultivars. The results also showed that cultivars were different for pod yield in both years. Sultan produced the highest pod yields under both sowing times.

Key words: *Arachis hypogaea, peanut, sowing time, cultivar, yield, oil, protein.*

INTRODUCTION

Peanut (*Arachis hypogaea* L.) is one of the important oilseed crops that occupies an area of 24.7 million hectares with production of 41.1 million tons in the world. In Turkey, total area harvested was 37.3 thousand hectares with production of 120 thousand tons (FAO, 2012). Peanut seeds are a good source of proteins, lipids, and fatty acids for human nutrition. They are rich in oil, naturally containing from 47 to 50% (Sanders, 2002).

Growth and yield of a crop depend on a number of factors; however, climate plays the most important role. Among the climatic parameters role of solar radiation, temperature, humidity, rainfall is very crucial. The oilseed crops, particularly peanut are very sensitive to climatic parameters such as radiation and temperature (Banik et al., 2009). Crop management practices such as time of sowing and duration of cultivar life cycle may influence pod yield, yield parameters and quality of peanut. Peanut is mainly sown in spring season (April-May) as main crop in southern of Turkey. Furthermore, in the southern and southeastern regions, peanut can be grown in the wheat fallows during post-rainy season if irrigation facilities are available. In southern of Turkey, peanut crop duration is shorter in second cropping system (late June), with lower temperature apparently affecting crop maturity. Thus, peanut crop will not reach optimum maturity for a marketable yield to justify commercial production in areas with fewer heat units during the growing season, especially when it is grown in double cropping system. The actual impact of seed maturity is dependent on genotype, climatic conditions, and genotype x climate interactions. Variations in weather patterns affect the length of growing season as well as flowering date and pod development. Stern (1968) suggested that declining minimum temperatures in later plantings may have retarded or even prevented pod development. Temperature has been found to affect oil and protein concentration of seeds of several species depending upon the combination of genotype and temperature regime (Golombek et al., 2001). The objective of this research was to compare the effect of two sowing times on yield, yield components, oil and protein content of three peanut cultivars grown under irrigated conditions in southern Turkey.

MATERIALS AND METHODS

The study was carried out at University of Dicle, Faculty of Agriculture, Field Crops Department, Diyarbakir located in South East Anatolian Region of Turkey in 2010 and 2012 growing seasons. Because of problem in irrigation system of the experimental field, the study cannot be carried out in 2011, so we had to delay the study to 2012. The region has a warm climate in summer, and the mean annual rainfall is around 450 mm, most of which fall in a major cropping season which extends from November to June. Thus, peanut can be grown during double cropping season with irrigation in cereal or food legume-based cropping systems in the region. Monthly air temperature, rainfall and humidity for 2010 and 2012 were presented in Table 1. The treatments were replicated three times in split plot based on randomized complete block design with two sowing times (mid-April as main crop, and late June as second crop after wheat harvest) in the main plots and three cultivars (Halis Bey, Osmaniye 2005 and Sultan) developed at Cukurova University in the sub-plots. The size of each plot was 2.8 x 5.0 m. Row spacing (four rows) was 0.7 m and the distance between plants in the row was 0.20 m, providing a sowing density of 7.2 plants m^2. On the basis of soil analysis, the crop was fertilized with 100 kg N and 100 kg P_2O_5 ha^{-1} applied as basal dose in the form of 20-20-0 fertilizer prior to sowing. In addition, top dressing nitrogen was provided at the time of full flowering stage at the rate of 100 kg ha^{-1} as ammonium nitrate (33% N) for all plots. Weeds were controlled by both Trifluralin (2.5 L ha^{-1}) as pre plant and by hand as needed. The field was uniformly irrigated at 10-day intervals until harvest period using overhead sprinklers. All plots were harvested from two central rows at mid-November in 2010 and 2012. At harvest, 10 peanut plants from each plot were taken to determine 100-seed weight, pod number $plant^{-1}$ and shelling percentage = (seed yield/ pod yield] x 100. Pod yields were determined by harvesting the whole plot area. Unshelled samples were sun dried for one week. The shelled pods by hand were again sun dried for two days, thereafter analyzed for oil and protein content. The seed samples were ground, the oil was extracted with diethyl ether using soxhlet apparatus.

Table 1. Monthly temperature (^oC), rainfall (mm) and humidity (%) in 2010 and 2012 growing seasons (Diyarbakir Turkish State Meteorological Service)

Months	Temperature (^oC)						Rainfall (mm)		Humidity (%)	
	Min.		Max.		Mean					
	2010	2012	2010	2012	2010	2012	2010	2012	2010	2012
April	1.4	2.0	26.7	27.8	14.2	15.2	22.4	26.2	60	58
May	7.0	8.6	34.1	33.0	20.4	19.6	31.6	41.0	49	58
June	11.7	9.4	42.0	41.7	27.2	27.7	11.2	7.0	29	28
July	17.7	14.5	43.3	43.7	32.3	31.3	0.0	1.6	20	21
August	17.2	17.1	42.7	41.0	32.0	31.1	0.4	0.0	21	26
September	13.8	12.8	39.7	37.9	27.0	26.1	0.0	1.8	27	23
October	3.9	7.3	31.0	35.6	18.1	18.4	63.0	107.4	56	55

Protein content was measured as N×6.25 after analysis with N analyzer (Leco FP-2000; Leco Corp., St. Joseph, MI). Data were analyzed separately by year. The statistical significance of differences in the traits between groups was analyzed with analysis of variance (ANOVA) and Tukey's HSD test using a statistical software package (JMP version 5.0.1a); $P<0.05$ was taken to indicate a statistically significant difference.

RESULTS AND DISCUSSIONS

Data in Table 2 indicated that sowing time had significant effect on pod yield, pod number $plant^{-1}$ and oil content in both years. Furthermore, significant differences were observed regarding 100-seed weight and protein content between sowing time in 2010. Non-significant differences were observed among used cultivars regarding most of all traits examined except of pod yield in both years and pod number $plant^{-1}$ in 2010. The interaction between sowing time and cultivar treatments was only significant on pod yield in 2012 and pod number $plant^{-1}$ in 2010.

Table 2. Analysis of variance for yield, yield components, oil and protein content of different peanut cultivars at two sowing times in 2010 and 2012[a]

Year/Sowing time/Cultivar	Pod yield (kg/ha)	100 seed weight (g)	Pod number $plant^{-1}$	Shelling percentage (%)	Oil content (%)	Protein content (%)
2010						
Sowing time (T)	*	*	*	ns	*	*
Cultivar (C)	**	ns	**	ns	ns	ns
T X C	ns	ns	*	ns	ns	ns
2012						
Sowing time (T)	**	ns	**	ns	*	ns
Cultivar (C)	**	ns	ns	ns	ns	ns
T X C	**	ns	ns	ns	ns	ns

[a]All values are means of three replications. ns, *, ** correspond to non-significant or significance at P<0.05 and 0.01, respectively.

Sowing time led to different pod yields of 4942.9 kg ha^{-1} and 5175.5 kg ha^{-1} in early and 3543.0 kg ha^{-1} and 3550.3 kg ha^{-1} in late sowing time in 2010 and 2012, respectively. The longer growing season in early sowing time resulted in a better pod yield performance. Thus, the early sowing time resulted in 39.0% and 45.7% pod yield increase (in 2010 and 2012, respectively).

Table 3 . Effect of different cultivars on pod yield (kg ha^{-1}) of peanut at early and late sowing time in 2010 and 2012

Cultivar/ Sowing Time	2010			2012		
	Early	Late	*Mean*	Early	Late	*Mean*
Halis Bey	4902.0	3707.3	*4304.6a*	4502.6b	3501.7c	*4002.1b*
Osmaniye	4640.5	3339.3	*3989.9b*	5525.4a	3414.9c	*4470.1a*
Sultan	5286.4	3582.4	*4434.4a*	5498.5a	3735.3c	*4616.9a*
Mean	*4942.9a*	*3543.0b*	*4242.9*	*5175.5a*	*3550.3b*	*4362.9*
LSD_T	652.2			121.6		
LSD_C	269.8			372.5		
LSD_{TXC}	-			673.5		

[a]Letters that are different for sowing time and cultivar are significantly different by Tukey's HSD test (P>0.05)

Canavar and Kaynak (2008) reported that pod yield of peanut was affected by sowing time, with early sowing resulting in highest yields. Also, Laurence (1983) reported that late sowing reduced pod yields by 19% (from 5.02 to 4.21 t/ha) compared with early sowing. In the present study, the relatively low yield for late sowing in both years averaged across all cultivars was likely due to the shortening of crop growth cycle by delayed sowing. Sultan and Halis Bey produced a significantly higher pod yield as compared to Osmaniye-2005 in 2010, while Halis Bey had the lowest pod yield in 2012. In respect of sowing time x cultivar interaction in 2012, the highest pod yield was obtained from Osmaniye-2005 and Sultan in early sowing time (5525.4 and 5498.5 kg ha^{-1}, respectively).

100-seed weight decreased from 72.45 to 65.93 g in 2010 and from 109.81 to 97.98 g in 2012 with delay in sowing time. Thus, early sowing produced more 100-seed weight than the late sowing by 10 and 12% in 2010 and 2012, respectively. This can be related to the lower temperatures at seed filling stage in late sowing which resulted in delayed maturity.

Table 4 . Effect of different cultivars on 100-seed weight of peanut at early and late sowing time in 2010 and 2012

Cultivar/ Sowing Time	2010			2012		
	Early	Late	*Mean*	Early	Late	*Mean*
Halis Bey	72.27	64.90	*68.58*	102.79	94.70	*98.75*
Osmaniye	70.57	68.73	*69.65*	117.47	97.50	*107.48*
Sultan	74.53	64.17	*69.35*	109.15	101.73	*105.44*
Mean	*72.45a*	*65.93b*	*69.19*	*109.81*	*97.98*	*103.89*
LSD_T	4.30			-		
LSD_C	-			-		
LSD_{TXC}	-			-		

[a]Letters that are different for sowing time and cultivar are significantly different by Tukey's HSD test (P>0.05)

This result confirm the finding of Bala *et al.* (2011) who reported that delayed sowing delayed 50% flowering and peanut plants accumulated less dry matter as sowing was delayed. Although there were not differences among cultivars tested for 100 seed weight it was within the range of 68.58-69.65 g in 2010 and 98.75-107.48 g in 2012 obtained for three cultivars. Osmaniye-2005 gave numerically the highest 100-seed weight while Halis Bey had the lowest value in both years.

Pod number plant^{-1} was significantly influenced by sowing time in both years.

Table 5. Effect of different cultivars on pod number plant^{-1} of peanut at early and late sowing time in 2010 and 2012

Cultivar/ Sowing Time	2010			2012		
	Early	Late	*Mean*	Early	Late	*Mean*
Halis Bey	36.00b	27.67bc	*31.83a*	36.37	27.63	*32.00*
Osmaniye	30.33bc	23.67c	*27.00b*	43.00	24.76	*33.88*
Sultan	44.67a	27.00c	*35.83a*	39.76	31.27	*35.52*
Mean	*37.00a*	*26.11b*	*31.55*	*39.71a*	*27.89b*	*33.80*
LSD_T		*7.69*			*0.67*	
LSD_C		*4.66*			-	
LSD_{TXC}		*8.42*			-	

[a]Letters that are different for sowing time and cultivar are significantly different by Tukey's HSD test (P>0.05)

Pod number plant^{-1} declined as much as 42% in both years. Similar influence of sowing time on pod number plant^{-1} had been reported by Murthy and Rao (1986) who attributed this to shortening of maturation period in the late sowing. Bell (1986) reported that pod numbers were more sensitive to sowing time than pod yield. Pod number plant^{-1} which ranged from 27.00 to 35.83 was significantly influenced by cultivars only in 2010. Sultan and Halis Bey produced more pod number plant^{-1} than that of Osmaniye-2005 (Table 5). In case of sowing time x cultivar interaction significant differences were observed for pod number plant^{-1} in 2010. In 2010, pod number plant^{-1} for Sultan was the highest for early sowing time. In 2012, Osmaniye-2005 had the highest pod number when sowing early although there was no significant difference statistically.

There were no significant differences in shelling percentage for sowing time, cultivar or sowing time x cultivar interaction in both years (Table 2). However, shelling percentage in early sowing time was numerically higher than that of late sowing, especially in 2010. This can be related to the lower soil temperature in seed filling period which resulted in delayed maturity.

Table 6. Effect of different cultivars on shelling percentage (%) of peanut at early and late sowing time in 2010 and 2012

Cultivar/ Sowing Time	2010			2012		
	Early	Late	*Mean*	Early	Late	*Mean*
Halis Bey	51.90	46.90	*49.40*	61.67	58.77	*60.22*
Osmaniye	51.63	44.93	*48.28*	63.00	60.63	*61.82*
Sultan	49.97	47.17	*48.57*	61.67	63.13	*62.40*
Mean	*51.17*	*46.33*	*48.75*	*62.11*	*60.84*	*61.48*
LSD_T		-			-	
LSD_C		-			-	
LSD_{TXC}		-			-	

[a]Letters that are different for sowing time and cultivar are significantly different by Tukey's HSD test (P>0.05)

In respect to cultivar, Halis Bey had the highest shelling percentage in 2010 whereas it had the lowest value in 2012. In 2012, the highest shelling percentage obtained from Sultan (Table 6).

Analyzed data revealed that there was significant effect on oil content by different sowing times in both years. Early sowing peanut produced significantly higher contents of oil (Table7).

Table 7. Effect of different cultivars on oil content (%) of peanut at early and late sowing time in 2010 and 2012

Cultivar/ Sowing Time	2010			2012		
	Early	Late	*Mean*	Early	Late	*Mean*
Halis Bey	50.90	48.50	*49.70*	51.63	49.37	*50.50*
Osmaniye	52.10	49.27	*50.68*	51.50	49.80	*50.65*
Sultan	51.23	49.23	*50.23*	52.70	49.80	*51.25*
Mean	*51.41a*	*49.00b*	*50.20*	*51.94a*	*49.65b*	*50.80*
LSD_T		*1.91*			*1.33*	
LSD_C		-			-	
LSD_{TXC}		-			-	

[a]Letters that are different for sowing time and cultivar are significantly different by Tukey's HSD test (P>0.05)

Between the early and the late sowing times, decrease in oil contents were 4.9% and 4.6% in 2010 and 2012, respectively. This may be because of the shorter growing season and cooler climate during seed filling stage (September-October) in late sowing time (Table 1). Higher temperatures during the period from seed filling stage to harvest increased oil content in the seed. The results of our study is also in line with the finding of Pritchard *et al.* (2000), Yousaf *et al.* (2002) and Ozer (2003) who also reported that delayed sowing decreased oil levels in rapeseed. Data reported by several researcher also indicates that relatively hot dry conditions in seed filling period may favor high oil content in *Camelina sativa* (Gugel and Falk, 2006). However, the oil content was not affected significantly by used cultivars, and sowing time x cultivar interaction. Among the cultivars, the highest oil content was obtained from Osmaniye-2005 and the lowest oil content was obtained from Halis Bey in both years with insignificant differences among cultivars (Table 7). Seed oil content is purely genetically controlled character and plays vital role in determining total oil yield per unit area.

Protein content was significantly influenced by sowing time in 2010. Contrary to oil content, higher protein content was recorded for plants obtained from late sowing times (Table 8).

Table 8 . Effect of different cultivars on protein content (%) of peanut at early and late sowing time in 2010 and 2012

Cultivar/ Sowing Time	2010			2012		
	Early	Late	*Mean*	Early	Late	*Mean*
Halis Bey	22.82	23.61	23.21	21.70	22.60	*22.15*
Osmaniye	22.00	24.25	23.13	21.10	22.87	*21.98*
Sultan	21.09	24.02	22.55	21.33	22.33	*21.83*
Mean	*21.97b*	*23.96a*	*22.96*	*21.38b*	*22.60a*	*21.99*
LSD_T		1.77			-	
LSD_C		-			-	
LSD_{TXC}		-			-	

[a]Letters that are different for sowing time and cultivar are significantly different by Tukey's HSD test (P>0.05)

The reasons of higher protein content in late sowing could be explained by lack of seed maturation resulted in shorter seed filling period. Results from previous research on the effect of sowing time on protein content were consistent with our result. For example, Canavar and Kaynak (2013) reported that protein content of peanut seed was increased by delaying the harvest time. Also, Golombek et al. (2001) indicated that a decrease in pod temperature lowered the protein concentration at a root temperature of 28/22 ^{0}C, whereas it increased protein concentration at a root temperature of 40/34 ^{0}C. In 2012, protein contents of peanut seeds decreased from 22.60 to 21.38% with early sowing times, but were not significant affected. Non-significant differences were observed among used cultivars and sowing time x cultivar interaction regarding protein content. However, Sultan contained slightly lower protein of 22.55% and 21.83% in 2010 and 2012, respectively as compared to other cultivars in both sowing times.

CONCLUSIONS

It can be concluded that peanut was significantly affected by sowing time. The late-sown crops matured during lower temperature conditions than did the early-sown crops. In all of the early sown crops, the duration of oil accumulation in the seeds was longer where it coincided with a period of particularly high temperatures. Thus, under ecological conditions in south-eastern of Turkey, early sowing time at the mid-April led to increases in pod yield and oil content compared to late sowing time. However, it is possible to obtain over 3500 kg ha^{-1} pod yield, which is considered as acceptable level by the grower in the region with shorter growth duration in double crop production. In respect to cultivar tested, Sultan produced the highest pod yields under both sowing times.

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NUTRITION VALUE OF TWO GRAIN COMMON WHEAT

Antoniya STOYANOVA[1], Gancho GANCHEV[1], Velika KUNEVA[2]

[1]Trakia University, Faculty of Agriculture, Stara Zagora, 6000, Student's town, Bulgaria
[2]Agricultural university of Plovdiv 4000, 12 "Mendeleev" Blvd., Bulgaria

Corresponding author email: toni_1219@abv.bg

Abstract

The research was conducted during 2011 - 2014 in the experimental field of the Department of Plant Production in Agriculture Faculty at Trakia University, Stara Zagora, Bulgaria. In this study has examined the nutritional value of two common wheat: Diamond (by the varietal list of Bulgaria) and Bologna (Syngenta). Comparative analysis of grain varieties and options of treatment of crops with some herbicides and herbicidal compositions and was made. The results of these variants were analyzed: 1. Control - no treatment; 2. Axial one - 1000 ml/ha; 3. Lintur +Traksos 150 g/ha+1200 ml/ha - a tank mix; 4. Logran+Traksos 37.5 g/ha +1200 ml/ha - a tank mix; 5. Lintur +Axial 150 g/ha+900 ml/ha - tank mixture and 6. Logran +Axial 37.5 g/ha+900 ml/ha - tank mixture. At the varieties Diamond and Bologna has been found that after treatment with the herbicides content of the crude protein for the period of the field study is moving in the range of 153.5 - 169.4 g/kg DM variety Diamant and from 156.9 to 158.7 g/kg DM for variety Bologna. Products for weed control does not significantly affect the content of FUG and FUM in two varieties of grain wheat. Analysis of regressions showed high positive correlation between PDI and CP in two varieties (r = 0.94-0.99) for the entire study period. Significantly higher the correlation between FUG and DEE. Data analysis for the content of intestinal digestible protein (PDI) show that the herbicide does not affect the levels of PDI in the grain.

***Key words**: common wheat, herbicides, protein digestible in (small) intestine (PDI), feed unit for growth (FUG), correlation coefficient of Pearson (r).*

INTRODUCTION

Productivity of the varieties and grain quality indicators are important in zoning the most suitable varieties for different regions. On one hand, the stability of yields and high quality parameters indicate the stability of the variety, but on the other hand, they are an indicator for the level of environmental plasticity.

Atanasova et al. (2010) found that the proportion of the genetic potential is 25% at 22 varieties of common wheat, and 35% is the phenotypic expression of each indicator.

The stability of varieties is important, but in practice plasticity is the result of interaction with growing conditions. In the case of wheat, it is decisive, because it has a long vegetation period, with different voltage climatic elements (Sharma et al., 2010).

The main criteria in the selection of varieties are resistance to abiotic and biotic stress, combined with high productive potential and grain quality. (Panayotov et al., 2004; Yanchev et al., 2012).

Technology of cultivation has influence on the quality parameters at varieties. Along with a high level of agro equipment, including optimal terms for sowing, balanced fertilization, proper tillage and others, significant influence has the weed control (Ivanova et al., 2009; Ilieva, 2011).

The biological characteristics of the variety, such as height, cold tolerance, viability, significantly affect the competitive ability against weeds.

The productivity of varieties of wheat and grain quality depends at a great extent on the efficiency of applied resources to combat weed infestation (Chhokar et al., 2007; Dixit et al., 2011; Khan et al., 2011; Delchev, 2012; Delchev et al., 2014; Stoyanova et al., 2015).

The study aims, by using correlation analysis, to evaluate the relationship between the chemical composition of the wheat grain, energy and protein nutritional value of wheat for ruminants, typical of the two varieties of common wheat, which are changed under the influence of the applied herbicide combinations (Zijlstra et al., 1999).

MATERIALS AND METHODS

This study investigated the nutritional value of two varieties of common wheat - Diamond and introduced variety Bologna. Experience was set by the method of fractional land in educational-experimental field of the Plant-growing Department at the Agricultural Faculty of Trakia University. The soil of the experimental field was characterized as meadow cinnamon. Experiment was conducted during the period of 2011-2014. With the result of the harvested grain from the three agricultural seasons, it was made an analysis of the chemical composition of the grain for both common wheat varieties.

It was made a comparative analysis of grain varieties and options of treatment of crops with some herbicides and herbicide mixtures. The results of the following variants were analyzed: 1. Control - no treatment; 2. Axial one - 1000 ml/ha; 3. Lintur +Traksos 150 g/ha + 1200 ml/ha - a tank mix; 4. Logran + Traksos 37.5 g/ha + 1200 ml/ha - a tank mix; 5. Lintur + Axial + 150 g/ha + 900 ml/ha - tank mixture and 6. Logran + Axial 37.5 g/ha + 900 ml/ha - tank mixture.

Besides the mentioned herbicides for weed control in the cultivation of the crop, it was applied a technology, which is standard for the area.

Chemical analysis of grain was done by the method Weende. Is definitely the content of the crude protein, crude fibre, crude fat, minerals, nitrogen free extract. By the formulas of Todorov and others (2004, 2007) it was calculated the content of FUG, FUM and PDI in ruminants.

$$GE = 0{,}0242\ CP + 0{,}0366\ EE + 0{,}0209\ CF + 0{,}017\ NFE$$

$$ME = 0{,}0152\ DP + 0{,}0342\ DEE + 0{,}0128\ DCF + 0{,}0159\ DNFE$$

$$q = \frac{ME}{GE}$$

$$FUM = ME\ (0{,}075 + 0{,}039q)$$

$$FUG = ME\ (0{,}04 + 0{,}1q)$$

$$PDI = 1{,}11CP\ (1 - Deg)\ Dsi + 0{,}093\ FOM$$

$$FOM = DOM - DEE - FP - CP\ (1 - P\Pi)$$

$$FP = 250 - 0{,}5\ DM$$

Statistical analysis: Using correlation analysis, it was identified and evaluated the correlation between survey indicators expressed by the coefficient of linear correlation of Pearson (r). Correlations are the product of mathematical and statistical processing of the output data on Genchev et al. (1975).

Mathematical data processing was carried out with the statistical program SPSS 13.

RESULTS AND DISCUSSIONS

Energy and protein nutritional value of forage is determined by their ability to meet animals' needs for energy and protein. Energy content in forage is crucial for the productivity of livestock. In ruminants, because of the different energy recovery from forage for lactation and growth, two indicators are used - feed unit for milk (FUM) and feed unit for growth (FUG).

Analysis of the results showed higher crude protein content in grain in the first experimental year. The content of crude protein moved within 153.5 - 169.4 g/kg DM for Diamond variety; from 156.9 to 158.7 g/kg DM for Bologna variety (Table 1). The average crude protein content in Diamond was 158.95 g/kg DM, while for Bologna it was 157.7 g/kg DM. Average for the varieties of crude protein content, in Diamond it was higher only 0.8% of the content recorded for variety Bologna. With respect of treatment options, in both wheat varieties were measured higher values of crude protein in the untreated form. Differences in options vary in a narrow range. In the second year, compared to the first year, results in Bologna variety were significantly lower for all options (Table. 2).

The chemical composition of grain is genetically determined, but is also influenced by the level of applied agricultural equipment.

GE – gross energy
ME – metabolizable energy, MJ/kg
CP – crude protein
DP – digestible protein
EE – Ether extract
DEE – digestible ether extract
CF – crude fibre
DCF – digestible crude fibre
NFE – nitrogen free extract
DNFE – digestible nitrogen free extract
Deg– degradability of dietary protein in the rumen
FOM – fermentable organic matter
DOM – digestible organic matter
FP – silage fermentable products

Table 1. Chemical composition of the grain of common wheat, g/kg DM, 2012

Variety	Variant	CP	EE	CF	NFE
	1	153.50	11.10	12.60	803.50
	2	158.00	11.90	13.90	797.30
Diamant	3	169.40	11.60	15.30	782.90
	4	157.00	10.60	14.20	799.00
	5	160.30	9.70	15.50	794.50
	6	155.50	10.90	16.30	798.20
	1	156.90	11.60	11.20	802.00
	2	157.60	12.30	10.80	801.30
Bologna	3	157.10	14.30	12.00	797.70
	4	158.20	13.20	10.80	798.50
	5	157.70	13.60	12.50	796.50
	6	158.70	12.98	11.10	797.80

Table 2. Chemical composition of the grain of common wheat, g/kg DM, 2014

Variety	Variant	CP	EE	CF	NFE
	1	136.30	12.40	12.90	822.50
	2	135.20	12.10	14.40	823.50
Diamant	3	142.10	14.20	15.60	809.70
	4	152.70	15.70	14.20	798.60
	5	159.30	13.40	12.50	798.20
	6	157.90	16.10	13.60	797.70
	1	115.40	13.70	13.00	841.90
	2	110.80	14.70	12.70	845.30
Bologna	3	118.30	14.60	12.20	839.70
	4	108.70	14.90	12.50	849.30
	5	111.30	12.60	12.90	848.80
	6	108.70	12.80	12.10	852.40

Table 3. Energy and protein value of wheat for ruminants in 1 кg DM

Variety	Variant	2011-2012			2013-2014		
		FUM	FUG	PDI	FUM	FUG	PDI
	1	1.45	1.61	106.21	1.47	1.64	103.84
	2	1.44	1.60	106.80	1.47	1.64	103.75
Diamant	3	1.43	1.58	108.31	1.46	1.62	104.25
	4	1.44	1.60	106.73	1.45	1.61	105.69
	5	1.44	1.59	107.19	1.45	1.61	107.10
	6	1.44	1.60	106.43	1.45	1.61	106.80
	1	1.45	1.61	106.80	1.49	1.67	100.62
	2	1.45	1.61	106.88	1.49	1.67	99.82
	3	1.45	1.61	106.52	1.49	1.67	101.06
Bologna	4	1.45	1.61	106.77	1.49	1.68	99.66
	5	1.45	1.60	106.58	1.49	1.68	10.25
	6	1.45	1.60	106.85	1.49	1.68	99.91

FUM – feed unit for milk (= 6 MJ net energy for lactation)
FUG – feed unit for growth (= 6 MJ net energy for growth)
PDI – protein digestible in (small) intestine

Agro-climatic characteristics of the region during the growing season have an important role in the formation of grain. It is scientifically proven that the influence of rainfall on the level of crude protein is significant (Delibaltova al. 2014). A reverse correlation was proven between these two factors, i.e. at a higher amount of precipitation, grain is formed with a lower crude protein content.

As a result of treatment with certain herbicides, it was reported a slight variation of the content of nutrition. In Diamond variety the content of FUM in 1kg DM in wheat grain was in the range of 1.43 to 1.45 1 kg DM in the first year FUM, and 1.45 to 1.47 1 kg DM FUM in the second year. The values of FUG moved in the range 1.58 - 1.61 1 kg DM in the first year, and 1.61 - 1.64 1 kg DM in the second year, respectively. In variety Bologna content of FUM and FUG in 1kg DM in wheat grain was 1.45 in the first year, and 1.49 1 kg DM in the second year, and was moving in the range 1.60 - 1.61 in the first year, and 1.67 - 1.68 1 kg DM in the second year. The results showed very weak influence of the applied herbicide during the crop vegetation.

The data for the content of PDI (Table. 3) showed that the applied methods of crop treatment did not affect the content. For Diamond variety it moved within 106.2-107.3, 1 kg DM for the agricultural period 2011-2012 and 103.8-107.1, 1 kg DM for the agricultural period 2013-2014. For variety Bologna again it was registered insignificant influence of the applied products for weed control.

Table 4. Correlation coefficients between the chemical composition of wheat grain, energy and protein nutritional value of wheat variety Diamond – 2012

	CP	EE	CF	NFE	FUG	PDI
CP	1					
EE	0.19	1				
CF	0.40	-0.31	1			
NFE	-0.99**	-0.20	-0.51	1		
FUG	-0.96**	-0.03	-0.62	0.97**	1	
PDI	0.99**	0.15	0.39	-0.98**	-0.96**	1
*,**- P<0.05, P< 0.01, respectively						

After the correlation analysis, the studied varieties of common wheat identified a high positive correlation PDI with the CP (r = 0.99, P<0.01) in Diamond variety for 2012. NFE was significantly correlated with FUG (r = 0.97, P<0.01). Fodder units for growth are negatively correlated (r = -0.62, P<0.01) with CF (Table 4).

Table 5. Correlation coefficients between the chemical composition of wheat grain, energy and protein nutritional value of wheat variety Bologna-2012

	CP	EE	CF	NFE	FUG	PDI
CP	1					
EE	0.15	1				
CF	-0.32	0.61	1			
NFE	-0.45	-0.87*	-0.64	1		
FUG	-0.58	-0.24	-0.45	0.64	1	
PDI	0.39	-0.79	-0.88*	0.64	0.09	1

The analysis of indicators in variety Bologna in 2012 established a lower degree of correlation PDI (r = 0.39, P <0.05) with CP and between FUG and NFE (r = 0.64 P <0.05).

The analysis of indicators set a degree of negative correlation of crude fibre (CF) (r = -0.88, P<0.05) with FUG (r = -0.45, P<0.05) (Table 5).

Table 6. Correlation coefficients between the chemical composition of wheat grain, energy and protein nutritional value of wheat variety Diamond-2014

	CP	EE	CF	NFE	FUG	PDI
CP	1					
EE	0.71	1				
CF	-0.37	0.18	1			
NFE	-0.97**	-0.83*	0.15	1		
FUG	0.95**	0.71	-0.42	0.92*	1	
PDI	0.99**	0.62	-0.47	-0.91*	0.94**	1

In the second year, in Diamond variety it was established again a high positive correlation of the PDI with the crude protein (CP) (r = 0.99, P<0.01), and in correlation with the FUG (r = 0.95, P<0.01), and significantly with NFE (r = 0.92, P<0.01).

Correlation coefficients, calculated in variety Bologna for 2014, showed quite different results from those of the same variety in 2012.

With high positive significant correlation is the PDI and CP (r = -0.94, P <0.01) and significant with the (r = 0.94, P <0.01), NFE was a significant positive correlation with a correlation forage unit for growth (FUG) (r = 0.89, P <0.05). Crude fibre are significant negative correlation with FUG (r = -0.20, P<0.05) (Table. 7).

Table 7. Correlation coefficients between the chemical composition of wheat grain, energy and protein nutritional value of wheat variety Bologna-2014

	CP	EE	CF	NFE	FUG	PDI
CP	1					
EE	0.21	1				
CF	0.08	-0.12	1			
NFE	-0.93**	-0.47	-0.21	1		
FUG	-0.75	-0.49	-0.20	0.89*	1	
PDI	0.94**	-0.03	-0.00	-0.81	-0.57	1

The analysis of correlations showed high positive correlation between PDI and CP for the two varieties (r=0.94-0.99) for the entire study period.

There was significantly high correlation dependence between NFE and FUG. For the whole period it was identified negative correlation between indicators FUG and CF.

CONCLUSIONS

The content of crude protein average for the period of the field study moved within 153.5 - 169.4 g/kg DM for variety Diamond and from 156.9 to 158.7 g/kg DM for variety Bologna.

Products for weed control did not significantly affect the content of FUM and FUG in the grain of the two wheat varieties.

Data analysis shows that the herbicides do not affect the levels of the PDI in the grain.

Correlation analysis shows a positive correlation between FUG and NFE ($r = 0.64 - 0.97$, $P < 0.01$), PDI and CP in two varieties ($r = 0.39 - 0.99$, $P < 0.01$) for the study period.

Crude fibre are significant negative correlation with FUG ($r = -0.20 - 0.62$, $P<0.05$).

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IMPACT OF SETTLEMENT POINTS ON SOME PROPERTIES OF A HIGHLAND RANGELAND VEGETATION OF EASTERN ANATOLIA REGION OF TURKEY

Mustafa SÜRMEN[1],Ali KOÇ[2]

[1]Adnan Menderes University, Faculty of Agriculture, Department of Field Crops, Aydın, Turkey
[2]Eskisehir Osman Gazi University, Faculty of Agriculture, Department of Field Crops, Eskisehir, Turkey

Corresponding author email:mustafa.surmen@adu.edu.tr

Abstract

In this study, three different rangeland sites were examined according to their attitude and usage degree in Kümbet village of Erzurum province during the year of 2004. Vegetation properties such as botanic composition, canopy coverage ratio, rangeland quality degree and health, carrying capacity, and similarity index were determined. Total 81 plants species were found in the experimental rangeland sites and sheep fescue (Festucaovina) was the dominant plant species at all sites. In botanic composition, the ratio of grasses, legumes and the other plant families were determined as 42.33%, 19.19% and 38.59% in average, respectively. Agropyron intermedium, Koeleria cristata and Bromus tomentollus from grasses; Astragallus microcephalus and Astragallus lagunus from legumes and Thymus parviflorus from the other families were the common plant species. Plant canopy coverage ratio was determined as 32.11%, 36.06%, and 58.24% at the I, II, and III rangeland sites, respectively. Rangeland site which has 35.47% quality score was evaluated as "Fair - at Risk Condition and health" class. In our study, rangeland site I was evaluated as "Poor –at Risk" condition and health class with 24.99% quality score, rangeland site II was evaluated as "Fair – at risk" condition and health class, and rangeland site III was evaluated as "fair - Healthy" condition and health class. In grazing season, rangeland carrying capacity was determined as 0.5 in I. site, 1.0 in II. site and 1.1 in III. site for Animal Unit.(AU) According to these results, 10 ha in site I, 5 ha in site II, and 3.18 ha in site III area were necessary for one AU during grazing season. Similarity index of rangeland plant canopy differed between 43 and 64. Current grazing management practices leads to overgrazing pressure especially around the permanent settlement; therefore, developing a suitable grazing management plan are necessary to provide sustainable use of the rangelands.

Key words:*Rangeland, botanical composition, canopy ratio, carrying capacity, similarity index.*

INTRODUCTION

Today, many countries in Africa, Northwestern and Southeastern Asia and Middle America come across insufficient feed sources and hunger problem in the world (Eswaren, 1996). Basic condition of meeting feed supply for increasing population is to increase production and keep sustainability of field crops and rangelands. The only way to overcome this problem is to increase production in a per unit area as agricultural lands are extremely limited.
Rangelands are highly important as they are enormous energy sources compared to agricultural lands (Lauenroth, 1979). They also play role on preventing erosion and protection of water resources, besides they are significant and cheap feed supplies. In addition, they maintain biological diversity since they are gene resources of plants and animals. Sustainability of the rangelands is important to challenge global warming. They are inevitable complements of country-life and wildlife (Holechek et al., 2004).
Sedentary husbandry system is common in the Eastern Anatolia, one of the important livestock region of Turkey. In summers, these rangelands are overgrazed; however, livestock are kept under shelter over harsh winters and fed on forage.
Overgrazing and over utilization of rangelands are main problems in Turkey. As a complementary damage of heavy grazing, erosion and deterioration of plant vegetation have been observed in many regions of the country. It was stated that Turkish rangelands have lost approximately 90% of their original vegetation (Gençkan et al., 1990). Therefore, losing plant vegetation of rangelands has accelerated erosion problem (Koç et al., 2000).

The rangelands which have been exposed to overgrazing are the close area to settling centers (Erkovan, 2000). After snow melts, livestock are grazed in close rangelands by owners until forming large flocks. After that, herders control and graze the herds in further rangelands. However, it does not mean that close rangelands are far from grazing pressure.

Overall these concept, this paper aimed to figure out the variation of rangeland vegetation under grazing concerning altitudes and distance to settling centers in Palandoken mountain ranges in Erzurum province of Turkey.

MATERIALS AND METHODS

The research was conducted in three rangeland sites (41º03’ long and 40º22’ lat), 18 km to Kumbet Village, in Erzurum province during the year of 2004. The altitude in the study area was between 1890 and 2100 m.

The rangeland was divided into 3 sites considering distance to settling area, altitude and utilization style. First site had 1820 m altitude, 200 m distance to settling center and 32% slope. This site was the closest to village and firstly grazed in early spring Therefore, this site was under heavy grazing during the season-long. The second site had about 1860 m altitude, 2 km distance to settling center and 13% slope. This site was grazed later than first site. So, it was hypothesized that grazing pressure in the second site would be less than first site because there is no grazing pressure upto the settlement’s animals combined into herds. The third site was the furthest zone to settling center (8 km distance to settling center) and had alpine characteristics with its high altitude (2100 m). It had slight slope (8%) and was mostly grazed by pre-milked heifers. First and second sites were under season-long grazing (no limitation), but grazing began in the middle of June and ended in the middle of September in third site.

Erzurum province located in Eastern Anatolia mainly has typical harsh continental climate. Mean of long term temperature and mean of long term precipitation of Erzurum are 5.7^{o}C and 435.6 mm, respectively (Anonimous, 2005). In the research year, climatic conditions were similar to long terms in temperature and precipitation.

Analysis for soil characters such as pH, organic matter, lime and salt content, available phosphor and potassium were done at the Laboratory of Directorate of Horticultural Research Institute. Results are presented in Table 1.

Concerning physical analysis; soil of the first range site was loamy, but the soil of the second and third range sites were clay loam.

The highest organic matter rate was found in the third range site with 4.94%, however; the lowest organic matter rate (0.87%) was found in the first range site. The second range site had 4.06%.

Soil pH of the range sites changed between 6.61 and 7.27. Lime contents of the first, second and third sites were 2.33%, 2.16% and 1.67%, respectively. Available phosphor was the lowest in the first site (41.1 kg ha^{-1}), highest in the second site 211.3 kg ha^{-1} and found 143.5 kg ha^{-1} in the third site. Available phosphor situations were sufficient in all sites according to Sezen (1991).

Table 1. Some physical and chemical properties of Rangeland sites

Soil characters	Rangeland sites		
	I	II	III
pH	7.27	6.61	6.91
Organic matter (%)	0.87	4.06	4.94
Lime (%)	2.33	2.16	1.67
Salt (%)	0.011	0.025	0.012
Phosphor (kg/da)	4.11	21.13	14.35
Potassium (kg/da)	136.97	140.33	143.16
Sand (%)	52.68	38.04	36.76
Silt (%)	31.84	36.52	36.65
Clay (%)	15.48	25.44	26.59
Texture class	loam	Clay loam	Clay loam

Botanical composition of the range sites were determined using the line-intercept method developed by Canfield (1941) in July of the year. Measurements were performed using 8 line intercept transects (for 10 m interval over a fixed 80 m length) considering the base area. The range condition score, condition and health classification were determined for each range site using the average botanical composition values according to Koc et al., (2003) criteria, consisting of a combination of (Dyksterhius, 1949) range condition classification and rangeland health methods of the Committee on

Rangeland Classification (National Research Council, 1994).

The percentage of vegetation cover-area was determined using the data used for determination of botanical composition (Gokkus et al., 2000).

In assessment of rangeland carrying capacity, the data of rangeland class and health based on grazing severity and particularly ecological factors were used, since rangeland feed was not able to be determined (Koc et al., 2003). In rangeland carrying capacity, 500 kg live weight was based for livestock.

Grazing period in Erzurum location is about 5 months (Koc, 1991). Therefore, grazing periods for the first and the second range sites regarded as 150 days; and 105 days for the third days regarding villagers' declarations.

Similarity indexes of the vegetation were calculated in the direction of Bakir (1970) and Okatan (1987) as follows:

$$(SI) = \frac{2W}{a+b} \times 100$$

SI: Similarity index

W: sum of least common values in the vegetation belonging to compared rangelands.

a: sum of botanical composition rates of common plant species which exist in the first location

b: sum of botanical composition rates of common plant species which exist in the second location

In order to compare the data obtained from 3 different sites of the experimental areas, arc sine transformation was applied to relative values (Cox 2002) after that, data were analyzed of variance at $p \leq 0.05$ and 0.01 levels of significance and means were compared using the least significant difference test at $p \leq 0.05$.

RESULTS AND DISCUSSIONS

Totally 81 plant species including 15 grasses, 11 legumes and 55 other families were determined in the three sites of the experimental area. In the botanical composition considering families, it was figured out that almost half of the plant species (42.23%) belonged to grass family. The other species followed the grasses (38.59%). Legumes had the lowest rate of the botanical compositions (19.19%) (Table 2).

Table 2. Botanical compositions of Rangeland sites

Plant species	I	II	III	Means	F	The mean square error
Agropyron intermedium	0.74 **B**	6.87 **A**	11.50 **A**	6.37	18.77**	12.41
Bromus tomentollus	0.64	4.27	2.63	2.51	3.20	8.23
Festuca ovina	21.06	30.30	28.62	26.66	1.67	116.23
Koeleria cristata	0.51 **b**	5.97 **a**	4.59 **a**	3.69	4.88*	43.31
Other grasses [11]	7.62 **A**	0.42 **B**	0.95 **B**	3.00	13.89**	9.27
Total	30.58 **B**	47.82 **A**	48.29 **A**	42.23	10.33**	78.88
[11] *Bromus erectus, Bromus inermis, Bromus japonicus, Bromus tectorum, Catabrocella parviflora, Dactylis glomerata, Elymus hispata, Poa bulbosa, Poa pratensis, Poa trivialis, Stipa lagascae*						
Astragalus lagurus	1.55	0.75	3.24	1.85	0.58	22.31
Astragalus microcephalus Other legumes[22]	6.81 **a**	3.44 **ab**	0.88 **b**	3.71	5.34*	52.11
Total	8.78 **b**	10.51 **b**	21.62 **a**	13.64	4.86*	79.85
	17.14	14.69	25.74	19.19	3.69	72.92
[22] *Astragalus lineatus, Astragalus ornitopodoides, Astragalus pinoterum, Medicago lupiluna, Medicago papillosa, Medicago varia, Onobrychis* spp., *Trifolium hybridum, Trigonella* spp.						
Thymus parviflorus	14.43 **A**	8.37 **AB**	1.38 **B**	8.86	9.57**	35.65
Other familes[33]	37.86	29.13	24.59	30.53	3.68	98.74
Total other families	52.29 **a**	37.50 **b**	25.97 **b**	38.59	21.01*	66.26
[33] *Acantalimon caryophila, Achilla biebersteyni, Achilla millefolium, Acinos rotundifolius, Alchemmilla* spp., *Allium* spp., *Alysum desertorum, Alysum minus, Anthemis cretica, Arenaria gypsophoides, Artemisia austriaca, Artemisia spisigera, Campanula* spp., *Carex* spp., *Carum carvi, Cenecio* spp., *Centaurea carduiformis, Centaurea sessilis, Chenepodium* spp., *Convolvulus lineatus, Eriyngium campestre, Erysimum leptocarpum, Euphorbia esula, Falcaria vulgris, Ferula* spp., *Galium* spp., *Gerenium* spp., *Gundellia* spp., *Herniaria incana, Lagotis stolonifera, Marrubium* spp., *Minuartia* spp,.*Muscari* spp., *Ornitogalum* spp., *Polygonum auculare, Potentilla argea, Potentilla bifurca, Rumex* spp., *Salvia* spp., *Salvia verticillata, Scariola wiminea, Scleranthus annuus, Scorzonera* spp., *Sessilis* spp., *Slene* spp., *Tanacetum abrotanifolium, Tanacetum absinthifolium, Tanacetum balsamita, Tanacetum* spp., *Taraxacum* spp., *Teucrium polium, Thesium* spp., , *Veronica oriemtalis, Xeranthemum annuum*						

According to analysis of variance, significant differences were found among the rangeland sites in both family groups and species ratios concerning botanical compositions (Table 2).

The ratios of *Agropyron intermedium* and *Koeleria cristata* in the botanical composition showed s tatistically significant differences in

experiment area ($p<0.01$ and $p<0.05$, respectively).
Average ratio of *Festuca ovina* which was the dominant species in range sites was found 26.66% and it did not show any statistically significant differences regarding botanical homogeneity in the range sites.
There was no statistically significant difference among the plant species belonging to legumes which are extremely important for animal feeding and fixing nitrogen. The most common legume species in three range sites were *Astragalus* spp. which has no feeding value. *Astragalus microcephalus* was common in first and second range sites; however, *Astragalus lagurus* was common in third site. The botanical composition ratios of these legume species were over 1%. Botanical variation of *Astragalus lagurus* was insignificant but it was statistically significant for *Astragalus microcephalus* regarding range sites ($p<0.05$).
Thymus parviflorus, belonging neither legumes nor grasses and one of the most common species after grasses, showed statistically significant variation in the sites ($p<0.01$).
Among the range sites, plant coverage rates showed statistically significant difference ($p<0.01$) (Table 3). The highest and the lowest coverage rates were found in the third range site (58.24%) and first range site (32.11%), respectively. The second range site had 36.06% plant coverage rate but no statistically significant difference was determined between the first site and second site.

Table 3. Plant covering percentages of Rangeland sites (%)

	Rangeland sites					
	I	II	III	Means	F	The mean square error
Plant Coverage Rates	32.11 B	36.06 B	58.24 A	42.14	26.07**	60.86
Rangeland Score	24.99	43.01	38.94	35.47		
Classification of Rangeland condition and health	Poor - At Risk	Fair – at Risk	Fair - Healthy	Fair - Healthy e		
Stocking Rate (Animal Unit (AU))	0.5	1.0	1.1	0.86		
The area for a cattle unit (ha)	10	5	3.18	6.06		

As an average experimental range sites had 35.47 quality score and were placed in Fair- at Risk condition and health class. Comparing range sites, the first site was in Poor – at Risk with 24.99 quality score, the second site was in Fair at Risk, and finally the third site was located in the group of Fair - Healthy condition and health class.
Table 3 shows that the first site provides feed for 0.5 AU per month, the second site supplies feed for 1.0 AU per month, and the third site meets the feed requirement for 1.1 AU per month. Considering grazing periods (5 months for I. and II. sites; 3.5 months for III. Site); for an AU, 10, 5 and 3.18 ha rangelands should be allocated in the first, second and third range sites, respectively.
While the lowest similarity percentage among the range sites was found between the first and third sites (43%), it was determined between the first and second range sites with (64%) (Table 4).

Table 4. Similarity indexes of different rangeland sites(%)

Rangeland sites	I-II		I-III	II-III
Similarity index	64		43	62

Results from the experiment show that rangeland have lost more than half of their potential performance. This is an indication that they have been misused for long time. So far, none of range site have got half of total rangeland score at the researches which were conducted in the region concerning De Vries et al. (1951) and the calculations on range classification.
Deterioration in the rangelands close to settling areas were higher than further rangelands as closer rangeland to settling areas are started to graze, as soon as snow melts and they are grazed until next snowing without any control. In addition to heavy grazing, early grazing is

also serious problem on rangelands, especially the rangelands close to permanent settlements. . The basic dilemma on rangelands far from settling areas is heavy grazing. Therefore, precautions should be taken to heavy and early grazing and proper grazing systems should be established.
Plant covering percentage of the rangelands close to settling areas was around the critical value. Even the data below the critical value was obtained in some experiments. This situation is a rather handicap for erosion concept. Taking preventive measures are essential so as to keep the soil in rangeland and increase the yield.

CONCLUSIONS

Rangeland classification is closely dependent on the ratios of desired species in botanical composition. It is only possible with the precautions which activate the growth of desired species and suppress undesired species such as controlling livestock rate and grazing severity etc. If not possible, weed control (undesired species) should not be considered. Even though these plants are not preferred by livestock, these plants take extremely efficient role to protect soil against erosion. However, rangeland improvement systems and grazing management should be applied in all rangelands of Turkey.

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PROJECTIONS OF CHANGES IN PRODUCTIVITY OF MAJOR AGRICULTURAL CROPS IN THE REPUBLIC OF MOLDOVA ACCORDING TO CMIP5 ENSEMBLE OF 21 GCMs FOR RCP2.6, RCP4.5 AND RCP8.5 SCENARIOS

Lilia ȚĂRANU

Climate Change Office, Ministry of Environment of the Republic of Moldova
156A Mitropolit Dosoftei St., Office 37, MD 2004, Chisinau, Republic of Moldova

Corresponding author email: tsaranu.lilia@gmail.com

Abstract

In present study, relationships between observed mean temperature and precipitation during growing season and average annual crop yield based on statistical data at the Republic of Moldova's agricultural enterprises of various categories were explored and then used to estimate potential impacts of climate change scenarios on anticipated average yields by 2035 (2016–2035), by 2065 (2046–2065), and by 2100 (2081-2100) on national and district level, based on the projected changes from the CMIP5 multi-model ensemble of the 21 GCMs used for AR5 of the IPCC, covering the end of 20th (reference period) and 21st (scenario) centuries introduced by three Representative Concentration Pathways (RCPs): RCP 8.5, RCP 4.5, and RCP 2.6. The typical winter (Triticum aestivum L.) and summer (Zea mays, Helianthus annuus L., Beta vulgaris L. and Nicotiana L.) crops were considered in this study in order to analyze the specific interactions between the changing climate and crops having different seasonal growth cycles. In these circumstances, without undertaken any adaptation measures, it can be expected on national level by 2100: a significant drop in the productivity for grain corn, from 34% (RCP 2.6) to 67% (RCP 4.5); and winter wheat, from 22% (RCP 2.6) to 46% (RCP 4.5); a medium drop in the productivity for sunflower from 16% (RCP 2.6) to 57% (RCP 8.5), respectively for sugar beet, from 9% (RCP 2.6) to 37% (RCP 8.5); and for tobacco, from 10% (RCP 2.6) to 30% (RCP 8.5), in comparison with the average productivity of the Republic of Moldova's major agricultural crops in the most recent period of 1981-2010. Due to changes in climatic conditions in the Republic of Moldova, by the end of the XXI century, the cultivation of grain corn and winter wheat will be impossible according to the RCP 8.5 high emission scenario.

***Key words**: crop yield, climate change, impact assessment, statistical models.*

INTRODUCTION

The regional distribution of climate change impacts on agricultural production is likely to vary widely (Donatelli et al., 2012; Iglesias et al., 2012). Southern Europe would experience the largest yield losses -25% by 2080 under a 5.4°C warming (Ciscar et al., 2011), with increased risks of rainfed summer crop failure (Ferrara et al., 2010; Bindi and Olesen, 2011). Warmer and drier conditions by 2050 (Trnka et al., 2011) would cause moderate declines in crop yields in Central Europe regions (Ciscar et al., 2011). The Republic of Moldova, without undertaken any adaptation measures could expect by 2080s: the significant drop in yield for grain maize from 49% (SRES B1) to 74% (SRES A1B), and winter wheat from 38% (SRES B1) to 71% (SRES A2); medium drop in yield for sunflower from 11% (SRES B1) to 33% (SRES A2), respectively for sugar beet from 10% (SRES B1) to 20% (SRES A2); and for tobacco from 9% (SRES B1) to 19% (SRES A2), in comparison with the average productivity of the Republic of Moldova's major agricultural crops in the most recent period of 1981-2010 (Taranu, 2014). For climate change impact assessment, crop growth models have been widely used to evaluate crop responses (development, growth and yield) by combining future climate conditions, obtained from General or Regional Circulation Models (GCMs and RCMs, respectively), with the simulation of CO_2 physiological effects, derived from crop experiments (Ainsworth et al., 2005). Crop models have been used to examine a large number of management and environmental conditions, such as interactions among various components of food production systems (Lenz-Wiedemann et al., 2010), determination of optimum crop management practices (Soltani and Hoogenboom, 2007), vulnerability and adaptability assessments (Sultana et al., 2009), evaluation of water consumption and water use efficiency (Kang et al., 2009). The robustness of crop model results depends on data quality, model skill prediction, and model complexity (Bellocchi et al., 2010). Modeling and experiments are each subject to their own uncertainties. For example, interactions among CO_2 fertilization, temperature, soil nutrients, O_3, pests, and weeds are not well understood (Soussana et al., 2010) and therefore most crop models do not include all of these effects, or broader issues of water availability, such as competition for water between industry and households (Piao et al., 2010). There are also uncertainties associated with generalizing the results of field experiments, as each one has been conducted relatively few times under a relatively small range of environmental and management conditions, and for a limited number of genotypes. This limits breadth of applicability both through limited sample size and limited representation of the diversity of genotypic responses to environment (Craufurd et al., 2013). The use of multiple crop models in impacts studies is relatively rare. Field-scale historical model intercomparisons have shown variations in the simulation of mean yield and above-ground biomass of more than 60% (Palosuo et al., 2011). Early results from impacts studies with multiple crop models suggest that the crop model uncertainty can be larger than that caused by GCMs, due in particular to high temperature and temperature-by-CO_2 interactions (Asseng et al., 2013).

Statistical models offer a complement to more process-based model approaches, some of which require many assumptions about soil and management practices. Process-based models, which extrapolate based on measured interactions and mechanisms, can be used to develop a causal understanding of the empirically determined relationships in statistical models (Schlenker and Roberts, 2009; Lobell et al., 2013a). Although statistical models forfeit some of the process knowledge embedded in other approaches, they can often reproduce the behavior of other models (Iglesias et al., 2000; Lobell and Burke, 2010) and can leverage within one study a growing availability of crop and weather data (Lobell et al., 2011b). Statistical models usually exclude the direct impact of elevated CO_2, making multi-decadal prediction problematic. In determining future trends, crop models of all types can extrapolate only based on historically determined relations.

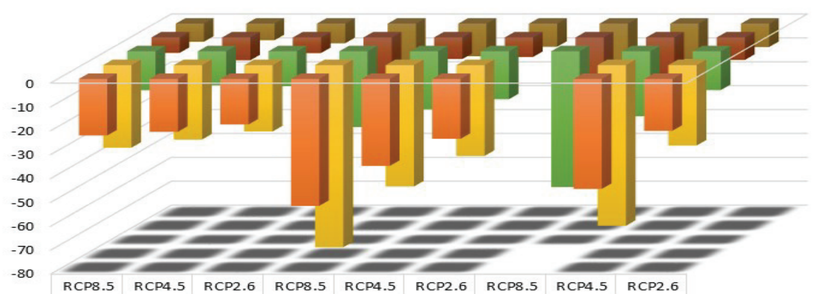
The purpose of this study was to (i) examine the statistic-empirical relationships between observed mean temperature and precipitation during growing season and average crop yield, based on yield data at the Republic of Moldova's agricultural enterprises of various categories, and (ii) use these relationships to postulate possible projections of future changes in yield of these crops by 2035 (2016–2035), by 2065 (2046–2065) and by 2100 (2081-2100) on national and district level, based on the projected changes from the CMIP5 multi-model ensemble of the 21 GCMs used for AR5 of the IPCC, covering the end of 20th (reference period) and 21st (scenario) centuries introduced by three Representative Concentration Pathways (RCPs): RCP 8.5, RCP 4.5, and RCP 2.6. The typical winter (*Triticum aestivum* L.) and summer (*Zea Mays, Helianthus annuus* L., *Beta vulgaris* L. and *Nicotiana* L.) crops were considered in this study in order to analyze the specific interactions between the changing climate and crops having different seasonal growth cycles.

MATERIALS AND METHODS

The assessment of the climate change impact on agricultural sector was made based on projections of changes in temperature and precipitation received by regionalization of global experiments the most reliable in the Republic of Moldova of CMIP5 21 GCMs experiments for RCP 8.5, RCP 4.5 and RCP 2.6 emission scenarios. To assess the vulnerability of main agricultural crops to climate change was used empirical-statistical approach linking fluctuations of crops production yields to climate conditions during the growing season. Additionally to the national level, we have assessed the impact of temperature and precipitation during the growing season on major crop productivity in the Republic of Moldova's territorial administrative units (district level) in order to distinguish the most and least vulnerable to climate change crop production districts see more in Taranu, 2014.

RESULTS AND DISCUSSIONS

The possible changes in the yield of major agricultural crops (winter wheat, grain maize, sunflower, sugar beet and tobacco), due to future climate changes in the Republic of Moldova, without undertaken any adaptation measures, according to the CMIP 5 Ensemble of 21 GCMs for RCP 8.5, RCP 4.5, and RCP 2.6 emission scenarios is shown in Figure 1.



	RCP8.5	RCP4.5	RCP2.6	RCP8.5	RCP4.5	RCP2.6	RCP8.5	RCP4.5	RCP2.6
	2016-2035			2046-2065			2081-2100		
Winter wheat	-24	-22	-19	-53	-36	-25		-46	-22
Grain maize	-35	-31	-28	-76	-51	-38		-67	-34
Sunflower	-16	-14	-15	-32	-24	-20	-57	-27	-16
Sugar beet	-6	-10	-7	-18	-9	-8	-37	-17	-9
Tobacco	-8	-7	-8	-18	-14	-10	-30	-15	-10

Figure 1. Projections of Future Changes in Productivity of Major Agricultural Crops in the Republic of Moldova, (%/30 years) Relative to 1981-2010 Current Period, According to the CMIP 5 Ensemble of 21 GCMs for RCP 8.5, RCP 4.5, and RCP 2.6 emission scenarios

The impact assessment performed on national level allow conclude that the negative effect of global warming, according to the CMIP 5 Ensemble of 21 GCMs for RCP 8.5, RCP 4.5, and RCP 2.6 emission scenarios in the XXI century will not be offset by increase of precipitations. In these circumstances, without undertaken any adaptation measures, it can be expected by 2100: a significant drop in the productivity for grain corn, from 34% (RCP 2.6) to 67% (RCP 4.5); and winter wheat, from 22% (RCP 2.6) to 46% (RCP 4.5); a medium drop in the productivity for sunflower from 16% (RCP 2.6) to 57% (RCP 8.5), respectively for sugar beet, from 9% (RCP 2.6) to 37% (RCP 8.5); and for tobacco, from 10% (RCP 2.6) to 30% (RCP 8.5), in comparison with the average productivity of the Republic of Moldova's major agricultural crops in the most recent period of 1981-2010. Due to changes in climatic conditions in the Republic of Moldova, by the end of the XXI century, the cultivation of grain corn and winter wheat will be impossible according to the RCP 8.5 high emission scenario.

Additionally to the national level we have assessed the impact of temperature and precipitation during the growing season on agricultural crops productivity in the Republic of Moldova's territorial administrative units (district level), in order to distinguish the most and least vulnerable districts to climate change.
According to projections, the most vulnerable districts for cultivation of winter wheat will be Basarabeasca, Taraclia, Cimislia, Causeni, Cahul, and Stefan Voda in Southern, and Dubasari, Anenii Noi, Hincesti, Ialoveni, Nisporeni, Criuleni, Telenesti and Orhei, in Central AEZs, in which productivity of the winter wheat may decrease from 19-26% under RCP 2.6 to 52-63% under RCP 4.5 by 2100.
The least vulnerable districts for cultivation of winter wheat production will be Donduseni, Briceni, Riscani, Soroca, and Singerei in the Northern AEZ; and Ungheni, Calaras and Soldanesti in Central AEZs, in which productivity of the winter wheat by 2100 could decrease from 8 to 28% under RCP 2.6 and/or from 69 to 94% under RCP 8.5 (Table 1).

Table 1. Projected Winter Wheat Yield Changes Relative to the Current Situation (%/30 Year) under the CMIP 5 Ensemble of 21 GCMs for RCP 8.5, RCP 4.5, and RCP 2.6 emission scenarios

AEZs/district	1981-2010, q/ha	2016-2035			2046-2065			2081-2100		
		RCP8.5	RCP4.5	RCP2.6	RCP8.5	RCP4.5	RCP2.6	RCP8.5	RCP4.5	RCP2.6
Northern AEZ										
Briceni	33.5	-19	-20	-19	-41	-31	-22	-75	-39	-22
Donduseni	29.0	-23	-18	-20	-49	-35	-23	-90	-41	-19
Drochia	32.1	-14	-13	-16	-36	-25	-19	-81	-37	-19
Edinet	30.0	-17	-19	-15	-45	-26	-23	-86	-42	-24
Falesti	32.4	-27	-23	-22	-56	-38	-28		-52	-26
Floresti	29.3	-29	-26	-25	-64	-42	-30		-57	-29
Glodeni	33.6	-24	-20	-20	-52	-35	-25	-97	-48	-24
Ocnita	30.4	-21	-24	-19	-49	-30	-28	-91	-47	-28
Riscani	31.4	-15	-16	-13	-37	-22	-20	-69	-34	-21
Singerei	30.6	-18	-19	-14	-45	-29	-24	-83	-42	-28
Soroca	29.5	-16	-17	-13	-40	-25	-21	-76	-38	-24
Central AEZ										
Anenii Noi	28.1	-29	-27	-23	-73	-48	-32		-63	-26
Calaras	24.9	-17	-16	-14	-46	-30	-19	-89	-39	-16
Criuleni	30.4	-22	-20	-14	-60	-39	-25		-52	-19
Dubasari	29.6	-26	-25	-20	-71	-47	-30		-62	-24
Hincesti	27.1	-26	-24	-20	-67	-44	-28		-58	-23
Ialoveni	26.6	-26	-24	-20	-66	-44	-28		-57	-23
Nisporeni	27.3	-23	-22	-19	-66	-43	-27		-57	-21
Orhei	28.3	-27	-25	-21	-65	-44	-29		-56	-25
Rezina	25.0	-24	-22	-19	-56	-38	-25		-48	-21
Straseni	26.5	-22	-20	-17	-55	-36	-24		-47	-21
Soldanesti	25.5	-21	-19	-16	-48	-32	-21	-94	-41	-18
Telenesti	25.1	-29	-26	-21	-66	-44	-30		-57	-25
Ungheni	30.9	-11	-9	-6	-32	-20	-11	-69	-27	-8
Southern AEZ										
Basarabeasca	25.5	-25	-24	-17	-68	-46	-30		-63	-27
Cahul	26.4	-24	-24	-19	-64	-43	-29		-56	-24
Cantemir	26.4	-19	-18	-13	-45	-30	-20	-88	-40	-17
Causeni	26.6	-24	-23	-17	-62	-42	-28		-57	-23
Cimislia	26.1	-25	-24	-18	-61	-43	-29		-57	-26
Leova	26.1	-20	-19	-14	-47	-32	-22	-92	-42	-19
Stefan Voda	30.2	-24	-23	-18	-60	-41	-29		-56	-24
Taraclia	28.7	-24	-23	-16	-63	-42	-27		-58	-24

Due to climate change the most vulnerable for grain corn cultivation would be the Central and in less extent the Northern and Southern AEZs. The most vulnerable districts will be Orhei, Anenii Noi, Straseni, Ialoveni, Nisporeni, Telenesti, Ungheni, Calarasi, Criuleni and Dubasari; and UTA, Basarabeasca, Cahul, Taraclia, and Stefan Voda in Southern AEZ, in which yield of the grain corn may decrease by 2100 from 28 to 50% (RCP 2.6) and/or up to 58-91% (RCP 4.5). The significant drop in grain corn yield from 65 to 100% under RCP 8.5 emission scenario is projected in Northern AEZ by 2100 relative to 1981-2010 reference period. The least vulnerable districts to climate change will be Donduseni, Drochia, Falesti, and Ocnita in Northern; Rezina, and Soldanesti in Central, and Leova in Southern AEZs, in which productivity of the grain corn may decrease by 2100, in dependence of the assessed emission scenario from 7 to 23% (RCP 2.6) and/or from 25 to 49% (RCP 8.5).

Without adaptation, due to changes in climatic conditions in the most districts of the Republic of Moldova, by the end of the XXI century, the cultivation of grain corn and winter wheat will be impossible according to the RCP 8.5 high emission scenario or economically not cost effective under the RCP 4.5 medium emission scenario (Table 2).

The most vulnerable for sunflower cultivation without application of adaptation measures, would be Central AEZ and in less extent Northern and Southern AEZs. According to projections, the most vulnerable districts will be Ialoveni, Hincesti, Straseni, Telenesti, Anenii Noi, Dubasari, and Orhei in Central AEZ, in which productivity of sunflower by 2100 may decrease from 23 to 37% (RCP 2.6) and/or from 44 to 76% (RCP 4.5).

Table 2. Projected Grain Corn Yield Changes Relative to the Current Situation (%/30 Year) under the CMIP 5 Ensemble of 21 GCMs for RCP 8.5, RCP 4.5, and RCP 2.6 emission scenarios

AEZs/district	1981-2010, q/ha	2016-2035			2046-2065			2081-2100		
		RCP8.5	RCP4.5	RCP2.6	RCP8.5	RCP4.5	RCP2.6	RCP8.5	RCP4.5	RCP2.6
Northern AEZ										
Briceni	36.0	-52	-51	-46		-88	-60			-50
Donduseni	28.9	-16	-15	-17	-35	-30	-16	-65	-25	-7
Drochia	25.1	-22	-24	-19	-49	-34	-25	-88	-34	-17
Edinet	28.6	-40	-37	-33	-87	-59	-41		-66	-31
Falesti	24.2	-19	-23	-20	-48	-33	-25	-88	-45	-29
Floresti	28.6	-46	-48	-40		-76	-55			-48
Glodeni	29.1	-33	-32	-27	-77	-49	-33		-56	-23
Ocnita	36.7	-21	-19	-16	-52	-34	-20	-93	-38	-16
Riscani	31.1	-38	-38	-29	-98	-62	-43		-73	-33
Singerei	26.2	-46	-45	-38		-76	-52		-90	-42
Soroca	30.7	-37	-38	-33	-90	-60	-40		-71	-33
Central AEZ										
Anenii Noi	25.3	-44	-48	-41		-78	-54			-47
Calaras	24.8	-35	-36	-32	-89	-60	-41		-77	-37
Criuleni	28.5	-53	-48	-44		-76	-54		-91	-44
Dubasari	28.6	-45	-43	-38		-68	-49		-83	-41
Hincesti	24.9	-35	-37	-31	-85	-57	-40		-72	-35
Ialoveni	26.5	-42	-44	-38		-71	-49		-89	-43
Nisporeni	27.5	-43	-44	-38		-71	-49		-88	-43
Orhei	24.0	-49	-51	-44		-82	-57			-50
Rezina	24.3	-24	-24	-17	-57	-37	-26		-49	-23
Straseni	23.8	-45	-45	-39		-74	-51		-93	-44
Soldanesti	23.6	-23	-25	-18	-55	-35	-26		-46	-22
Telenesti	19.7	-38	-41	-34	-89	-59	-43		-73	-36
Ungheni	34.3	-29	-28	-23	-68	-46	-32		-58	-28
Southern AEZ										
Basarabeasca	24.8	-30	-33	-27	-76	-52	-33		-69	-34
Cahul	27.0	-42	-42	-35	-99	-67	-47		-85	-40
Cantemir	23.8	-27	-29	-25	-64	-43	-30		-52	-25
Causeni	25.1	-31	-32	-28	-73	-49	-35		-60	-28
Cimislia	20.6	-31	-33	-26	-84	-54	-33		-69	-33
Leova	24.7	-21	-24	-19	-54	-36	-24		-45	-21
Stefan Voda	26.5	-31	-30	-26	-69	-47	-34		-58	-28
Taraclia	27.6	-31	-33	-28	-77	-52	-35		-65	-30
UTA	26.0	-32	-35	-29	-82	-55	-37		-69	-32

The least vulnerable for sunflower cultivation districts will be Floresti, Falesti, Riscani, Briceni, Donduseni, Drochia, Edinet, Ocnita, Singerei, and Soroca in Northern AEZ in which productivity of sunflower may decrease by 2100, from 4 to 15% (RCP 2.6) and/or from 17 to 40% (RCP 4.5). Without adaptation measures due to changes in climatic conditions in the most districts of the Republic of Moldova, by the end of the XXI century, the cultivation of sunflower will be impossible or economically not cost effective according to the RCP 8.5 high emission scenario (Table 3). According to projections, without application of adaptation measures, the most vulnerable districts for sugar beet cultivation will be Glodeni, Drochia, Falesti, Floresti, and Singerei in Northern; Telenesti, Orhei, and Rezina in Central AEZs, in which productivity of sugar beet may decrease by 2100 from 14 to 27% (RCP 2.6) and/or from 65 to 87% (RCP 8.5). The least vulnerable districts for sugar beet cultivation will be Briceni and Donduseni in Northern; and Ungeni in Central AEZs, in which productivity of the sugar beet may increase by 2100 from 2 to 9% (RCP 2.6) and/or from 9 to 34% (RCP 8.5), in comparison with the reference period. Increase in the productivity of sugar beet is also projected for Edinet and Ocnita districts in Northern AEZ, however the yield trends in reference period (1981-2010) are statistically significant on the lowest significant level ($p \leq 0.1$), so it can be noted just a tendency to yield increase in these districts (Table 4).

The most vulnerable to climate change tobacco areas in the Republic of Moldova would be Northern, Central and in less extent Southern AEZs. The most vulnerable districts for tobacco cultivation will be Donduseni, Briceni, Ocnita, Edinet, Soroca, Floresti, Riscani, and Glodeni in the Northern; Nisporeni, and

Ungheni districts in Central; and Cimislia in Southern AEZs, in which tobacco productivity could decrease from 23 to 56% (RCP 2.6) and/or from 47 to 98% (RCP 4.5).

The least vulnerable districts for tobacco cultivation will be Cantemir, Leova,

Table 3. Projected Sunflower Yield Changes Relative to the Current Situation (%/30 Year) under the CMIP 5 Ensemble of 21 GCMs for RCP 8.5, RCP 4.5, and RCP 2.6 emission scenarios

AEZs/district	1981-2010, q/ha	2016-2035			2046-2065			2081-2100		
		RCP8.5	RCP4.5	RCP2.6	RCP8.5	RCP4.5	RCP2.6	RCP8.5	RCP4.5	RCP2.6
Northern AEZ										
Briceni	16.3	-21	-16	-16	-53	-35	-22	-97	-40	-15
Donduseni	15.4	-20	-17	-17	-51	-33	-20	-95	-39	-14
Drochia	18.3	-20	-16	-16	-49	-31	-20	-91	-37	-13
Edinet	17.0	-19	-17	-17	-49	-31	-20	-93	-37	-14
Falesti	16.2	-9	-8	-8	-25	-15	-11	-51	-22	-9
Floresti	15.7	-9	-7	-9	-24	-15	-8	-46	-17	-4
Glodeni	19.7	-16	-12	-14	-40	-25	-15	-76	-31	-10
Ocnita	16.5	-17	-15	-15	-43	-27	-18	-82	-33	-13
Riscani	16.4	-5	-4	-5	-17	-10	-5	-35	-12	-1
Singerei	17.2	-12	-11	-11	-33	-20	-14	-65	-27	-11
Soroca	15.4	-10	-7	-9	-26	-17	-8	-50	-19	-4
Central AEZ										
Anenii Noi	12.2	-36	-32	-32	-74	-55	-42		-63	-33
Calaras	11.7	-22	-19	-19	-49	-32	-27	-90	-46	-26
Criuleni	15.2	-29	-25	-25	-60	-44	-35		-51	-28
Dubasari	13.3	-29	-27	-26	-66	-46	-33		-57	-29
Hincesti	13.8	-30	-28	-26	-70	-49	-35		-60	-31
Ialoveni	13.5	-37	-35	-33	-88	-61	-43		-76	-37
Nisporeni	14.9	-17	-16	-18	-45	-35	-27	-90	-45	-21
Orhei	14.5	-29	-28	-27	-68	-47	-32		-58	-30
Rezina	12.7	-21	-19	-19	-44	-33	-26	-80	-38	-22
Straseni	12.7	-23	-21	-20	-51	-37	-27	-92	-44	-23
Soldanesti	14.0	-10	-9	-9	-25	-16	-15	-48	-26	-15
Telenesti	13.8	-28	-26	-25	-67	-45	-31		-59	-27
Ungheni	16.5	-12	-11	-12	-29	-20	-18	-53	-28	-16
Southern AEZ										
Basarabeasca	12.4	-36	-37	-31	-87	-60	-42		-76	-37
Cahul	11.3	-17	-16	-15	-31	-21	-15	-57	-23	-11
Cantemir	13.6	-9	-10	-9	-21	-15	-11	-43	-18	-8
Causeni	12.9	-25	-24	-22	-57	-40	-30		-49	-24
Cimislia	13.4	-36	-36	-31	-86	-59	-42		-75	-35
Leova	12.7	-17	-19	-15	-43	-30	-20	-80	-37	-16
Stefan Voda	13.5	-19	-20	-17	-47	-31	-23	-85	-40	-20
Taraclia	10.5	-16	-15	-14	-28	-17	-13	-49	-19	-8
UTA	10.4	-12	-14	-8	-30	-20	-14	-62	-28	-10

Table 4. Projected Sugar Beet Yield Changes Relative to the Current Situation (%/30 Year) under the CMIP 5 Ensemble of 21 GCMs for RCP 8.5, RCP 4.5, and RCP 2.6 emission scenarios

AEZs/district	1981-2010, q/ha	2016-2035			2046-2065			2081-2100		
		RCP8.5	RCP4.5	RCP2.6	RCP8.5	RCP4.5	RCP2.6	RCP8.5	RCP4.5	RCP2.6
Northern AEZ										
Briceni	250.3	3	2	1	6	6	5	9	3	3
Donduseni	228.7	10	5	5	21	17	11	34	17	9
Drochia	258.9	-18	-20	-16	-47	-31	-24	-87	-45	-25
Edinet	213.9	7	1	3	11	9	5	22	12	4
Falesti	284.1	-18	-22	-16	-45	-26	-21	-87	-40	-20
Floresti	225.7	-12	-16	-11	-31	-17	-14	-65	-30	-16
Glodeni	262.9	-14	-14	-12	-38	-23	-17	-68	-34	-17
Ocnita	227.6	12	8	7	28	20	13	48	23	9
Riscani	251.0	-3	-6	-4	-13	-6	-4	-23	-10	-4
Singerei	250.5	-25	-26	-24	-60	-40	-28		-52	-27
Soroca	207.1	-7	-13	-8	-20	-9	-8	-43	-19	-10
Central AEZ										
Orhei	213.1	-17	-19	-15	-36	-24	-18	-65	-30	-16
Rezina	150.1	-13	-16	-12	-34	-20	-15	-62	-29	-14
Soldanesti	176.0	1	0	0	5	4	3	10	6	2
Telenesti	183.4	-17	-18	-13	-41	-24	-19	-73	-36	-18
Ungheni	281.1	-5	-5	-5	-9	-7	-4	-18	-7	-3

Taraclia and UTA Gagauzia in Southern AEZ, in which productivity of tobacco may increase by 2100 from 9 to 11% (RCP 2.6) and/or from 7 to 34% (RCP 8.5), in comparison with the 1981-2010 reference period. Without adaptation measures, due to changes in climatic conditions, by the end of the XXI century the cultivation of tobacco in Donduseni, Briceni, Edinet, Soroca, Glodeni, Floresti, Ocnita, Riscani, Nisporeni, Ungheni and Cimislia districts will be either impossible according to the RCP 8.5 high emission scenario, or economically not cost effective according to RCP 4.5 medium emission scenarios (Table 5).

Table 5. Projected Tobacco Yield Changes Relative to the Current Situation (%/30 Year) under the CMIP 5 Ensemble of 21 GCMs for RCP 8.5, RCP 4.5, and RCP 2.6 emission scenarios

AEZs/district	1981-2010, q/ha	2016-2035			2046-2065			2081-2100		
		RCP8.5	RCP4.5	RCP2.6	RCP8.5	RCP4.5	RCP2.6	RCP8.5	RCP4.5	RCP2.6
Northern AEZ										
Briceni	13.0	-42	-43	-40		-72	-55		-98	-56
Donduseni	13.9	-48	-43	-41		-73	-55		-97	-56
Drochia	17.0	-15	-14	-14	-41	-28	-19	-72	-37	-18
Edinet	12.9	-21	-21	-19	-52	-36	-27	-94	-50	-27
Falesti	15.6	-15	-13	-12	-35	-24	-19	-62	-34	-20
Floresti	15.8	-31	-29	-26	-61	-45	-37		-60	-37
Glodeni	14.6	-33	-30	-30	-80	-55	-37		-72	-34
Ocnita	12.1	-41	-42	-42	-65	-53	-47	-96	-63	-48
Riscani	15.9	-28	-23	-24	-56	-41	-31	-94	-54	-30
Singerei	16.1	-10	-9	-10	-21	-15	-10	-40	-19	-9
Soroca	13.0	-33	-30	-27	-79	-57	-42		-77	-43
Central AEZ										
Criuleni	15.3	-4	-4	-7	-7	-10	-7	-11	-6	-6
Dubasari	14.6	-12	-8	-8	-27	-19	-12	-52	-24	-10
Hincesti	14.7	-11	-9	-8	-33	-19	-14	-62	-31	-15
Ialoveni	14.5	-3	-3	-5	-8	-7	-3	-14	-6	-1
Nisporeni	12.6	-28	-26	-24	-69	-46	-34		-64	-33
Orhei	14.1	-2	-2	-3	-6	-4	-3	-8	-4	-5
Rezina	12.7	-1	-2	-4	-9	-7	-2	-14	-7	-2
Soldanesti	11.6	-18	-16	-16	-39	-28	-22	-68	-33	-20
Telenesti	14.3	-11	-10	-10	-25	-18	-12	-45	-21	-11
Ungheni	15.3	-20	-18	-17	-51	-34	-24	-95	-47	-23
Southern AEZ										
Cantemir	12.7	8	8	8	20	13	11	34	20	11
Causeni	10.2	-12	-8	-14	-32	-15	-16	-42	-21	-16
Cimislia	12.6	-28	-29	-23	-65	-49	-35		-63	-36
Leova	13.7	1	0	1	6	-1	0	7	-1	0
Stefan Voda	15.6	-6	-5	-8	-13	-9	-9	-16	-10	-10
Taraclia	14.9	8	5	7	16	9	10	27	14	9
UTA	15.1	9	7	6	18	10	8	33	16	9

Autonomous adaptation by farmers, through the advancement of sowing and harvesting dates and the use of longer cycle varieties (Moriondo et al., 2011; Moriondo et al., 2010; Olesen et al., 2011) could result in a general improvement of European wheat yields in the 2030s compared to the 2000s (Donatelli et al., 2012). However, farmer-sowing dates seem to advance slower than crop phenology (Siebert, Ewert, 2012), possibly, because earlier sowing is often prevented by lack of soil workability and frost-induced soil crumbling (Oort et al., 2012). Simulation studies, which anticipate on earlier sowing in Europe, may thus be overly optimistic. Further adaptation options include changes in crop species, fertilization, irrigation, drainage, land allocation and farming system (Bindi, Olesen, 2011). At the high range of the projected temperature changes, only plant breeding aimed at increasing yield potential jointly with drought resistance and adjusted agronomic practices may reduce risks of yield shortfall (Olesen et al., 2011; Rötter et al., 2011; Ventrella et al., 2012). Crop breeding is however challenged by temperature and rainfall variability, since (i) breeding has not yet succeeded in altering crop plant development responses to short-term changes in temperature (Parent, Tardieu, 2012) and (ii) distinct crop drought tolerance traits are required for mild and severe water deficit scenarios (Tardieu, 2012).

Adaptation to increased climatic variability may require an increased use of between and within species genetic diversity in farming systems (Smith, Olesen, 2010) and the development of insurance products against weather-related yield variations (Musshoff et al., 2011). Adaptive capacity and long-term economic viability of farming systems may vary given farm structural change induced by climate change (Mandryk et al., 2012; Moriondo et al., 2010b).

CONCLUSIONS

The impact assessment performed on national level allow conclude that the negative effect of global warming, according to the CMIP 5 Ensemble of 21 GCMs for RCP 8.5, RCP 4.5, and RCP 2.6 emission scenarios in the XXI century will not be offset by increase of precipitations. In these circumstances, without undertaken any adaptation measures, it can be expected by 2100: a significant drop in the productivity for grain corn, from 34% (RCP 2.6) to 67% (RCP 4.5); and winter wheat, from 22% (RCP 2.6) to 46% (RCP 4.5); a medium drop in the productivity for sunflower from 16% (RCP 2.6) to 57% (RCP 8.5), respectively for sugar beet, from 9% (RCP 2.6) to 37% (RCP 8.5); and for tobacco, from 10% (RCP 2.6) to 30% (RCP 8.5), in comparison with the average productivity of the Republic of Moldova's major agricultural crops in the most recent period of 1981-2010. Due to changes in climatic conditions in the Republic of Moldova, by the end of the XXI century, the cultivation of grain corn and winter wheat will be impossible according to the RCP 8.5 high emission scenario.

Additionally to the national level was assessed the impact of temperature and precipitation during the growing season on agricultural crops productivity in the RM's territorial administrative units (district level), in order to distinguish the most and least vulnerable districts to climate change.

According to projections, the most vulnerable districts for cultivation of winter wheat will be Basarabeasca, Taraclia, Cimislia, Causeni, Cahul, and Stefan Voda in Southern, and Dubasari, Anenii Noi, Hincesti, Ialoveni, Nisporeni, Criuleni, Telenesti and Orhei, in Central AEZs, in which productivity of the winter wheat may decrease from 19-26% (RCP 2.6) to 52-63 % (RCP 4.5) by 2100.

The least vulnerable districts for cultivation of winter wheat production will be Donduseni, Briceni, Riscani, Soroca, and Singerei in the Northern AEZ; and Ungheni, Calaras and Soldanesti in Central AEZs, in which productivity of the winter wheat by 2100 could decrease from 8 to 28% (RCP 2.6) and/or from 69 to 94% (RCP 8.5).

Due to climate change the most vulnerable for grain corn cultivation would be the Central and in less extent the Northern and Southern AEZs. The most vulnerable districts will be Orhei, Anenii Noi, Straseni, Ialoveni, Nisporeni, Telenesti, Ungheni, Calarasi, Criuleni and Dubasari; and UTA, Basarabeasca, Cahul, Taraclia, and Stefan Voda in Southern AEZ, in which productivity of the grain corn may decrease by 2100 from 28 to 50% (RCP 2.6) and/or up to 58-91% (RCP 4.5).

The significant drop in grain corn yield from 65 to 100% (RCP 8.5) is projected in Northern AEZ by 2100 relative to 1981-2010 reference period. The least vulnerable districts to climate change will be Donduseni, Drochia, Falesti, and Ocnita in Northern; Rezina, and Soldanesti in Central, and Leova in Southern AEZs, in which productivity of the grain corn may decrease by 2100, in dependence of the assessed emission scenario from 7 to 23% (RCP 2.6) and/or from 25 to 49% (RCP 8.5). Without adaptation, due to changes in climatic conditions in the most districts of the Republic of Moldova, by the end of the XXI century, the cultivation of grain corn and winter wheat will be impossible according to the RCP 8.5 high emission scenario or economically not cost effective under the RCP 4.5 medium emission scenario.

The most vulnerable for sunflower cultivation without application of adaptation measures, would be Central AEZ and in less extent Northern and Southern AEZs. According to projections, the most vulnerable districts will be Ialoveni, Hincesti, Straseni, Telenesti, Anenii Noi, Dubasari, and Orhei in Central AEZ, in which productivity of sunflower by 2100 may decrease from 23 to 37% (RCP 2.6) and/or from 44 to 76% (RCP 4.5). The least vulnerable for sunflower cultivation districts will be Floresti, Falesti, Riscani, Briceni, Donduseni, Drochia, Edinet, Ocnita, Singerei, and Soroca in Northern AEZ in which productivity of sunflower may decrease by 2100, from 4 to 15% (RCP 2.6) and/or from 17 to 40% (RCP 4.5). Without adaptation measures due to changes in climatic conditions in the most districts of the Republic of Moldova, by the end of the XXI century, the cultivation of sunflower will be impossible or economically not cost effective according to the RCP 8.5 high emission scenario.

According to projections, without application of adaptation measures, the most vulnerable districts for sugar beet cultivation will be Glodeni, Drochia, Falesti, Floresti, and Singerei in Northern; Telenesti, Orhei, and Rezina in Central AEZs, in which productivity of sugar beet may decrease by 2100 from 14 to 27% (RCP 2.6) and/or from 65 to 87% (RCP 8.5).

The least vulnerable districts for sugar beet cultivation will be Briceni, and Donduseni in Northern; and Ungeni in Central AEZs, in which productivity of the sugar beet may increase by 2100 from 2 to 9% (RCP 2.6) and/or from 9 to 34 % (RCP 8.5), in comparison with the 1981-2010 reference period. Without application of adaptation measures, the most vulnerable to climate change tobacco areas in the Republic of Moldova would be Northern, Central and in less extent Southern AEZs. The most vulnerable districts for tobacco cultivation will be Donduseni, Briceni, Ocnita, Edinet, Soroca, Floresti, Riscani, and Glodeni in the Northern; Nisporeni, and Ungheni districts in Central; and Cimislia in Southern AEZs, in which tobacco productivity could decrease from 23 to 56% (RCP 2.6) and/or from 47 to 98% (RCP 4.5).

The least vulnerable districts for tobacco cultivation will be Cantemir, Leova, Taraclia and UTA Gagauzia in Southern AEZ, in which productivity of tobacco may increase by 2100 from 9 to 11% (RCP 2.6) and/or from 7 to 34% (RCP 8.5), in comparison with the 1981-2010 reference period. Without adaptation measures, due to changes in climatic conditions, by the end of the XXI century the cultivation of tobacco in Donduseni, Briceni, Edinet, Soroca, Glodeni, Floresti, Ocnita, Riscani, Nisporeni, Ungheni and Cimislia districts will be either impossible according to the RCP 8.5 high emission scenario, or economically not cost effective according to RCP 4.5 medium emission scenarios.

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AGROBIOLOGICAL PECULIARITIES AND PROSPECTS OF THE *Lathyrus perennial* SPECIES IN MOLDOVA

Alexandru TELEUŢĂ, Victor ŢÎŢEI

Botanical Garden (Institute) of the Academy of Sciences of Moldova,
Chişinău, 18 Padurii str., MD 2002 Republic Moldova

Corresponding author email: director@gb.asm.md

Abstract

We investigated the agrobiological peculiarities and biochemical composition of the species Lathyrus latifolius, Lathyrus pisiformis and Lathyrus sylvestris from the Botanical Garden (Institute) of the Academy of Sciences of Moldova, the traditional leguminous fodder crops Medicago sativa and Onobrychis viciifolia served as control variants. The fodder productivity of Lathyrus sylvestris reached 10534 nutritive units/ha and 2085 kg/ha of digestible protein; Lathyrus latifolius – 9891 nutritive units/ha and 2085 kg/ha of digestible protein; exceeding essentially the traditional leguminous fodder crops Medicago sativa and Onobrychis viciifolia. Lathyrus latifolius was distinguished by high levels of phosphorus, potassium, magnesium, iron, copper and manganese, but reduced levels of calcium and strontium in fodder. The methane yield of Lathyrus species ranged from 1821 to 2936 m^3/ha. The more promising species as feedstock for biogas production, Lathyrus sylvestris and Lathyrus latifolius exceeded Medicago sativa with 33 %.

Key words: *agro biological peculiarities, biochemical composition, biogas yield, fodder value, Lathyrus species.*

INTRODUCTION

Agriculture plays an important role in the world economy since it provides much of the food that is necessary for people as well as raw material for various industrial sectors. Livestock production is an important source of protein and other nutrients for human diet, and the development depends on the production of fodder which is necessary for animal nutrition. A higher fodder production can be achieved by increasing the diversity of cultivated species, by expanding the areas where fodder crops are grown and by creating new varieties with increased genetic potential for productivity, quality and increased resistance to harmful biotic and abiotic factors.

In the Botanical Garden (Institute) of the ASM, it has been founded the fodder plant collection, which currently includes more than 320 taxa from different floristic regions (Europe, Asia and America). Particular attention is paid to mobilization and study of species of the family *Fabaceae* Lindl., which can contribute to the production of nutritionally balanced forage, while providing a part of the protein, carbohydrate and mineral requirements (Teleuță and Titei, 2012; 2014).

One important advantage of legume crop production is the ability of these species to form symbiotic associations with nitrogen (N)-fixing *Rhizobium* bacteria, reducing their dependence on inorganic N fertilizers, nutrient recycling, soil structural benefits, erosion control and nitrogen nutrition for following crops (Duke, 1981; Luscher et al., 2003). The fodder leguminous species play an important role in increasing the quality of feed, due to a significant contribution in protein, vitamins and minerals, which raise the nutritional value of feed and livestock products, they are also used as raw material for anaerobic digestion, produce biogas, a methane-rich gas that can be used as fuel and digestate, a source of nutrients. However, if digestate is used for manuring, nutrients will be kept in the biological cycle – which saves emissions from an energy-intensive mineral fertiliser production (Montemurro et al., 2003).

The genus *Lathyrus* L. is the largest genus in the economically important tribe *Fabeae* (Adans.) DC., family *Fabaceae* Lindl. Most researchers divide *Lathyrus* into 12 or 13 sections which include about 160 species. It is distributed throughout temperate regions of the northern hemisphere and extends into tropical East Africa and South America. Its main centres of diversity are in the Mediterranean and Irano-Turanian regions, with smaller centres in North and South America. Most *Lathyrus* species are diploid (2*n* = 14), with a few natural autopolyploids or allopolyploids, or contain both diploid and autopolyploid forms. Members of the *Lathyrus* genus include food and fodder crops, ornamental plants, are used in medicine, as soil nitrifiers, dune stabilizers, important agricultural crops and model organisms for genetic and ecological research (Belaid et al., 2006; Chtourou-Ghorbel et al., 2001). *Lathyrus sylvestris* is the most studied of the perennial species of this genus (Flachowsky et al., 1982; Foster, 1990; Kuporitskaia, 1978; Pavelka, 1985; Kupicha 1983).

Lathyrus latifolius L., synonyms *Lathyrus megalanthus* Steud., common names: Everlasting peavine, Everlasting-pea, Perennial pea, Perennial sweet pea, Broad-leaved Everlasting Pea. Romanian: Mănerei de pădure. It is a perennial plant, 1-2 m tall, with prostrate or climbing stem, clutching by means of leaf tendrils. Its stem is biangular, with two broad wings. Stipules – broadly lanceolate, semisagittate, 2-4 cm long, about 1 cm wide, with well distinct longitudinal veins. Petioles – broadly winged. Leaf rachis ends in a branched tendril. Leaves consist of 1 pair of oblong-oval leaflets, 5.5-9 cm long, 1-3(5) cm wide, with 3-5 very distinct veins. Leaf blade ends in a cusp. Peduncles are thick, angular and longer than leaves. Inflorescence is a rather lax raceme of 3-10 flowers. Pedicel is as long as calyx. Flowers are large, 2-2.5 cm long, bright red. Calyx is broadly campanulate, its upper teeth are triangular-lanceolate, as long as tube, lower tooth lanceolate-subulate, longer than tube and the other calyx teeth. Standard gradually narrowed toward its base into short unguis, wings distinctly shorter than standard, on narrow short unguis, keel half-round, on short unguis. Pods are oblong-linear, horizontally patent, narrower toward base, 5-6 cm long, about 1 cm wide, compressed, with acuminate end, with 3 longitudinal scabrous ribs at upper suture. Pod valves with longitudinal-reticular venation. Seeds are globose or oblong, weakly tuberculate. General distribution: Central and Atlantic Europe, Mediterranean. Former USSR: European part - Carpathians, Moldova, Dnieper area, Crimea (Smekalova, 2008a).

Lathyrus pisiformis L. common names: Pisiform grass pea. Perennial plant, 50-100 cm in height, with a long, branchy root. Stems slightly cling with the help of short cirri; stems are almost upright. Stipules are large, 20-50 mm in length, 8-18 mm in width, ovate, with lengthened top and denticles at the base. Leaves are bluish green below, usually consisting of 4-6 pairs of ovate or oval leaflets, 25-50 mm in length and 10-30 mm in width. The leaf axis culminates in short cirrus. Racemes are shorter than leaves, with 8-15 flowers. Flowers are medium-sized, 10-15 mm in length, red-lilac. Pedicels are shorter than the calyx. Calyx is short and tubular, thickening slightly at the base; its denticles are triangular. Flag is round-elliptical with dark mesh veins and dredging on top, on wide stem. Wings are oblong-lanceolate. Keel is bent almost at a right angle to the bottom edge. Pods are linear, slightly compressed from the sides, 40-50 mm in length, 4-5 mm in width. Valves of pods are dark brown. Seeds are almost spherical, brown; there are 10-12 seeds in a pod. Hilum length is equal to 1/6 the circumference of the seed. Chromosome number: 2n=14. Distribution: Central Europe, Russia (Smekalova, 2008b).

This research was aimed to evaluate the biological peculiarities, biochemical composition of the natural fodder of the perennial species of the genus *Lathyrus* L. (*L. latifolius, L. pisiformis, L. sylvestris)* in the conditions of Moldova and perspectives for their use as fodder in animal husbandry and as biogas substrate.

MATERIALS AND METHODS

The perennial species of the genus *Lathyrus*: *Lathyrus latifolius, Lathyrus pisiformis, Lathyrus sylvestris* maintained in monoculture, served as object of study. The traditional leguminous fodder crops *Medicago sativa* and *Onobrychis viciifolia* served as control variants. The experiments were performed on non irrigated experimental land in the Botanical Garden (Institute) of the ASM with previously scarified seeds of *Lathyrus* species. They started in spring, when the soil had reached the physical readiness. The experimental design was a randomised complete block design with four replications, and the experimental plots measured 10 m^2.

The seeds were sown at a depth of 2.0-3.0 cm with soil compaction before and after sowing. The scientific researches on growth and development, yield and biochemical composition of the plants were carried out according to the methodical indications (Novosiolov et al.,, 1983; Petukhov et al., 1989).
The carbon content of the substrates was obtained from volatile solids (organic dry matter) data using an empirical equation reported by Badger et al. (1979).
The biogas production potential and the specific methane yields were evaluated by the parameter "content of fermentable organic matter", according to Weissbach (2008).

RESULTS AND DISCUSSIONS

As a result of the conducted research, it has been established that the studied *Lathyrus* species need a moist seedbed for seed germination. In spite of the fact that seeds had been previously scarified mechanically, the emergence of seedlings at the soil surface was uneven and occurred 15-27 days later in comparison with traditional leguminous fodder crops. In the first year of vegetation, the studied species had a rather slow growth and development rate. Thus, *Lathyrus latifolius* and *Lathyrus sylvestris* plants reached the flowering stage and grew 43-54 cm tall, and *Lathyrus pisiformis* developed a rosette which grew up to 23 cm tall.
We might mention that, the next year, the vegetation period of the species of the genus *Lathyrus* started 3-7 days later in comparison with *Medicago sativa* and *Onobrychis viciifolia*, the most delayed start of vegetation period was characteristic of the species *Lathyrus latifolius*. In comparison with traditional leguminous fodder crops, the *Lathyrus* species needed a 17-33 day longer period to reach budding period, a 8-50 day longer period – to reach flowering stage and a 30-51 day longer period – to reach seed maturation. A more delayed development during the growing season was characteristic of *Lathyrus sylvestris* plants; we could also mention that *Lathyrus latifolius* plants had a more rapid pace of development and were distinguished by a short flowering period (Table 1).
From the resumption of growth till the end of April, a more rapid growth rate was observed in *Lathyrus sylvestris* plants (26.4 cm) and a slower one – in *Lathyrus pisiformis* plants (19.6 cm), this tendency was maintained in the flowering phase. During this period, *Lathyrus sylvestris* plants reached 187.78 cm, *Lathyrus latifolius* – 165.60 cm and *Lathyrus pisiformis* – 124.40 cm while the control *Medicago sativa* and *Onobrychis viciifolia* plants reached 83.20-85.50 cm high. In other studies, it has been mentioned that *Lathyrus sylvestris* plants can reach 3.00 m (Kuporitskaia, 1978), *Lathyrus pisiformis* – 0.75 m (Abramciuc, 2013).
The total forage yield, the quality and the seasonal distribution of forage production may be of great importance to the livestock producers.
It is known that about 65-80% of the yield is obtained at the first harvest. We might mention that, in the second year, *Lathyrus sylvestris* and *Lathyrus latifolius* provided a natural fodder yield of 4.58-4.71 kg/m^2 or 1.03-1.16 kg/m^2 dry matter, exceeding *Medicago sativa* with 25-40 % and *Onobrychis viciifolia* with 16-18 %. *Lathyrus pisiformis* plants provided a poorer yield; this can be explained by the fact that this species, as claimed by some authors (Vishnjakova and Belyaeva, 2006; Povalyaeva, 1992) achieves full yield potential in the 4th vegetation year.
The harvested fodder of the studied *Lathyrus* species was richer in leaves (48-55%).
In some papers, it has been mentioned that the fresh mass of *Lathyrus sylvestris* harvested in the 4th vegetation year reaches 92-125 t/ha (Foster, 1990; Kuporitskaia, 1978), *Lathyrus latifolius* – 95.5 t/ha (Aleman and Wotto, 2003).
Proteins have high biological value for growth and serve as structural elements in all plant tissues. In the animal body, they are utilized for growth, replacement of old, damaged or worn-out cells/tissues and formation of milk. They are of particularly great value to young growing animals and lactating ruminants (McDonald et. al., 2010). It has been found that the studied species of the genus *Lathyrus* are characterized by relatively high content of protein in dry matter, ranging from 20.31% at *Lathyrus pisiformis* to 22.62% at *Lathyrus latifolius*.

Table 1. Agro-biological peculiarities of the studied species of the family *Fabaceae*

Indicators	*Onobrychis viciifolia*	*Lathyrus sylvestris*	*Lathyrus latifolius*	*Lathyrus pisiformis*	*Medicago sativa*
Days from the beginning of vegetation up to:					
- budding	75	103	92	103	70
- flowering	99	132	107	128	82
- seed ripening	133	184	165	163	143
Plant height, cm					
- at the end of April	23.30	26.40	22.00	19.60	38.10
- at flowering	85.50	187.78	165.60	124.40	83.20
The yield:					
- fresh mass, kg/m^2	3.95	4.58	4.71	2.33	3.11
- dry matter, kg/m^2	1.03	1.16	1.03	0.63	0.82
The leaf share of the fodder, %	35	54	55	48	35

Table 2. Fodder value of the studied species of the family *Fabaceae*

Indicators	*Onobrychis viciifolia*	*Lathyrus sylvestris*	*Lathyrus latifolius*	*Lathyrus pisiformis*	*Medicago sativa*
Nutritive units	9085	10534	9891	6291	6531
Metabolizable energy for cattle, GJ/ha	113	114	106	54	71
Digestible protein productivity, kg/ha	1471	2085	1887	1038	1073
Digestible protein, g/ nutritive unit	160	198	190	166	164

The studied *Lathyrus* species are characterised by lower fat content (2.50-3.06%) in comparison with *Onobrychis viciifolia,* but advanced – in comparison with *Medicago sativa.* Analyzing each species, we could mention that *Lathyrus sylvestris* has high content of cellulose and minerals and low content of fat and nitrogen free extractive substances, and *Lathyrus latifolius* and *Lathyrus pisiformis* – inversely proportional. The dry matter content and its biochemical composition influence the nutritional value of fodder. It has been found that the harvested fodder of *Lathyrus pisiformis* has high dry matter content, but not as high as *Onobrychis viciifolia*.

We might also mention that the harvested fodder of the studied species of the genus *Lathyrus* has higher content of digestible protein: 40-45 g/kg natural fodder or 166-197 g/ nutritive unit.

In the conditions of the Republic of Moldova, the fodder productivity of *Lathyrus sylvestris* reaches 10534 nutritive units/ha, 2085 kg/ha of digestible protein and 114 GJ/ha metabolizable energy for cattle; *Lathyrus latifolius* – 9891 nutritive units/ha, 2085 kg/ha of digestible protein and 106 GJ/ha metabolizable energy for cattle; exceeding essentially the traditional leguminous fodder crops *Medicago sativa* and *Onobrychis viciifolia* (Table 2).

The species *Lathyrus latifolius* and *Lathyrus pisiformis* have about the same carotene content (30 mg/kg) in the fodder as *Onobrychis viciifolia*, but a higher content in comparison with *Medicago sativa.* The fodder of *Lathyrus sylvestris* is very poor in carotene (10 mg/kg). Vitamin C plays an important role in the body due to its strong antioxidant character. The fodder of *Lathyrus latifolius* contains 19.96 mg/%, *Lathyrus sylvestris* – 35.71 mg/% and *Lathyrus pisiformis* – 39.73 mg/% versus 41.21 mg/% in *Onobrychis viciifolia* and 45.23 mg/% – *Medicago sativa.*

The presence of minerals in animal nutrition is indispensable for their growth and health, because they are essential components of all tissues and organs that maintain osmotic pressure at a constant level, participate in the regulation of acid-base balance, activate a number of enzymes, moderate the neuromuscular activity and prevent the emergence and development of diseases of animals (McDonald et. al., 2010).

The content of mineral elements in fodder is variable, depending on species. It has been established that the content of macro elements in the dry matter of the harvested fodder of the studied *Lathyrus* species is as follows: 6.76-12.05 g/kg of calcium, 5.54-10.00 g/kg of phosphorus, 9.33-18.86 g/kg of potassium, and 2.89-4.58 g/kg of magnesium (Table 3).

Comparing each macro element separately, we could mention that the content varies from species to species. The species *Lathyrus sylvestris* and *Lathyrus pisiformis* are characterised by higher content of phosphorus and magnesium in comparison with *Medicago sativa,* but lower – in comparison with *Onobrychis viciifolia; Lathyrus latifolius* has high content of phosphorus, potassium, magnesium and reduced – of calcium.

Sodium is the chief cation of blood plasma and other extracellular fluids of the body; it plays an important role in the transmission of nerve impulses and in the absorption of sugars and amino acids from the digestive tract. The *Lathyrus* species have about the same sodium content as *Onobrychis viciifolia*, but advanced – in comparison with *Medicago sativa.*

It has been determined the content of trace elements in the dry matter of *Lathyrus* species which constitutes: 4.53-10.33 mg/kg copper, 22.13-27.38 mg/kg zinc, 68.19-113.93 mg/kg manganese, 194.75-381.73 mg/kg iron, and 28.41-45.32mg/kg strontium. The fodder of *Lathyrus latifolius* contains high amounts of iron, copper and manganese; *Lathyrus sylvestris* is poor in iron, zinc, strontium and manganese; *Lathyrus pisiformis* is poor in zinc and copper, but contains large amounts of strontium.

The high content of protein would influence positively the methane production.

The ratio of the content of carbon and nitrogen (C/N) of the raw material is essential in the production of biogas. The C/N ratio of the studied *Lathyrus* species varied from 14 to 16, *Medicago sativa* and *Onobrychis viciifolia* – 19 (Table 4). The optimal C/N ratio is expected to be in the range 15-25, when the anaerobic digestion process is carried out in a single stage, and for the situation when the process develops in two steps, the optimal C/N ratio will range: for step I: 10-45; for step II: 20-30 (Dobre et al., 2014).

The gas forming potential of the fermentable organic matter of biomass of the studied *Lathyrus* species varied from 448 to 550 litre/kg VS (Table 4). The best methane yield was achieved in *Lathyrus latifolius* and *Lathyrus pisiformis* with methane production yield of 285-289 l litre/kg VS, the lowest – in the biomass of *Lathyrus sylvestris.*

The methane yield per ha of studied species of the family *Fabaceae* ranged from 1821 to 2936 m^3/ha, *Lathyrus sylvestris* and *Lathyrus latifolius* exceeding *Medicago sativa* with 33 %.

Table 3. Chemical composition of the studied species of the family *Fabaceae*

Indicators	*Onobrychis viciifolia*	*Lathyrus sylvestris*	*Lathyrus latifolius*	*Lathyrus pisiformis*	*Medicago sativa*
Minerals, per kg dry matter					
Calcium, g	11.20	6.76	9.84	12.05	16.94
Phosphorus, g	7.53	7.18	10.10	5.54	4.42
Magnesium, g	3.28	2.89	4.58	3.27	2.71
Potassium, g	15.17	10.33	18.86	9.33	15.38
Sodium, mg	366.20	387.40	361.76	373.20	349.50
Iron, mg	343.20	194.75	381.73	209.83	250.83
Manganese, mg	91.55	68.19	113.93	85.86	50.90
Zink, mg	26.15	24.00	27.38	22.13	22.37
Copper, mg	6.75	6.97	10.33	4.53	7.00
Strontium, mg	34.53	28.41	28.42	45.32	49.77

Table 4. Gas forming potential of the fermentable organic matter from the studied species of the family *Fabaceae*

Indicators	*Onobrychis viciifolia*	*Lathyrus sylvestris*	*Lathyrus latifolius*	*Lathyrus pisiformis*	*Medicago sativa*
Ratio of content carbon and nitrogen (C/N)	19	14	14	16	19
Fermentable organic matter, g/kg VS	658	603	678	687	642
Biogas, liter /kg VS	526	448	543	550	514
Methane, liter /kg VS	276	253	285	289	270
Methane productivity, m3/ha	2843	2935	2936	1821	2214

CONCLUSIONS

1. In the conditions of the Republic of Moldova, the fodder productivity of *Lathyrus sylvestris* reaches 10534 nutritive units/ha and 2085 kg/ha of digestible protein; *Lathyrus latifolius* – 9891 nutritive units/ha and 2085 kg/ha of digestible protein; exceeding essentially the traditional leguminous fodder crops *Medicago sativa* and *Onobrychis viciifolia*.
2. The species *Lathyrus pisiformis* has about the same digestible protein productivity as *Medicago sativa.*
3. *Lathyrus latifolius* is distinguished by a high level of phosphorus, potassium, magnesium, iron, copper and manganese, but a low one of calcium and strontium in fodder.
4. The methane yield per ha ranged from 1821 to 2936 m^3/ha, *Lathyrus sylvestris* and *Lathyrus latifolius* exceeding *Medicago sativa* with 33 %.

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SPECIES OF PERENNIAL GRASSES AS FEEDSTOCK FOR BIOGAS PRODUCTION IN THE REPUBLIC OF MOLDOVA

Victor ŢÎŢEI

Botanical Garden (Institute) of the Academy of Sciences of Moldova
Chişinău, 18 Padurii str., MD 2002, Republic of Moldova

Corresponding author email: victitei@ gmail.com

Abstract

The increasing world population, growing energy consumption, greenhouse gas emission and diminishing supplies of fossil fuels obligate to look for alternative ways, development of new technological processes of energy production. The selection of the appropriate plant species as feedstock for biogas production is an important aspect in decision-making. We investigated some agro-biological peculiarities and biochemical composition of biomass of native perennial grasses Dactylis glomerata, Festuca arundinacea and introduced Agropyron desertorum, Agropyron sibiricum, Miscanthus giganteus, Miscanthus sinensis cultivated on the experimental land of the Botanical Garden (Institute) of the Academy of Sciences of Moldova. The studied species differ in the pace of growth and development, productivity and chemical composition of the harvested mass. The gas forming potential of the fermentable organic matter of biomass varied from 328 to 479 liter/kg volatile solids. The best results were achieved for Dactylis glomerata and Miscanthus sinensis with methane production yield of 248-252 liter/kg volatile solids, likely higher content of nitrogen-free extract. The calculated methane yield per ha for native perennial grasses ranged from 2077 to 2243 m^3/ha, and from 1386 to 1605 m^3/ha – Agropyron species, while from 3348 to 4128 m^3/ha for Miscanthus sinensis and Miscanthus giganteus.

Key words: *agro-biological peculiarities, biochemical composition, perennial grasses, specific methane yield.*

The increasing world population, growing energy consumption, greenhouse gas emission and diminishing supplies of fossil fuels obligate us to look for alternative ways, development of new technological processes of energy production. Using biomass to provide energy services is one of the most versatile options for increasing the proportion of renewable energy in the global energy system.

The biomass resource can be considered as organic matter, in which the energy of sunlight is stored in chemical bonds. The value of a particular type of biomass depends on the chemical and physical properties of the large molecules from which it is made.

Perennial grasses play an important role as an extensive CO_2 sink, significantly increases the content of soil carbon, dry organic matter possesses many beneficial attributes as energy crops, and there has been increasing interest in their use for this purpose in the US and Europe since the mid-1980s (Lewandowski et al., 2003; El Bassam, 2010; Klimiuk et al., 2010).

Miscanthus is a peculiar genus native to East Asia. About 25 species were listed by various researchers. *Miscanthus sinensis* Andersson, *Miscanthus sacchariflorus* (Maxim.) Franch., *Miscanthus floridulus* (Labill.) Warb. ex K. Schum. and Lauterb., *Miscanthus lutarioriparius* L.Liu ex S.L.Chen and Renvoize and the hybrid *Miscanthus giganteus (Miscanthus sinensis* x *Miscanthus sacchariflorus*) Greef et Deu. are mainly used for biomass production because of their high biomass potential (El Bassam, 2010; Arnoult and Brancourt-Hulmel, 2015). At present, China has the largest area under *Miscanthus* cultivation in the world, approximately 100,000 ha, while in Europe, there are estimated 30,000 ha.

Cocksfoot, *Dactylis glomerata* L., and tall fescue, *Festuca arundinacea* Schreb., are native to Europe, differ in their requirements of rainfall, temperature and soil type and fertility for growth, therefore they have a varying degree of adaptation in different regions, are highly productive and can be used as fodder and pasture. These species are investigated in many scientific centres and implemented as crop in different regions of the Earth, not only as a source of fodder, but also as feedstock for bioenergy production (El Bassam, 2010; Tilvikiene et al., 2012). They are also common in the spontaneous flora of the Republic of Moldova, there have been researched and selected forms that have a productivity of 50-65 tons/ha of fresh mass or 15-17 tons of hay (Bahcivanjii et al., 2012).

Taking into account the expansion of areas of degraded soils and the frequency of droughts, it is necessary to mobilize and introduce new species that would ensure production in these harsh conditions. The most promising perennial grasses to be introduced and that may contribute to the solution of these problems are the species of the genus *Agropyron* Gaertn.: desert wheatgrass, *Agropyron desertorum* (Fischer ex Link) Schultes (syn. *Triticum desertorum* Fischer ex Link) and Siberian wheatgrass *Agropyron sibiricum* (Willd.) Beauv. *Agropyron fragile* (Roth) Candargy (syn. *Agropyron fragile* (Roth) Candargy; *Triticum fragile* Roth; *Triticum sibiricum* Willd), their natural distribution range – from the Central Europe and the Middle East across Central Asia to Siberia, China and Mongolia. They are long-lived, cool-season, drought tolerant, and winter hardy grasses with extensive root systems that may extend past 2 m into the soil, contributing to stabilize soils and reduce erosion. Desert wheatgrass is best suited for loamy and clayey light chestnut soils and solonetz soils. *Agropyron desertorum* and *Agropyron sibiricum* provide highly nutritional forage for livestock, especially in the early spring, furnish hay of excellent quality and remain productive for more than 30 years (Medvedev and Smetannikova, 1981).

The Republic of Moldova imports 95% of fossil energy resources, according to the Energy Strategy of the Republic of Moldova (2013), the total amount of energy produced from renewable sources should be increased to 20% by the year 2030 and ¾ of this amount will make energy from biomass.

In the last 65 years, as a result of the introduction and acclimatization researches done in the Botanical Garden (Institute) of the ASM, collections and exhibitions of plants with multiple uses, necessary for the development of the national economy, were founded. The investigation of local and introduced plant species for biomass production is an important objective (Teleuta et al., 2012; Ţîţei, 2013; 2015).

The selection of the appropriate plant species as feedstock for biogas production is an important aspect in decision-making.

The aim of this work was to evaluate the native species *Dactylis glomerata*, *Festuca arundinacea,* the introduced species *Agropyron desertorum*, *Agropyron sibiricum, Miscanthus sinensis* and hybrid *Miscanthus giganteus* as feedstock for biogas production based on the chemical composition and biomass yield under the conditions of the Republic of Moldova.

MATERIALS AND METHODS

The perennial grasses: the native species *Dactylis glomerata, Festuca arundinacea,* the introduced species *Agropyron desertorum*, *Agropyron sibiricum, Miscanthus sinensis* and the hybrid *Miscanthus giganteus*, maintained in monoculture, served as subject of research. The experiments were performed on non irrigated experimental land in the Botanical Garden (Institute) of the ASM. The experiments started in spring, when the soil had reached the physical readiness, with seeds of *Agropyron desertorum*, *Agropyron sibiricum*, *Dactylis glomerata*, *Festuca arundinacea* and rhizomes of *Miscanthus giganteus* and *Miscanthus sinensis.* The experimental design was a randomised complete block with four replications, and the experimental plots measured 10 m^2. The plant growth, development and productivity were assessed according to the methodical guidelines (Novoselov et al., 1983).

The species of perennial grasses were harvested by hand in different periods and development stages: *Agropyron desertorum*, *Agropyron sibiricum*, *Dactylis glomerata* and *Festuca arundinacea* – in the flowering stage (26.05.2014), but *Miscanthus sinensis* and *Miscanthus giganteus* – in the inflorescence formation period (09.07.2014).

Fresh mass yield was measured by weighing. Dry matter or total solid (TS) content was detected by drying samples up to constant weight at 105°C. Crude protein – by Kjeldahl method; crude fat – by Soxhlet method, crude cellulose – by Van Soest method; ash – in muffle furnace at 550°C (Petukhov et al., 1989). Nitrogen free extract (NFE) was mathematically appreciated, as difference between organic matter values and analytically assessed organic compounds. Organic dry matter or volatile solids (VS), was calculated through differentiation, the crude ash being subtracted from dry matter.

Theoretical biogas normalized litre per kg of volatile solids and methane yields were calculated using the gas forming potential of nutrients according to Baserga (1998). The biogas production potential and specific methane yields were evaluated by the parameter "content of fermentable organic matter", according to Weissbach (2009).

RESULTS AND DISCUSSIONS

In the first year of vegetation, the studied species of perennial grasses were characterized by a different pace of growth and development. It was found that the emergence of seedlings of the species *Agropyron desertorum*, *Agropyron sibiricum*, *Dactylis glomerata* and *Festuca arundinacea* at the soil surface took place simultaneously after 10-13 days from sowing. The species *Agropyron desertorum* and *Agropyron sibiricum* developed 48-66 cm tall shoots, went through all ontogenetic stages and formed seeds, but *Dactylis glomerata* and *Festuca arundinacea* did not develop shoots. The species of the genus *Miscanthus* were distinguished by faster growth, they developed shoots that reached a height of 114-128 cm – *Miscanthus sinensis* and 152-183 cm – *Miscanthus giganteus*, and finished their growth cycle during the flowering stage.

We might mention that, in the following years, the regrowing season for the species *Agropyron desertorum*, *Agropyron sibiricum*, *Dactylis glomerata* and *Festuca arundinacea* started in the first half of March, when the average temperature was above 3-5ºC and for *Miscanthus sinensis* and *Miscanthus giganteus* – in April. The resumption of growth of the species *Agropyron sibiricum* took place 8 days earlier in comparison with *Dactylis glomerata* and 39 days – in comparison with *Miscanthus giganteus*. *Dactylis glomerata* was distinguished by a more intense development and required a shorter period for the formation and maturation of seeds. The plants of the genus *Miscanthus*, from the resumption of growth to the formation of inflorescences required a period of 83-95 days and 99-125 days to full flowering, the hybrid *Miscanthus giganteus* developed later (Table 1).

Table 1. Agro-biological peculiarities of the studied species of perennial grasses, 2014

Indicators	*Festuca arundinacea*	*Dactylis glomerata*	*Agropyron sibiricum*	*Agropyron desertorum*	*Miscanthus sinensis*	*Miscanthus giganteus*
Beginning of vegetation	10.03	15.03	7.03	10.03	12.04	15.04
Days up to:						
- inflorescence formation	66	60	66	65	83	95
- flowering	86	72	83	88	99	125
- seed ripening	122	111	127	118	126	-
Plant height, cm						
- on April 20	76	72	62	59	12	8
- at flowering	131	112	100	93	188	324
The yield, 1st harvest						
- fresh mass, kg/m^2	4.08	3.89	2.05	2.43	4.22	7.54
- dry matter, kg/m^2	0.88	0.89	0.70	0.66	1.35	2.40

The studied species differed also in the pace of growth. Thus, by late April, *Dactylis glomerata* and *Festuca arundinacea* plants reached a height of 72-76 cm, the plants of the genus *Agropyron* – 59-62 cm, and the plants of the genus *Miscanthus* – 8-12 cm, and by full flowering – 112-131 cm, 93-100 cm and 188-324 cm, respectively.

It is known that the pace of growth and development of plants influences the biomass accumulation and the dry matter content. Among the species of perennial grasses that were harvested in the end of May, the native species *Dactylis glomerata* and *Festuca arundinacea* produced the highest yield of fresh mass – 3.89-4.08 kg/m^2, but the introduced species of the genus *Agropyron* – 2.05-2.43 kg/m^2. The species *Agropyron sibiricum* is characterized by high content of dry matter in the harvested biomass.

In Lithuania the variation of dry matter yield of tall fescue ranged from 13.37 to 13.84 t/ ha, of cocksfoot from 10.39 to 11.47 t/ha (Tilvikiene et al., 2012). Romanian varieties *Dactylis glomerata* and *Festuca arundinacea* had a productivity of 55-75 t/ha fresh mass or 12-17 t/ha dry matter (Maruşca et al., 2011). In Russia hay productivity of *Agropyron* species varies from 2.2 to 4.0 t/ha (Medvedev and Smetannikova, 1981).

The species of the genus *Miscanthus* grew faster in late May. At harvest time, the fresh mass yield and the dry matter content of these species was higher. So, the yield of *Miscanthus sinensis* harvested in the first decade of July reached 4.22 kg/m^2 fresh mass or 1.35 kg/m^2 dry matter, and *Miscanthus giganteus* – 7.54 kg/m^2 fresh mass or 2.40 kg/m^2 dry matter.

Organic dry matter or volatile solid yield is an important factor influencing biogas and methane yield. The studied species differ in the content of volatile substances from 911.1 to 951.8 g/kg. A lower content was found in *Festuca arundinacea, Dactylis glomerata* and *Miscanthus giganteus,* and the highest one – in *Miscanthus sinensis*. In the harvested biomass of the species of the genus *Agropyron*, the content of volatile substances was high.

Crude protein is the main nitrogen-containing nutrition component for microbes converting biomass. Analyzing the obtained data, we could mention that the local species *Dactylis glomerata* and *Festuca arundinacea* were characterized by a high content of protein (7.42-9.51% TS) in comparison with the species of the genus *Miscanthus* (5.41-5.63% TS). The introduced species *Agropyron desertorum* and *Agropyron sibiricum* didn’t differ essentially in the content of crude protein (Table 2).

It is well known that fat is a good source of energy (Baserga, 1998; Weissbach, 2009). A higher content of fat was found in the species *Festuca arundinacea* and *Agropyron sibiricum*, the species *Dactylis glomerata* and *Miscanthus sinensis* were at the same level, but *Agropyron desertorum* and the hybrid *Miscanthus giganteus* had a low content of fat.

Carbohydrates supply most of the energy for maintaining vitality. The two carbohydrate fractions commonly used in evaluating the carbohydrate content of feed are crude cellulose and nitrogen-free extract.

It was found that the studied species had a high content of crude cellulose, which varied from 35.59% to 45.28%. The harvested biomass of *Miscanthus giganteus* and *Agropyron sibiricum* was characterised by a very high content of crude cellulose – 41.60-45.28%, and the local species *Festuca arundinacea* and *Dactylis glomerata* had a moderate content of 35.59-37.29 %. Nitrogen-free extract comprises sugars, starch and a large part of the material classed as hemicellulose. In the biomass of the investigated plant species, the nitrogen-free extract varied from 41.45% to 49.76%. Lower nitrogen-free extract content was noted in the biomass of the species *Festuca arundinacea* and the hybrid *Miscanthus giganteus*, higher content – in *Miscanthus sinensis* (49.65), *Dactylis glomerata* (46.62%).

The theoretical biogas yield ranged from 722 to 756 l/kg VS (Table 3). The calculated methane content in the biogas ranged from 50.8 to 53.9 %. The native species *Dactylis glomerata* and *Festuca arundinacea* had a reduced potential of biogas (722-726 l/kg VS), but were distinguished by a higher content of methane (52.0-53.9%).

The theoretical methane yield ranged from 2541 to 9192 m^3/ha and it depended on the biomass productivity of the studied species. The species *Agropyron desertorum* and *Agropyron sibiricum* were less productive: 2541-2737 m^3/ha, and the species of the genus *Miscanthus* reached values of 5184-9192 m^3/ha, the hybrid *Miscanthus giganteus* reached the highest values.

Differences in gas formation potentials of crops are mainly due to specific chemical compositions of the plant material.

Table 2. Biochemical composition of the biomass of the studied species of perennial grasses, 2014

Indicators	*Festuca arundinacea*	*Dactylis glomerata*	*Agropyron sibiricum*	*Agropyron desertorum*	*Miscanthus sinensis*	*Miscanthus giganteus*
Dry matter contains:						
crude protein, %	9.51	7.42	7.01	6.85	5.63	5.41
crude fat, %	2.86	1.96	2.62	1.58	1.96	1.62
crude cellulose, %	37.29	35.59	38.51	41.60	37.83	45.28
nitrogen free extract, %	41.45	46.62	46.12	44.05	49.76	41.52
crude ash,%	8.89	8.41	5.74	5.92	4.82	6.17
organic dry matter, %	91.11	91.59	94.26	94.08	95.18	93.83

Table 3. Stoichiometric gas production potential of the biomass of the studied species of perennial grasses, 2014

Indicators	*Festuca arundinacea*	*Dactylis glomerata*	*Agropyron sibiricum*	*Agropyron desertorum*	*Miscanthus sinensis*	*Miscanthus giganteus*
Biogas, liter /kg VS	722	726	750	744	756	744
Biomethane, liter /kg VS	382	378	391	385	384	383
Methane content %	53.9	52.0	52.1	51.8	50.8	51.5
Theoretical methane yield, m^3/ ha	3662	3364	2737	2541	5184	9192

Table 4. Gas forming potential of the fermentable organic matter of the studied species of perennial grasses, 2014

Indicators	*Festuca arundinacea*	*Dactylis glomerata*	*Agropyron sibiricum*	*Agropyron desertorum*	*Miscanthus sinensis*	*Miscanthus giganteus*
Fermentable organic matter, g/kg VS	561	599	567	499	590	410
Biogas, liter /kg VS	449	479	454	399	472	328
Specific methane yield, liter /kg VS	236	252	238	210	248	172
Methane yield, m^3/ha	2077	2243	1666	1386	3348	4128

The capability of biomass methanization is tightly associated with nutrient digestibility and plant species. When crude cellulose content increases, digestibility usually decreases. Nitrogen-free extract contains the most digestible portion of the carbohydrates. The research performed by many authors proved that high lignin content significantly reduces the digestibility of plant material and effectively inhibits the process of anaerobic digestion (Dandikas et al., 2015). Fermentable organic matter represents the proportion of organic matter which can be biologically degraded under anaerobic conditions and, thus, can be potentially utilized in biogas facilities (Weissbach, 2009). Gas forming potential of the fermentable organic matter of biomass of the studied species of perennial grasses varied from 328 to 479 l/kg VS (Table 4). The best results were achieved for *Dactylis glomerata* and *Miscanthus sinensis* with methane production yield of 248-252 l/kg VS, likely higher content of nitrogen-free extract. The lowest methane potentials per VS were found in the biomass of *Miscanthus giganteus* and *Agropyron desertorum.* The obtained values are in good accordance with Lemmer and Oechsner (2001) who observed similar values for fresh grass of 0.23-0.41 m^3/kg VS and Amon et al. (2004) who observed 0.25 m^3/kg VS, methane yields from grasses with intensive growth after the early harvest at mid May were larger with 310-360 l/kg VS (Mähnert et al., 2002), *Miscanthus giganteus* (silages), harvested in autumn, reached values of 0.10 m^3/ kg VS (Klimiuk et al., 2010).

The methane yield per ha for native perennial grasses ranged from 2077 to 2243 m^3/ha, and from 1386 to 1605 m^3/ha – *Agropyron* species, while from 3348 to 4128 m^3/ha for *Miscanthus sinensis* and *Miscanthus giganteus*, respectively.

The research showed, however, that the degree of organic conversion into methane, respective methane yields of theoretical yield, was 45% for *Miscanthus giganteus* and 65% for *Miscanthus sinensis*, 61% for *Dactylis glomerata* and *Agropyron desertorum,* 55-57% for *Agropyron sibiricum* and *Festuca arundinacea.*

CONCLUSIONS

The studied perennial grasses species differ in the pace of growth and development, productivity and chemical composition of the harvested mass, which have influenced the methane yield. The gas forming potential of the fermentable organic matter of biomass varied from 328 to 479 l/kg VS. The best results were achieved for *Dactylis glomerata* and *Miscanthus sinensis* with methane production yield of 248-252 l/kg VS, likely higher content of nitrogen-free extract. The calculated methane yield per ha for native perennial grasses ranged from 2077 to 2243 m^3/ha, and from 1386 to 1605 m^3/ha – *Agropyron* species, while from 3348 to 4128 m^3/ha for *Miscanthus sinensis* and *Miscanthus giganteus*, respectively.

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ESTABLISHING SOWING DENSITY AND OPTIMAL DOSAGE OF FERTILIZER FOR INCREASING PRODUCTION OF WINTER WHEAT AND BARLEY, UNDER CLIMATE CHANGE CONDITIONS

Daniela TRIFAN[1, 2], Marcel BULARDA[1, 3], Radu ISPAS[1], Nicolae POPESCU[1]

[1]Agricultural Research and Development Station of Braila, Km. 9, Vizirului Str, Braila, Romania
[2]BRAICOOP Agricultural Cooperative, No.39, Imparatul Traian Str., Braila, Romania
[3]"Dunarea de Jos" University of Galati, Engineering and Agricultural Faculty of Braila, No. 29, Calarasilor Str., Braila Romania

Corresponding author email: dana.trifan@yahoo.com

Abstract

Polifactorial experience was located in North Baragan Plain, and experimental factors were: - sowing density, with three graduations (450 gs/sqm; 550 gs/sqm; 650 gs/sqm); - type and dose of fertilizer (chemical - NH_4NO_3 and urea, biological - AgroArgentum - 2 doses, and unfertilized). By carrying out chemical analyses of the soil before and after application of chemical and biological fertilizers in different vegetation phases, we established the dynamics of nutrients for every variant of fertilization, compared to unfertilized control. Compared with the control, has revealed a different dynamics of nitrogen in the soil, fertilized variants biological nitrogen supply being weaker than the control but in a continued increase from April to June. Instead, chemically fertilized variants were well supplied with nitrogen, but in a continuous decline, reaching as June have lower values than the control, especially variant fertilized with urea. Biological fertilisation with AgroArgentum Forte 100 ml/ha obtained differences significant positive compared to the average experience were obtained at densities between 550 and 650 gs/sqm variety Boema, with 1291 kg/ha and 1135 kg/ha more than control. Barley were recorded positive differences from the average experience (6421 kg/ha) only to versions with sowing densities 550 and 650 gs/sqm, chemically fertilized, the biggest positive difference is the variant 650 gs / sqm ammonium nitrate 150 kg/ha, with a difference of 1321 kg/ha, followed by variant 450 gs/sqm, AgroArgentum Forte 100 ml/ha) with a difference of 1004 kg/ha compared to the average experience.

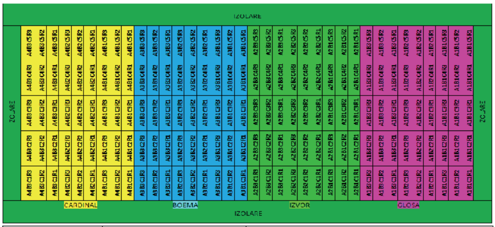
Key words: *winter barley, wheat, sowing densities, fertilization.*

INTRODUCTION

The issue of climate change has become increasingly popular and is felt year after year, in the size and quality crop yields. Farmers are often forced to take special measures crop management, from setting fertilizers and their doses, to establish seeding density and treatments during the growing season.
There's market range of products, starting from seed, continuing with chemical and biological fertilizers, and treatments, so that farmers became an adventure in choosing the best solutions of obtaining productions quality.
Despite genetic improvements and the use of fertilizers and pesticides, cereal production is still closely linked to climate conditions, due to the fact it is grown in open fields over vast areas and, in many cases, without irrigation. (Tuttolomondo et al., 2009).
In North Baragan area, the annual average for the period 1900-2014 climate is defined by the following parameters: annual rainfall (agricultural year) - 445 mm, annual average air temperature – 11°C, potential evapotranspiration (after Thornthwaite) - 715 mm and a climatic deficit water annual average of 272 mm. It predicts a decrease in annual rainfall from 445mm to 440mm and an increase in average annual temperatures from 11°C to 11,3°C until 2025 (Visinescu et al., 2014).
This paper shows how the sowing densities (best three densities for our zone), the type and dose of fertilizer (chemical and biological) can influence production, given the current climate change from North Baragan Plain, in Romania. We can determine the optimal density in this way, how the mineral elements absorption by plants and set the type and dose of fertilizer effective for increasing production from winter wheat and barley.

MATERIALS AND METHODS

The experience described in this paper was polifactorial and located on a total area of 5250m^2 in Chiscani Experimental Centre of SCDA Braila, and comprised 60 variants and 180 experimental plots, arranged after-storey block method in three repetitions (Figure 1.).



VARIETY – A	SOWING DENSITY – B		TYPE AND DOSE OF FERTILIZATION – C	
BOEMA – A1	450 b.g./m^2 550 b.g./m^2 650 b.g./m^2	B1 B2 B3	AgroArgentum Forte 100 ml/ha AgroArgentum Forte 200 ml/ha Urea – 150 kg/ha Ammonium nitrate – 150kg/ha Unfertilized	C1 C2 C3 C4 C5
IZVOR – A2	450 b.g./m^2 550 b.g./m^2 650 b.g./m^2	B1 B2 B3	AgroArgentum Forte 100 ml/ha AgroArgentum Forte 200 ml/ha Urea – 150 kg/ha Ammonium nitrate – 150kg/ha Unfertilized	C1 C2 C3 C4 C5
GLOSA – A3	450 b.g./m^2 550 b.g./m^2 650 b.g./m^2	B1 B2 B3	AgroArgentum Forte 100 ml/ha AgroArgentum Forte 200 ml/ha Urea – 150 kg/ha Ammonium nitrate – 150kg/ha Unfertilized	C1 C2 C3 C4 C5
CARDINAL – A4	450 b.g./m^2 550 b.g./m^2 650 b.g./m^2	B1 B2 B3	AgroArgentum Forte 100 ml/ha AgroArgentum Forte 200 ml/ha Urea – 150 kg/ha Ammonium nitrate – 150kg/ha Unfertilized	C1 C2 C3 C4 C5

Figure 1. The scheme of experience location

Experimental factors were:
- sowing density, with three graduations (450 gs/m^2; 550 gs/m^2; 650 gs/m^2);
- type and dose of fertilizer applied in vegetation (chemical - NH_4NO_3 and urea, biological - AgroArgentum - 2 doses, and unfertilized)
- species and variety (barley – Cardinal, and wheat - Boema, Izvor and Glosa).

Maintenance works were:
- 19-20.03.2015 - applying mineral fertilizers (urea - C3, ammonium nitrate - C4) 150 kg / ha
- 25-26.03.2015 – applying foliar fertilizer AgroArgentum Forte in doses of 100 ml / ha (C1) and 200 ml / ha (C2) - 17/04/2015
- herbicide Granstar Super 40 g/ha and treatment against disease with fungicide Duett Ultra 0,7 l / ha.

We made measurements like plant density - after emergence and in spring, and also laboratory tests: chemical analysis on soil and plants: before fertilization, and at 30, 40, and 50 days. After harvest we made following measurements: plant height, no. plants/sqm; no. ears/sqm; average weight of the ear; average number of kernels/ear; kernels weight/sqm, humidity of kernels; MMB, MH, yield estimation at 14% humidity.

As statistical interpretation methods were used: variance analysis – ANOVA test, statistical averages method - AVERAGE test, and correlation method, using MS Excel.

RESULTS AND DISCUSSIONS

Climatic conditions in 2015 have shown that compared to the annual average temperature, there was a significant increase temperature in the period from January to March and May to July 2015, between 1.1 - 2,4°C (Figure 2).

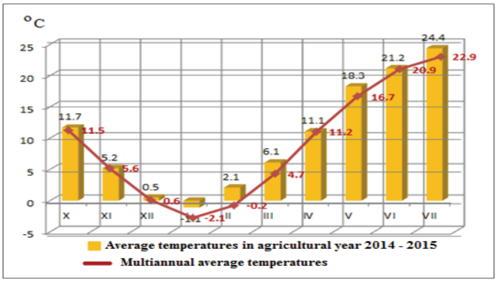


Figure 2. The graph of monthly average temperatures recorded during the vegetation period, compared with multiannual average temperature

Average monthly rainfall exceeded multiannual with 23 - 25mm in the period October to December 2014, ensuring optimum germination and tillering, also topped with 57mm, leaving the winter, but were lower in April and May, in May registering a difference of 37mm of the multiannual average (Figure 3).

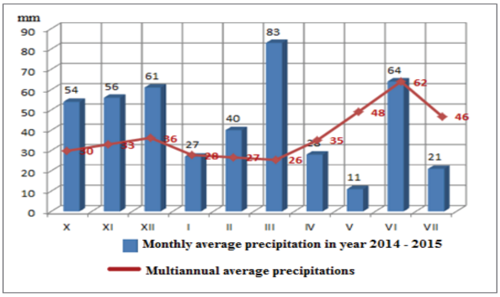


Figure 3. The graph monthly average rainfall recorded during the vegetation period, compared with average multiannual monthly rainfall

By carrying out chemical analyses of the soil before and after application of chemical and biological fertilizers in various phenophases was established nutrient dynamics for each variant of fertilization, compared to unfertilized control. Also, by comparing the values determined in control variant, it could highlight the dynamics of mineral elements absorption and establish critical phases of nutrition at winter wheat and barley.

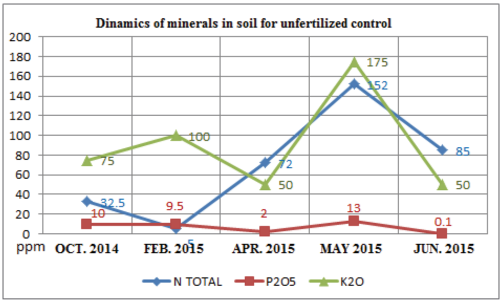


Figure 4. The graph for dynamics of nitrogen, phosphorus and potassium in soil at unfertilized control

After applying fertilizers, we made analysis for all variants fertilized differently, by harvesting every 20 individual samples, the method grid, the depth of 0 - 25cm of each variant, which were mixed, resulting in the final 5 samples average , belonging to the five variants of fertilization. Compared with the control, has revealed a different dynamics of nitrogen in the soil, fertilized variants biological nitrogen supply being weaker than the control but in a continued increase from April to June (Figure 5). Chemically fertilized variants were well supplied with nitrogen, but in a continuous decline, reaching as June have lower values than the control, especially variant fertilized with urea.

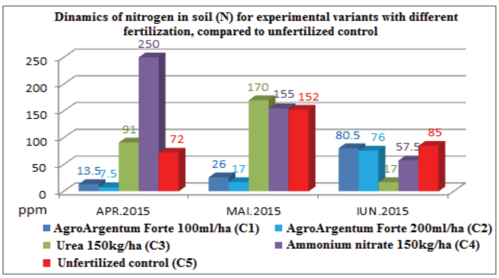


Figure 5. The graph for dynamics of soil nitrogen content compared to unfertilized variant

Phosphorus is an essential nutrient for plant growth and the role of phosphorus cannot be replaced by any other nutrient (Trifan, 2014). For these reasons, it needs a proper supply of plant phosphorous playing a key role in metabolism, participating in processes of photosynthesis, respiration, biosynthesis of carbohydrates, lipids, enzymes and phosphatides. Phosphorus is found in rocks that contain phosphorus as calcium phosphate, which is a tough insoluble form and slowly used by the plant. The concentration of phosphate ions in the soil solution is low (0.1-1.5 mg/l or 0.1-1.5 kg/ha) (Davidescu, 1981). Phosphorus is fixed in soil in three ways: clay by calcium bridges, the humus in the form of humic phosphate and active limestone. Phosphorus is soluble, but may become insoluble by precipitation in acid soil in the form of iron phosphate or alumina, crystallization in alkaline medium or diffusion of the layers of the clay. In the experience compared to the control, only C1 variant had a similar dynamic, with an increase in absorption of phosphorus from the soil in April and June. C2 variant was a progressive absorption, the largest being in phenophase of grains filling. Instead, the chemically fertilized variants, phosphorus absorption was more pronounced at ear formation (Figure 6).

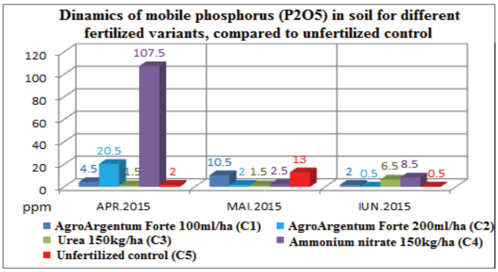


Figure 6. The graph of dynamics for phosphorus content in soil compared to the control

Potassium is widespread in nature, and for plant nutrition is an equally important as nitrogen and phosphorus. Physiological role of plant organisms is much greater than to animal, actively participating in water absorption; reduce perspiration; influences synthesis of carbohydrates, lipids and proteins; enhances photosynthesis; stimulates cell division and growth of plants (Trifan, 2013). In the experience, it was found that all experimental variants had the same dynamic absorption of potassium by plants, higher in April and June, except variant C2, which absorb increased gradually from April to June, when it was more intense than the other variants (Figure7).

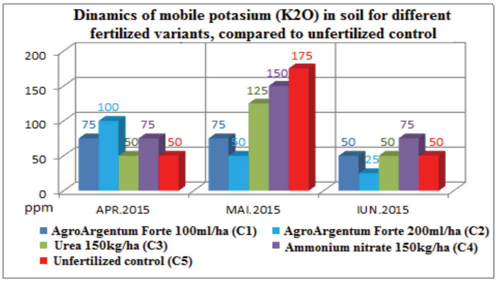


Figure 7. The graph of dynamics for potassium content in soil compared to the control

Besides supplying soil nutrients, soil reaction is a very important element required to be met and monitored as occurs in many physical and biological mechanisms of soil, including having a role in root absorption of mineral elements. Compared to unfertilized, the dynamics soil pH was one ascending, from leaving the winter, only variant fertilized with ammonium nitrate had the same growth trend, and the other, there was a decline in April, followed growth close pH control variant, in May, then decline in June (Figure 8).

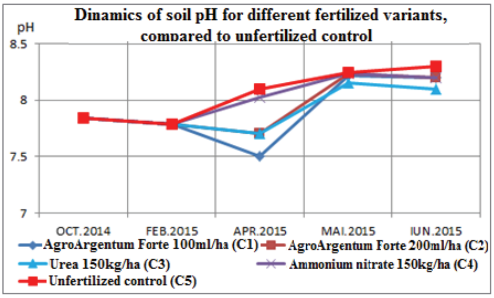


Figure 8. The graph of dynamics for soil pH compared to the unfertilized control

In intensively fertilized soils, the concentration of soluble salts can greatly increase, without taking into account the specific consumption of crops, soil quality and condition of supply minerals. The soil that was placed experience is desalted and dynamics of the total content of soluble salts in the soil, determined in aqueous extract soil: water by 1: 5, is plotted in Fig 9. Compared with the control variant, all experimental variants had a downward trend in the concentration of soluble salts in the soil from spring until harvest (Figure 9).

Calcium (Ca) plays an important role in increasing resistance to frost and drought and colloidal clay-humic complex composition. Ion exchange, on which root absorption occurs, could not do without calcium ions or absence of water.

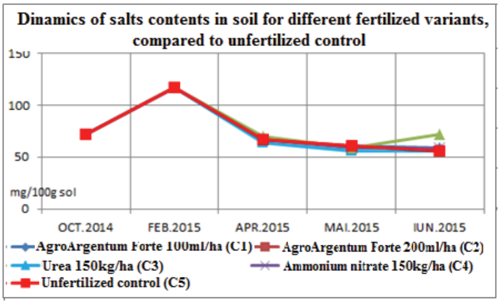


Figure 9. The graph of dynamics for salts contents in soil compared to the unfertilized control

In the experience compared to the untreated control, which was an increase in the concentration of calcium carbonate until April and then a progressive decline in the other experimental versions, there was a progressive decrease in the calcium carbonate in the soil since spring until harvest (Figure 10).

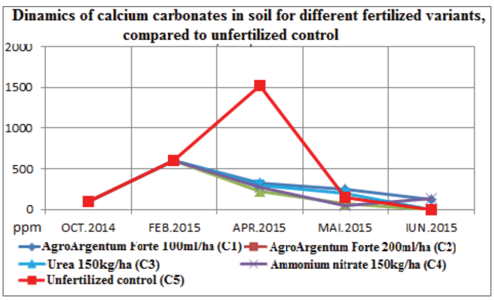


Figure 10. The graph of dynamics for calcium carbonates in soil compared to the unfertilized control

Biometric measurements were performed in different vegetation phases and at harvest to observe the influence of sowing density and different fertilizations, comparing the results with unfertilized variants and with average of experience. Based on results achieved in the experience we were able to make correlations between biometrics, in order to identify the influences of the main characteristics and physiological processes. Correlation coefficients are summarized in Table 1.

Thus, there were positive correlations between number of tillers and number of leaves (r = 0.256) (Figure 11), between number of tillers and root length (r = 0.256) between the number of leaves and root length (r = 0.235) (Figure 12), and between the length leaf and dry matter weight of leaves (r = 0.522) (Figure 12).

Table 1. Correlation coefficiences established between biometrics achieved in 14.04.2015

Specification	No. leaves	Length of leaves	Length of roots	Dry matter in leaves
No. tillers	0.894	-0.396	0.256	-0.508
No. leaves		-0.427	0.235	-0.569
Length of leaves			-0.177	0.522
Length of roots				-0.300

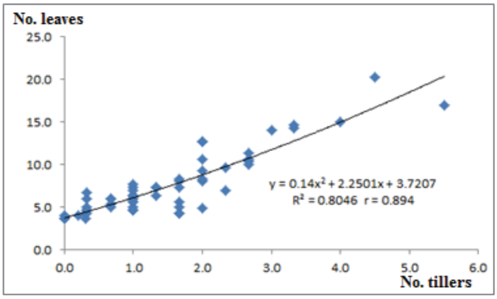


Figure 11. The graph of correlation between number of tillers and number of leaves, in experiences with different fertilizers and densities

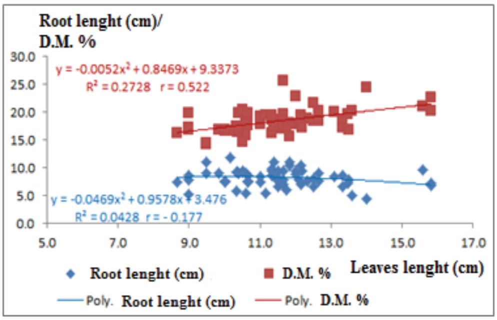


Figure 12. The graph of correlations between leaves length and root length or dry matter in leaves, in experiences with different fertilizers and densities

Negative correlations have been established between number of tillers and the leaf length (r = - 0.396) (Figure 13), between number of siblings and leaf dry weight (r = - 0.508) (Figure 14) between the number of leaves and leaf length (r = - 0.427) (Figure 15).

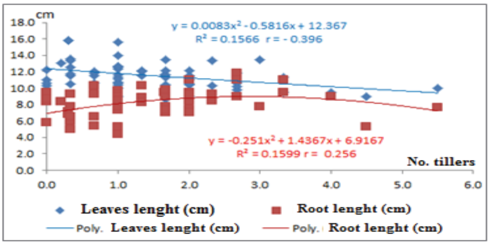


Figure 13. The graph of correlations between number of tillers with leaves length, and with root length, in experiences with different fertilizers and densities

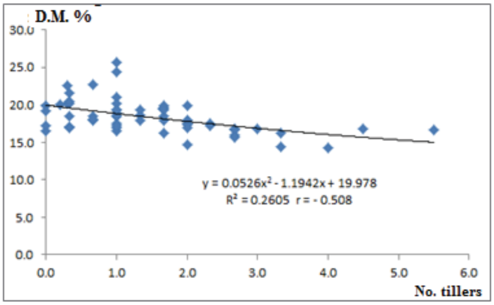


Figure 14. The graph of correlations between number of tillers and dry matter content in leaves, in experiences with different fertilizers and densities

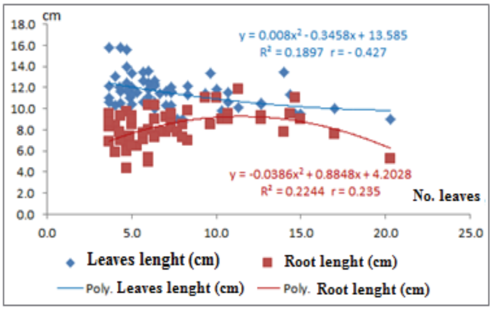


Figure 15. The graph of correlations between number of leaves and leaves length or root length, in experiences with different fertilizers and densities

Biometric measurements were performed at harvest, measurements of productivity indexes and the humidity, MMB, MH, for each experimental variant. The results were compared to unfertilized control and average of experience, both for wheat and for barley.

- Plant size, calculated as the average of repetitions, compared to unfertilized control, was superior to chemically fertilized variants, both wheat and barley in all three seeding densities (Figure 16).
- The average number of ears per plant to differentiate both the varieties and in different densities and fertilization compared with unfertilized so (Figure 17):
• for Boema variety at densities between 450 and 650 gs/sqm, the best results on the average number of ears/plant were obtained from fertilized variants AgroArgentum Forte, 200 ml, followed by chemically fertilized variants density of 550 gs/sqm;
• for Izvor variety, the best result for no environmental spice / herb was obtained variant C1 (AgroArgentum Forte 100 ml) at a density of 650 gs/m, followed in descending order of variations chemically fertilized in all three densities Drills practiced in the experience;
• for Glosa variety, the best result for this indicator was obtained variant fertilized with urea, density of 450 gs / m, followed by variant fertilized with ammonium nitrate density of 650 gs/sqm and fertilized variants AgroArgentum Forte 100 ml, in all three seeding densities practiced;
• for barley Cardinal variety, the best result on the number of ears/plant was obtained variant fertilized with AgroArgentum Forte 200ml / ha density of 650 gs/sqm, followed by variants fertilized with AgroArgentum Forte 100ml / ha in the other two densities.
- The average length of the ear compared to unfertilized was noted these types of fertilizer and densities (Figure 18):
• Boema variety variants fertilized biological density of 650 gs/sqm, followed by fertilized variants chemical with densities of 550 and 450 gs/sqm;
• Izvor variety, chemically fertilized variants density of 450 gs/sqm, followed by variants fertilized biological density of 650 gs/sqm;
• Glosa variety, chemically fertilized variants density of 550 gs/sqm, followed in descending order of variants fertilized with AgroArgentum Forte 200ml / ha in the other two densities.
• Cardinal variety barley, the best results on average ear length were obtained from fertilized variants AgroArgentum Forte and urea at densities between 450 and 650 gs/sqm compared to unfertilized.

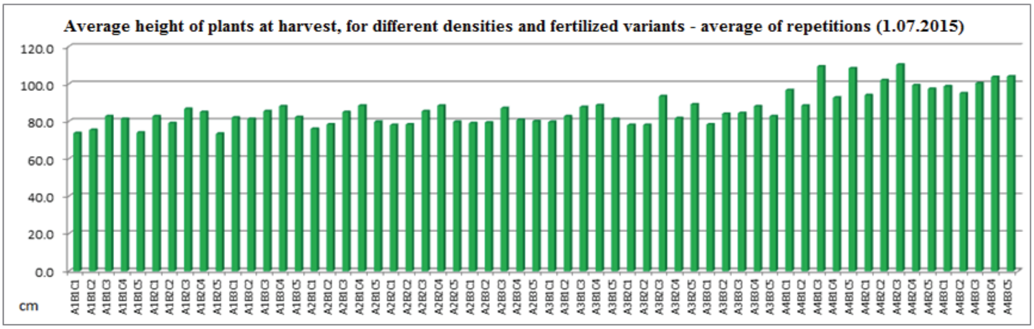


Figure 16. The graph of average values for plant height in the experience with different densities and fertilization on wheat and barley

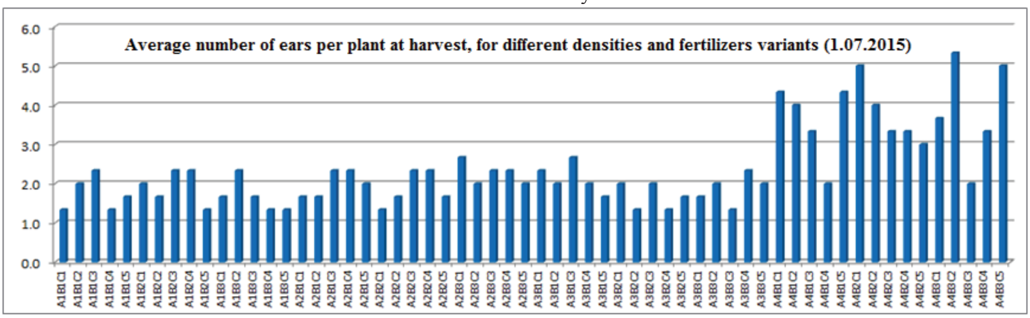


Figure 17. The graph of average values for number of ears per plant in the experience with different densities and fertilization on wheat and barley

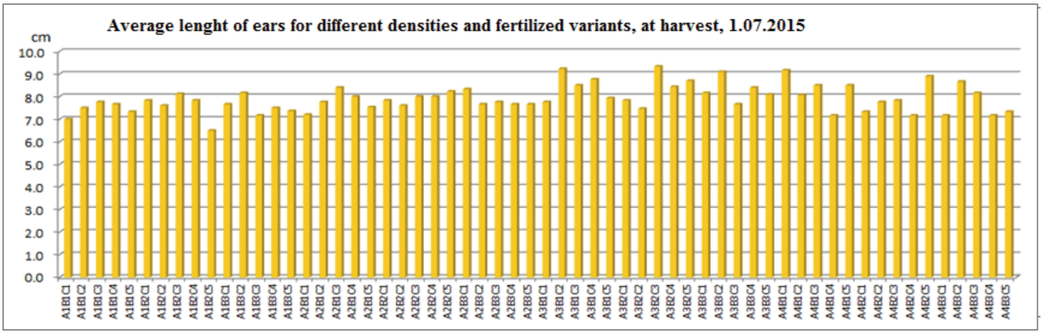


Figure 18. The graph of average values for ears length in the experience with different densities and fertilization on wheat and barley

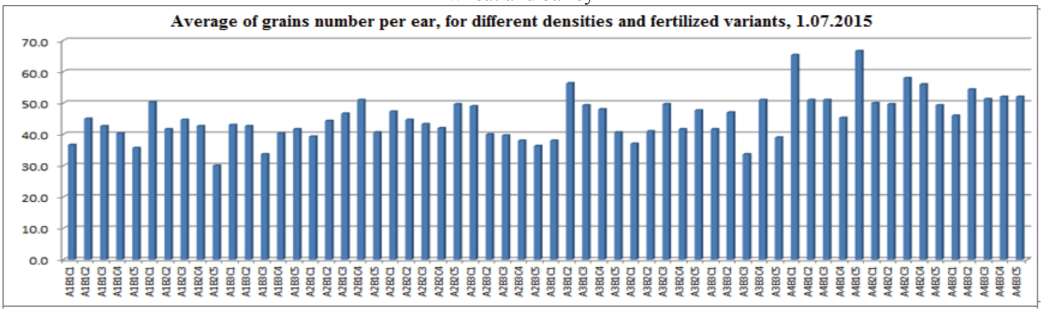


Figure 19. The graph of average values for grains per ear in the experience with different densities and fertilization on wheat and barley

- The average number of grains/ear compared to unfertilized was recorded the following results (Figure 19):

• Boema variety, the best results were recorded at a density of 550 gs/sqm fertilized variants biological, followed in descending order by chemically fertilized variants at the same density and other densities variants fertilized biological practiced.

• Izvor variety, the best results were recorded by chemically fertilized variants density of 450 gs/sqm, followed by variants fertilized biological density of 650 and 550 gs/sqm. Respectively

• Glosa variety, the best result was obtained variant fertilized with AgroArgentum Forte 200 ml/ha density of 450 gs/sqm, followed by versions for other densities practiced chemically fertilized.

• Cardinal variety barley, the best result was obtained biological variant fertilized with 100 ml / ha, density of 450 gs/sqm, followed by chemically fertilized variants with 550 gs/sqm and 650 gs/sqm densities.

Differences of productions were calculated use the average production control calculated for each experience, respectively for wheat and barley. Thus, at wheat experience, differences positive very significant compared to the average control (6291kg/ha) were obtained variant A2B3C3 (Izvor, 650 gs/sqm, fertilized with urea 150kg/ha), with a difference of 2361kg/ha, followed by A1B2C3 version (Boema variety, 550 gs/sqm, urea 150kg/ha), with a difference of 2104kg/ha, A2B3C4 variant (Izvor 650gs/sqm, ammonium nitrate 150kg/ha), with a difference of 2052kg/ha and A2B1C4 (Izvor, 450 gs/sqm, ammonium nitrate 150 kg/ha), with a difference of 1691kg/ha compared to the average experience control.

Biological fertilisation with AgroArgentum Forte 100 ml/ha, obtained differences significant positive compared to the average experience at densities between 550 and 650 gs/sqm Boema variety, with 1291 kg/ha and 1135kg/ha more than control (Figure 20).

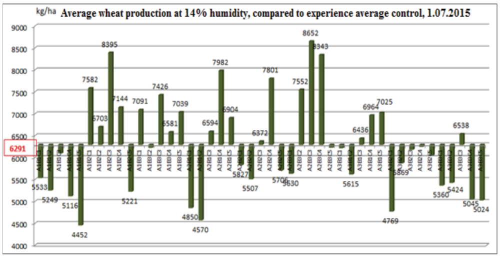


Figure 20. Differences in production compared to the average production obtained from wheat experience

In barley experience, we noticed a positive difference compared to control for the variants with 550 and 650 gs/sqm densities, chemically fertilized and density of 450 gs/sqm variant fertilized biological with AgroArgentum Forte 100ml/ha (Figure 21).

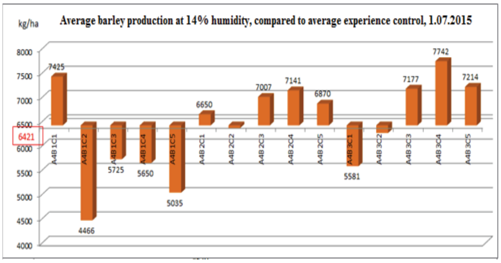


Figure 21. Differences in production compared to the average production obtained from barley experience

The weight of a thousand grains was compared for each species and experimental variant, with the average of experiences observing the following:

¬ for wheat differences significant positive compared to average only obtained varieties Boema and Izvor so: the Izvor variety looked like density 450 and 550 gs/sqm, fertilized biological, followed by Boema variety, fertilized biological densities of 450 and 550 gs/sqm and fertilized biological and chemical density of 650 gs/sqm (Figure 22).

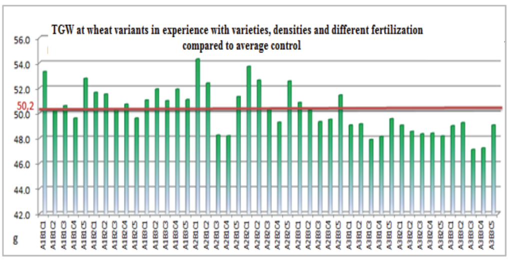


Figure 22. Thousand grains weight of wheat variants compared to average of experience

For winter barley, the highest values of TGW, compared with the average of experience were obtained at sowing density of 450gs/sqm, fertilized biological with AgroArgentum 200ml/ha, followed by ammonium nitrate 150kg/ha, and biological 100ml/ha and urea 150kg/ha (Figure 23).

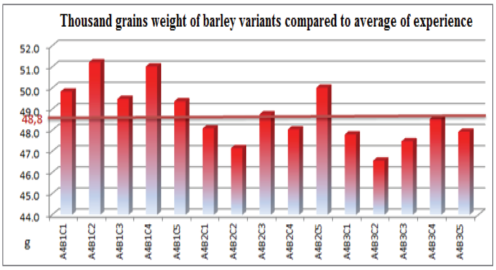


Figure 23. Thousand grains weight of barley variants compared to average of experience

Hectolitre mass was compared in the same manner as MMB for each species and experimental variant, with the average of experience we observed the following:

¬ for wheat the best values were following variants (Figure 24): Boema variety sown at 450gs/sqm and fertilized with AgroArgentum 100ml/ha (83kg/ha), followed by variants fertilized with 650gs/sqm density, and the density of 450 gs/sqm fertilized biological with dose 200ml/ha and variants seeded with a density of 550 gs/sqm chemically fertilized.

For a variety Izvor noted sown density variety of 450gs/sqm and fertilized with AgroArgentum 200ml / ha, followed by variant fertilized with ammonium nitrate seeding density of 550 gs/sqm. For Glosa variety, all variants fertilized with AgroArgentum 200ml / ha achieved above average hectolitre mass values, followed by variants fertilized with ammonium nitrate density of 550gs/sqm and 450gs/sqm. For winter barley, hectolitre mass values were noted compared with the experience average control were fertilized variants biological with dose 100ml/ha at densities between 450 and 650gs/sqm, with 200ml density of 550 and 650 gs/sqm and nitrate ammonium variant sown with 550gs/sqm (Figure 25).

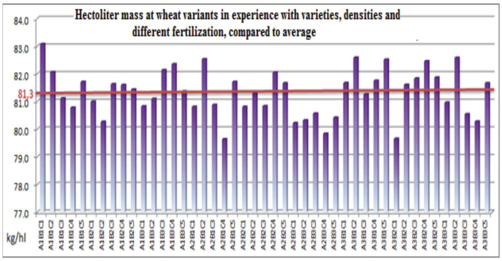


Figure 24. Hectolitre mass of wheat variants compared to average of experience

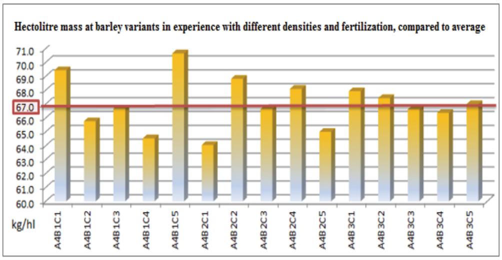


Figure 25. Hectolitre mass of winter barley variants compared to average of experience

CONCLUSIONS

Experience revealed a different dynamics of nitrogen in the soil, fertilized variants biological nitrogen supply being weaker than the control but in a continued increase from April to June.

Instead, chemically fertilized variants were well supplied with nitrogen, but in a continuous decline, reaching as June have lower values than the control, especially variant fertilized with urea.

The choice and dose density sowing fertilizer for growing wheat and barley to fall must always be correlated with soil conditions, climate and cultivars.

In North Baragan Plain we recommend the densities from 550 to 650 gs/sqm and fertilization with doses correlated to minerals concentration in soil and specific consumption of cultivated species because it is very important to keep soil in ecological parameters of fertility for a sustainable agriculture.

If, due undesirable climatic phenomena we obtain a lower density of winter barley or wheat, we can apply biological fertilizer type AgroArgentum Forte in dose of 100ml/ha, to increase the quantity and quality of production.

ACKNOWLEDGEMENTS

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EFFECTS OF FERTILIZATION ON SEED YIELD AND FORAGE QUALITY OF COMMON VETCH (*Vicia sativa* Roth.)

Mevlüt TÜRK, Fatma YILDIZ

Süleyman Demirel University, Faculty of Agriculture, Department of Field Crops, Isparta, Turkey

Corresponding author email: email: mevlutturk@sdu.edu.tr

Abstract

This research was conducted to determine the effects of five phosphorus rates (0, 30, 60, 90 and 120 kg ha^{-1}) on seed yield and forage quality of common vetch (Vicia sativa Roth.). The crude protein yield, dry matter intake (DMI), digestible dry matter (DDM), seed yield and 1000 seed weight were determined in this research. Phosphorus rates significantly affected all components determined in common vetch. Phosphorus rates increased crude protein yield, dry matter intake (DMI), digestible dry matter (DDM), seed yield and 1000 seed weight of common vetch.

***Key words**: Common vetch, crude protein yield, seed yield, 1000 seed weight.*

INTRODUCTION

Common vetch is commonly grown to provide a seed and hay crop in many different farming systems in Turkey (Albayrak et al., 2004). Several researchers found that seed yield varied from 0.45 to 2.76 t ha^{-1} in common vetch grown in the different regions of Turkey (Elçi and Orak, 1991; Açıkgöz et al., 1986; Arslan and Anlarsal, 1996; Gökkuş et al., 1996; Mermer et al., 1996; Anlarsal et al., 1999; Başbağ et al., 2001; Albayrak et al., 2006). Vetches can be used for the grazing of livestock, green manure, forage or silage, or the grain fed to livestock (Caballero, 1993; Chowdhury et al., 2001; Egan and Crouch, 2006). Phosphorus fertilization affects dry matter yield and chemical composition of vetch (Bell et al., 2001; Turk, 2001).

Phosphorus (P) plays a major role in legume crop nutrition. Cell division, root lengthening, seed and fruit development, early ripening and resistance to various stresses (i.e., low temperature, diseases) are closely related to P nutrition. Phosphorus deficiency can cause nitrogen (N) deficient legume plants since it helps out the formation of rhizobia bacteria in their root nodules (Israel, 1987; Sekhon et al., 1986). Turk and Tawaha (2001) concluded that phosphorus application significantly affect the seed yield, number of pods per plant, number of seeds per pod, number of primary branches per plant, 100 seed weight, pod length and seed weight per plant of Vetch. The factors influencing the nutritive value of forage are many and the degree to which they are interrelated may vary considerably from one area to another. These factors may include, alone or in combination, plant type, climate, season, weather, soil type and fertility, soil moisture, leaf to stem ratio, physiological and morphological characteristics and others, and may change depending on whether the plants are annuals perennials, grasses or legumes. Nutrient composition levels are not necessarily the only criterion in evaluating the nutritive value of plants (Stobbs, 1975; Cook and Harris, 1979).

The aim of this research was to determine the effects of P on seed yield and forage quality of common vetch.

MATERIALS AND METHODS

The study was conducted at Usak (38°39′N, 29°39′E, elevation 910 m) located in the Aegean region of Turkey. Total precipitation was 378 mm in 2014 (March–June). The long-term average is 280 mm. Average temperature was 15.1^{o}C in 2014. The long- term average is 14.9^{o}C.

The experiments were established in a randomized complete block design with three replications in March in 2014. Five different phosphorus rates (0, 30, 60, 90 and 120 kg P ha^{-1}) were applied in this study. Seeding rate was 80 kg ha^{-1}. Individual plot size was 1.8 × 6 m = 10.8 m^2. Phosphorus was broadcast as triple superphosphate (46% P_2O_5) during sowing in March.

The harvest time was based on the 50% flowering stage (May 20) of common vetch for forage quality. All plots were harvested for seed yield on June 14. Crude protein yield, dry matter intake (DMI) and digestible dry matter (DDM) were investigated in samples were taken from quadrats (1 m^2). Samples taken from each plot were dried at room temperature then dried in an oven at 65°C till they reached constant weight. After cooling and weighing, the samples were ground for mineral contents analyses.–Nitrogen content was calculated by Kjeldahl method (Kacar 1972). The ANKOM Fiber Analyzer was used for NDF and ADF analysis. ANKOM F57 filter bags were used for ADF and NDF analysis in this study.

Dry matter intake (DMI) and digestible dry matter (DDM) values were estimated according to the following equations adapted from (Horrocs and Vallentine, 1999):

DMI (% of BW) = 120/ NDF % dry matter basis

DDM (% of DM) = 88.9-(0.779 x ADF % dry matter basis)

The data were analyzed together using the Proc GLM (SAS 1998). Means were separated by LSD at the 5 % level of significance.

RESULTS AND DISCUSSIONS

The results of ANOVA summarized in Table 1. The results of variance analysis showed that crude protein yield, DMI, DDM values, seed yield and 1000 seed weight of common vetch were influenced significantly by phosphorus treatments (Table 1).

Table 1. Results of Analysis of Variance Traits Determined

	df	Crude protein yield	DMI	DDM	1000 seed weight	Seed yield
Block	2	0.96	0.0007	0.027	0.03	0.33
Phosphorus	4	159.96**	0.16**	4.65**	26.21**	292.77**
Error	8	1.43	0.0005	0.015	0.26	2.92

df: degrees of freedom, *P<0.05 and **P<0.01.

Table 2. The CP yield, DMI, DDM, 1000 seed weight and seed yield of common vetch at different phosphorus doses

Phosphorus doses (t ha^{-1})	Crude protein yield (t ha^{-1})	DMI (%)	DDM (%)	1000 seed weight (g)	Seed Yield (t ha^{-1})
0	0.43 d	3.33 d	67.79 c	47.46 d	1.59 d
30	0.46 c	3.58 c	69.27 b	49.80 c	1.67 c
60	0.53 b	3.61 c	69.47 b	51.90 b	1.74 b
90	0.60 a	3.84 b	70.64 a	54.08 a	1.81 a
120	0.58 a	3.90 a	70.92 a	54.45 a	1.83 a
LSD (5%)	0.02	0.04	0.31	0.96	0.03

In present study, increasing P fertilization increased crude protein yield. The highest CP yield was obtained from 90 and 120 kg ha^{-1} P rate (0.60 and 0.58 t ha^{-1}), while the lowest CP yield (0.43 t ha^{-1}) was obtained from control plot (Table 2). Similar result was reported by Balabanlı and Akkeçili (2006).

The highest DDM value was obtained from 90 and 120 kg ha^{-1} P rate, while the lowest DDM value was obtained from control plot (Table 2). The highest DMI value (3.90%) was obtained from 120 kg ha^{-1} P rate, while the lowest DMI value (3.33%) was obtained from control plot. Dry matter intake is estimated from NDF and DDM from acid detergent fiber. Equations have been developed that predict DMI from forage NDF levels and DDM from levels of ADF in the forage (Linn and Martin, 1989). Subsequently, estimated DMI and DDM of the forage are used in an equation to assign a relative feed value (RFV) to the forage, which is used as an estimate of potential energy intake of a forage. In present study, increasing phosphorus treatments resulted in an increase in DDM and DMI values. The NDF is used to predict DMI and is negatively correlated with DMI, which means that when NDF is high the quality and the DMI are low (Horrocks and Vallentine, 1999).

Phosphorus fertilizer increased 1000 SW of common vetch. The highest 1000 SW were obtained from 90 and 120 kg ha^{-1} P rate (54.45 and 54.08 g), while the lowest DM yield (47.46 g) was obtained from control plot (Table 2). Similar results were reported by Turk and Tawaha (2001), Noulas et al., (2012). Elçi and Orak (1991) reported that 1000 seed weight of common vetch changed between 41.83 and 63.35 g. Arslan and Anlarsal (1996) reported that 1000 seed weight of common vetch changed between 44.1 and 56.94 g. Our results are in agreement with those reported by Elçi and Orak (1991), Arslan and Anlarsal (1996).

The highest seed yield was obtained from 90 and 120 kg ha^{-1} P rate (1.83 and 1.81 t ha^{-1}), while the lowest DM yield (1.59 t ha^{-1}) was obtained from control plot (Table 2). Increase in seed yield due to P application is well documented by many authors (Gurmani et al., 2006; Turk and Tawaha, 2001; Noulas et al., 2012). Several researchers found that seed yield varied from 0.45 to 2.76 t ha^{-1} in common vetch grown in the different regions of Turkey (Elçi and Orak, 1991; Açıkgöz et al., 1986; Arslan and Anlarsal, 1996; Gökkuş et al., 1996; Mermer et al., 1996; Anlarsal et al., 1999; Başbağ et al., 2001; Albayrak et al., 2006).

CONCLUSIONS

Common vetch has adequate mineral content for ruminant animal requirements for production in the Agean conditions of Turkey. Increasing P rates resulted in increased seed yield and forage quality. The highest seed yield and 1000 seed weight were obtained from 90 and 120 kg ha^{-1} P rates. The content of CP increased while increasing P fertilization rates. As P rate increased from 0 to 120 kg ha^{-1}, DMI and DDM values increased. At the end of this research conducted in Agean conditions of Turkey, 90 kg ha^{-1} phosphorous fertilizer is recommended for high seed yield and forage quality in common vetch.

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EFFECTS OF SALT STRESS ON GERMINATION OF SOME SILAGE MAIZE (*Zea mays* L.) CULTIVARS

Mevlüt TURK, Ozge ESER

Süleyman Demirel University, Faculty of Agriculture, Department of Field Crops, Isparta, Turkey

Corresponding author email: mevlutturk@sdu.edu.tr

Abstract

This study was conducted to investigate the effects of salt stress on germination of four silage maize (Zea mays L.) cultivars (Ozgem, Efe, Safak and Side). The degree of salinity tolerance among these cultivars was evaluated at seed germination stage at four different salt concentrations (0, 4, 8 and 12 dS m^{-1} NaCl). The germination percentage, salt tolerance index, shoot dry weight, root dry weight were determined in this research The results showed that in all cultivars as the salt concentration increased, germination percentage decreased significantly. Responses of cultivars to salt stress indicated differences. Cultivar Efe had the highest germination percentage. The highest shoot dry weight was obtained from cultivar Efe while the lowest shoot dry weight was obtained from cultivar Ozgem. Salt concentration decreased shoot and root dry weight. Efe and Safak had the highest root dry weight. The results showed that Efe is the cultivar to be recommended for saline soils.

Key words: *maize, germination percentage, salt tolerance index, shoot dry weight, root dry weight.*

INTRODUCTION

Maize (*Zea mays* L.) is in the third rank after wheat and rice and is grown all over the world in a wide range of climatic condition. Being highly cross pollinated, maize has become highly polymorphic through the course of natural and domesticated evolution and thus contains enormous variability in which salinity tolerance may exist (Paterniani, 1990).

High salt content in the soil is one of the most important environmental factors limiting global crop production. Out of 230 million hectares of irrigated agricultural land approximately 45 million hectares are salt-affected (Athar and Ashraf, 2009). Salinity is a major environmental constraint to crop productivity throughout the arid and semi-arid regions of the world (Foolad and Lin, 1997). Salinity has reached a level of 19.5 % of all irrigated-land (230 million ha of irrigated land, 45 million ha are salt-affected soils and 2.1 % of dry-land (1500 million ha of dryland agriculture, 32 million are salt-affected soils) agriculture worldwide. According to the FAO, around 1.5 million ha of land have both salinity and sodicity problems (FAO, 2009).

Seed germination is a major factor limiting the establishment of plants under saline conditions. Salinity may cause significant reductions in the rate and percentage of germination, which in turn may lead to uneven stand establishment and reduced crop yields (Foolad et al., 1999).

Maize, which belongs to the plants with C4 metabolism, is also classified as moderately sensitive to salinity. For maize grown under salinity, reduction in growth characters and yield were observed (Ouda et al., 2008).

This study was conducted to determine the silage maize cultivars resistant to salt stress which can be grown on cultivated lands having salt problems.

MATERIALS AND METHODS

This study was carried out in Suleyman Demirel University, Agricultural Faculty, Field Crops Department, Turkey in 2011. Four cultivars (Ozgem, Efe, Safak and Side) of silage maize (*Zea mays* L.) were used and their seeds were obtained from the Bati Akdeniz Agricultural Research Institute. These cultivars are largely grown in Mediterranean Region by the farmers.

To obtain homogeneous emergencies after seedlings, seeds with similiar size and weight were selected. Seeds were surface sterilized in 1.5 % (v/v) sodium hypochlorite for 10 min and thoroughly washed with distilled water. Twenty seeds were placed on filter papers which contained different salt concentrations and located in 15 cm diameter steril petri dishes. Salt stress was realized by subjecting the seeds to 15 ml salt solutions of 0, 4, 8 and 12 dS m^{-1} NaCl. In addition 15 ml of distilled water without NaCl was used as control. The filter papers were changed with the new ones after 48 hours in order to avoid salt accumulation.

Germination percentage: Initiation and completion of germination was recorded daily. The germination percentage was recorded daily for 10 days and germination percentage was calculated with the following formula (Carpıcı et al., 2009):

Germination percantage (%)= Number of germinated seeds / Number of total seeds x 100.

The dry weights of the shoots and roots of the seedlings were measured immediately after 10 days. The dry weights were meausered after drying the shoot and root at 80 ºC for 24 h, to standardize the weight (Carpıcı et al., 2009).

Salt tolerance index: This value was calculated as the ratio of the total dry weight of plants subjected to different salt concentrations to the total dry weight of plants of control.

Salt tolerance index (%) = (TDW at S_x/TDW at S_0) × 100.

TDW= total dry weight, S_0 =Control, S_x=A given concentration out of five salt concentration.

The experiment was conducted by using randomized block desing with 3 replications. The data of germination percentage and stress tolerans index were transformed using by arcsine values prior to statistical analysis. Significant differences between treatments were determined using LSD test at the 0.05 level.

RESULTS AND DISCUSSIONS

The results showed that measured components of maize cultivars were significantly affected by salt concentrations (Table 1). At different salt concentrations, Efe and Safak had the highest and lowest germination percentage as 93.58% and 89.75% respectively. Rahman et al.(2000) reported that maize cultivars were significantly more tolerant to salt stress at germination than at later stages of growth. Seeds in the control and 4 dS m^{-1} NaCl treatments had the highest germination percentage (100%), and as the salt concentration increased, germination percentage decreased up to 12 dS m^{-1} NaCl treatment. There were no statistically significant differences in germination percentage among control and 4 dS m^{-1} NaCl treatments. A higher germination percentages of cultivars at control (0 dS m^{-1} NaCl) were due to lack of salt in the medium. High concentration of NaCl in the salt solution increases its osmotic potential. In addition, high absorption of Na and Cl ions during seed germination can be due to cell toxicity that finally inhibits or slows the rate of germination and thus decreases germination percentage (Taiz and Zeiger, 2002). Our results were supported by many researchers conducted on this subject (Rahman et al., 2000; Gill et al., 2002; Almodares et al., 2007; Blanco et al., 2007; Sozharajan and Natarajan, 2014).

Shoot dry weights of cultivars were negatively affected by increasing salt treatments. The average shoot dry weight of cultivars was 26.3 mg $plant^{-1}$ at control and this value gradually decreased throughout the increasing salt concentrations, and reached to 18.1 mg $plant^{-1}$ at 12 dS m^{-1}. The highest shoot dry weight was obtained from cultivar Efe while the lowest shoot dry weight was obtained from cultivar Ozgem. Our results are in agreement with the results of other researchers. For example, Hussein et al. (2007), reported that a negative relationship was detected between vegetative growth parameters and increasing salinity. In same study, shoot dry weight was 52.01 mg plant-1 at control while it decreased linearly to 25.26 mg plant-1 at 4000 ppm. The same results were also obtained by other researchers (Alberico and Cramer, 1993; Cramer et al., 1994; Mansour at al., 2005; Hoque et al., 2015; Shtereva et al., 2015).

Root dry weight of cultivars decreased significantly as the levels of salinity increased from 0 to 12 dS m^{-1} NaCl. Thus, the highest root dry weight (55.3 mg $plant^{-1}$) was determined at control and the lowest root dry weight (42.6 mg $plant^{-1}$) at the highest salinity level. Among the cultivars, Efe and Safak were affected least by salinity. Akram et al. (2007)

reported that root dry weight of all corn hybrids showed a decline towards increase in salinity level. On the other hand, reduction in plant growth as a result of salt stress has also been reported in several other plant species (Mishra et al., 1991; Ashraf and O'leary, 1997).

Table 1. Effects of different salinity levels on germination and seedling characteristics of four maize cultivars

		Germination Percentage (%)	Shoot Dry Weight (mg plant^{-1})	Root Dry Weight (mg plant^{-1})	Salt Tolerance Index
Salt Concentrations (dS m^{-1})					
0		100.00 a	26.3 a	55.3 a	100.00 a
4		100.00 a	23.5 b	52.4 b	70.51 b
8		92.14 b	20.8 c	48.3 c	44.29 c
12		75.02 c	18.1 d	42.6 d	26.76 d
LSD (5%)		6.42	1.8	2.4	12.25
Cultivars					
Özgem		91.50 b	20.1 d	47.1 c	60.00
Efe		93.58 a	24.4 a	51.8 a	59.21
Şafak		89.75 c	23.5 b	51.2 a	61.50
Side		92.33 b	20.7 c	48.5 b	59.85
LSD (%5)		1.05	0.5	1.2	ns
Significance	df				
Cultivars (C)	3	*	**	**	ns
Salt (S)	3	**	**	**	**
C * S int.	9	ns	ns	ns	ns

Means followed by the same letter were not significantly different at 0.05 level using LSD test. *, **, *F*-test significant at $P < 0.05$ and $P < 0.01$, respectively. ns, not significant.

There were no statistically significant differences in salt tolerance index among cultivars. The effects of different salt concentrations on salt tolerance indices of cultivars were significant. As the salt concentrations increased the salt tolerance indices of cultivars decreased. Therefore, the lowest value of salt tolerance index (26.76) was determined at 12 dS m^{-1} NaCl (Table 1). Our results were supported by Carpici et al. (2009). Salt tolerance at germination stage is important factor, where soil salinity is mostly dominated at surface layer. High concentration of salts have detrimental effects on germination of seeds (Rahman et al., 2000; Sharma et al., 2004; Saboora and Kiarostami, 2006). Plant growth is ultimately reduced by salinity stress but plant species differ in their sensitivity or tolerance to salts (Rogers et al., 1995).

CONCLUSIONS

The results from the effects of salt stress on germination of four silage maize in Mediterranean conditions of Turkey can be summarized as follows.

The results showed that in all cultivars as the salt concentration increased, germination percentage decreased significantly. Responses of cultivars to salt stress indicated differences. Cultivar Efe had the highest germination percentage. The highest shoot dry weight was obtained from cultivar Efe while the lowest shoot dry weight was obtained from cultivar Ozgem. Salt concentration decreased shoot and root dry weight. Efe and Safak had the highest root dry weight. The results showed that Efe is the cultivar to be recommended for saline soils.

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MINIMIZING OF SIDE EFFECTS OF PESTICIDES ON AGRICULTURAL ENVIRONMENT

Nigar YARPUZ-BOZDOGAN[1], Ali Musa BOZDOGAN[2]

[1]University of Cukurova, Vocational School of Technical Sciences, Misis, Adana, Turkey
[2]University of Cukurova, Faculty of Agriculture, Dept of Agricultural Machinery and Technologies Engineering, Sarıcam, Adana, Turkey

Corresponding author email: nyarpuzbozdogan@cu.edu.tr

Abstract

Pesticides have negative effects on environment if pesticides are applied in unsuitable conditions such as inappropriate equipment, under unsuitable meteorological conditions, overdose, etc, pesticides can be drifted non-target organisms, and then they are harmful for human health and environment. However, there is a major problem before and after pesticide applications: point source pesticide pollution (PSPP). This pollution occurs during filling before application and cleaning after application. For minimizing of pesticide contamination on agricultural environment, biobed is used in some countries especially Sweden, France, England, Guatemala, and Belgium. Biobed is a biological system for minimizing and degrading of pesticide contamination in agricultural environment. The origin of biobed is Sweden in 1990's. Biobed components are the clay layer, the biomix, and the grass layer. Number of biobeds increases year by year. In some countries, biobed is renamed as biofilter, biomassbed, phytobac, biobac, and biotable that are made some modifications from the original biobed design. In world, approximately 100 researches about biobed were published in several journals, conferences, workshops, etc. In Turkey, totally 6 projects were supported financially by University of Cukurova, and of which 1 by TUBITAK (The Scientific and Technological Research Council of Turkey). For awareness of farmers about biobed, the government agencies, farm associates', and other private sectors related to agriculture environment have to be arranged meetings, workshops, conferences.

Key words: *biobed, pesticide, agriculture, environment, sprayer.*

INTRODUCTION

Generally, in worldwide, pesticide consumption in per year is about two million tonnes, 45% of which is used by Europe (De et al., 2014). In 2013, the amount of pesticides used was approximately 35,000 tonnes for Turkey, and 7,000 tonnes for Romania (FAO, 2016).

In 2010, pesticide active ingredient (a.i.) in arable land and permanent crops was 0.75 kg per ha for Romania, and 1.59 kg per ha for Turkey (FAO, 2016).

In Turkey, total agricultural land is about 40 million ha (TUIK, 2016). In Turkey, the number of sprayers is approximately 1.1 million of which approximately 30% is power take-off (PTO) driven sprayers (TUIK, 2016).

In agriculture, pesticides are important for growing higher quality and quantity crops. Yet, pesticides may contaminate to agricultural environment in three ways: during filling of the sprayer before pesticide applications (Figure 1a), during pesticide applications (Figure 1b), and during cleaning of the sprayers after pesticide applications (Figure 1c) (Castillo et al., 2008).

If pesticides are applied in unsuitable conditions such as inappropriate equipment, under unsuitable meteorological conditions, overdose, etc, pesticides can be drifted non-target organisms, and then they are harmful for human health and environment.

In this contamination, pesticides are generally diluted with water due to make suitable for pesticide application.

Therefore, drifted droplets are diluted (Figure 1b). Yet, there is a major problem for environment before and after pesticide applications: point source pesticide pollution (PSPP) (Figure 1a and c).

Biobed

In general, farmers fill the sprayer near the field, farmyard, water sources, etc. before pesticide application. Also, they generally clean it in same location (Figure 2a and 2b).

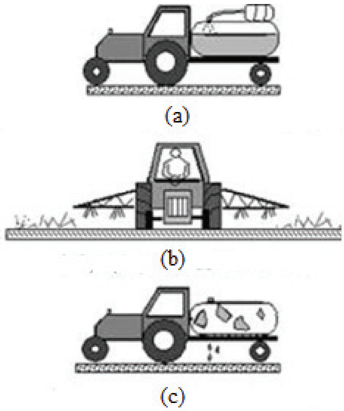

Figure 1. Ways of pesticide contamination into environment (Castillo et al., 2008)

Figure 2. Cleaning of sprayer in the farmyard (Photo by Nigar Yarpuz-Bozdogan, 2008)

In these procedures, deposited pesticide a.i. contaminates the environment. Yet, during fill the sprayer with pesticide, if there are leak in sprayer equipment or splash carelessness, pesticide a.i. will be maximum concentration on soil at this point where is filled the sprayer with pesticide. In Turkey, farmers do not take care of location for filling and cleaning of sprayer. Daglioglu (2014) indicated that farmers generally fill pesticides to sprayer in farmyard (41.6%), near field (24.7%) and water bodies (12.8%). They clean the sprayer in farmyard (57.4%), near field (26.7%) and water bodies (8.9%). Researcher determined that only 7.9% of farmers think of pesticide contamination in agricultural environment during filling of the sprayer.

For minimizing and eliminating of this problem, in Sweden, 1993, it is established a construction named as biobed (Figure 3). Biobed is a simple and cheap construction intended to collect and degrade spills of pesticides on farms (Castillo et al., 2008). It consists of clay layer, biomix, and grass.

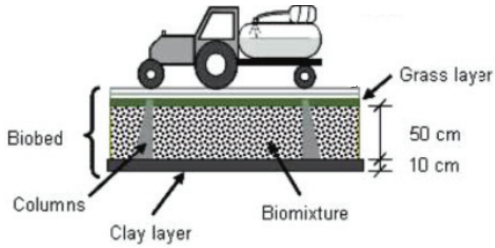

Figure 3. Biobed (Castillo et al., 2008)

Clay layer helps to decrease the water flow downward, and to increase the pesticide retention time in the biobed (Castillo et al., 2008).

Biomix composes of straw (50% v.), peat (25%v.), and soil (25%v.). The straw is used for pesticide degradation and microbial activity, especially from lignin-degrading fungi (such as white rot fungi), which produce phenoloxidases (peroxidases and laccases). The broad specificity of these enzymes makes them suitable for degradation of mixtures of pesticides. The agricultural soil is used for sorption capacity (Castillo et al., 2008). The peat helps to sorption capacity, moisture control, and degradation of pesticides. The peat is expensive material especially southern European countries such as Italy, France, Greece and Turkey. Therefore, in these countries, many experiments are made on organic materials instead of peat.

The grass layer helps to regulate the moisture of the biobed by creating an upward transport of water (Castillo et al., 2008).

Biobed in the World

Biobed number was 1,682 in 2004, and 6,604 in 2012 (Figure 4a, b). It means that biobed number has increased approximately 4 times in 8 years.

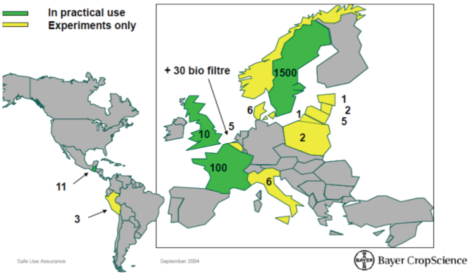

Figure 4a. Biobed number in world in 2004 (Husby and Börgartz, 2004)

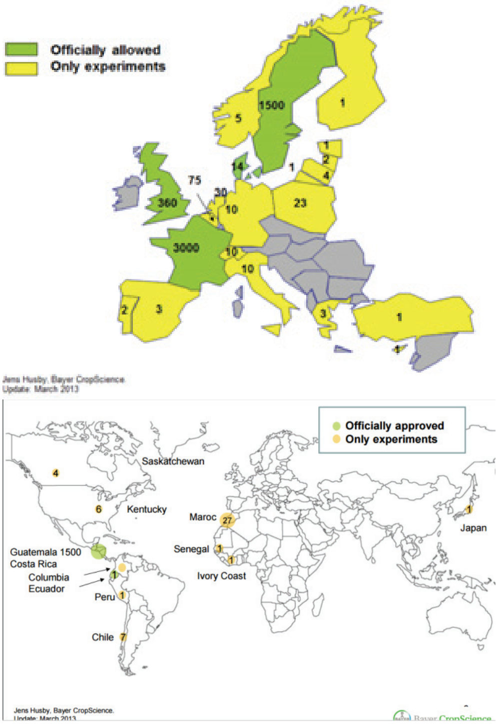

Figure 4b. Biobed number in world in 2012 (Husby, 2013)

In some countries, biobed is renamed as biofilter, biomassbed, phytobac, biobac, and biotable that are made some modifications from the original biobed design.

The European Biobed Workshops were held in Malmö (Sweden, 2004), Ghent (Belgium, 2007), Piacenza (Italy, 2010), and Wageningen (The Netherlands, 2013). In the four workshops, number of participants is 14 in 2004, 41 in 2007, 45 in 2010, and 42 in 2013. They were from 6, 12, 16, and 19 different countries. Moreover, two workshops were organized as Latin-American Biobed Workshop in Chile-2012 and Guatemala-2014 (Anonymous, 2016).

In world, approximately 100 researches about biobed were published in several journals, conferences, workshops, etc. In Turkey, totally 6 projects were supported financially by University of Cukurova, and of which 1 by TUBITAK (The Scientific and Technological Research Council of Turkey). Also, 10 papers about biobed were presented in journals, congress, workshops, etc (Bozdogan and Yarpuz Bozdogan, 2007a; Bozdogan and Yarpuz Bozdogan, 2007b; Bozdogan et al., 2009; Bozdogan et al., 2010; Bozdogan, et al., 2013; Berçik and Bozdogan, 2013; Bozdogan et al., 2014; Daglioglu, 2014; Bozdogan and Yarpuz Bozdogan, 2015a; Bozdogan and Yarpuz Bozdogan, 2015b).

CONCLUSIONS

Biobed is a simple and easy way to minimize pesticide contamination in agricultural environment. For this reason, farmers should be educated about biobed, and importance of agricultural environment. For awareness of farmers about biobed, the government agencies, farm associates', and other private sectors related to agriculture environment have to be arranged meetings, workshops, conferences.

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VEGETATION FEATURES OF ALPINE AND SUBALPINE RANGELANDS IN EASTERN BLACK SEA REGION

Tamer YAVUZ[1], Mustafa SÜRMEN[2]

[1]Ahi Evran University, Faculty of Agriculture, Department of Field Crops, Kırşehir, Turkey
[2]Adnan Menderes University, Faculty of Agriculture, Department of Field Crops, Aydın, Turkey

Corresponding author email: tameryavuz551@hotmail.com

Abstract

This current study was conducted by using modified wheel point method to determine the features of the vegetation of alpine and subalpine rangelands in Giresun province located in Eastern Black Sea Region of Turkey. Plant covered ratios were detected from 33.0 % to 100.00 %. Botanical composition rates of families were determined between 3.71-45.81 % for legumes, 4.59-86.00% for grasses and 8.00-84.13% for other plant species in rangelands. During the vegetation surveys, a total of 148 different species were identified including 25 legumes, 32 grasses, and 91 belonging to other families. In addition, 23 of identified species were classified as decreasing species, 14 of them were classified as increasing species and 111 of them were classified as invasive species. Rangelands in the study area were categorized as healthy-risky rangeland according to range health classification and moderate-poor rangeland according to range condition classification. From the Giresun rangelands, a part, representing 47.17% has been grazed intensively, 35.85% moderately, 9.43% lightly and 7.55% weren't grazed. Research results showed that grazing pressure must be decreased by regulating the grazing systems for Eastern Black Sea Region to improve rangeland quality.

Key words: *rangeland vegetation, grazing intensity, range health, range condition.*

INTRODUCTION

The grasslands are high-quality forage source for ruminants and natural life areas for wild animals worldwide. Stockbreeding is very important for many countries and mainly depends on rangelands (Ünal et al., 2014). Unfortunately, rangelands in Turkey have been destroyed within the last 70 years, decreasing from 45 million hectares to 14.6 million hectares (Anonymous, 2015). Giresun rangelands (97.9 thousand hectares) in Eastern Black Sea Region are located in alpine and subalpine zones. The remaining rangelands have been overgrazed beyond their capacities, contrary to management rules (Ayan et al., 2007).

Grazing frequency affects botanical composition and productivity of rangeland vegetation (Kadziulis and Kadziuliene, 2006). Thus, a large proportion of rangelands need urgent improvement plans. However, the success of improvement programmes directly related to the vegetation features of rangelands. Forage production is dependent on the management of the rangelands (Rashid and Abbas, 2011). The vegetation features of rangelands are one of the most important factors in the choice of the improvement program or the grazing system.

The aim of this study was to identify some of the vegetation characteristics of the grasslands in Giresun province, to contribute to the accumulation of knowledge required for future possible improvement programmes.

MATERIALS AND METHODS

In this study, vegetation surveys were carried out by using modified wheel point method at 53 sites (Koç and Çakal, 2004) to determine the features of the vegetation of alpine and subalpine rangelands in Giresun province located in Eastern Black Sea Region of Turkey. This vegetation study was conducted at the flowering period of the plants. Characteristics of rangeland surface such as slope, vector, aspect and altitude were considered. Determining of the cover ratio of the vegetation on the rangeland was based on the study of

Gökkuş et al. (2000), and determining the range health and condition was based on the study of Koç et al. (2003).

RESULTS AND DISCUSSIONS

Plant covered ratios in the rangelands ranged between 33.0 and 100 %. Decreaser species rates in botanical composition varied between 0.0 to 50.95 %, increaser species rates in botanical composition varied between 0.0 % to 52.60 %, and the rates of the invaders species varied between 35.06 to 100 %. In the determined botanical composition rates of families, between 3.71 and 45.81 % belong to legumes, 4.59 to 86.00 % belong to grasses, and 8.00 to 84.13 % belong to other families in rangelands (Table 1).

According to the average value, plant covered rate in rangelands was 71.08 %. The average ratio of the decreaser species in the botanical composition was calculated as 16.24 %, ratio of the increaser species as 15.9%, and ratio of the invaders species as 67.86 %. Average rates of legumes, grasses and other families in the botanical composition were found as 20.74 %, 33.34 % and 45.92 %, respectively. Rangelands in the study area were categorized as healthy-risky rangeland according to range health classification and moderate-poor rangeland according to range condition classification (Table 1).

It was determined that there were no grazing in 4 points, light grazing in 5 points, moderate grazing in 19 points and intensive grazing in 25 points in Giresun rangelands (Table 1). In these rangelands, a part, representing 47.17 % has been grazed intensively, 35.85 % moderately, 9.43 % lightly, and 7.55 % weren't grazed. Thus, it can be said that most of the rangelands were exposed to intensive grazing (Figure 1).

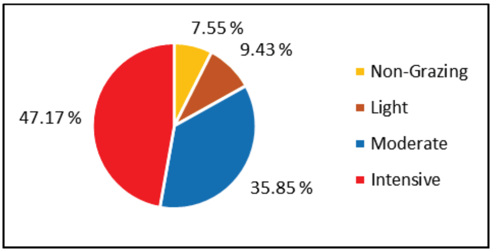

Figure 1. Grazing intensity in Giresun rangelands

Totally, 148 species were identified and these species were classified according to family they belong: 25 of them were legume, 32 were grasses and 91 belong to other families. Also, 23 species were classified as decreaser, 14 of them were increaser and 111 were invaders species (Figure 2).

The vegetation surveys reveal that the ratios of species from legumes, grasses, and other families of identified species were 16.89 %, 21.62 % and 61.49 %, respectively. Among the identified species, 15.54 % of species were found as decreaser, 9.46 % as increaser, 75.00 % as invaders (Figure 2).

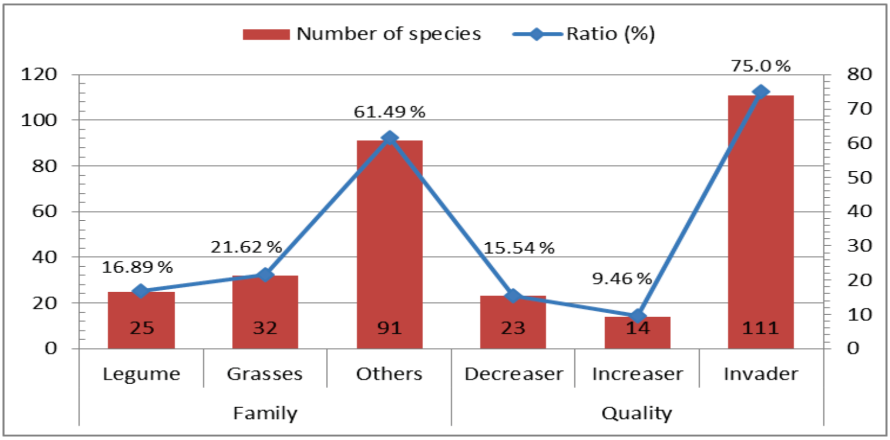

Figure 2. The identified species according to families and quality (number, %)

Table 1. Some features of the rangeland vegetation of Giresun province

District	Village	*PCR (%)	RDBC (%)	RIBC (%)	RINBC (%)	RLBC (%)	RGBC (%)	ROBC (%)	Grazing Intensity	Range Health	Range Condition
Alucra	Arda	64.00	34.37	18.76	46.87	15.63	46.88	37.49	Moderate	Risky	Good
Alucra	Hacıhasan	57.00	23.68	15.80	60.52	43.86	14.92	41.22	Intensive	Risky	Moderate
Alucra	Yeşilyurt	45.00	20.00	22.23	57.77	24.45	24.45	51.10	Intensive	Problem	Moderate
Alucra	Yeşilyurt	62.00	16.12	35.50	48.38	16.13	46.78	37.09	Intensive	Risky	Moderate
Alucra	Konaklı	56.00	5.35	10.73	83.92	10.72	21.43	67.85	Intensive	Risky	Poor
Alucra	Demirözü	75.75	7.59	23.77	68.64	22.12	34.33	43.55	Intensive	Healthy	Moderate
Alucra	Beylerce	79.75	6.26	16.32	77.42	21.32	22.58	56.10	Light	Healthy	Poor
Alucra	Kavaklıdere	59.50	21.84	10.10	68.06	18.49	31.94	49.57	Moderate	Risky	Moderate
Alucra	Suyurdu	54.50	14.67	13.78	71.55	11.93	29.36	58.71	No grazing	Problem	Moderate
Alucra	Aktepe	65.00	6.15	0.0	93.85	27.70	16.93	55.37	No grazing	Risky	Poor
Alucra	Bereketli	77.50	3.87	0.0	96.13	32.26	29.68	38.06	Intensive	Healthy	Poor
Alucra	Çakrak	81.00	3.70	0.0	96.30	3.71	16.05	80.24	Light	Healthy	Poor
Alucra	Tohumluk	81.00	3.70	0.0	96.30	3.71	16.05	80.24	Moderate	Healthy	Poor
Alucra	Tohumluk	82.00	4.87	23.18	71.95	25.61	36.59	37.80	Light	Healthy	Poor
Alucra	Elmacık	81.00	3.70	0.0	96.30	3.71	16.05	80.24	Moderate	Healthy	Poor
Bulancak	Tokmaden	100.00	0.0	20.00	80.00	4.00	66.00	30.00	Moderate	Healthy	Poor
Çamoluk	Pelitli	74.50	32.88	16.12	51.00	33.56	29.54	36.90	Moderate	Healthy	Moderate
Çamoluk	Yenice	76.00	13.15	30.28	56.57	25.00	35.53	39.47	Moderate	Healthy	Moderate
Çamoluk	Karadikmen	65.50	4.58	0.0	95.42	45.81	4.59	49.60	Moderate	Risky	Poor
Çamoluk	Kayacık	62.00	38.70	9.69	51.61	19.36	40.33	40.31	Moderate	Risky	Moderate
Çamoluk	Yeniköy	37.00	21.62	18.93	59.45	10.82	37.84	51.34	Moderate	Problem	Moderate
Çamoluk	Taşdemir	65.50	4.58	0.0	95.42	45.81	4.59	49.60	Intensive	Risky	Poor
Çamoluk	H.Ahmetoğlu	51.50	19.41	3.90	76.69	21.36	13.60	65.04	Intensive	Problem	Poor
Dereli	Kümbet	91.25	34.24	23.03	42.73	41.37	24.66	33.97	Moderate	Healthy	Moderate
Dereli	Tamdere	100.00	2.00	36.00	62.00	6.00	86.00	8.00	No grazing	Healthy	Poor
Dereli	Tamdere	77.00	23.37	16.89	59.74	28.58	36.37	35.05	Moderate	Healthy	Moderate
Dereli	Kızıltaş	84.00	19.04	21.44	59.52	21.43	60.72	17.85	Intensive	Healthy	Moderate
Dereli	Aksuk	83.00	19.27	24.11	56.62	16.87	53.02	30.11	Intensive	Healthy	Moderate
Dereli	Güzyurdu	92.00	0.00	30.44	69.56	17.40	60.87	21.73	Moderate	Healthy	Poor
Dereli	Güzyurdu	100.00	0.00	20.00	80.00	4.00	66.00	30.00	Moderate	Healthy	Poor
Şebinkarahisar	Ahırcık	67.50	0.00	52.60	47.40	14.45	52.97	32.58	Intensive	Risky	Moderate
Şebinkarahisar	Hocaoğlu	57.75	24.24	15.59	60.17	30.74	34.64	34.62	Intensive	Risky	Moderate
Şebinkarahisar	Ovacık	78.75	26.66	34.30	39.04	30.48	43.18	26.34	Intensive	Healthy	Moderate
Şebinkarahisar	Evcili	74.00	12.16	31.09	56.75	18.92	37.84	43.24	Moderate	Healthy	Moderate
Şebinkarahisar	Evcili	77.00	19.48	14.29	66.23	16.89	23.38	59.73	Intensive	Healthy	Moderate
Şebinkarahisar	Dereköy	67.75	0.0	12.92	87.08	4.43	11.44	84.13	Moderate	Risky	Poor
Şebinkarahisar	Arslanşah	94.00	0.0	14.90	85.10	6.39	21.28	72.33	Intensive	Healthy	Poor
Şebinkarahisar	Evcili	80.00	16.25	17.50	66.25	22.50	33.75	43.75	Intensive	Healthy	Moderate
Şebinkarahisar	Şaplıca	66.00	21.21	4.55	74.24	34.85	9.10	56.05	Intensive	Risky	Poor
Şebinkarahisar	Bayhasan	33.00	9.09	9.10	81.81	24.25	15.16	60.59	Intensive	Problem	Poor
Şebinkarahisar	Duman	62.50	12.80	14.40	72.80	11.20	36.80	52.00	Intensive	Risky	Moderate
Şebinkarahisar	Ekecek	46.00	28.26	13.05	58.69	30.44	17.40	52.16	Moderate	Problem	Moderate
Şebinkarahisar	Ozanlı	68.00	20.58	5.90	73.52	14.71	19.12	66.17	Intensive	Risky	Moderate
Şebinkarahisar	Gündoğdu	71.00	45.07	19.72	35.21	28.17	39.44	32.39	Moderate	Healthy	Good
Şebinkarahisar	Tekkaya	60.00	43.33	3.34	53.33	13.34	43.34	43.32	Moderate	Risky	Moderate
Şebinkarahisar	Ocaktaşı	79.00	13.92	20.26	65.82	25.32	43.04	31.64	Intensive	Healthy	Moderate
Şebinkarahisar	Yeniyol	78.50	50.95	7.65	41.40	31.85	29.30	38.85	Intensive	Healthy	Good
Şebinkarahisar	Sarıyer	73.00	28.76	12.34	58.90	17.81	30.14	52.05	Light	Healthy	Moderate
Şebinkarahisar	Yıltarıç	70.50	35.46	2.84	61.70	11.35	29.79	58.86	Intensive	Risky	Moderate
Şebinkarahisar	Gökçetaş	51.00	0.0	0.0	100.00	19.61	27.46	52.93	No grazing	Problem	Poor
Yağlıdere	Akpınar	77.50	15.48	11.62	72.90	23.23	43.88	32.89	Intensive	Healthy	Moderate
Yağlıdere	Akpınar	77.50	15.48	11.62	72.90	23.23	43.88	32.89	Moderate	Healthy	Moderate
Yavuzkemal	Tamdere	77.00	12.98	51.96	35.06	22.08	57.15	20.77	Intensive	Healthy	Moderate
Average		71.08	16.24	15.9	67.86	20.74	33.34	45.92			

*PCR: Plant covered ratio, RDBC: Ratio of decreaser in the botanical composition, RIBC: Ratio of increaser in the botanical composition, RINBC: Ratio of invaders in the botanical composition, RLBC: Ratio of legume family in the botanical composition, RGBC: Ratio of grasses family in the botanical composition, ROBC: Ratio of other families in the botanical composition

CONCLUSIONS

According to results, the rangelands in Giresun were classified as healthy-risky rangeland according to range health classification and as moderate-poor rangeland by range condition classification. A large part of rangelands has been grazing intensively with forcing their capacity. Results obtained from Giresun rangelands have suggested that grazing pressure must be decreased by controlling grazing in Eastern Black Sea Region to improve rangeland quality.

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PRODUCTIVITY AND YIELD STABILITY OF SIX GRAIN LEGUMES IN THE MODERATE CLIMATIC CONDITIONS OF BULGARIA

Tsenka ZHELYAZKOVA, Dimitar PAVLOV, Grosi DELCHEV, Antoniya STOYANOVA

Trakia University, 6000 Stara Zagora, Bulgaria

Corresponding author email: tsenka@abv.bg

Abstract

Increasing the production of plant protein for feed and food purposes is one of the most important tasks of agricultural production. The aim of study was to establish the productive capacity and yield stability of six annual grain legumes: 2 conventional species - spring pea (Pisum sativum L.) and wintering pea (Pisum arvense L.) and 4 new species: spring vetch (Vicia sativa L.), bitter vetch (Vicia ervilia L.), grass pea (Lathyrus sativus L.) and chickpea (Cicer arietinum L.) in the environmental conditions of Bulgaria during 2010 - 2013, at the experimental base of the "Plant Growing" Department, Trakia University - Stara Zagora. The trial was designed by the block method in 4 repetitions. The plants were cultivated by the conventional technology. Results obtained for the grain yield were statistically processed by ANOVA and regression equations among the yield and rainfalls were developed. It was established that in the non-irrigation conditions of Bulgaria, P. sativum and C. arietinum were the most productive. The most valuable was L. sativus due to combines high grain yield and high stability. Climatic conditions over the years had the least impact on the productivity of C. arietinum and L. sativus. The type of crop as factor had the strongest influence on grain yield and plant height than the year. The stem height in the examined legumes correlated well with the rainfall in May. The grain yield of P. arvense and V. ervilia was in a good correlation with the amount of rainfall during the period from March to June, and of V. sativa – with the amount of the rainfall in May. Regression equations were developed on this base, which allows preliminary assessment of legumes grain productivity with approximate accuracy for practical purposes.

***Key words**: regression equations, legumes, rainfall, stem height, yield.*

INTRODUCTION

Legumes play an important role in natural ecosystems, agriculture and agroforestry, where their atmospheric nitrogen fixation ability makes them excellent predecessors for most crops, and also for successful human and animal nutrition. One of the most important factors determining their great economic importance is the high protein content with a high nutrition effect in their seeds (Duranti, 2006). The areas of leguminous crops have declined repeatedly despite their high nutritive value. A recent investigations published by the European Commission, revealed a significant decrease in the production of protein crops in the European Union, especially over the last ten years. Main leguminous plants decreased by 30% and soybean production by 12%.

Pea is one of the most widespread grain legumes due to its easy cultivation as a wintering and spring crop, being an excellent predecessor for cereals and its indisputable contribution to resolving the protein problem (Georgieva et al., 2013; Miller et al, 2003; Tekeli and Ates, 2003; Zhelyazkova and Pavlov, 2007; Zhelyazkova et al., 2007a). Productivity of this culture in Bulgaria has been influenced mostly by the weather conditions (Zhelyazkova et al., 2007a; 2012). The unstable yields of peas have been a serious reason to look for the cultivation of alternative crops.

Spring vetch (*Vicia sativa* L.) with its good economic performance and lower demands to soil and climate conditions is an alternative source of plant protein (Mihov et al., 2005; Nenova and Venkova, 2005; Delchev et al., 2013; Zhelyazkova et al., 2007b). After its growing, the available nitrogen in the soil increases, which makes it an excellent predecessor for winter cereals.

Chickpea (*Cicer arietinum* L.) is the third largest grain bean culture in the world beans production. It can be grown in different ecological conditions, saline, arid and semi-arid areas (Krouma, 2009). Traditionally it is grown in Asia, Europe, Africa and Australia (Berger and Turner, 2007), as a source of cheap protein for human nutrition (Zia Ul-Haq et al., 2007). The seeds of C. arietinum contain protein like kidney beans, but have higher amino acids value, fats, vitamins A and B1 and minerals. It possesses a number of valuable features such as hard stem, resistant to insects, adapted for mechanized harvesting (Atanasova and Mihov, 2005). It has also high productive capacity and obtaining yields above 2000-2500 $kg.ha^{-1}$ is possible for most soil and climate conditions (Toker and Canci, 2003).

Grass pea (*Lathyrus sativus* L.) is characterized by high resistance to biotic and abiotic stress, which means less attack from diseases and pests (VazPatto et al., 2006). *L. sativus* seeds contain high levels of proteins (25.6 ± 0.20 g. 100 g^{-1}), essential amino acids (7.92 g. 100 g^{-1}), lysine, polyunsaturated fatty acids (αlinolenic, linoleic and γ-linolenic) and are valuable source for healthy foods (Chinnasamy et al., 2005; Tamburino, et al., 2012). The good taste and high nutritional value of seeds evoke the growing interest to this culture. Under favourable climatic conditions from *L. sativus* more than 3 t. ha^{-1} seeds can be obtained (Montenegro and Mera, 2009).

Bitter vetch (*Vicia ervilia* L.) is propagated in the Mediterranean region characterized by many favorable characteristics: resistance to drought, diseases and pests, short vegetation period, easy, cultivation and harvesting (Sadeghi et al., 2009). Its seeds are valuable source of energy and protein to animals (Reisi et al., 2011; Sadeghi et al., 2009a). With its high drought resistance this legume would be suitable for growing in South-Eastern Bulgaria, where there are many of its wild forms (Vateva and Krumov, 2011). Its biological potential is good as a forage crop. The straw contains more protein than that of *V. sativa* and grain yields are often higher. Increasing the production of plant protein for fodder and food purposes is one of the important tasks of agriculture production. To produce the highest amount of protein in a specific area, at the lowest cost, the legumes most appropriate for the specific circumstances must be explored and recommended.

The aim of the present study was to establish the productive capabilities and yield stability of six annual grain legumes: 2 conventional species - spring pea (*Pisum sativum* L) and wintering pea (*Pisum arvense* L) and 4 new species: spring vetch (*Vicia sativa* L), bitter vetch (*Vicia ervilia* L), grass pea (*Lathyrus sativus* L) and chickpea (*Cicer arietinum* L) in the agro-environmental conditions of South-Central Bulgaria.

MATERIALS AND METHODS

The survey was conducted during the period October 2009 – July 2013 on the experimental base of the "Plant Growing" Department at Trakia University, Stara Zagora. A field experiment was conducted to establish the growth and productivity of six annual grain legumes - 2 conventional species: -spring pea (*Pisum sativum* L.) cultivar Bogatir, wintering pea (*Pisum arvense* L.) cultivar Mir and 4 new species: spring vetch (*Vicia sativa* L.) cultivar Dobrudja, bitter vetch (*Vicia ervilia* L.) cultivar Borina, grass pea (*Lathyrus sativus* L) cultivar Strandja and chickpea (*Cicer arietinum* L.) selection line FLIP 06-136. The species of spring pea, wintering pea, spring vetch, grass pea and bitter vetch originated from Bulgaria. The test line chickpea FLIP 06-136 was received through exchange of breeding materials for improved dry and cold resistance from the International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria. The experiment was conducted by the block method in 4 repetitions, after a wheat predecessor.

The legumes were grown according to the conventional technology adopted in the country and the region, without irrigation.

To prepare the soil, tillage at 22 cm was used after harvesting the predecessor and as pre-sowing cultivation with harrowing. Before the tillage, fertilizer of 60 $kg.ha^{-1}$ phosphorus was applied, whereas with the pre-sowing cultivation nitrogen in a dose 40 kg. $ha^{-1}$was applied. For weed control after sowing before emergence herbicide Afalon 45 SC (Linuron) at a dose rate of 3 l. $ha^{-1}$was applied. For pest control against the grain weevils, two treatments – at the beginning of flowering and 8 – 10 days later were conducted every year. The insecticide Nurele D (Chlorpiriphosetyl + Cypermethrin) was used at a dose rate of 500 $ml.ha^{-1}$.

During the experiment the height of plants at harvest and yield of grain in standard humidity (13%) were established. The data obtained was processed statistically and used to establish the correlation and regression equation by means of StatSoft STATISTICA for Windows (2000). Yield stability and technological value of cultivated annual grain were established on the base of the factor analyses, interaction of plant yield and year by the methods of: stability variances σi2 and Si2 of Shukla (1972), the ecovalence Wi of Wricke (1962) and the technological value stability criterion YSi of Kang (1993).

The soil in the area was typical *Gleic Chromic Luvisols*, moderately supplied with hummus, with a slight acidic reaction, poorly supplied with nitrogen and phosphorus and very well supplied with potassium (Table 1). These soil conditions are favorable for the development and growth of the grain legumes.

Table 1. Soil characteristics

pH (KCl)	Humus, %	Mineral N, mg.1000 g^{-1}	N –NH_4, mg.1000 g^{-1}	N-NO_3, mg.1000 g^{-1}	Available P_2O_5, mg.100 g^{-1}	Available K_2O, mg.100 g^{-1}
5.44	3.93	33.2	13.6	19.6	3.9	44

RESULTS AND DISCUSSIONS

The climate conditions during the period of study differed significantly. 2010 was the most humid when the rainfall was 31.3% above the average for the period 1936-2009 (Table 2). 2012 was also humid, and then the rainfall was 11.7 % above the average for the multi-annual former period. 2011 was characterized as dry, during which the amount of rainfall was 32.3% below the long-term period. Closest to the average multi-annual former period was the annual rainfall in 2013.

The distribution of rainfall in the four years of the study was uneven by months, with periods of intense drought and moisture. In terms of temperature 2012 and 2013 were warm years and the average annual air temperatures were 1.2-1.3°C above to the multi-annual period values. 2011 was cool and then the average annual air temperature was 0.2°C below the multi-annual period.

The amount of rainfall during the growing season (March – June) of the spring crops (*P. sativum, V. sativa*, *L. sativus*, *V. ervilia* and *C. arietinum*) average for 73 years (1936-2009) was a little higher than precipitation during growing season for the years of study.

The greatest amount of rainfall during vegetation period was registered in 2010 and the smallest in 2011. The largest monthly amount of rainfall during the growing period 2010 – 2013 was supplied in May 2012), while the smallest was in March 2012. During the vegetation period, multi-annual average rainfall was distributed unevenly, with highest values in May and June. During the years of study, this unevenness was also well expressed in

Table 2. Climate conditions of South-Central Bulgaria

Years	Janu-ary	Febru ary	March	April	May	June	July	August	September	Okto ber	Novem ber	December	I-XII
Total rainfall, mm - Stara Zagora													
2009	68.8	60.4	39.1	10.3	22.3	73.6	75.1	43.5	29.8	63.1	26.6	75.6	588.2
2010	46.9	105.3	48.1	65.7	28.3	76.0	145.0	19.8	44.0	101.9	11.2	33.2	725.4
2011	35.6	27.2	12.4	15.8	34.4	26.7	40.9	51.7	13.3	70.6	1.3	44.3	374.2
2012	107.9	84.3	8.3	23.4	110.4	32.4	5.0	43.9	35.3	59.3	14.9	91.9	617.0
2013	90.0	74.8	49.0	53.5	11.9	70.7	29.1	5.3	16.6	75.3	49.3	8.6	534.1
1936-2009	40.1	33.8	37.6	45.4	63.7	62.3	51.0	44.3	35.1	40.8	50.5	48.0	552.5
Average temperature, ^{0}C – Stara Zagora													
2009	0.1	3.3	6.3	11.7	18.4	22.3	24.6	24.2	19.2	13.9	7.8	4.4	13.0
2010	0.7	3.6	6.1	12.4	17.8	21.4	23.5	26.9	20.4	11.4	11.4	3.1	13.2
2011	1.3	1.6	6.6	10.9	17.2	21.6	23.5	24.1	21.8	11.4	3.9	2.8	12.2
2012	-0.3	-0.7	7.2	14.0	17.3	23.9	27.9	25.7	21.0	16.2	9.1	1.3	13.6
2013	1.4	5.0	7.6	14.2	20.4	22.1	24.8	26.2	19.8	11.6	9.4	1.3	13.7
1936-2009	1.0	2.8	6.6	12.0	17.1	21.1	23.6	23.1	18.9	13.0	7.4	2.7	12.4

2011 and 2013, as these years were characterized by severe spring drought, especially dramatically in March and April 2011 and in May 2013.

In 2010 and 2011 the average air temperatures during the growing season of spring crops did not differ substantially compared to the average multi-annual previous period. In 2012 and 2013, the average monthly air temperatures in the initial phases of development of the plants (March and April) were above normal with 1.0 to 2.2^{o}C. In May 2013 during the flowering and ripening phases, the average monthly air temperatures were significantly higher –3.3^{o}C above the average multiannual for the same period. This, combined with the drought, extended the periods of the reproductive phases. The rainfall in May - 11.9 mm, had negative effect on the plants development and their productivity.

Regarding wintering pea, the amount of rainfall during the growing season (October – June) in 2009-2010, 2011-2012 and 2012-2013 was 13.2%, 14.4% and 10.9% above the average for the multiannual previous period, respectively. The vegetation amount of rainfall during the period of 2010-2011 was 37% below the average for the long-term period, which characterized 2011 as a dry year. The winter conditions were normal and no damage by low temperatures was reported on crops of *P. arvense*, with the exception of the months of January and February in 2012, when were reported record low temperatures, 1.3 and 3.5^{o}C below normal, respectively. The thin snow cover and high winter resistance of *P. arvense* variety "Mir" resulted in minimal frost damage (14.2%) on plants and crop formation of optimum density.

The yield of grain as a resulting parameter showed the best of all productive potential of the crops. It varied by years depending on the agro climatic conditions (Table 3). 2010 was characterized with more favorable weather conditions, which created the precondition for an optimal growth and formation of high yields in all tested legumes. A significantly drier spring of 2011, adversely affected the growing crops and the yields that year were lower - 19.4% less compared to 2010.

Table 3. Yield potential by years, average for the period 2010 – 2013

Plant	Yield of grain, kg.ha^{-1}, n=96					
	Years				Average	
	2010	2011	2012	2013	kg.ha^{-1}	%
Pisum sativum L.	2800.0	2030.0	1910.0	1685.0	2106.3a	100.00
Pisum arvense L.	2425.0	1625.0	1850.0	1660.0	1890*** b	89.73
Vicia sativa L.	1526.7	1525.0	1575.0	1480.0	1526.7***	72.48
Vicia ervilia L.	1650.0	1250.0	1300.0	1175.0	1343.8***	63.80
Lathyrus sativus L.	2375.0	1850.0	1775.0	1575.0	1893.8*** b	89.91
Cicer arietinum L.	2150.0	2150.0	1975.0	1625.0	1975.0** ab	93.77
Average	2154.4	1738.3	1730.8	1533.3	1789.2	
LSD, P < 0.05	140.6	176.8	142.7	104.4	141.1	7.89
LSD, P < 0.01	194.7	244.9	197.7	144.6	195.4	10.92
LSD, P < 0.001	268.6	337.8	272.7	199.4	269.6	15.07
SD					391	
CV					152969	
SEE					40	
Min					1100	
Max					2900	

* Different letters indicate statistically significant differences among variants at P < 0.05

*, **, *** - Statistically significant differences of the variants and control at P< 0.05; 0.01 and 0.001, respectively.

In terms of productivity, in 2011, the response of the species to naturally generated abiotic stress was of importance. The analysis of the data showed that in 2011 significantly higher yields were preserved in *L. sativus* and *C. arietinum*. Preserving the level of yields in these two plants in 2011 at the level of the yields in 2010, was probably due to their high drought tolerance. The yields were the lowest in 2013, when the monthly average temperatures during flowering period and the grain forming period were unusually above normal but the rainfall was below normal.

Average for the period of investigation the highest grain yield was obtained from *P. sativum*. The second highest productivity was obtained from *C. arietinum*. The difference between the productivity of these two cultivars was not statistically significant. Maintaining a higher level of yield in the *C. arietinum* in comparison with the other tested legumes was probably due to its great drought resistance.

On the third place was the productivity of *P. arvense* and *L. sativus*. The differences between the productivity of these two cultures and *C. arietinum* were not statistically proven. The specific climatic conditions over the years had the least impact on productivity of *C. arietinum* and *L. sativus*.

On average for the period of study from the *V. sativa* was received yield with 27.52% lower compared to the average productivity of *P. sativum*. According to Nenova and Venkova (2005) the productivity of this culture in Bulgaria is influenced strongly by the water supply during the reproductive phase, and the productive possibilities are function of the interaction between rainfall and temperatures during the months of April, May and June.

V. ervilia was with the lowest productivity, both in years and on average for the research period. This lower productivity of *V. ervilia* was statistically significant at $p<0.001$compared to all other varieties. Height of the stem is an important indicator on which depends the resistance to fall of the crop, suitability for mechanized harvesting, the quantity and quality of the seeds. The stem height in the leguminous crops is a trait that depends mainly on the specific climatic conditions (Table 4).

It is known that a major influence on the height of the stem in the legumes is mostly affected by rainfall. Relatively greater rainfall in 2010 and 2012 and especially the great amount of rainfall during the months of April and May led to formation of plants with greater height of the stem in all studied crops. During these years stem fall of plants for peas and vetches was found. In 2013, the climatic conditions during the vegetation period created a prerequisite for forming stems with 3.3% (*C. arietinum*) to 52.2% (*V. sativa*) lower height at harvest, compared to 2012.

Table 4. Stem height at harvest by years and average for the period 2010 – 2013

Plant	Stem height, cm, n=96					
	Years				Average	
	2010	2011	2012	2013	cm	%
Pisum sativum L.	85.80	52.40	89.20	44.43	67.96 a	100.00
Pisum arvense L.	149.88	123.25	151.10	113.70	134.48***	197.89
Vicia sativa L.	65.86	52.23	98.35	47.00	65.86 a	96.91
Vicia ervilia L.	37.90	29.05	49.28	28.70	36.23***	53.32
Lathyrus sativus L.	65.97	53.98	87.30	43.35	62.65 a	92.19
Cicer arietinum L.	52.38	36.90	39.00	37.73	41.50***	61.07
Average	76.30	57.97	85.70	52.48	68.11	
LSD, P < 0.05	4.05	6.60	9.80	3.83	6.07	8.93
LSD, P < 0.01	5.61	9.15	13.57	5.31	8.41	12.37
LSD, P < 0.001	7.73	12.62	18.72	7.33	11.60	17.07
SD					35.99	
CV					1295.40	
SEE					3.67	
Min					28.00	
Max					156.00	

* Different letters indicate statistically significant differences among variants at P < 0.05

*, **, *** - Statistically significant differences of the variants and control at P< 0.05; 0.01 and 0.001, respectively.

V. ervilia and *C. arietinum* had the lowest stem without fall from investigated types. The stem of *P. arvense* was the highest and with a natural aptitude for fall. In *L. sativus* and *V. sativa*, the height of stem was near to the values of *P. sativum*, such as differences in this indicator between the three cultures were not proven. The specific climatic conditions significantly affected the height of the stem in grain legumes, and were most poorly expressed in *L. sativus* and *C. arietinum*.

The study on establishing the influence of the investigated factors (type of variety and year) showed that the strongest, very well proven ($P < 0.001$) influence on the yield of grain and the height of the stem was manifested by the type of legume culture - 46.63% and 80.15% of the total variation in the data, respectively (Table 5).

The power of influence of climate conditions over the years on the indicators of plant height and yield of grain was also very well proven ($p < 0.001$), but lower. The reason was probably the large variations in meteorological conditions of the years.

The specific climatic conditions over the years as a factor exerted a greater influence on the generative (grain) potential and productivity (33.83% of the total variation) than on the vegetative (stem height) parameters (14.11% of the total variation).

Table 5. Influence of factors on the grain yield and height of plants

Source of variation	Sum of squares	Degree of freedom	Mean squares	F*	P<	%
Factor analysis for yield of grain, kg.ha^{-1}						
Plants	6775730	5	1355146***	157.76	0.001	46.63
Year	4916768	3	1638923***	190.8	0.001	33.83
Plants*Year	2221124	15	148075**	17.24	0.01	15.28
Error	618456	72	8590			4.26
Factor analysis for stem height, cm						
Plants	98630.7	5	19726.1***	967.96	0.001	80.15
Year	17367.4	3	5789.1**	284.07	0.01	14.11
Plants*Year	5597.7	15	373.2*	18.31	0.05	4.55
Error	1467.3	72	20.4			1.19

*F- ratio among the variables; P- Statistical significance, *p≤0.05; **p≤0.01%; ***p≤0.001%.

It is very complicated to explain the exact influence of the climate conditions concerning the generative or vegetative development of legumes. From a practical point of view, especially for the legumes which have a stem likely to fall, the tendency that the drought influenced to a bigger extent the stem height than the grain formation, on one hand, had a positive effect to keep the grain yield and, on the other hand, to preserve fall of stem.

Interaction among the factors, type of legume plant and climate conditions during the years had a lower but statistically significant at $P<0.05$ to 0.01 effect on the yield and stem height.

Based on proven crop by year interaction, it was evaluated stability parameters for each variant for grain yield of legumes with relation to years (Table 6). It was calculated the stability variances σi2 and Si2 of Shukla, the equivalence Wi of Wricke and the stability criterion YSi of Kang.

Stability variances (σi2 и Si2) of Shukla, which recorded respectively linear and nonlinear interactions, unidirectional evaluate the stability of the variants. These variants which showed lower values are considered to be more stable because they interact less with the environmental conditions.

Table 6. Stability parameters for the legume grain yield with relation to years

Plant	$\bar{x}$	σ_i^2	S_i^2	W_i	YS_i
Pisum sativum L.	2106.3	277696,1**	18063,4	630694,9	2+
Pisum arvense L.	1890.0	116529,6**	150195,9**	308415,9	-1
Vicia sativa L.	1526.7	338197,8**	-4070,3	751752,4	-9
Vicia ervilia L.	1343.8	-12390,2	-3116,6	50576,5	-3
Lathyrus sativus L.	1893.8	6497,9	8430,8	88352,5	7+
Cicer arietinum L.	1975.0	177777,3**	240006,0**	430911,3	1+

Negative values of the indicators σi2 and Si2 are considered 0. At high values of either of the two parameters - σi2 and Si2, the variant are regarded as unstable. At the ecovalence Wi of

Wricke, the higher are the values of the index, the more unstable is the variant.

On this basis, using the first three parameters of stability, it is found that *C. arietinum* and *P. arvense* are most unstable. In these variants values of stability variance σi2 and Si2 of Shukla and equivalence Wi of Wricke are the highest and mathematically proven. At these two legumes instability is a linear and nonlinear type - proven values of σi2 and of Si2. At *V. sativa* and *P. sativum* instability is a linear type - values σi2, the values of Si2 are not proven.

The reason for this high instability is greater variation in grain yields during years of experiment as weather conditions affect those most. *L. sativus* and *V. ervilia* demonstrate high stability because they interact poorly with the conditions of years. To evaluate the complete efficacy of each legume should be considered as its effect on quantity of grain yield and its stability - the reaction of legumes during the years.

Important information about the technological value of the variant gives the stability criterion YS_i of Kang for simultaneous assessment of yield and stability, based on the reliability of the differences in yield and variance of interaction with the environment. The value of this criterion is that using nonparametric methods and warranted statistical differences we get a summary assessment aligning variants in descending order according to their economic value.

Generalized stability criterion YS_i of Kang, taking into accounts both the stability and value of yields gives a negative assessment of *V. sativa*, *V. ervilia* and *P. arvense*. *V. sativa* and *P. arvense* have these assessments due to their high instability. *V. ervilia* has this assessment due to its low yield. According to this criterion, the most valuable technology appears to be *L. sativus*. It combines high levels of grain yield and high stability of this index during the years. From the technologies point of view for legumes growing, high rating also have *P. sativum* and *C. arietinum*. They combine relatively good grain yields with low stability during the years of the investigation.

Principal component analysis for influence of rainfall on the grain yield of all six annual legumes demonstrated that during the different periods rainfall had a specific effect on the yield and stem height of annual grain legumes.

The amount of rainfall during the months March, April and June had a positive influence as factor 1 and factor 2 on the yield and stem height of investigated annual legumes (Figure 1). The two of the eigenvalues are higher than 1.

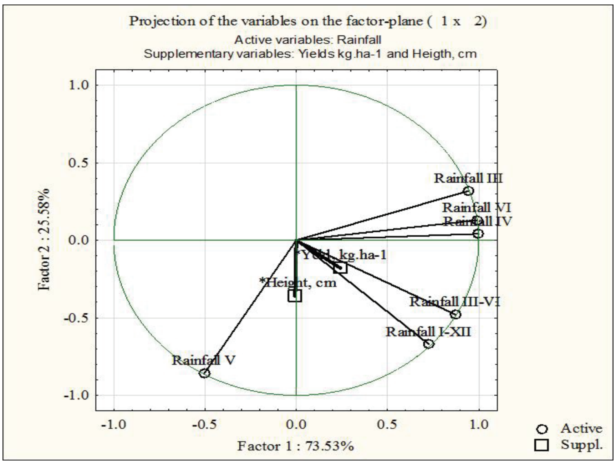

Figure 1. PC Analyse influence of rainfall on the yield and stem height of six annual grain legumes.

Factor loading correlations among rainfall, yield and stem height for these months is very high (0.990-0.997, Table 7). Total sum of rainfall during the year (January-December and the rainfall during vegetation period (March – June) had a positive influence on the same direction with yield as factor 1 describing more than 70 % of the variations. The total rainfall during the year and during the vegetation period is negative as factor 2 describing about 25 %.

Table 7. Factor-variable correlations (factor loadings), based on correlations

	Factor 1	Factor 2	Factor 3
Rainfall I-XII	0.726246	-0.66991	0.154237
Rainfall III-VI	0.871655	-0.47871	-0.10513
Rainfall III	0.945235	0.318289	-0.07227
Rainfall IV	0.997909	0.041708	0.049382
Rainfall V	-0.50449	-0.85834	-0.09354
Rainfall VI	0.990363	0.129537	-0.04901
*Yield, kg/ha	0.241472	-0.17948	0.512696
*Height, cm	-0.0064	-0.36165	0.109521
Eigenvalues	4.411837	1.534509	0.053654
% Total - variance	73.53062	25.57515	0.89423
Cumulative - %	73.5306	99.1058	100.00

Rainfall during May had negative impact on the yield and stem height by the two factors. It can be assumed that rainfall during May is critical period in the development of most of annual grain legumes. Zhelyazkova (2007) has obtained the same results for critical influence of rainfall during May on the yield of peas and vetch.

Water supply during May had an important role for the intensive growth of stem from one side and for normal flowering, pollination and fertilization from other side. This period is very important for both vegetative and generative potential formation of legumes. If rainfall during May are low the stem are also low and the pollination is low. If water supply is too high there is a danger for stem fall and low yield.

Having in mind the specific type of growth, grain yield potential and stem height the different annual grain legumes had a different reaction concerning to water supply by rainfall during different months.

Calculation of the correlation dependencies between productivity, plant height and rainfall (Table 8) shows that the yield of grain in the pea positively correlated with height of the plants, better expressed in *P. arvense*. The correlation analysis of the data indicated that the factor of greatest influence on the height of the tested legumes was rainfall in May.

The yields of grain of *P. arvense* and *V. ervilia* were in a good positive correlation with rainfall during the period March-June. Rainfall in May had higher influence on productivity of *V. sativa*.

Table 8. Correlations (r) among grain yield, height of plants and precipitation

	Yield, $kg.ha^{-2}$	Height, cm	$W_{I\text{-}XII}$, mm	$W_{III\text{-}VI}$, mm	W_{III} mm	W_{IV}, mm	W_{V}, mm	W_{VI}, mm	$W_{X\text{-}VI}$, mm
Pisum sativum L.									
Yield, $kg.ha^{-1}$	1.00	0.53*	0.31	0.39	0.31	0.49	-0.15	0.38	
Height, cm	0.52*	1.00	0.56*	0.47	-0.19	0.09	0.65*	-0.02	
***Pisum arvense* L.**									
Yield, $kg.ha^{-1}$	1.00	0.70*	0.57*	0.69*	0.43	0.65*	-0.02	0.55*	0.01
Height, cm	0.70*	1.00	0.58*	0.44	-0.21	0.089	0.63*	-0.04	-0.11
***Vicia sativa* L.**									
Yield, $kg.ha^{-1}$	1.00	0.47	0.24	-0.03	-0.41	-0.289	0.51	-0.33	
Height, cm	0.47	1.00	0.48	0.25	-0.53*	-0.28	0.94*	-0.36	
***Vicia ervilia* L.**									
Yield, $kg.ha^{-1}$	1.000	0.299	0.462	0.515*	0.322	0.52*	-0.05	0.42	
Height, cm	0.299	1.000	0.568*	0.373	-0.412	-0.144	0.889*	-0.232	
***Lathyrus sativus* L.**									
Yield, $kg.ha^{-1}$	1.000	0.259	0.228	0.365	0.255	0.438	-0.103	0.333	
Height, cm	0.259	1.000	0.441	0.215	-0.540*	-0.273	0.905*	-0.371	
***Cicer arietinum* L.**									
Yield, $kg.ha^{-1}$	1.000	0.360	0.028	-0.248	-0.367	-0.232	0.192	-0.329	
Height, cm	0.360	1.000	0.543*	0.665*	0.520*	0.707*	-0.173	0.616*	

$W_{I\text{-}XII}$– total rainfall for the period January – December; W_{III-VI} - total rainfall for the period March – June; W_{III} - rainfall in March; W_{IV} - rainfall in April; W_{V} - rainfall in May; W_{VI} - rainfall in June; $W_{X\text{-}VI}$- total rainfall for the period October – June, mm; * Statistical significance at $P < 0.05$

The good relationships between the height of the plants, the yield of grain and rainfall, allowed developing regression equations (Table 9) for preliminary evaluation of these parameters by climatic factors. For all six legumes the yield of grain can be predicted

Table 9. Regression equations for predicting of yield and stem height based on rainfall

Plant	Equation	*R	SEE	F	P
All six legumes	Yield, $kg.ha^{-1} = 4608.311-12.269\ W_{I-XII}+0.012W_{I-XII}^{2}$	0.593	5.14	5.7	0.0106
All six legumes	Yield, $kg.ha^{-1} =3566.471 - 29.993W_{III-VI}+0.107_{III-VI}^{2}$	0.529	12.7	4.08	0.0319
Pisum sativum L.	Height, $cm = 36.08+1.182W_V - 0.0064W_V^2$	0.681	15.8	5.62	0.0173
Pisum arvense L.	Yield, $kg.ha^{-1} = 2456.459 - 55.162W_{IV} + 0.811W_{IV}^{2}$	0.819	0.03	13.3	0.0007
Pisum arvense L.	Yield, $kg.ha^{-1} = 3751.352 - 100.725W_{VI} + 1.06W_{VI}^{2}$	0.675	0.12	5.44	0.019
Vicia sativa L.	Height, $cm = 43.776 + 0.440W_V + 0.00048W_V^2$	0.940	7.18	49.3	0.000001
Vicia ervilia L.	Yield, $kg.ha^{-1} = 1873.636 - 43.844W_{IV} + 0.605W_{IV}^{2}$	0.800	0.02	11.5	0.0012
Vicia ervilia L.	Height, $cm = 28.35 + 0.126W_V + 0.00056W_V^2$	0.889	4.03	24.7	0.00003
Lathyrus sativus L.	Height, $cm = 35.65 + 0.858W_V - 0.0035W_V^2$	0.918	6.8	34.9	0.000006
Cicer arietinum L.	Height, $cm = 53.59 - 1.18W_{IV} + 0.017W_{IV}^{2}$	0.885	5.3	23.6	0.00004
Cicer arietinum L.	Height, $cm=77.53 - 0.69W_{III} – VI + 0.0026W_{III–VI}2$	0.942	7.46	51.5	0.000001

*R- coefficient of determination; SEE- standard error; F- ratio among the variables; P- Statistical significance; W_{IV} - rainfall in April; W_V - rainfall in May; W_{VI} - rainfall in June; W_{III-VI} - total rainfall for the period March – June, mm

by regression equation based on annual (I-XII) and vegetative (III-VI) rainfall. The grain yields of *P. arvense* and *V. ervilia* could be determined with high accuracy depending on the amount of rainfall in April. The height of plants for V. sativa, *L. sativus* and *V. ervilia* could be determined with high accuracy depending on the amount of rainfall in May. The height of *C. arietinum* plants was determined with high accuracy on the base of the amount of rainfall during the period March-June as an independent variable. The mentioned regression equations had a high degree of statistical significance ($P < 0.000$) and good reliability. The developed regression equations could be used for approximate preliminary assessment of productivity with accuracy satisfactory for practical purposes.

CONCLUSIONS

Pisum sativum and *Cicer arietinum* cultivated in non-irrigated conditions in the area of South-Central Bulgaria are most highly productive out of the tested grain legumes. The specific climatic conditions over the years had the least impact on productivity of *Cicer arietinum* and *Lathyrus sativus*.

The productive capacity (grain yield) and stem height of the investigated annual legumes during the tested years were influenced mainly by the specific morphological and biological characteristics as factors. The climatic conditions (rainfall and temperature) had lower influence on the yield performance and stem height formation.

Rainfall during March, April and June had a positive influence on the yield and stem height. Water supply during May had critical impact influencing negatively on the vegetative (stem height) and on generative (grain yield) development of annual legumes.

Developed regression equations based on the amount of rainfall during the specific months as independent variables could be used for approximate preliminary assessment of productivity and stem height of annual legumes with accuracy satisfactory for the practice.

Vicia sativa, *Vicia ervilia* and *Pisum arvense* had a negative assessment according to stability criterion YS_i of Kang due to their high instability. From technological point of view the most valuable was *Lathyrus sativus,* because combines the two important characteristics high levels of grain yield and high stability of this index during the years. *Pisum sativum* and *Cicer arietinum* also had high rating due to combine relatively good grain yields with low stability during the years.

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MIXING AMELIORANTS IN SOIL WITH DIFFERENT ACTIVE DISK WORK BODIES

Manol DALLEV, Ivan IVANOV, Ivan MITKOV, Jordanka ZAPRJANOVA

Agricultural University of Plovdiv, 12 Mendeleev Blvd, 4000, Plovdiv, Bulgaria

Corresponding author email: manol_dallev@abv.bg

Abstract

The article examines the degree of mixing of the soil ameliorants. Mixing is done with a new active disk machine, combining kinematics of tiller with a horizontal axis of rotation and displacement of soil from disk work bodies. The disk of the machine are of a different shape - cut along the periphery and a circular saw. Experiments were conducted on heavy sandy-clay soils with a clay content 56.6%, with 21% humidity and a constant speed of 4 km/h.
The study aims to determine the extent of mixing soil with different discs of the machine. After the study is built diagram characterized the distributions of the improvers.
Established was that the cut disk allocated improvers more depth and a circular lower, which It is due to more cut peripheries (more low contact with the soil). Thus, according to the requirements which we have, we can select the appropriate disk which satisfies them.

***Key words**: tillage, soil, active machine, ameliorants.*

INTRODUCTION

Economic importance of soil is determined by its generalized characteristic fertility, which is its ability to provide the necessary plant nutrients, water and air. Soil fertility depends on its condition, which quantitatively expressed by its properties, porosity, density and humidity.
The amendment of these properties due to its structure and construction impacts to which it is subjected.
One of the soils are damaged by heavy metals, improper fertilization and are threatened by erosion.
Ameliorants are materials that are added to the soil, the main function of which is to improve the physical and chemical properties of the soil, as well as its biological activity.
Their incorporation into the soil is essential for the growth and development of crops.
The aim of the study was to determine the extent of mixing of ameliorants soil with active disk machine for surface treatment of soil, combining kinematics of rotary cultivators with a horizontal axis of rotation and horizontal displacement of soil from disk working body with two different types of discs.

MATERIALS AND METHODS

As imitation ameliorants used is a mosaic, it can be separated from the soil and to define the mixing easier.
Mosaic is spread evenly over stubble with hand, several sites measuring 1 m^2.
The tractor with active body working on messy ameliorants, then place the box without bed with dimensions 400 x 300 x 300 mm. Box stuck into the soil and every 2 cm to 12 cm are sifting mosaic and weighting method determines the quantity and the corresponding soil layer.
Crop residues and weeds on the surface of the field is not controlled as in the selection of
Experimental field is respected for they are relatively evenly distributed.
The experiments were conducted in this condition because essential to the dynamics of the process has soil with its properties.
The machine (Dallev, 2013) is equipped with two different types of discs – cut (Dallev et all, 2015) and circular disk (Ivanov et al., 2015).

Figure 1. Distribute ameliorant prior to the test

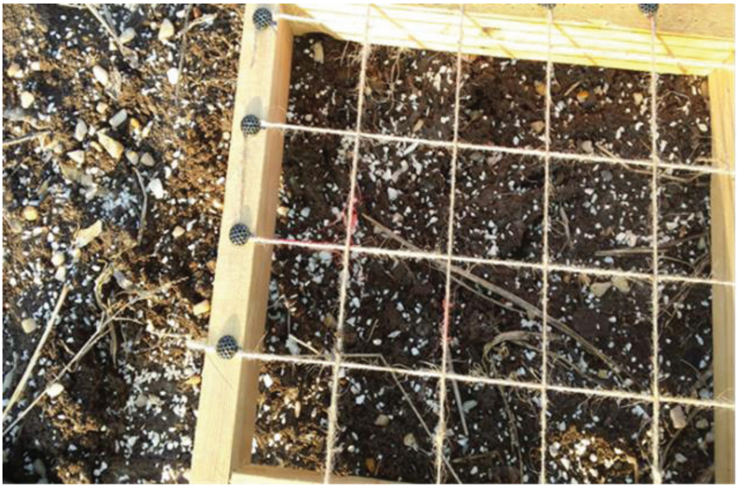

Figure 2. Distribution of crop residues and weeds

Figure 3. Cut disk

Figure 4.Circular disk

RESULTS AND DISCUSSIONS

The experiments were conducted in the village Bryagovo region. Plovdiv, heavily sandy - loam soil with containing loam- 56.5%.
The machine is aggregated with a tractor MTZ-80, v - speed is 4 km/h and is controlled by GPS Garmin 12.

From the graphics better able to discern that in the cut disk concentration ameliorants in layers 4 to 10 mm, and when circular from 0 to 6 mm. This is due to the fact that circular saw has a larger cut-out portion, i.e., smaller contact area with the soil.

Figure 5. Conducting experience

When cut disk:

Table 1. Cut disk

Depth of layer, cm	0-2	2-4	4-6	6-8	8-10	10-12
Average distribution,%	6.7	7.3	42.1	33.2	6.4	4.3

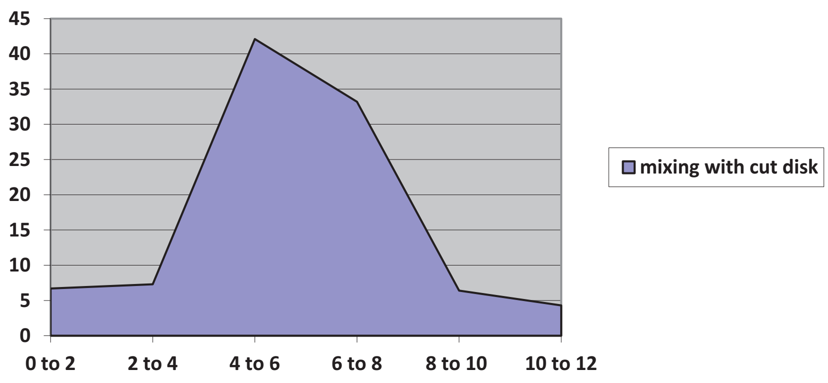

Figure 6. Degree of mixing with cut disk

Figure 7. Degree of mixing with cut disk

When circular disk:

Depth of layer, cm	0-2	2-4	4-6	6-8	8-10	10-12
Average distribution,%	12.4	22.1	37.9	20.4	5.3	1.9

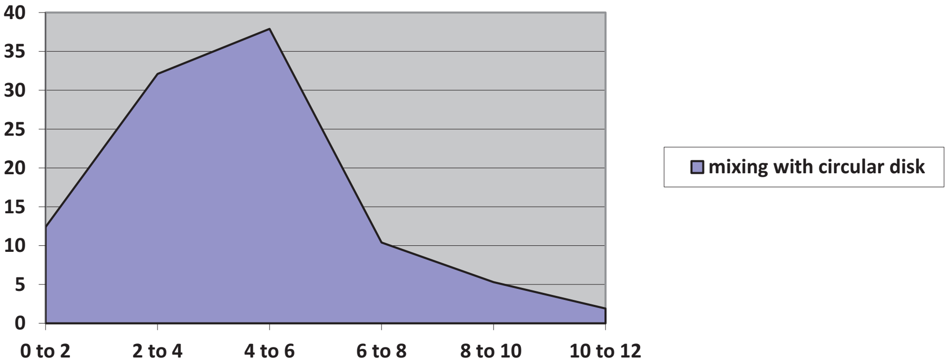

Figure 8. Degree of mixing with circular disk

Figure 9. Degree of mixing with circular disk

If we compare both types of displacement disc:

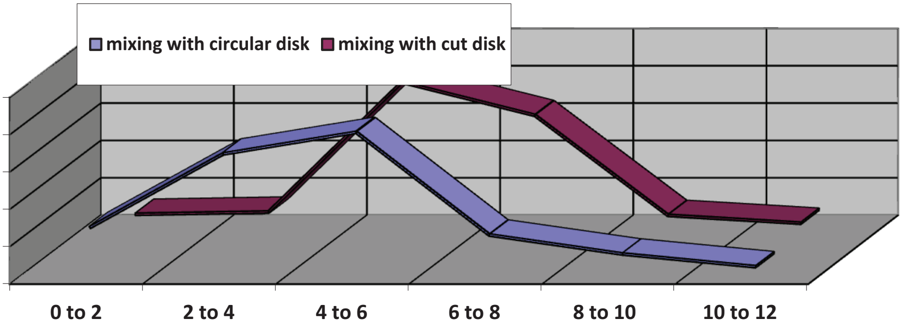

Figure 10. Degree of mixing with both disks

CONCLUSIONS

Certain areas are the mixing of the soil ameliorants with two disks - cut and circular.
Depending on the needs of cultures concentration of soil improver can be managed by different types of discs.

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SYSTEM FOR RECORDING THE ANALYSIS RESULTS AS PART OF THE QUALITY CONTROL PLANES IN A STARCH FACTORY

Georgiana DECIU, Arina Oana ANTOCE

University of Agronomic Sciences and Veterinary Medicine of Bucharest,
59 Marasti Blvd, District 1, 011464, Bucharest, Romania

Corresponding author email: aantoce@horticultura-bucuresti.ro; aantoce@yahoo.com

Abstract

The paper aims to present the way in which a recording data system can be created using only programming in the EXCEL software, proposed as an efficient alternative to other expensive and complicated software programmes. A quality plan of a starch factory was taken as reference and a recording data system was issued starting from the results usually obtained at the analyses performed to ensure and follow the quality of the products. Each production step is controlled and for each product several parameters are identified using different analysis methods. The results are recorded and various functions available in EXCEL are used in order to facilitate the data interpretation, as well as to reduce at minimum the human errors. Instead of the paper recording results, we create easy to use EXCEL files in which the important data are marked, to facilitate the control of the production process and validate the quality and safety of the finished products.

Key words*: quality control, data recording system, starch.*

INTRODUCTION

Quality is defined by ISO 9000 as being the “degree to which a set of inherent characteristics fulfils requirement” and it is one of the most complex notions, which includes the product capacity to satisfy the requirements and, also, economical aspects related to its production and uses (Chira, 2010). The quality control plans are issued in order to ensure that the products obtained during a technological process correspond to their technical specifications.

The production process used in a starch factory is based on the wet-milling, being described in the literature as a big scale complicated process, aiming to separate the chemical components from the corn kernels (Jackson and Shandera, 1995). The principal production steps include:

- Steeping corn kernels
- Milling and germs separation
- Hulls separation from milled corn
- Gluten separation
- Wash and dehydrating the starch slurry
- Starch drying and packaging

The most important steps are steeping and gluten separation (Malumba et al., 2009).

In a starch plant the quality control plan should include production process steps, samples to be analyzed, parameter check, acceptance range, analysis method, frequency and the methodology of recording the results.

In order to be able to control a production process, assure the quality of the final product in accordance to the product technical data sheet, the analyses results must be constantly recorded and reported in a manner which allows for an easy interpretation.

Although, to manage the records from the laboratory special software already exists, such as Laboratory Information Management Systems (Paszko and Turner, 2002; Helsens et al., 2010; Stephan et al., 2010) or Electronic Laboratory Notebooks (Dessy, 2002; Rubacha et al., 2011), they are expensive and not custom-made. It is always a challenge for any company to be efficient and to save money (Brown, 2001), thus, an in-house developed record system may help doing that. An alternative to some commercial softwares is the use of Excel, which was used before as a laboratory data management tool, as described in several research papers for applications in HPLC (Rubin et al., 2010), for

electrophysiological data (Brown, 2006) or even for complex testing (Wahlsten, 2011). All these papers aimed to offer an alternative to the expensive software created for manage the data in laboratories.
This paper shows an alternative laboratory results recording system, by using connected Excel files, which allow for safe and rapid control of the production process, in order to assure the quality of the final products.

MATERIALS AND METHODS

In order to create an optimal recording system, all the types of analytical results were gathered and several worksheets were designed in Excel to accurately describe the recordings usually kept on paper files as part of the quality control plan. The excel files were designed to be used more easily than the paper records, allowing for the automate calculations and straightforward interpretation of results. For the automatic calculations Excel available formulas and functions were used for programming, while for the interpretation, conditional formatting facility was used to provide results in several colours and fonts, to signal normal values or to emphasize cases when the allowed range is exceeded.
We took into account the monitoring frequency for each step and the way in which the recorded data (the analysis results) are to be further used. The working sheets were issued in a certain established order, to allow us to obtain reports of the average results per day, month and year.
The abbreviations used in all the Excel files, in alphabetical order, are the following:

- A.N.=native starch
- ARM=aerometer
- Be=Baumé
- BS=tank for preparing SO_2 solution
- C.=concentration
- CA=starch content
- CGF=corn gluten feed
- CGM=corn gluten meal
- Cnmt.=timing
- CSL=corn steep liquor
- Dep.=storage
- DESH. GLT.= gluten dehydration
- Evac.=evacuation
- F.G.=heavy phase
- G=fat
- G.I.=steeping grade
- G.I.G.=installation for concentrate the steeping solution
- G.P.= corn gluten
- Gz.=granularity smaller than 160 microns
- H=hours
- I.M.=before milling
- L.A.=starch slurry
- Ln=line no. n
- nH=sampling frequency at each n hours
- P=protein
- PMn(m)=average sample formed from first n samples taken to each m hours
- P.N.=black spots
- R.S.=washing ratio water/L.A.
- S.=solution
- S.A.G.=suspension of starch and gluten
- SEP.=separation
- SU=dry substance
- T.A.=starch cake
- T.G.=gluten cake
- T.I.=steeping time
- T=temperature
- TR= thermometer
- U=moisture

The entire industrial process was presented in a previous paper (Deciu and Antoce, 2014).

RESULTS AND DISCUSSIONS

The laboratory results record keeping is a system of several Excels files and worksheets. All the Excel files created for each product contain a sheet with working instructions and abbreviations, the sheets in which the analysis results are recorded and one sheet for monthly and annually average value reports. Each monitoring working sheet contains a table having in the headings all the information necessary to fulfil the quality control as follows: production step, sample submitted for analysis, type of analysis, method of analysis, analysis frequency and acceptance ranges for the results.
For the first production step, the steeping of the corn kernels, an Excel file was created to include the analysis results for each steeping tank, for each tank used to prepare SO_2 solution and for the by-product obtained after the concentration of the steeping solutions. An example for table headings is presented in

Table 1 and for monitoring recording in Figure 1.

Table 1. Information record for the Steeping Production Step as transposed from the Quality Control Plan

STEEPING TANK NO. 1						
Step	CORN STEEPING					G.I.G.
Sample	STEEPING SOLUTION / CORN					CSL
Analyze	SO_2(%)	SU(%)	T(°C)	T.I.(ore)	G.I.(%)	SU(%)
Limits	≤ 0.15	≤ 25	48-52	42 - 72	≥ 42	46-52
Method	IL-L-04	IL-L-07	TR	Cnmt.	IL-L-05	IL-L-07
Frequency	3H	3H	3H	I.M.	I.M.	3H EVAC./ 12H DEP.

In order to facilitate the visualisation of the analysis method used and to check the established reference values, we created for both cases a „hyperlink", which leads and open the respective document stored on the server. In this way the human errors and the time necessary to check the data and the documents related to the quality control plan are reduced to a minimum level, because with just one click of a mouse the user is directed to the correct document.

Then, the system continues by identifying the optimal monitoring form for each production step, by taking into account the monitoring frequency and the way in which the data need to be later used. Even though the monitoring frequency is the same for almost all the analysis types and the data recording design is made in such a manner that should easily permit the calculation of an average after a given period of time, for the steeping step simple data recording way would not be helpful enough. Thus, because for the steeping process the average per day or per month is only useful for the process quality control, but not to monitor the evolution throughout the steeping cycle, it was chosen to centralize the analysis results for each steeping tank.

Each table in which the data should be recorded includes 8 rows and 72 columns. The first column indicates the information which should be recorded in each row. The fourth row has the values already set, from 1 to 72, representing the maximum period of time for corn steeping, in hours. Taking into account these values, at each 3 hours the analyst will select the number of hours corresponding to the sampling time and then input the analysis results for each of the following parameters: sulphur dioxide concentration, dry substance, temperature and steeping grade.

The Excel sheet formatting used to highlight the values which are outside the reference range was done using the function „Conditional Formatting". For each line type a specific rule is present: for all the cells which contain reference values, the formatting „Format all cells based on their values", „Format Style: 2-Color Scale", „Colour" is used, while for the cells which contain other values than the reference the formatting „Format only cells that contain", „Format only cells with: Cell Value", „Format" is applied.

As they are imput, the values become differently coloured, as follows: the values which are out of the reference range will become red and bold on a white background, while the normal values will remained black, but positioned on cells with light orange background (Fig. 1). At the right end of each table with measured parameters of each tank, another small table is placed to include the concentration of the sulphur dioxide solution used in the process. This table (Figure 1 right side) includes the time, the sulphur dioxide concentration was measured and the tank from which was taken. The analyst should record: name, date, sampling time and the value obtained for the concentration. After input, a good value for the solution concentration appears on a background coloured in green, showing that the SO_2 solution can be released in the steeping process. In case that the cell containing the concentration value does not appear coloured in green then, in the tank with an insufficiently concentrated solution more sulphur dioxide should be added and the analysis repeated. The new values are recorded in the table and when the concentration is signalled as being correct, the process of steeping is started. Figure 1 contains an example of a record for 2 steeping tanks, their measured parameters after 1, 4 and 7 h of steeping and the concentration of sulphur dioxide solutions used in the process.

Steeping Tank no. 1														
Analyst:	Name			...				Name				**Analyst:** Name		
Date:	14/15.01.2016			...				17.01.2016				**Date:** 17.01.2016		
Time:		01:00			04:00			07:00				**Time:**	**SO_2(%)**	
Duration (H)	**1**	**2**	**3**	**...**	**53**	**54**	**55**	**56**	**...**	**72**		**Tank**	**1**	**2**
SO_2(%)		0,003		...	0,116				...			**07:00**	**0,1**	
SU(%)		17,8		...	4,3				...			**08:00**		**0,09**
T(ºC)		**24**		...	48				...			**12:00**	**0,21**	
G.I.(%)				...				42,3	...			**13:00**		**0,19**
Steeping Tank no. 2														
Analyst:	Name			...				Name				**Analyst:** Name		
Date:	14/15.01.2016			...				17.01.2016				**Date:** 17.01.2016		
Time:			01:00		04:00			07:00				**ORA**	**SO_2(%)**	
Duration (H)	**1**	**2**	**3**	**...**	**54**	**55**	**56**	**57**	**...**	**72**		**Tank**	**1**	**2**
SO_2(%)			0,005	...	0,119				...			**07:00**	**0,1**	
SU(%)			18,3	...	4,7				...			**08:00**		**0,09**
T(ºC)			**26**	...	48				...			**12:00**	**0,21**	
G.I.(%)								**41,9**	...			**13:00**		**0,19**

Value **in** range

Value **out** of range

Value to be **released**

Figure 1. Example of a record for 2 Steeping Tanks

It can be observed that the cells in which normal values are recorded are coloured, while the values which do not fall within the established limits are marked with bold font and red colour. In this way the results obtained from analyses can be rapidly observed and easier interpreted. In order to keep unaltered the formatting in a table, some simple rules should be obeyed when filling the result boxes. Among those rules it can be mentioned:

- No text should be recorded in the numeric cells, because the text format will affect the application of formula and the already set conditional formatting, which depends on numbers magnitude;
- The cells in which values are calculated based on should be protected with passwords during programming.

The cells protection is made using the function „Protect Sheet”, which allow to decide which actions are permitted for the users. The administrator establishes the rules and then sets a password for rule change. In the Excel file created to record parameters during the steeping step, a formula is used only for dry substance calculation and monitoring in the CSL, being reported as the mean value of several measurements:

$$= \boldsymbol{average}(\boldsymbol{number1}; \boldsymbol{number2}; \dots)$$

In case no values are yet recorded in the file, in order to avoid an error displaying when the computer attempts to calculate the average and leave empty the cell containing the formula, another “IF” function is used, as follows:

$$= \boldsymbol{IF}(\boldsymbol{SUM}(\boldsymbol{number1}; \boldsymbol{number2}; \dots) = \mathbf{0}, "", \boldsymbol{AVERAGE}(\boldsymbol{number1}; \boldsymbol{number2}; \dots))$$

For the following steps, the production process is proceeding toward the obtainment of one or more of the final products: corn germs, corn gluten feed, corn gluten meal and corn starch, which are stored in bulk or/and packed. For these products the samples for the quality control are taken at each 3 hours and average values are calculated at the end of each shift, in order to highlight the batch characteristics. As the package method leads to certain requirements the best way to record the products parameters are in separate EXCEL files, either for the bulk products or for the packed products. Taking into account that the main final product is the corn starch and the others are only by-products, the record files for starch are separated from the by-product files. In the figures below we present examples with a recorded parameter file for germs separation and extraction steps (fig. 2) and for gluten separation and starch refining (fig. 3), respectively. It can be observed that the values for the limits and the analysis methods are underlined due to the fact that they are linked to the correspondent document on the server. Also there are some values in red font which shows that they are out of range. Average values are calculated for each shift, after 12 hours and for each day, after 24 hours.

Step	DEGERMINATION					EXTRACTION												
Sample	Wet Germs		Dried Germs			Wet Fiber			CGF	Corn Gluten Feed								
Analyze	U(%)	CA%/SU	Smell	Aspect	U (%)	U(%)		CA%/SU	U(%)	Smell	Aspect	U (%)	P (%)	CA%/SU				
Limits	≤ 55	≤ 8.0	conform	conform	≤ 6.0	≤65		≤ 17	≤ 13	conform	conform	≤ 13	≤ 17	≤ 8	BUNKER CGF			
Method	PS09	IL-L-03	S.1	IL-L-23	PS09	PS09		IL-L-03	PS09	S.1	IL-L-23	PS09	PS 06	IL-L-03				
Frequency	3H	PM2(3)	3H	3H	3H	3H	3H	PM2(3)	3H	3H	3H	3H	3H	PM2(3)				
Point	Presser		Drier			Arm 1	Arm 2	Presser	Drier	Fiber Mill					A	B	C	D
07:00	54,0		0 rancid smell	1	1,0	65,2	65,2		13,1	1	1	10,5			X			
08:00									12,4	1	1				X			
09:00															X			
10:00	55,2	7,9	1	1	2,5	65,2	65,3	15,2	11,3	1	1	9,6		15,2		X		
11:00																X		
12:00																X		
13:00	53,8		1	1	5,6	63,5	61,1		8,5	1	0 unmilled	6,2				X		
14:00									11,2	1	1					X		
15:00																X		
16:00	55,0		1	1	3,0	66,1	65,9		10,9	1	1	9,9					X	
17:00																	X	
18:00													16,9				X	
Shift 1	**54,5**	**7,9**	**1**	**1**	**3,0**	**65,0**	**64,4**	**15,2**	**11,2**	**1**	**1**	**9,1**	16,9	**15,2**				
19:00	54,4		1	1	12,4	67,9	67,2		12,1	1	1	10,9				X		
20:00					2,4											X		
21:00																X		
22:00	53,1	8,3	1	1	4,1	64,9	65,3	15,7	11,9	1	1	10,6		15,7				X
23:00																		X
00:00																		X
01:00	53,6		1	1	5,9	63,9	64,1		9,8	1	1	9,2						X
02:00																		X
03:00																		X
04:00	52,8		1	1	6,0	64,2	64,9		10,9	1	1	11,9						X
05:00																		X
06:00													17,7					X
Shift 2	**53,5**	**8,3**	**1**	**1**	6,2	65,2	65,4	**15,7**	**11,2**	**1**	**1**	**10,7**	**17,7**	**15,7**				
Daily average	**54,0**	**8,1**	**1**	**1**	**4,6**	65,1	**64,9**	**15,5**	**11,2**	**1**	**1**	**9,9**	**17,3**	**15,5**				

Figure 2. Example of a 1-day record file for starch, for germ separation and extraction steps

In figure 2 we also see that the values for organoleptic analysis are recorded with “1” if the smell corresponds to the reference and with “0” if there a faulty smell is perceived, in this last case being necessary to add a comment describing the nonconformity. In this example it was identified that the smell for dried germs, determined at 7:00 o’clock, was not in accordance to the reference value, thus “0” value was input and a comment added in the corresponding cell as “rancid smell”. As other example, for Corn Gluten Feed at 13:00 o’clock a non corresponding aspect was identified, the product being unmilled.

In figure 4 we presented an example of a filled table for 1 batch of 10 packaging units from packaging corn germs, corn gluten feed and corn gluten meal. We can observe that for corn germs we have 2 values out of range for moisture, for CGF packed from “BUNKER A” we have 2 nonconforming values: 1 for aspect unmilled and 1 for protein content.

In figure 5 we presented together the tables for record the values obtained for corn starch in bulk and packed in big-bags for 1 shift. We marked with green colour the cells in which the operator should introduce his name, the batch number, the date, the line on which the corn starch is produced and the tank from which the starch is packed. We can observe that the values out of range are marked in red and for organoleptic nonconforming values a comment was inserted describing the deviation.

All these 5 files are coded and gathered in a system and from them reports can be extracted to monitor and control each product at a certain time.

Step	GLUTEN SEPARATION			SEPARATION - WASHING - CENTRIFUGATE STARCH SLURRY								
Sample	T.G.		G.P.	S.A.G.	F.G.	L.A.	WATER	L.A.	R.S.	L.A.	L.A.	T.A.
Analyze	U(%)	CA%/SU	U (%)	C.(Be)	C.(Be)	C.(Be)	FLOW	FLOW	WATER/L.A.	P(%)	pH	U(%)
Limits	≤62	≤12	≤ 13	5.0 - 6.0	12.0-17.0	20.0-22.5			1.1-1.3	0.2-0.3	≤6.9	≤36
Method	PS09	IL-L-03	PS09	ARM	ARM	ARM	FLOWMETER		CALCUL	PS06	PS05	PS09
Frequency	3H	3H	3H	3H	3H	3H	3H	3H	3H	PM4(3)	3H	3H
Point	F.C.V.		Usc.	MERKO	W-URI						CFG.	
07:00	*63,6*		9,8	5,1	13,0	20,5	30	24	1,25	0,21	5,5	33,5
08:00	61,3											
09:00												
10:00	60,8	11,3	10,1	5,3	12,7	20,5	32	25	1,28		5,6	35,7
11:00												
12:00												
13:00	61,2		10,9	5,9	12,5	21,0	30	24	1,25		5,5	*36,4*
14:00												35,5
15:00												
16:00	60,9		10,5	6,0	12,9	21,0	29	24	1,21		5,7	33,7
17:00												
18:00												
Shift 1	**61,6**	**11,3**	**10,3**	**5,6**	**12,8**	**20,8**	**30**	**24**	**1,25**	**0,2**	**5,6**	**35,0**
19:00	61,2		10,9	5,3	12,7	20,5	29	24	1,21	0,3	5,5	33,5
20:00												
21:00												
22:00	60,8	10,5	10,5	5,9	12,5	21,0	30	24	1,25		5,6	35,7
23:00												
00:00												
01:00	61,3		10,1	6,0	12,9	21,0	32	25	1,28		5,5	35,4
02:00												
03:00												
04:00	60,9		9,8	5,1	13,0	20,5	30	24	1,25		5,7	33,7
05:00												
06:00												
Shift 2	**61,1**	**10,5**	**10,3**	**5,6**	**12,8**	**20,8**	**30**	**24**	**1,25**	**0,3**	**5,6**	**34,6**
Daily average	**61,3**	**10,9**	**10,3**	**5,6**	**12,8**	**20,8**	**30**	**24**	**1,25**	**0,2**	**5,6**	**34,8**

Figure 3. Example of a 1-day record files for gluten separation and starch refining steps

Step	PACKAGING GERMS				PACKAGING CGF									PACKAGING CGM				OBSERVATION
Sample	Corn Germs				Corn Gluten Feed									Corn gluten meal				
Analyze	Smell	Aspect	U (%)	G (%)	Smell	Aspect	U (%)	P (%)	...	Smell	Aspect	U (%)	P (%)	Smell	Aspect	U (%)	P (%)	
Limits	conform	conform	≤ 6.0	≥ 42	conform	conform	≤ 13	≥ 17	...	conform	conform	≤ 13	≥ 17	conform	conform	≤ 13	≥ 58	
Method	S.1	IL-L-23	PS09	IL-L-17	S.1	IL-L-23	PS09	PS06	...	S.1	IL-L-23	PS09	PS06	S.1	IL-L-23	PS09	PS06	
Frequency	Each sample			PM	Each sample			PM	...	Each sample			PM	Each sample			PM	
Point	BUNKER				BUNKER A				...	BUNKER D				DRIER				
1	1	1	4,8		1	1	10,5		...	1	1	10,5		1	1	11,5		
2	1	1	5,5		1	1	10,0		...	1	1	9,9		1	1	10,7		
3	1	1	5,8		1	1	9,9		...	1	1	8,9		1	1	10,6		
4	1	1	5,6		1	1	9,6		...	1	1	9,6		1	1	9,8		
5	1	1	5,5		1	1	8,9		...	1	1	10,5		1	1	10,1		
6	1	1	5,8		1	1	7,8	unmilled		1	1	9,9		1	1	11,2		
7	1	1	*6,2*		1	*0*	8,9		...	1	1	7,8		1	1	8,7		Identified with red label
8	1	1	*6,1*		1	1	9,9		...	1	1	9,9		1	1	9,1		
9	1	1	5,6		1	1	10,5		...	1	1	10,5		1	1	9,6		
10	1	1	5,8		1	1	9,9	*16,8*	...	1	1	9,9	17,2	1	1	9,9	60,8	
Average / batch	**1**	**1**	**5,7**		**1**	**1**	**9,6**	***16,8***	**...**	**1**	**1**	**9,7**	**17,2**	**1**	**1**	**10,1**	**60,8**	

Figure 4. Example of a record file for 1 batch of 10 packaging units from by-products packaging step

BULK	NAME:									
CORN STARCH	BATCH:				DATE:					
Step	LINE:									TANK
Sample	A.N.	A.N.	A.N.	A.N.	A.N.	A.N.	A.N.	A.N.	A.N.	
Analyze	Smell	Aspect	P.N./dm²	Taste	U(%)	Gz.(%)	pH	P(%)	SO2-ppm	
Limits	conf.	conf.	≤50	conf.	≤13	≥95	4.5-5.5	≤0.40	≤10	
Method	S.1	IL-L-23	S.3	IL-L-23	PS09	IL-L-50	PS05	PS06	IL-L-54	
Frequency	3H	3H	PM4(3)	3H	3H	3H	3H	PM4(3)	3H	
Point	DRIER									
07:00	1	1		1	11,5	98,50	5,1		2,00	3
08:00										3
09:00										3
10:00	1	1		1	10,1	98,0	5,3		2,00	3
11:00		pungent								3
12:00										3
13:00	*0*	1		1	11,2	98,3	5,4		*11,00*	4
14:00									9,00	4
15:00									7,00	4
16:00	1	1		1	10,6	98,6	4,9		5,00	4
17:00										4
18:00			6					0,32		4
Shift 1	**1**	**1**	**6**	**1**	**10,9**	**98,4**	**5,2**	**0,32**	**6,00**	

PACKED						NAME:				
CORN STARCH		BATCH				DATE:				
Step	TANK FROM IS PACKAGING:									Packaging type
Sample	A.N.	A.N.	A.N.	A.N.	A.N.	A.N.	A.N.	A.N.	A.N.	
Analyze	Smell	Aspect	P.N./dm²	Taste	U(%)	Gz.(%)	pH	P(%)	SO2-ppm	
Limits	conf.	conf.	≤50	conf.	≤13	≥95	4.5-5.5	≤0.40	≤10	
Method	S.1	IL-L-23	S.3	IL-L-23	PS09	IL-L-50	PS05	PS06	IL-L-54	
Frequency	5	5	PM4(3)	5	5	5	5	PM4(3)	5	
Point										
1	1	1		1	9,8	98,3	5,2		5	Big-bag
2										Big-bag
3										Big-bag
4			slightly sour	1						Big-bag
5	1	1		*0*	10,7	98,8	5,1		8	Big-bag
6				1						Big-bag
7										Big-bag
8										Big-bag
9							4,5			Big-bag
10	1	1		1	10,4	97,9	*4,4*		8	Big-bag
11							4,6			Big-bag
12			1					**0,34**		Big-bag
Average	**1**	**1**	**1**	**1**	**10,3**	**98,3**	**4,8**	**0,34**	**7,0**	

Figure 5. Example of a record file for corn starch in bulk and packed

CONCLUSIONS

A file recording system was created for the use as part of the quality control plan of a starch factory in order to simplify the laboratory results keeping and speed up the decision taking in case of non-conformity, in the benefit of the production process. The system consisting of five files was created by using EXCEL software, which allows simple data input, facilitates the interpretation of the analysis results and minimizes human errors by changing colours of the font or the background in case of wrong data input or in the case of non-conforming parameter determined.

The EXCEL files created simplify the work done by the quality control operator, which can perform the analyses, record the results directly in the computer and report the deviations in a shorter time than before, when the records had to be kept on paper. The new system is more efficient and leads to cost reduction by saving time and reducing errors.

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INSECTICIDES IMPACT ON SEED GERMINATION AND EARLY SEEDLINGS GROWTH IN MAIZE (*Zea mays* L.)

Elena DELIAN[1], Elena SĂVULESCU[1], Ion SĂVULESCU[2], Adrian Marius TEBAN[2]

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, Bucharest, Romania
[2]DuPont Romania

Corresponding author email: delianelena@yahoo.com

Abstract

The germination is the initial step of plant life cycle and seedling establishment and it is the crucial physiological periods for plant development. On the one hand, an appropriate seed treatment may help seeds to overcome biotic stress during storage and on the other it has beneficial effects on physiological seed quality. In this study were investigated under laboratory conditions the germination and early seedlings growth response of maize to different types of insecticides (antranilamids: HGW86 and E2Y45; neonicotinoids: Poncho 600 FS) applied 90 days before the laboratory trial. Untreated seed was used as control variant. The treatments for maize seeds in order to protect against biotic stress agents generally had no negative effects on germination and early seedlings growth. Nevertheless, choosing the right combination of products to apply as a seed treatment is very important. Future research needs to clarify the impact of insecticides treatment on maize seeds physiological quality.

Key words*: maize, seeds germination, insecticides.*

INTRODUCTION

Maize (*Zea mays* L.) is the most important cereal crop in the world after wheat and rice, with regard to cultivation areas and total production (Verheye, 2010), so it is a topic designed for a multidisciplinary approach (Staller et al., 2006).
Maize is a species with a great capacity to adapt to environmental conditions, but diseases and pest incidence may become the causes leading to decrease production and yield quality. On the other hand, during prolonged storage seeds are exposed to qualitative and quantitative losses caused by pests, as for instance weevils (Antonello et al., 2009).
Germination and emergence of seeds are primordial stages of ontogenetic cycle of the plant influenced by environmental factors, especially temperature and humidity (Baskin and Baskin, 2014). Physiological qualities of maize seeds affect plant behavior to stress factors in the juvenile stage, when incidence of diseases and/or pests can become fatal. Therefore, besides the interest of breeders for obtaining a biological material resistant to diseases and pests, seeds treatments is applied by means that can prevent or reduce the incidence of certain pathogens or pests of interest.
For instance, the agronomic performance of transgenic *Bacillus thuringiensis* (Bt) hybrid versus chemical and seed coated insecticides to control the rootworm pest were studied by Ma et al. (2009). It was showed that Bt rootworm seed technology was effective to control the rootworm larvae and protected grain yield under severe infestation.
The chemical treatments must also consider the possible accumulation of residues in soil. In this context, application of clothianidin did not induced a significantly accumulation of its residues in soil, as well as plant bioavailability of residues in soil was limited, next to that exposure to pollinators was not increase over time in fields receiving multiple applications of this product (Xu et al., 2016).
Therefore, in this study there were evaluated in the laboratory conditions the effects of the new seed treatments submitted for authorization applied to control the soil pests such *Agriotes* spp. (wireworm) and *Tanymecus dilaticollis* Gyll (maize leaf weevil) on maize seed germination and seedlings vigor.

MATERIALS AND METHODS

Biological material
Zea mays L. (*cv Pioneer* PR33A46) seeds purchased from DuPont were used to evaluate

influence of different seeds treatments on germination and seedlings vigor.

Seed Treatments

Prior to treating with insecticides, the maize seeds were treated with the fungicide Maxim XL 2.7 FS, then seven variants were prepared using different insecticides treatments as we can see in *Table 1*. The check plot included fungicide-only (V8).

Table 1.Insecticide treatments applied to corn seeds before germination test

Number	Treatments*	Rate of active ingredient/kernel (UAT)
1.	DPX-HGW86 625 FS	750 µg
2.	DPX-HGW86 625 FS	1000 µg
3.	DPX-HGW86 625 FS	1250 µg
4.	DPX-E2Y45 625 FS	750 µg
5.	DPX-HGW86 625 FS + PONCHO 600 FS	750 µg +500 µg
6.	PONCHO 600 FS	500 µg
7.	PONCHO 600 FS	1250 µg
8.	Untreated with insecticide	Control

*DPX-HGW86 625 FS= cyantraniliprole 625 g L^{-1}, FS
DPX-E2Y45 625 FS= chlorontraniliprole 625 g L^{-1}, FS
PONCHO 600 FS = chlothianidin 400 g L^{-1} + 53.3 g L^{-1} beta-cyfluthrin, FS

The study of germination was performed in laboratory conditions with the seeds stored 90 days after treatment. There were used Petri glass dishes (10 x 30 cm), as described by standardized procedures developed by the Association of Official Seed Analysts (AOSA, 1993). The temperature was daily registered under day/night natural room conditions. There were prepared four replications each consisted of 25 seeds and the double Whatman no.2 filter paper was humidify with 15 ml sterile distillated water. The seedlings were watered as needed.

The followings physiological indicators were registered: the degree of seeds imbibition (%); germination percentage (GP) (%) on the 4th day; mean germination time (MGT) (days); length of coleoptile and radicle were recorded on the 5th day after the start of the trial (expressed in cm $plant^{-1}$); fresh and dry weight of radicle and coleoptiles (g seedling $^{-1}$). As usually the criterion for germination is emergence of the root and some researchers consider that a certain length must be reached to be a valuable data, seeds were considered germinated when radicle length exceeded the length of the seed.

Electrolyte leakage (EL) was determined by immersing seedlings in 20 ml distilled water and reading after 3.5 hours, and 24 hours respectively, electrical conductivity of that solution, using a model OK-101 conductivity meter. The result was expressed in µS $cm^{-1}g^{-1}$.

The objective of the study was to determine seed germination traits of maize at different types and levels of seed treatment, specifically aimed at improving seeds and seedlings behavior under the incidence of some biotic stress factors.

RESULTS AND DISCUSSIONS

As recent highlight Baskin and Baskin (2014), before carrying out studies on seeds germination it is recommended to test if seeds will imbibe water. Germination rate depends not only to seeds vigor and/or the treatments applied, but also to its capacity to absorb water, especially during the imbibition phase, as the first process that assure seeds hidratation and subsequently permits storage substances breakdown.

Data in *Figure 1* show that there were not significantly differences between the seeds treatments, from the view point of imbibition degree. The insecticides seeds treatment applied did not affect water supply in the first step of water acquisition by the desiccated seed.

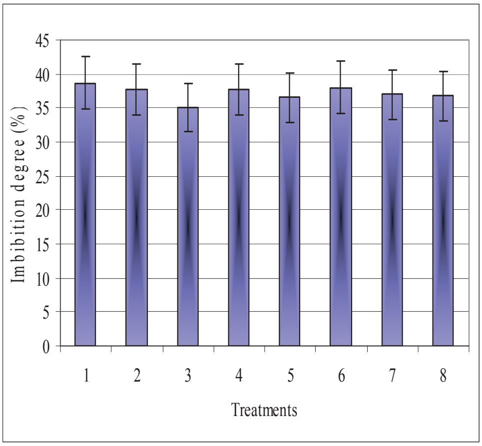

Figure 1. Maize seeds imbibition degree after insecticides treatment

Imbibition importance for the proper development of subsequent physiological processes was evidenced in the case of maize by Tnani et al. (2012). They identified after maize seeds imbibition 30 genes expressed in the scutellar epithelium and many of them activated in different metabolic processes, especially having a digestive function during germination. Moreover, according Law and Gallagher (2015) due to the release of volatile substances during imbibition, it can also lead to seed detection by invertebrate and seed consumption respectively. Therefore, it may also represent one way of activating the incidence of biotic stress, while DNA repair mechanisms activated during imbibitions enhance seed vigor (Ventura et al., 2012).

Germination percentage (GP) was evaluated at the fourth day and data presented in *Table 2,* to further clarify the effect of seeds treatment on germination. As we can see, the obtained results indicate that GP was not significantly changed under the insecticide applied treatments. However, the mixture of DPX-HGW86 625 FS + PONCHO 600 FS (750 µg +500 µg) (V5) negatively affected the seeds germination and the differences against the control were very significantly on the fourth day after the start of the trial.

Our results indicate that maize seeds treated with insecticides had a capacity to promote seed germination and early seedling growth. At least in part, these capacities may be first explained by the non influence on seed imbibition, then no influence on storage nutrients mobilization. On the other hand, the second phase of germination (germination in the strict sense) was not affected by the active ingredient used. It is well known that the early protection of seeds as against some stress factors may be crucial to germination performance, as well as to early seedlings growth.

As shows in *Figure 2*, mean germination time was closely to 2.1 days. The germination rates of maize seeds were increased on different ranges under different insecticides treatments, but generally there were no significant differences compared to control (untreated with insecticide). It is reported that combining the DPX-HGW86 625 FS + PONCHO 600 FS (750 µg a.i./kernel) with Poncho (500 µg a.i./kernel) caused an increase in average time of germination, as against the control and the other experimental treatments.

Cyantraniliprole contained by HGW 86 represents a new class of insecticides with systemic action against cutworm infestation. The insecticide is safe for beneficial insects as well as for humans, and studies conducted by the DuPont have also revealed that it increases plant vigor. Poncho is a new chloronicotinyl (CNI) seed treatment insecticide under development for use on corn in the United States, with Environmental Protection Agency (EPA) registration in the 2^{rd} quarter of 2003. It is effective against corn pests such as: wireworm, cutworm, grape colapsis, billbug and corn rootwarm (Pitts, 2003).

Table 2. The dinamic of the germination percentage (%) of maize seeds after insecticides treatment

	After 48 h			After 72 h			After 96 h		
Treatment	Mean value	Diference	Semnification	Mean value	Diference	Semnification	Mean value	Diference	Semnification
T1	75	0.00	-	89	-6.00	-	90	-6.00	-
T2	74	-1.00	-	88	-7.00	-	88	-8.00	0
T3	69	-6.00	-	90	-5.00	-	92	-4.00	-
T4	83	8.00	-	92	-3.00	-	96.50	-0.50	-
T5	70	-5.00	-	81	-14.00	00	81	-15.00	000
T6	82	7.00	-	94	-1.00	-	96	0.00	-
T7	87	12.00	-	96	1.00	-	97	1.00	-
T8	75	-	Control	95	-	Control	96	-	Control
	DL 5%	DL 1%	DL 0.1%	DL 5%	DL 1%	DL 0.1%	DL 5%	DL 1%	DL 0.1%
	12.44	16.93	22.85	8.11	11.03	14.89	7.02	9.55	12.90
	16%	22%	30%	9%	12%	16%	8%	10%	14%

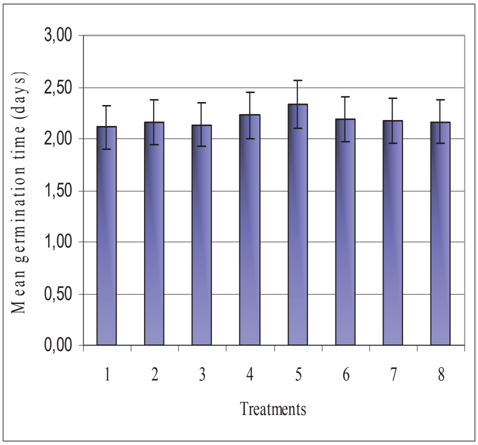

Figure 2. Mean germination time of maize seeds after insecticides treatments

The diamine insecticides: chlorantraniliprole and cyantraniliprole could be useful to reduce the negative effect of the neonicotinoides used long time for seed treatment and not only in reducing the number of foliar applications required for lepidopteran pests on soybean, as recently was reported by Thrash et al. (2013).
However, reduced seed germination and vigor caused by applying fungicide and insecticides treatments is variable in relation to the product used and also depends on the duration over which the seeds remain stored (Deuner et al., 2014).
Radicle and coleoptile lengths on the five day of germination are presented in Figure 3.

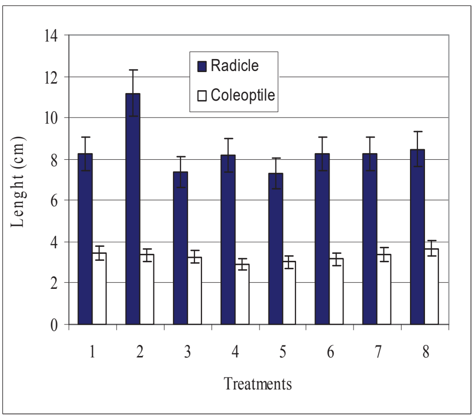

Figure 3. The radicle and coleoptile lengths on the five day

As we can observe, the radicle length was significantly higher in the case of T2 as against the Poncho treatment or control, while in rest not pronounced differences were registered. However, the coleoptile length was not influenced by insecticides treatments.
Single or combined insecticide treatments influenced radicle and coleoptile fresh weight (Figure 4), also their dry weight/fresh weight ratio (Figure 5). As a general rule, values were lower in the case of applied insecticides.

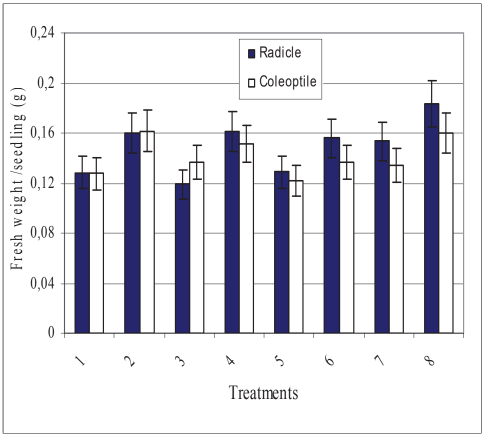

Figure 4. Maize seedlings fresh weight on the seven day

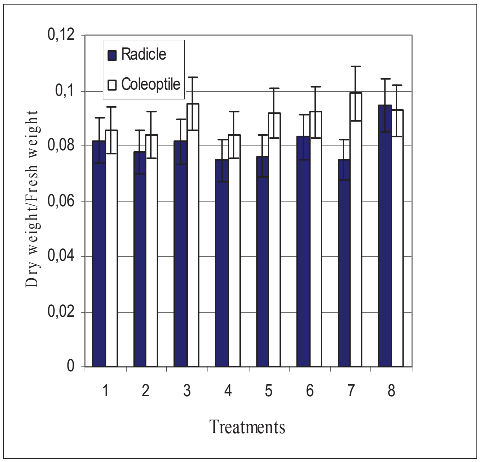

Figure 5. Maize seedlings dry weight/fresh weight ratio

Our results are in line with the findings of Wozniak and Martineau (2004) in the case of maize seeds pre-treated with Poncho™ 1250 when seedlings were visible smaller than those from Poncho™ 250 indicating an inhibitory effect of Poncho™ at the higher rate.

Also, improved germination is related to repairing of cell membrane integrity during seed imbibition. In this context, our data as regard as electrolytes leakage (Figure 6) indicate significantly differences as against the control, especially in the case of T2.

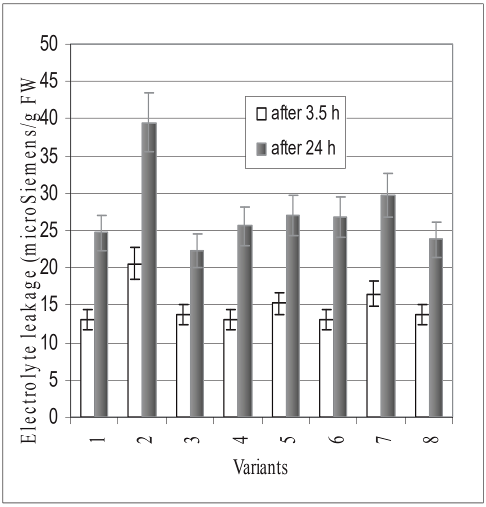

Figure 6. Electrolyte leakage during maize seeds imbibition

The massive out flow of solutes that occurs in the early hours of imbibitions can helps accelerate the germination processes, as it decreases the concentration of inhibitors. This process can be also associated with disturbances caused by membranes operation due to an inadequate rehydration. For instance, maintaining membrane integrity demonstrated by decreasing electrolyte leakage was assured by magnetic treatment of corn, which reduced the effect of aging on seed vigor (Vashisth and Nagarajan, 2009).

Understanding the molecular responses associated with seed rehydration (e.g. characterization of gene expression level, enzyme activity, difference in signal transduction response and regulatory mechanisms in stored seeds during the early period of imbibition) allows obtaining useful information that can be translated into applications in order to obtain high quality seeds (see review Ventura et al., 2012).

CONCLUSIONS

The treatments for maize seeds in order to protect against biotic stress agents during storage (90 days) didn't generally negative effects on physiological seed quality. Nevertheless, choosing the right combination of products to apply as a seed treatment is very important. Future research needs to clarify the impact of maize seed insecticides treatment on seeds physiological quality. Taking into consideration that companies constantly search for new alternatives or improved products, further investigation on their impact on seeds should be recommended.

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INFLUENCE OF DRYING PROCESS ON PHENOLIC CONTENT AND ANTIOXIDANT ACTIVITY OF TWO DIFFERENT AUTOCHTHONOUS ALBANIAN FIG VARIETIES

Luziana HOXHA, Renata KONGOLI

Agricultural University of Tirana, Fakulty of Biotechnology and Food,
Kodër Kamëz, Tirana, Albania

Corresponding author email: hoxhaluziana@hotmail.com

Abstract

This paper aimed to evaluate the drying effect on phenolic content and antioxidant activity of two autochthonous fig varieties (Roshnik and Malakuq) with different colour taken respectively from Berat and Elbasan region in Albania. For drying of samples were applied sun-drying and hot air dehydration processes. Before processing fig varieties were analyzed for their total polyphenolics content, flavonoids and anthocyanins content separately in the whole fresh fruit, pulp and peel., also determinations were done in the dried fruits after sun-drying and hot air dehydration process. Antioxidant activity was evaluated using DPPH (1,1-diphenyl-2-picryl hydrazyl) and ABTS (2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid) radical scavenging assays. Total polyphenolic content in whole fresh fruit, pulp, and peel and dried figs ranged 81.30-214.59 mg GAE 100 g^{-1} DM^{-1}, anthocyanins content ranged 0.0-17.76 mg C3G 100 g^{-1} DM^{-1}, and flavonoids content ranged 19.17-95.66 mg CE 100 g^{-1} DM^{-1} of sample. Antioxidant activity evaluated using DPPH assay results ranged from 3.09 to 6.48 mol TE 100 g^{-1} DM^{-1}, and from ABTS assay values ranged from 14.04 to 34.88 mol AAE 100 g^{-1} DM^{-1} of sample. The data obtained showed that autochthonous fig varieties are good source of antioxidants, and selected red fig variety showed higher phenolic content, compared to yellow fig variety. It was seen that peel showed higher antioxidant activity than pulp, as it resulted with higher total polyphenolic, flavonoids and anthocyanins content. Both drying processes influenced on increasing the total phenolic content and antioxidant activity, but hot air dehydration process influenced more in increasing total phenolic content and antioxidant activity, also influenced more in lowering moisture content and pH, and increasing total acidity of final dried product compared to sun-drying process.

Key words: *antioxidants, autochthonous, drying influence, fig.*

INTRODUCTION

Ficus carica is a tropic and subtropical plant produced in all Mediterranean basin and countries that have similar climate conditions. Albania is very rich in biodiversity of fig trees, and there are a lot of varieties, forms, ecotypes, and genotypes of figs (Koka, 1999).

Berat and Elbasan are the most known regions in Albania for fig growing, due to their geographical position and climate condition. These regions are known especially for figs that have good qualities for drying.

Fig fruit has high water activity, so it is highly perishable, even in refrigerated conditions (Hardenburg et al., 1986; Piga et al., 1995), and thus nearly all the world production is preserved in the dried form.

In Albania sun drying is the conventional method commonly used that requires low capital, simple equipment and low energy input.

There are concerns about the safety of the final product, and these concerns can be overcome by artificial drying (Piga et al., 2004). Nonetheless, hot air dehydration has gained importance because it has many advantages over sun-drying (Barbosa-Ca´ novas & Vega-Mercado, 1996), these include: (a) the process is under better sanitary conditions, because of a reduction in contamination by dust and other foreign matter; (b) drying parameters can be accurately set, controlled and changed over the entire processing time, thus a more consistently uniform product can be achieved with less quality degradation; (c) dehydration is not conditioned by rain or weather changes; (d) when a constant rate of dehydration is reached, increasing the air flow can result in shorter drying times; (e) labour costs are lower.

For millennium, figs have been a typical component in the health promoting Mediterranean diet (Solomon et al., 2006).
The beneficial effects of figs are associated with the constitutive presence in the products of biologically active components, like carotenoids, phenolics, some vitamins and fibres.
Phenolics are an important constituent of fruit quality because of their contribution to the taste, color and nutritional properties of fruit. The functionality of these compounds is mainly expressed in their scavenging free oxygen radicals, which are involved in many pathological conditions (Briviba and Sies, 1994; Tadić et al., 2008; Hasan et al., 2010).
Rababah et al. (2005) reported that the levels of total phenolic compounds were higher in dried fruits (apple, strawberry, and peach) followed by pureed and fresh products.
Vinson et al. (2005) reported that figs, especially dried ones, are an excellent source of nutrients and are in vivo antioxidants; the antioxidant capacity of human plasma increased significantly for hours after their consumption.
Phenolics, flavonoids, anthocyanins, and related total antioxidant activities based on chemical extraction have typically been measured using methanol or methanol/water mixtures (Solomon et al., 2006; Veberic et al., 2008; Çaliskan & Polat., 2011; Del Caro and Piga, 2008; Duenas et al., 2008).
There are no studies investigating phenolic content of these two autochthonous Albanian fig cultivars. Comparison of total phenolic content and antioxidant activity of two different fig varieties have been taken under consideration too. Also this work attempt to compare influences on quality of dried fig fruit parameters, applying two drying methods, as sun-drying and hot air dehydration processes.

MATERIALS AND METHODS

For experiments were selected two different autochthonous fig varieties, traditionally used as dried products: "*Roshnik*" (yellow colour) harvested from Berat region (40°42'51.56"N 19°58'48.02"E) and "*Malakuq*" (red colour) of Elbasan region (40°59'56.31"N 20°10'55.04"E) in Albania. In September 2015, fruits were harvested at their optimal ripening time and for further analyses, were transported immediately to the laboratory.
Fig fruits were preselected based on their weight, appearance, maturity, and health conditions, before drying process and were not pre-treated; no chemicals used before. For natural sun-drying 50 fruits were set on a tray, three repetitions, for about 7 days, the average temperature during the day was 37^{o}C. Hot air dehydrator was a closed cabinet with a fan inside to blow the air "horizontally" across the trays (fruits were set on trays inside the drying chamber). Once the air was heated electrically, temperature of the heater was adjusted to 60^{o}C, air relative humidity was approximately 40% (at the beginning) and 10% (at the end), and the process duration was about 24 h.
Methanol extracts were prepared by extracting 1 ± 0.001 g grinded fig samples with 10 ml of aqueous methanol 80% (v/v), homogenized for 1 minute using Ultra-Turrax T-25 (Ika-Labortechnik, GR), with speed set 11000 1/min, and centrifuged using centrifuge Eba 21 (Hettich, GR) for 15 min at 4500 rpm, and this process was repeated three times and supernatants were collected and analyzed. Extracts of whole fresh fruit, pulp, peel, and dried fig samples were prepared separately. All samples were analyzed in triplicate.
Fresh and dried fruits were analyzed for physico-chemical parameters. Moisture content (%) were determined according to method AOAC (2002), pH value was determined using pH meter UB-10 (UltraBasic, Denver Instrumet) (AOAC, 2000), total acidity (% citric acid) by titrating with 0.1N NaOH (AOAC, 2000).
Total phenolic content of the extracts was determined according to the method of Singleton and Rossi's (1965) with some modification and results were expressed as *gallic acid equivalents* (mg GAE 100 g^{-1} DM^{-1} (dry matter) of sample). The absorbance was measured at 760 nm using UV/Vis spectrophotometer Libra S22 (Bichrom, UK).
Total flavonoid content was measured using $AlCl_3$, a colorimetric method (Zubair et al., 2013). The absorbance was measured at 510 nm using the spectrophotometer Libra S22 (Bichrom, UK), and results were expressed as

(+) catechin equivalents (mg CE 100 g^{-1} DM^{-1} of sample).

Total anthocyanins content was measured according to the pH differential method (Cheng and Bren, 1991). Absorbance of extracts was measured at 520 nm and 700 nm in buffers at pH 1.0 and pH 4.5 where absorbance was:
$A = (A_{520}–A_{700})_{pH\ 1.0} −(A_{520}–A_{700})_{pH\ 4.5,}$ (with molar extinction coefficient of 26.900 and molecular weight of 449.2). Results were expressed as *cyanidin-3-glucoside equivalents* (mg C3G 100 g^{-1} DM^{-1} of sample).

Antioxidant activity of extracts was determined using ABTS radical scavenging assay (Re. et al., 1999). ABTS and potassium persulfate mixture was kept in the dark at room temperature for 16 h before use. For the analysis, the stock solution was diluted in aqueous methanol 80% (v/v) until the absorption at 734 nm was 0.7± 0.02. 10 μl of extract was mixed with 990 μl of ABTS reagent. The absorption was measured after 6 min of incubation, and the result was expressed as *ascorbic acid equivalents* (mol AAE 100 g^{-1} DM^{-1} of sample).

DPPH radical scavenging assay was used for determination of antioxidant activity of fig extracts, according to the method of Sun et al. (2007) with some modifications. A series of sample extracts (15, 30, 45 μl) were completed to 2 ml with 0.1 mM DPPH and the absorption was measured (A_{sample}) the absorbance of DPPH was $A_{control}$. 2 ml of 80% aqueous methanol was used as a blank solution. The percentage of inhibition was calculated as: Inhibition % = $(A_{control}–A_{sample})/A_{control}$. The amount of sample necessary to decrease the absorbance of DPPH by 50% (IC_{50}) was calculated graphically. The antioxidant activity was expressed as *Trolox equivalents* (mol TE 100 g^{-1} DM^{-1} of sample).

RESULTS AND DISCUSSIONS

Reduction rate of fig moisture content was increased with the prolongation of time of drying process, increasing air temperature and thickness of skin. The increased water-holding capacity of the heated air is a key factor of drying process.

The weight (Table 1) of pre-selected fig fruits was 25±1.2 g ("*Roshnik*" variety) and 45±0.5g ("*Malakuq*" variety).

Both drying processes had decreasing effect on moisture content, where initial moisture ranged 67.92-69.81% and after sun-drying (SD) decreased from 18.36 to 25.6%, while after hot air dehydration (HAD) process decreased from 18.36 to 18.78%. "*Malakuq*" variety had lower moisture content in fresh state and resulted with higher dry matter after both drying methods; even it has bigger fruit size. Titratable acidity expressed as citric acid, predominant organic acid in fig fruit, ranged from 0.38%-0.62% citric acid in fresh fruits, after drying processes process it was increased to 0.64-1.024% citric acid, this because the dried fig fruit samples contain less water, more concentrated are organic acids in dried figs. "*Malakuq*" fig variety showed highest values of acidity, both in fresh and dried state (MF had 0.62 % g citric acid, MSD and MHAD had same values of acidity 1.024 % citric acid). Accordingly, after drying process the pH values were decreased with increscent of total acidity. "*Malakuq*" variety showed lowest pH values both in fresh (MF resulted 4.67) and dried samples (MSD resulted 4.19 and MHAD resulted 4.21).

Table 1. Characteristics of fresh and dried fig fruits

Cultivar	Color	Weight[a] (g)	Sample	Code	Dry matter[a] (%)	pH[a]	Acidity[a] (% citric acid)
Roshnik	yellow	25±1.2	fresh	RF	30.19±0.01	4.76±0.005	0.38±0.01
			sun-dried	RSD	74.4±0.7	4.35±0.02	0.64±0.001
			hot air dried	RHAD	81.22±0.93	4.35±0.01	0.83±0.002
Malakuq	red	45±0.5	fresh	MF	32.08±0.09	4.67±0.03	0.62±0.02
			sun-dried	MSD	81.64±0.12	4.21±0.02	1.024±0.09
			hot air dried	MHAD	83.31±0.41	4.19±0.03	1.024±0.001

(a: mean values with standard deviation, n=3)

Total polyphenolic (TP) content (Figure 1) was determined in fresh figs, and TP in the whole fruit ranged 83.61-120.25 mg GAE 100 g^{-1} DM^{-1}, in pulp ranged 81.3-109.78 mg GAE 100 g^{-1} DM^{-1}, and in peel ranged 97.86-137.44 mg GAE 100 g^{-1} DM^{-1}. From the data was noted that polyphenols were more concentrated in the peel than in pulp. "*Malakuq*" variety had higher TP content in both fresh and dried state (MF had 120.25 mg GAE 100 g^{-1} DM^{-1}, MSD had 160.04 mg GAE 100 g^{-1} DM^{-1} and MHAD had 214.59 mg GAE 100 g^{-1} DM^{-1} of sample). Drying methods applied had different influences on TP content in both fig varieties, where HAD had an increasing effect on phenolic content compared to SD. It was noted that after hot air dehydration fruits had higher TP content compared to sun-drying (TP after HAD ranged 168.42-214.59 mg GAE 100 g^{-1} DM^{-1}, while after SD ranged 110.31-160.04 mg GAE 100 g^{-1} DM^{-1} of sample).

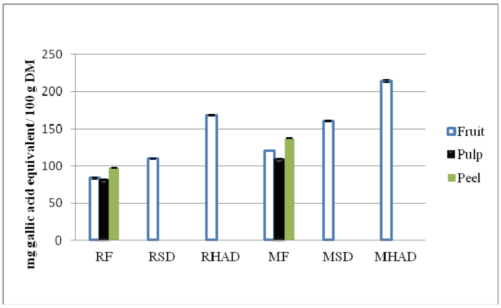

Figure 1. Total polyphenolic content in fresh figs (whole, fruit, pulp and peel) and dried figs

Total anthocyanins (TA) content ranged 0.0-17.76 mg C3G 100 g^{-1} DM^{-1} of sample (Figure 2). Anthocyanins were detected in fresh figs, while in dried figs were depleted. Yellow variety showed moderate content in pulp, and not in peel, so the presence in the whole fruit came from anthocyanins in the peel. Due to its red colour, "*Malakuq*" variety showed the presence on anthocyanins both in pulp and peel.

Total flavonoid content (TF) in fresh figs (Figure 3) ranged in whole fruit 20.27-32.23 mg CE 100 g^{-1} DM^{-1}, in pulp 19.17-31.94 mg CE 100 g^{-1} DM^{-1} and peel 26.90-37.65 mg CE 100 g^{-1} DM^{-1} of sample. In dried fruit TF after SD ranged 27.11-49.30 mg CE 100 g^{-1} DM^{-1} of sample, and after HAD ranged 51.95-95.66 mg CE 100 g^{-1} DM^{-1} of sample.

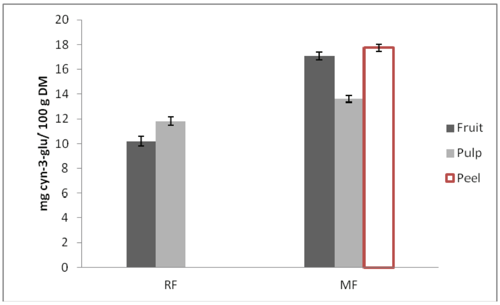

Figure 2. Total anthocyanins content in fresh figs varieties

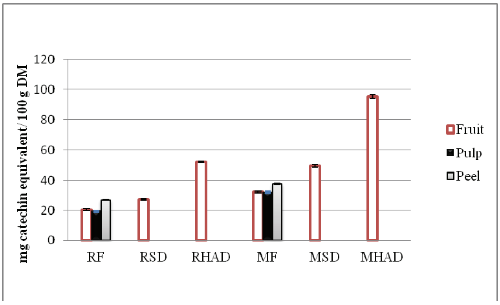

Figure 3. Total flavonoid content in fresh figs (whole, fruit, pulp and peel) and dried figs

Antioxidant activity was determined using ABTS (Figure 4) and DPPH (Figure 5) radical scavenging assay. From both assays was noted that highest antioxidant activity resulted in peel 14.63-24.14 mol AAE 100 g^{-1} DM^{-1}, and 3.60-4.45 mol TE 100 g^{-1} DM^{-1} of sample) than in pulp (14.05-16.05 mol AAE 100 g^{-1} DM^{-1} of sample and 3.09-3.71 mol TE 100 g^{-1} DM^{-1} of sample).

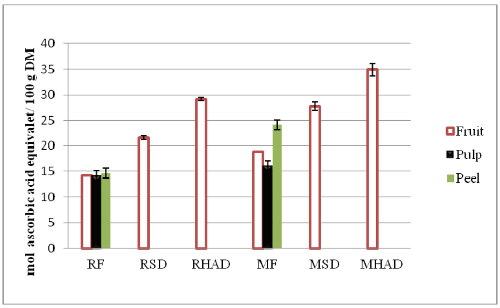

Figure 4. Antioxidant activity in fresh and dried figs, ABTS assay

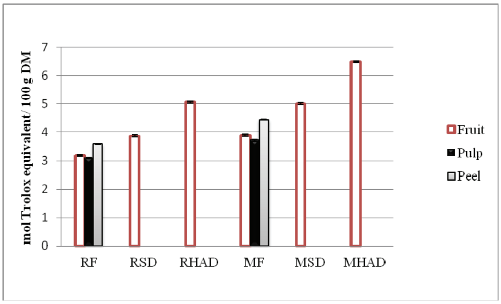

Figure 5. Antioxidant activity in fresh and dried fig fruit, DPPH assay

"*Malakuq*" variety showed highest values of antioxidants activity both in fresh and dried state. Antioxidant activity determined with both assays resulted higher at all dried figs varieties, compared to fresh figs. Also, it was noted that antioxidant activity of samples hot air dried resulted higher compared to sun dried.

Total phenolic content seems to be a good indicator of the fruit antioxidant potential and other authors have reported a correlation between these parameters. Nevertheless, the contribution of organic acids cannot be denied.

In our study dried fig showed higher content of phenolic content compared to fresh figs. Also, between the two drying processes applied, had different influences on phenolic content and antioxidant activity. Phenolic content and antioxidant activity of hot air dried fig samples resulted higher compared to sun-dried samples.

CONCLUSIONS

Based on the results between two selected fig varieties were seen differences on physicochemical parameters, which may be due to genotypic factor and the region of cultivation. Comparing two varieties taken under study "*Malakuq*" variety expressed higher values of dry matter (32.08% fresh, and 83.31% dried samples), correspondingly lower water activity, and about 20-38% higher acidity and lower pH values, which indicates that as a dried product may be more stable from microorganism contamination. Two varieties showed differences on phenolic content, also antioxidant compounds were about 25 % more concentrated in peel, than in pulp. "*Malakuq*" variety showed about 1.5-fold higher antioxidant activity, also related with its higher values on phenolic, anthocyanins and flavonoids content compared to "*Roshnik*" variety.

Comparing the influence of two drying methods applied resulted that hot air dried product achieved lower moisture content compared to sun-dried product, also application of hot air dehydration had an increasing effect on total acidity for "*Roshnik*" variety more than sun-drying process, indeed for "*Malakuq*" variety this parameter was not affected, as final products were nearest in values, pH was decreased but not affected by the drying process applied. Between two dried varieties "*Malakuq*" showed about 30% higher potential of antioxidant compounds compared to "*Roshnik*" variety, while anthocyanins were depleted at both dried varieties. Hot air dehydration processes influenced differently on the phenolic content, showing an increasing effect about 25-35% on phenolic content compared to sun-drying.

This study showed that both autochthonous Albanian fig varieties, besides fresh consumption showed high potential to be processed as dried products, but "*Malakuq*" variety showed better quality for drying compared to "*Roshnik*" variety even it had bigger fruit size, also it resulted with higher dry matter content, higher acidity, lower pH, higher phenolic content and antioxidant activity compared to "*Roshnik*" variety.

This work may suggest that hot air dehydration process should be taken under consideration for application to food industries as more suitable method for fig drying, relating this with its influence in improving the quality of final dried product, and influenced more in lowering moisture content and pH, increasing acidity, also increasing phenolic content and antioxidant activity compared to sun-drying process.

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THE PARADOX OF MALATHION USED FOR HUMAN LIFE

Yakup Onur KOCA[1], Ahmet Onder USTUNDAG[2], Melis YALCIN[3]

[1]Adnan Menderes University, Faculty of Agriculture, Crop Science Department, Aydın – 09100, Turkey
[2]Adnan Menderes University, Faculty of Agriculture, Animal Science Department, Aydın – 09100, Turkey
[3]Adnan Menderes University, Faculty of Agriculture, Plant Protection Department, Aydın – 09100, Turkey

Corresponding author email: koca2002@hotmail.com

Abstract

Malathion is an organophosphorus insecticide and has been used in public health and agriculture since World War II (1945). It has been intensively treated on crops against warehouse and storehouse pests and other many organisms over years. But the risk of its usage could not be determined completely for ecosystem and human health. Many studies have shown that the potential carcinogenicity potential of malathion and similar compounds because of the direct usage in agricultural products and it also had indirectly contamination (water, soil and air pollution) while and after malathion application in the agriculture and public health issues. In this review, the directly effect of malathion on some experimental animals is studied how malathion negatively affected body weight, cerebral alterations and reproductive system on rats. Furthermore, the pesticide had alteration of protein, fat and energy metabolisms, and oxidative balance. There are many results about indirect effects of malathion on human life and pesticide residues on animal products (honey, milk and meat) from livestock, bees, fishes and poultry. Besides, malathion has been observed in many vegetables such as onions, cucumbers, tomatoes and peppers. Consequently, we recommend that direct and indirect malathion effects on human life should be investigated practically more in the near future.

Key words: *malathion, side effect of malathion, pesticide residues.*

INTRODUCTION

Pesticides are the chemicals that are used for the controlling of the reproduction of unwanted organisms such as insects, weeds, fungi and rodents in agriculture as well as in public health (Bhanti and Taneja, 2007; Kumari et al., 2012). The American continent takes the first place over the World (about 153 thousand tons active ingredients) with the highest pesticide use (FAO, 2013). European Union's pesticide use (approximately 26 thousand tons active ingredient) has been one sixth according to the Americans (FAO, 2013). Pesticides are used in many different applications such as stored commodities, empty storage facilities, home and garden, the golf courses, ornamental nursery stock and turf, Christmas tree plantations, parks, cemeteries, garbage areas, irrigation systems, intermittently flooded areas, sewage systems, pastures, and rangeland (Ergonen et al., 2005).

Malathion, one of the important pesticides is an organophosphorus insecticide used in public health and agricultural areas (Sweeney and Lyon, 1999; Brocardo et al., 2007) as early as 1950. Products containing malathion may be in liquids, dusts, wettable powders, or emulsion forms (Blasiak et al., 1999). Over 100 food crops can be treated with malathion which are grains of cereals, fibre crops, oil crops and thus forage crops are disinfected with the insecticide. Besides, malathion may also be found in some personal things like body, hands, facial or hair shampoos. Two main impurities found in technical malathion include isomalathion and malaoxon (Bavcon-Kralj et al., 2007; Gervais et al., 2009) which has substantially more toxic in the organic metabolism (Edwards, 2006).

Environmental contamination

Because of being used outdoors to control a wide variety of insects in agricultural settings and around people's homes, malathion can cause serious contamination to the soil, water and atmosphere; hence, it should be seen as a threat to plants, animals and humans (Cheng et al., 2015; Clemens, 2006; Singer et al., 2007). It has also been accepted by the United States Food and Drug Administration (FDA) to be added into shampoos for controlling the head lice (Anonymous, 2006). Malathion is released into the environment by using in management of agricultural pests. It can be transported by rainfall, precipitation or wind. It can soak into the soil and pass into water supplies or enter the air and can also spread to other areas where no pesticides are used (Turgut et al., 2011). Malathion can be degraded in soil within a few weeks by hydrolysis, photolysis or biodegradation by microorganisms. It has been reported that half-life of malathion in soil is approximately 18 days (Bradman et al., 1990; Getenga et al., 2000). However, low concentration of malathion was observed in water (Larromendy and Soloneski., 2015; Leilanie and Lu., 2015). Hydrolisis and bacteria in water can break down the malathion in water. The half-life of malathion in water was observed until 1.65 days at pH 8 and 17.4 days at pH 6 (Wang, 1991). In air, malathion reacts with other chemicals and can break down to malaoxon by sunlight. On Sierra Nevada Mountains, low malathion concentrations were observed in air (< 1 $ng.m^{3-1}$) and 64 to 83 $ng.L^{-1}$ in surface water (Larromendy and Soloneski, 2015). Published data indicate that Malathion exceeded the acceptable maximum residue limit in soil of Sta. Maria, Pangasinan and it was reported that farmers had been using malathion for 25 years at about 16.5 ml. application equivalent^{-1} to 0.4 lt years of exposure (Leilanie and Lu, 2015). In one experiment, malathion residues in the soil was observed to be higher at a depth of 21-30 cm while the lowest concentrations were observed at a depth of 0-10 cm (Mahmud et al., 2015).

Residues in food

Environmental pollutants such as pesticides are widespread used chemicals in agriculture for different purposes in the world (Voigt et al., 2014). The intensive usage of pesticide causes residues on food such as fruits and vegetables. In one experiment grapes were collected from different vineyards in three different Aegean regions and 27 pesticide residues were analyzed in the investigation. As a result, some pesticide residues were frequently observed. According to the results, it was mentioned that preharvest intervals should be discussed (Turgut et al., 2011). On the other hand, because of the intensive usage of pesticides, some chemicals play an important role in our environment and daily life, they could be carcinogenic in laboratory animals and they could be implicated to lung, breast and colon cancers. In one experiment, some human milk samples were collected from Mersin province, organochlorine and polycyclic hydrocarbons were detected in human breast milk (Çok et al., 2012). Malathion was observed in milk samples (Bedi et al., 2015; Shaker and Elsharrkawy, 2014). U.S. EPA presented the MRL (maximum residue limit) of Malathion as 8 parts per million (ppm) (Larromendy and Soloneski, 2015). According to the experiment, goats were fed with 86 ppm malathion and chickens with 28 ppm malathion for 4 days. Parent chemicals weren't found in any tissues except goat kidney. Because of the rapid metabolization, oral ingestion of goats and chickens wasn't found dangerous. Ingested malathion was converted to acetate or acids and in the end components were incorporated to the carbon pool (Cannon et al., 1996). The estimated daily intakes of these chemicals could possess health problems. Royal jelly and honey, the most important bee products, were contaminated by malathion (Karazafiris et al., 2008; Bezerra et al., 2010) For example, the OPs concentrations in fresh vegetables from China were examined. The results showed that 23.4% of samples contained OPs above maximum residue limit and %12.1 of samples contained malathion (Yu et al., 2016). Due to the bioaccumulation of malathion in lipophilic tissues, for example, in liver, pesticide residues can be found in this organ. The study about fish liver confirmed this claim (Caldas et al., 2013).

Side effect of malathion on some experimental animals

Malathion kills insects by preventing nervous system from working fairly (De Silva et al., 2006). When healthy nerves send signals to each other, a special chemical messenger travels from one nerve to another to continue the message. The nerve signal stops when an enzyme is released into the space between the nerves. Malathion binds to the enzyme and prevents the nerve signal from stopping. This causes the nerves to signal each other without stopping. The constant nerve signals make it so that the insects can't move or breathe normally and they die.

Exposure to pesticides (direct effects) has been associated with many hazardous effects, including: acute and chronic toxicosis (Yarsan et al, 1999; Dahamna et al., 2004; Bonner et al., 2007). Therefore, due to extensive and unconscious usage, malathion may have some undesirable effects (side effects) on other plants, poultry, fishes and mammals during its application to limited insecticides population (Garg et al., 2004; Gwinn et al., 2005; Mahmoud et al., 2012). The researchers discovered that mitodepressive action on mitosis mitotic abnormalities increased and the mitotic index decreased depending on the concentration and duration time of the pesticide applied on plants (Amer and Mohamed 2002; Gharib, 2006; Pandey, 2008; Sibhghatulla et al., 2012). Furthermore, some abnormalities on chromosome stickness and contraction, scattered chromosome, lagging chromosome on plants were observed (Asita and Makhalemele, 2013; Adam et al., 2014) and inducing chromosomal aberration or DNA damage in cells of fungicides and different organisms with malathion treatment (Asya et al., 2012; Mahfouz et al., 2013; Karabag-Coban et al., 2015). It is considered that the pesticide may have genotoxic effects in human beings (Eryigit, 2002; Pandey, 2008).

Toxic chemicals in fish received considerable stimulus when it was shown that it could affect human health when fishes containing this toxicity were consumed (Martinez-Tabche et al., 2002). Malathion treatment was shown acute toxicity on Poecilia reticulate (lepistes fish) (Bakal, 2010) and it was investigated that it would cause the unpaired swimming and unbalanced movements, loss of equilibrium and to fall to the bottom and respiration problems (Surucu, 2000). And some hormones such as cortisol, estradiol and testosterone, lipid peroxidation and glutathione levels decreased on Cyprinus carpio (carp fish) with malathion toxicity (Ozturk, 2009). Furthermore, the activity of acetylcholinesterase and the levels of glutathione decreased at malathion exposures (Oren, 2009) and the malathion caused neurotoxicity and oxidative stress-mediated endocrine disruption effect (John et al., 2001; Fortunato et al., 2006) in Oreochromis niloticus (The Nile tilapia) and salmon (Oren, 2009; Wang et al., 2015).

Other experiments were observed that there were malathion side effects (direct effects) on rats. Their body and kidney weights decreased with malathion treatment (Uzun, 2007) while their liver weight increased and pathological changes in liver were detected (Karaduman, 1998). Moreover, it was observed in the experiments that less thyroid activity were measured than the control groups (Uzun, 2007). The histopatological investigations were also found out to have several damages. The damages to fatty degeneration, hyperemia in sinusoid in liver and fatty degenerations on apical cytoplasm, metaplasic degenerations on simple prismatic epithelium and degenerations from single epithelium to stratified epithelium in small intestine in Kidney were observed (Karaduman, 1998). Other studies were reported that cellular damage in rats' heart and kidney tissues was detected and some intoxication may be the cause of the results (Tugyan, 2001; Mossa and Abbassy, 2012). Even low concentration of malathion (10 $mg.kg^{-1}$ dose from drinking water) was claimed to have genotoxic effects for rats (Hornga et al., 2007; Ermis, 2014). Moreover, the effects may also cause the development of cancer cells (Muniz, 2008). No studies have been done regarding cancer in humans following oral exposure to malathion, but several bioassays have been conducted to examine the carcinogenicity of malathion in animals. So it may be comprehensible according to this result that low dose of malathion may cause health problems on human beings as well (Ergonen et al., 2005).

CONCLUSIONS

Malathion is almost an indispensable thing for standard human life because of pests and other many organisms onto agricultural products and around people's homes, garages, stores and warehouses. Moreover, it can cause serious contamination to the soil, water and atmosphere during treatments onto plants or anywhere else. Even if low concentration of malathion is claimed to have genotoxic effects, cancer cells into such organisms can be thrived with the insecticide treatment. Furthermore, no studies were carried out regarding cancer in human beings following oral exposure to malathion. However, several bioassays have been conducted to examine the carcinogenicity of malathion in animals. So, we can claim that low dose of malathion may cause health problems. There have been no studies done about whether children are more sensitive than adults to malathion or not. Therefore, we suggest that malathion effects (direct and side effect) should be determined for all ages of children and adults. Consequently, we recommend that malathion effects on human life should be searched and its results obtained be put into practice in the near future.

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AN INVESTIGATION INTO THE RAM EFFECT ON SYNCHRONISING OESTRUS AND IMPROVING CONCEPTION AND PREGNANCY RATES OF A HILL FLOCK DURING THE BREEDING SEASON

Carol MOFFAT[1], Anya WESTLAND[1], Lancelot BUTTERS[2]

[1]Myerscough College, Bilsborrow, Preston PR3 0RY, United Kingdom
[2]University of Central Lancashire, Preston, Lancashire, PR1 2HE, United Kingdom

Corresponding author email: awestland@myerscough.ac.uk; lbutters@myerscough.ac.uk

Abstract

Sheep breeding can be manipulated by several methods and is hugely dependant on the use of hormones to modify the physiological events involved in reproduction. This study aims to investigate the use of the "ram effect" by teasing the ewes for different timescales to synchronise breeding, induce oestrus, to improve conception and pregnancy rates during the breeding season. During the 17 day pre-breeding synchronisation period 126 ewes were assigned to three treatments and a control. Treatment group one was exposed to a vasectomised ram for 17 days (n=30). Treatment group two were exposed to an entire ram for two days (n=30). Treatment group three were exposed to an entire ram for four days (n=31). The control were not exposed to either a vasectomised or an entire ram (n=35). This study found a significant difference (P=0.002) in conception rates in ewes exposed to an entire ram for four days in that they conceived less than expected in the first half of cycle one compared to the other treatments and control. It was also found that ewes had conceived significantly more than expected when exposed to an entire ram for four days for the second half of cycle one compared to the other treatments and control (P=0.043). In conclusion in this study it was found that the ram effect is not effective at inducing oestrus during the breeding season. The synchronicity of the ewes was achieved; however other factors may have influenced this study including flushing, photoperiod, and the female effect.

Key words: *sheep, oestrus, reproduction, vasectomised, conception, conceive, synchronised.*

INTRODUCTION

Reproduction in sheep can be controlled by several methods, including administering hormonal changes to modify the physiological events that effect the reproductive cycle (Abecia et al., 2012). The ram effect is a natural phenomenon to induce oestrus synchronisation, improve conception and pregnancy rates (Delgadillo et al., 2009). The use of vasectomised rams (teaser ram) is not a new concept to synchronise ewes to induce oestrus in seasonally anovulatory ewes and is widely used in the sheep industry (Hawken et al., 2007). The use of a teaser ram is inexpensive, the typical cost for the operation to vasectomise a ram is £30-40 and can last for many breeding seasons, one teaser can be very efficient with the ability to cover over 100 ewes at a time (Eblex, 2014). Previous studies suggest the teaser is a reliable and non-pharmaceutical method to induce oestrus when compared to intravaginal sponges which artificially alter the hormone balance of the ewe (Hawken et al., (2008) and Rosa & Bryant (2002). The management of sheep breeding and synchronisation is however complex and is dependent upon many factors (Evans et al., 2004). This study will investigate natural methods of oestrus synchronisation using the "ram effect". This study will also evaluate the influences of ram effect including the hormonal balance associated with sheep reproduction and other factors that can also enhance the synchronisation of oestrus, and improve conception and pregnancy rates.

METHODOLOGY

1. Location

This study was conducted at Thwaite Head Farm, Garsdale, Sedbergh, Cumbria. England. LA10 5PB (latitude 54^{o} N longitude -2^{o} S) at an altitude of 200-657 meters above sea level, during the ewe's pre-breeding season of November 2013 following the methodology of Kenyon et al. (2008).

2. Treatments and 17 day pre-breeding synchronisation

On day one of the experiment 126 Swaledale primiparus and nulliparous ewes between the ages of 18 and 30 months were randomly assigned to three treatment groups and a control for the 17 day pre-breeding synchronisation period. The ewes were treated with a combined flukicide, anthelmintic and sheep scab treatment (Closamectin), as well as a mineral drench (Farmers Choice) and an insecticide (Crovect) to control biting lice.

The entire rams were fertility tested to check the sperm for strength, motility and abnormalities. This was carried out at by Paragon Vets in Penrith, Cumbria who specialise in advanced breeding. The semen was collected by training the ram to jump a teaser ewe, an artificial vagina was used to capture the semen (Paragon Vets, 2013). The teaser ram and the entire rams were raddled yellow on their briskets with a small paddle daily during the pre-breeding synchronisation period to indicate if ewe's were mated by the presence of a yellow raddle mark on the ewe's rumps.

Ewes in treatment group one were exposed to one vasectomised (teaser) ram for 17 days, on day one of the pre-breeding synchronisation period (teased 17 days, *n*=30). Treatment group two ewes were exposed to one entire ram for two days on day one of the pre-breeding synchronisation period (two day teased, *n*=30) shown in plate three. Treatment group three ewes were exposed to one entire ram for four days on day one of the pre-breeding synchronisation period (four day teased *n*=31). The control group were not exposed to either an entire ram or teaser ram (*n* = 35) during the pre-breeding synchronisation period (see table 1 for summary).

Table 1. Data collection protocol

Day 1 Pre breeding period	Day 3 (48hrs teased)	Day 5 (96hrs teased)	Day 18 Began breeding day 1	Day 26 (8 days)	Day 35 (18days cycle 1)	Day 52 (35 days cycle 2)
Treatment 1began 17 days of teasing. Treatment groups 2 and 3began the period of teasing.	Treatment 2 ram was removed	Treatment 4 ram was removed	Treatment 1 teaser ram was removed and rump marks recorded. All ewes were put to the entire rams for breeding. Rams had red raddle applied	All rump marks were recorded and The raddle colour was changed to blue.	All new rump marks recorded including ewes returned to service. Raddle colour was changed to green.	All new rump marks recorded including ewes returned to service. Rams were removed.

3. Flushing and pre-breeding synchronisation

During the 17 day pre-breeding synchronisation period each treatment group were managed separately under comparable grass sward in different pastures consisting of common bent, matt grass, sheep's fescue, along with soft and heath rush. The pastures had around 10 cm of grass growth, which is optimum sward height for flushing ewes without the use of compound feed (Eblex, 2013). An average of 20 kg of dry matter per hectare per day of grass growth is available to the ewes and is effective for pre-breeding flushing (*Ibid*). The pastures had been free of sheep for six weeks before the study commenced to ensure a clean pasture for newly drenched ewes to be free from parasites. The pastures were of similar size between 10 and 15 hectares at the same altitude of around 450 metres above sea level. The control group were taken on to a pasture 0.5 km away from the treatment, a sufficient distance so as not to be influenced in any way by the rams in any of the treatments such as pheromones excreted from the rams.

4. Breeding period

On the morning of day 18 all the ewes were merged and split evenly between two entire pedigree Swaledale rams and were introduced for breeding. The duration of the breeding period was for two oestrus cycles 34 days (days 18-52) as described in table one**.** The rams were marked on their brisket with a red raddle for the first half of cycle one for the identification of ewes mated as demonstrated in plate five. The raddle colour was changed at each data collection day (day 26 to blue and 35 to green) as outlined in table one. The number of ewes which displayed raddle marks were counted on each data collection day as described in table one. The raddle was applied daily to the rams to ensure the rump mark were visible on the ewe when they had been mated.

The ewes were recorded as being mated in the first half of cycle one (days 18-26), second half of cycle one (days 26-35) or in cycle two (days 35-52). In addition to this the ewes were then also recorded if mated during both the first and second cycles indicating these ewes had returned to service, and not mated due to no raddle marks on the rump.

5. Post breeding period

The ewes were allocated into scanning groups cycle one and cycle two according to the colour of the rump marks. The ewes that displayed raddle marks were pregnancy scanned by a skilled technician who has been scanning ewes for over 25 years he used an Ovi-Scan ultrasound sheep scanner (as shown in plate six) to determine how many foetus's the individual ewe's were pregnant with, this was carried out on day 94, 35 days after ram removal. Each ewe was identified as either non-pregnant, single, twin or triplet.

6. Statistical methods

The computer program used to investigate the data was Mini Tab 16. A chi square statistical analysis was used to examine any significant differences within the data collected for each treatments and the control. Excel 2010 was used to generate graphs and input the raw data.

RESULTS

1. Pre-breeding period

Treatment one ewes teased for 17 days had fourteen (46.6%) out of 30 ewes which displayed raddle marks in the pre-breeding period. In contrast no ewes treated by the entire ram for two and four day treatments in the pre-breeding period were mounted by the rams as indicated by the lack of rump marks.

2. Conception rates

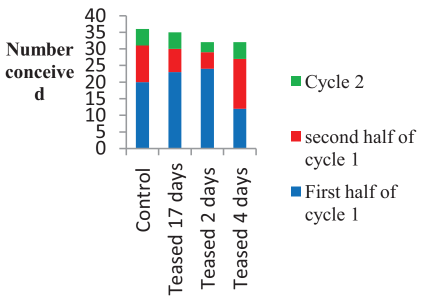

Figure 1. Proportion of the conception rates for the treatments over the different breeding periods

Figure one clearly outlines teased four day treatment has a higher proportion of ewe's mated in the second half of cycle one, compared to all the other treatments and the control. In contrast the other treatments and control have more ewes mated in the first half of cycle one.

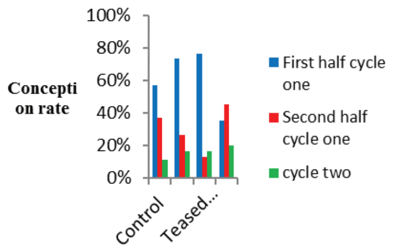

Figure 2. the percentage of ewe conceived for the treatments over the different breeding periods

Figure two summaries the conception percentages for the first half of cycle one are higher for teased 17 days treatment and teased two day treatment this is almost 20% higher than the control and 35% higher than the teased four day treatment. Figure two outlines a higher conception percentage in teased four day treatment for the second half of cycle one, when compared to the other treatments and the control.

Table 2. Effect of ram contact treatments on conception rates

Treatment		First half of cycle one	Second half of cycle one	Whole of cycle one	Cycle two	Cycle one and two
Teased 17 days *n*=30	O	23	7	28	2	5
	E	18.81	9.05	27.38	2.62	4.29
	χ^2	0.934	0.463	0.01	0.146	0.119
Teased two days *n*=30	O	24	5	29	1	3
	E	18.81	9.05	27.38	2.62	4.29
	χ^2	1.4322	1.81	0.096	1.001	0.073
Teased four days *n*=31	O	12	15	27	4	5
	E	19.44	9.35	28.29	2.71	4.43
	χ^2	2.854	3.415	0.059	0.168	0.073
Control no ram contact *n*=35	O	20	11	31	4	5
	E	21.94	10.56	31.94	3.06	5
	χ^2	0.172	0.019	0.027	0.291	0

Key O = observed number
E= expected
χ^2 = chi square value
The red indicates a significant difference (P=<0.05) in the data.

There was no significant differences in conception rates between the teased 17 days treatment and teased two days treatment compared to the control, however there is a significant difference between teased four days treatment (P=0.002, degrees of freedom (DF) =3) and all other treatments in the first half of cycle one. Indicating there were fewer ewes mated in the first half of cycle one than expected due to the lack of raddle marks on the rumps of the ewes in teased four days treatment. Table two highlighted in red indicates the significant difference in the expected conception rates in teased four days treatment. There was no significant difference in the treatment groups for the whole of cycle one (P=0.480 DF=3) when including the first half of cycle one and ewes returned to service data shown in table two.

The second half cycle one found a significant difference between teased four days treatment and the other treatments and control (P=0.043 DF=3). Table two highlighted in red indicates a significant difference in conception rates in the second half of cycle one with more than expected conceiving from the presences of raddle marks.

There were no significant differences between the treatments or the control (P=0.871 DF=3) in cycle two including ewes returned to service as shown in table two. Indicating all treatments and control observed a similar number of raddle marks, with similar numbers of ewes returning to service. No significant differences were found between the treatments and control (P=0.480 DF=3) excluding ewes returned to service shown in table two indicating the observed and expected values were similar.

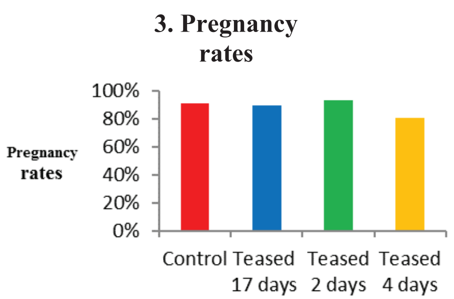

Figure 3. Proportion of pregnancy rates for the treatments over the whole breeding period (34 days)

Pregnancy rates for each group are expressed visually in figure three, outlining the range of 80-93% for the pregnancy rates across the treatments and control this indicates the similarities across the treatments.

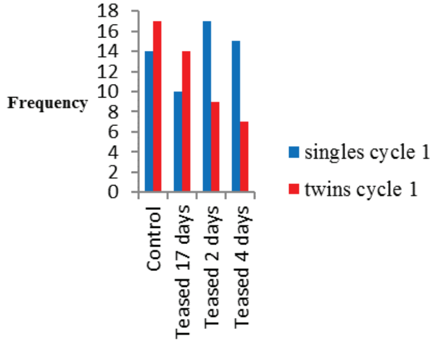

Figure 4. Frequency of ewe pregnant with twins and single with in the treatment groups in the first 17 days of breeding

The frequency of twins and single in cycle one are visually expresses in figure four indicting there are more twins in the control and in the 17 days teased treatment than in entire ram treatment groups (teased two and four days).

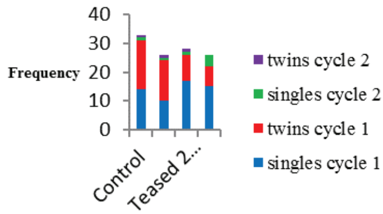

Figure 5. Proportion of ewes pregnant with twins and singles for each treatment in cycle one and two

The proportion of ewes pregnant with twins and single across the different breeding periods are visually outlined in figure five. There were no ewes pregnant with twins in the four day teased treatment in the second cycle. There were a higher proportion of ewes pregnant with singles in the teased four day treatment when compared to the other treatments and the control.

There is no significant difference between the treatments (P=0.268 DF=3) for both cycles as outlined in table three. There were fewer twins in teased two days treatment and teased four days treatment compared to teased 17 days treatment and the control, however this was not significant. Pregnancy rates for cycle one found no significant difference between the treatments (P=0.143 DF=3) as shown in table three. The pregnancy rates for cycle two were unable to generate a P value because of the lack of data for cycle two as most ewes we pregnant in cycle one as indicated in table three and expressed visually in figure five.

Table 3. Pregnancy rates for the treatments over the different breeding periods

Treatment group			Cycle one	Cycle two	Whole breeding period (cycle one and two)
Teased 17 days n=30	Twin	O	14	1	14
		E	11.19	0.71	11.43
		χ^2	0.705	0.114	0.578
	Single	O	10	1	13
		E	13.33	1.66	15.71
		χ^2	0.833	0.266	0.469
Teased 2 days n=30	Twin	O	9	1	10
		E	11.19	0.71	11.43
		χ^2	0.428	0.114	0.179
	Single	O	17	1	18
		E	13.33	1.66	15.71
		χ^2	1.008	0.266	0.332
Teased n=31	Twin	O	7	0	7
		E	11.56	0.73	11.81
		χ^2	1.801	0.738	1.960
	Single	O	15	4	19
		E	13.78	1.72	16.25
		χ^2	0.108	3.012	0.469
Control n=35	Twin	O	17	1	17
		E	13.06	0.83	13.33
		χ^2	1.191	0.033	1.0083
	Single	O	14	1	116
		E	15.56	1.94	18.33
		χ^2	0.155	0.458	0.297

DISCUSSIONS

1. The null hypothesis

This study tested the null hypothesis that there is no effect on synchronising oestrus and increasing conception and pregnancy rates by using the different variations of the "ram effect" on a hill flock during the breeding season. The null hypothesis was accepted as using a teaser ram and short term exposure to entire rams did not show any significant differences for inducing oestrus or increasing conception and pregnancy rates during the breeding period.

The results indicated the majority of ewes were mated in oestrus cycle one, however other factors could have also influenced the ewes to synchronise oestrus. The study by Kenyon et al., (2008) found the use of teasing and short term exposure was effective to induce oestrus this was also the case in several other studies (Celi et al., (2013); Delgadillo et al., (2009); Evans et al., (2004); Hawken et al., (2007); Hawken et al., (2008); Maatoug-Ouzini et al., (2013).

2. Oestrus synchronisation benefits

The agriculturalist can benefit from synchronising ewes by controlling and shortening the lambing period, which allows for the subsequent management of weaning and slaughter or sale of lambs (Abecia et al., 2012). Synchronisation can also allow more efficient use of labour, the efficient use of facilities such as lambing sheds and the ability to forward plan feeding, including pasture management and medicine use (Martin et al. 2004). The synchronisation of the flock in this study was apparent; however there was not a particular treatment in this study that significantly accounted for this.

3. The male effect on oestrus synchronisation

The introduction of rams to seasonally anovulatory ewes has been recognised to stimulate reproductive activity in ewes for over a century (Delgadillo et al., 2009). The "ram effect" is more effective when used to induce oestrus in anovulary ewes which are not cycling (Ibid).

The ram is proven in several studies to increase the secretion of luteinising hormone (LH) within 20 minutes, this explains why 46% of the ewes in the 17 days teased treatment were mounted as the teaser ram induced oestrus during the pre-breeding synchronisation period (Kenyon et al., 2008; Hawken et al., 2007; Evans et al., 2004). The presence of LH and follicle stimulating hormone (FSH) are vital for ovulation to occur and subsequently oestrus and conception (Hawken et al., 2007). In this study the influence of the ram effect has been recognised to have worked in the first half of cycle one due to more ewes mated. The study conducted by Kenyon et al. (2008), confirmed the teaser ram to be the most effective to induce oestrus. There was no significant difference in this study across the treatments and contradicts the findings of Kenyon et al,. (2008). The ewes in this study have mainly conceived in the cycle one, none of the treatments however have significantly increased the conception rates, this is evident from the control having similar results in this study.

The presence of the ram or teaser has had an influence on the synchronisation of the ewes in this study; however other factors have also played a part. In a study conducted by Hawken et al. (2007) suggested the ram effect is not as effective to induce oestrus synchronisation during the breeding season when ewes are cycling. This may have been the case in this study as the ewes in treatment one were cycling, this was evident with 46.6% of the ewes displaying raddle marks in the pre breeding synchronisation period. In the study conducted by Kenyon et al, (2008) this was not the case, finding only 5% of the teased treatment had displayed mating activity, as the study had been conducted in the pre breeding season. The study by Kenyon et al, (2008) found the use of teaser rams to have been effective to induce oestrus synchronisation, however short term teasing with entire rams also has a significant influence on conception rates.

Hawken et al, (2007) found that cycling ewes will be influenced by the presences of rams by the increase of LH levels compared to before rams were introduced. Rosa & Bryant (2002) reported the presence of a ram will induce ovulation within five days of introduction with 60% of ewes ovulating at the beginning of the breeding period and 28% during the middle of the breeding period. This study has found an advancement of the breeding period seeing the majority of ewes mated in cycle one, therefore the pre-breeding synchronisation treatments may have been ineffective when comparing to the control. The ram effect has had synchronising effect in this hill flock, due to the high number of ewes mated in cycle one across all treatments and control indicating other factors have influenced the outcome of this study.

4. Short term exposure to entire rams

In the Kenyon et al., (2008) study the use of short term exposure to entire males were found to be effective to increase conception rates and compact the lambing period; however this was not as effective as the use of a vasectomised ram this was also found in the study by Bedos et al., (2014). The use of short term exposure of an entire ram can be an alternative to the vasectomised teaser ram to induce oestrus and synchrony of a flock during the breeding period (Hawken et al., 2008). The use of an entire male which will be used for breeding is a more cost effective way to synchronise a flock as he will be producing valuable progeny as a result of breeding him after the pre-breeding synchronisation period (Ibid). The vasectomised ram has the added expense of feeding all year round, and the surgical treatment to vasectomise him, yet he will be unable to produce offspring (Kenyon et al., 2008).

In this study, the short term exposure treatments was not as clear and contradicted the findings by Kenyon et al., (2008). The use of the four day teased treatment had a significant difference compared to the other treatments and was not as effective as two day teased treatment, however other factors may have influenced this study. The two day teased treatment did not show any significant differences to inducing oestrus when compared to the 17 day teased treatment. This indicates that a relatively short period is just as effective as a longer period such as 17 days when synchronising during the breeding period. Given that the rams can increase LH in as little as twenty minutes and potentially induce ovulation approximately 72 hours later, short term exposure of an entire male is another method of synchronising breeding (Hawken and Beard, 2009).

5. Pheromones

The use of the ram effect is reliant on the pheromones excreted by the ram and is present in the wool, bare skin next to the eyes, nostrils and flanks (Rosa and Bryant 2002). The ram can stimulate oestrus activity in anoestrus ewes through olfactory receptors in the ewe (Ibid). The pheromones are elevated when the rams come into contact with ewes, which increase the release of testosterone and LH, increasing the production of pheromones (Ibid). The influence of the pheromones along with sounds and contact with the ram is enough to trigger oestrus in anoestrus ewes (Ibid). In this study the use of the same entire rams in the pre-breeding synchronisation period were also used in the breeding period indicating that these rams were at their peak for breeding. The study by Rosa and Bryant., (2002) remarked that the continual contact of rams during breeding will increase cycling activity. This was also confirmed in a study by (Martin et al. 2004). All the ewes were mated in this study demonstrating the rams were able to influence cyclic behaviour themselves over the entire breeding period.

6. Age of the ram

The age of the ram is likely to influence how well he can perform over the breeding period. This was agreed by (Ungerfeld et al., 2008) where the use of adult (experienced) rams were compared to yearling rams, a significant difference of 78.5% (adult) compared to 61% (yearling) of ewes showing oestrus, concluding that adult ram were more effective to synchronise oestrus and increase conception and pregnancy rates. In this study the entire rams and the teaser were four and a half years old and had three previous breeding periods indicating that they had experience to perform sexually.

7. Female to female effect

The continuous presence of cyclic ewes in a flock can induce and synchronise oestrus, this phenomenon is brought about by social stimulations known as the "female effect" (Rosa and Bryant 2002). The high presence of cyclic ewes of up 50% can influence the anoestrus flock mates to induce oestrus which was found in the study by Rosa and Bryant (2002). There is no reason why this effect cannot influence ewes during the breeding season to induce oestrus. Zarco et al., (1995) confirmed this in there study explaining the higher proportion of cyclic ewes in a flock can induce oestrus of the flock mates by up to 40% this is similar to the findings by Rosa and Bryant., (2002).

The female influence in this study could explain why the control results were similar to the treatment groups, if ewes in the treatment groups were cycling then the control could have been spontaneously cycling too. The pre breeding results for treatment one found 46% of the ewes with raddle marks indicating that they were cycling due to the presence of the teaser ram. The study conducted by Zarco et al., (1995) suggested that there is a direct stimulation of the hypothalamus pituitary gland brought about by oestrus ewes are similar to the pheromones produced by the ram. The indication of the female pheromone is apparent from the rams ability to identify the difference between an oestrus ewe and non-oestrus ewe from the vaginal secretions (Ibid).

This female to female effect is more apparent in cattle from the interactions of the herd to the oestrus cow the vaginal secretions from oestrus cows can enhance the synchronisation of herd (Ibid). This study found no significant differences between the control and the treatments, this indicates that a phenomenon such as the "female effect" could have influenced the results and could be an effective natural way to induce oestrus outside the breeding season.

8. Melatonin levels and short day length

The transition from the anoestrus period to the breeding period is slow and developed by the day length (Rosa and Bryant 2003). The melatonin which is released from the pineal gland when the days begin to shorten (known as the photoperiod) has a major influence on the levels of LH and FSH secretions which are vital as already mentioned to trigger oestrus and ovulation (Malpaux et al., 1996). Melatonin can be used to enhance oestrus by using a melatonin implants which is placed in the ear of the ewe (Ibid). A study carried out by Celi et al. (2013) found that the use of melatonin implants and the male effect were beneficial to induce oestrus and the fecundity of Payoya goats and the study suggested this would also be beneficial to the sheep industry.

The Swaledale breed of sheep as used in this study are particularly inclined to increase melatonin levels when the photoperiod shortens this is due to the natural way in which they survive in high latitudes which are greater than 40 percent (Chemineau et al., (1992) and Abecia et al., (2012). The natural shortening day length in this study determined the melatonin excretion levels may have increased as the breeding period went on from early November to early December and would influence the ewes to begin oestrus. This is another explanation for the control group having similar results to its teased counterparts, which would stimulate LH and FSH, when the control ewes began breeding the ram would trigger the LH and explain why the control began to oestrus at a similar time to the treatments.

In the study by Rosa and Bryant., (2002) described that the "female effect" is particularly effective following a long anoestrus period and in ewes which are naturally seasonal breeders. This was experienced by the control group and the treatments in this study. This was not considered in the study carried out by Kenyon et al., (2008) and may have been a contributing factor in their study. Melatonin is a natural occurring phenomenon that can aid the synchronisation of oestrus with the influence of the ram effect, and may have been a contributing factor in this study.

9. Female previous experience of rams

A ewes previous experience of ram contact will influence how fast oestrus induction occurs (Chanvallon et al., 2010). The nulliparous ewes in the study conducted by Chanvallon et al., (2010) found to have a slower response to the ram effect than the parous ewes. The results for this study found a significant difference in the four days teased treatment, by observing fewer ewes mated than expected in the first half of cycle one and more than expected mated in the second half of cycle one. The reasons for this was concluded to be because of a higher proportion of nulliparous ewes with 20 out of the 31 ewes in four days teased treatment compared to the other treatments as outlined in figure six. This was over looked when randomly assigning the ewes to treatments. The results in this study concurred with Chanvallon et al., (2010) and are an explanation for the significant difference in the results for this study. Kenyon et al., (2008) was using ewe lambs (nulliparous) in their study and therefore this would not have influenced the data collected as it did in this study.

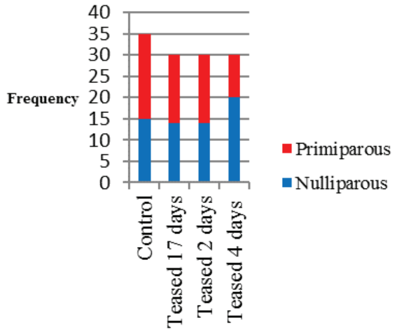

Figure 6. Proportion of nulliparous and primiparous ewe in each treatment

10. Nutrition and flushing

Nutrition has an important part to play in the fertility of the ewe, offering a high plane of nutrition 6 weeks prior to breeding and is commonly known as flushing (Robinson et al., 2006). This technique can increase the ovarian follicular growth, improve the function of the corpus luteum pre breeding and aid with embryo survival post breeding (Ibid). In this study the ewes were introduced to a higher plane of nutrition for the pre-breeding synchronisation period (17 days), however the pregnancy results of this study may have been different if the flushing period was extended to six weeks prior to breeding.

The results for the control was similar to the treatment groups, the control group were moved to a pasture further away and where the grass was possibly of better nutritional value compared to the treatments. The pasture had slightly more grass growth on a larger area with more DM per head per hectare as a result the ewes were of slightly better body condition score (compared to the treatments) as a result of a better plane of nutrition when the breeding period began. Robinson et al., (2006) concurred this when ewes taken from poor grass on to lush new grass growth can influence the oestrus induction of ewes as well as increasing fecundity, this is also found in the study conducted by Molleat et al. (1995).

CONCLUSIONS

The breeding of seasonally anoestrus ewes is an area of further research that will be useful to farmers to apply to their flocks. The timing of when to introduce the ram effect is dependent on many factors; this study found the use of teasers is not as effective during the breeding season in November to December this finding was true of a previous study by Delgadillo et al. (2009). The use of the ram effect does have a role to induce oestrus increase conception rate and in turn synchronise ewes during the breeding period as found in this study. Teasing is relatively inexpensive with the cost of the vasectomy being £30 and the teaser can last over five breeding seasons. This is compared to a pharmaceutical synchronisation method at a cost of around five pounds per ewe (Paragon vets, 2013).

The entire ram treatment used in this study can also play a role with the two day teased treatment being more effective than the four day teased treatment, this is more cost effective that the vasectomised ram as he does not need a vasectomy and as he is used for breeding and can produce progeny. The ram effect is a natural method to compact breeding and in turn lambing to take advantage of better market price for finished lamb, management of feed and medicines and better use of labour. However this study outlined other factors that will influence how breeding progresses as this was apparent when looking at the control and the similarities to the treatments.

Natural methods to advance the breeding season are often used by farmers as common practice, but may not be using teasers, instead rely on feeding and short day length to enhance breeding and fertility; however the use of the ram effect can be used to more effectively synchronise ewes pre-breeding (August to September). This study found the use of a teaser ram is less effective during the breeding period this is concurred by Hawken et al., (2007). The effective use of teasers whether it is a short exposure from an entire ram or longer periods with the use of a vasectomised ram can be used alongside sufficient flushing, and melatonin from shortening days.

The collaboration of few of the factors discussed in this study could be the best way to synchronise ewes during the breeding period and appears to be convincing. This could be particularly effective when used on higher hill farms in the northern hemisphere when lambing is much later usually in late April beginning of May taking advantage of shorter photoperiods. Teaser rams could be run with anoestrus ewes in July/August for a period of a month before breeding to enhance oestrus of lowland flocks and begin cycling much earlier, Hawken and Beard (2009) concurred with this in their study.

This study could have been improved if the method of inputting the data collection protocol utilised electronic identification (EID). All the ewes in the study were tagged with EID and could have accurately counted mating activity over the different breeding periods and could easily record if an individual ewe returned to service. The pregnancy scanning results for each treatment groups and lambing records could be easily recorded without the risk of human error, this could be a consideration if the study was repeated.

The method in this study could be improved if the nulliparous and primiparous ewes were studied separately as this may have influenced the ram effect due to the experience of the primiparous ewes as mentioned in the discussion. This was not possible in this study due to the lack of comparable pastures at Thwaite Head. The quantity of ewes would not have been a large enough sample size to generate enough data to compare differences between nulliparous and primiparous ewes. This could be something to consider if the study was repeated.

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DETERMINATION OF BIOGAS POTENTIAL OF AYDIN PROVINCE

Berker ÖZTÜRK[1], Ahmet KILIÇKAN[2]

[1]Adnan Menderes University, Institute of Natural and Aplied Science, Aydın, Turkey
[2]Adnan Menderes University, Faculty of Agriculture, Department of Biosystem Engineering, Aydın, Turkey

Corresponding author email: akilickan@hotmail.com

Abstract

A fast increase has been seen in the use of energy acquired from fossil based and renewable resources along with the increasing population in the world and Turkey. It leads the studies to find new energy resources that fossil resources have been depleting day after day.
Aydın Province that is located on 800.700 ha area over the lowlands irrigated by Büyük Menderes River is among the biggest cities of Turkey due to both animal number and area at which agricultural production is done. 363.215 ha cultivated area which is 45.3% of the total land is irrigable land. There are 70.884 units agricultural enterprises in the city and these enterprises are small and medium scale enterprises. 36% of these agricultural enterprises are the enterprises that make animal and vegetative production together, 35% of them are the enterprises that make only vegetative production and 29% of them are the enterprises that make only animal production. The unused wastes occurred after the production at these enterprises that makes animal and plant production pose a big problem for the enterprises and biogas that is a gas type having a high energy potential due to the methane gas inside it may be produced after they are fermented.
In this paper, animal and vegetative production data of Aydın province will be reviewed and biogas potential of the province will be determined by calculating the waste amount occurred due to the production.

Key words: *Turkey, Aydın, animal waste, vegetative waste, biogas, agricultural production.*

INTRODUCTION

Today, energy has become main need of all communities. For economic and social development, clean energy demand at cheap, reliable and sustainable price is to be met. Along with that, structure of global energy sector and whole supply demand chain has started to take shape with the environmental factors. The climate change draws new route of the world in the energy such in the all policies.
Nowadays, energy demand world-wide is mainly supplied from fossil fuel resources such as coal, oil, natural gas, etc. But these resources are fast depleting depending on their use due to that they are limited. Contrary to these, natural resources such wind energy, solar energy, hydroenergy and biomass are called as never ending in other words renewable energy resources due to that they renew themselves. Advantages of renewable energy resources are helping protection of the environment by decreasing the carbon dioxide emission, decreasing the foreign source dependency in the energy due to that they are domestic resources and making contribution to increase of the employment. Thanks to these properties, renewable energy resources receive support of the public.
Turkey is a lucky country in terms of its biomass potential. The biomass technology among the renewable energy resources have been increasingly demanded in the recent years due to the incentives. The biomass may be used in the energy technology by being directly burned or acquired alternative biofuels (easy transportable, storable and usable fuels) having equal properties to available fuels after their fuel qualities are increased through various processes. The waste biomass (scats, forest and agricultural wastes, municipality wastes, etc.) is traditionally used for cooking or heating in various places of the world. As well as that the biomass resources may be directly used as fuel, they are the products that are very convenient for biogas, biocarbon and biodiesel and have a high potential.

MATERIALS AND METHODS

Within the scope of this study, plant production and capacities of the wastes occurred due to the production will be revealed out as well as properties of the animal enterprises in the Aydın province, animal amounts and their capacities. Within this frame, official data of Ministry of Agriculture Provincial Directorate of Agriculture were used.

Aydın Province was established on 800.700 ha land on the B. Menderes lowland and has total 368.338 ha agricultural land according to 2013 data. 151.681 ha of this land is cultivated land and 216.657 ha is long-termed plant land. In other words, approximately 45% of total surface area is formed from agricultural land. The agricultural enterprises in Aydın are small scale and multipartite enterprises. There are 70.884 agricultural enterprises in the city. These agricultural enterprises generally make animal and plant production together and rate of these enterprises is 36%. The enterprises that make only vegetative production with the rate of 35% and the enterprises that make only animal production with the rate of 29% follow these enterprises, respectively. The distribution of the agricultural enterprises in Aydın by their scales is given at Table 1.

Table 1. Distribution of agricultural enterprises in Aydın by their scales (TUIK 2014)

Scale of the Enterprises (da)	% of the Enterprises
0 - 10	29.1%
11 - 50	51.45%
51 - 100	12.31%
101 - 200	5.57%
201 - 500	1.48%
501 - +	0.09%

The bovine dairy stockbreeding enterprise number in Aydın by scale of the enterprises is Table 2, the bovine stockbreeding enterprise number is given at Table 3 and ovine stockbreeding enterprise number is given at Table 4 (TUIK 2014).

Table 2. Distribution of bovine dairy stockbreeding enterprises in Aydın by their scales (TUIK 2014)

Scale of the Enterprise (per unit)	Number of the enterprises (Unit)	% of the enterprises
1 – 5	24421	52.73%
6 – 10	9644	20.81%
11 – 25	9299	20.1%
26 – 50	2185	4.71%
51 – 100	617	1.33%
101 – 200	122	0.26%
201 < per unit	27	0.06%
Total	46315	100%

Table 3. Distribution of bovine stockbreeding enterprises in Aydın by their scales (TUIK 2014)

Scale of the Enterprise (per unit)	Number of the enterprises (Unit)	% of the enterprises
1 – 5	622	50.12%
6 – 10	287	23.13%
11 – 50	302	24.33%
51 < per unit	30	2.42%
Total	1241	100%

Approximately 44% of the ovine enterprises in Aydın raise 1-25 animals and 19% of these enterprises raise 26-50 animals.

Table 4. Distribution of ovine enterprises in Aydın by their scales (TUIK 2014)

Scale of the Enterprise (per unit)	Number of the enterprises (Unit)	% of the enterprises	Number of the animals (per unit)
1 – 25	1951	43.7%	27495
26 – 50	857	19.2%	29048
51 – 100	810	18.15%	54631
101 – 250	572	12.82%	83157
251 – 500	104	2.33%	36129
501 < per unit	170	3.8%	29088
Total	4464	100%	259548

It is seen in Table 5 that fruit, beverage and spice plants form the biggest part of distribution of agricultural lands in Aydın province.

Table 5. Distribution of use of the agricultural lands in Aydın (TUIK 2014)

Use type of agricultural lands	Land sizes (da)
Cereals and other plant products	1330001
Fallow area	35569
Vegetable gardens	111290
Fruit, beverage and spice plants	2155207
Ornament plants	79
Total	3632146

In the method; the literature data concerning to waste amounts depending on the animal numbers and types and plant product range and waste amounts depending on plant product range will be taken into consideration in order to reveal out biogas potential of the province and rural area.

There are so many factors that are effective on the waste amount occurred at the animal and agricultural enterprises and biogas amount to be acquired. These are animal type, live weights, total additive ratio, plant range, volatile solid ratio, usability of the waste and biogas efficiency.

At the calculation of animal waste amount; 5-6% of the alive weight may be taken as basis for daily waste amount as well as that 10-20 kg/day (age) waste efficiency may be accepted for bovine animals. In the same way, 2 kg age/day or 4-5% of the live weight may be accepted as daily waste production for sheep and goat (Yokuş, 2011).

At the calculation of animal waste amount; the wastes occurred due to the production in proportion to acquired agricultural products cover 90-160% of the total production (ITEP, 2010). The waste amounts of some croplands and garden products in Aydın are seen at Table 6.

It is suitable for biogas production that nutrition material is between 8% and 13% TS (Total Solid). When the solid material is too low, precipitation of the material inside the solid is a matter.

Table 6. Waste amounts of some field crops and garden products in Aydın (TUIK 2014)

Products	Product amount (ton/year)	Wastes	Usable waste amount (ton/year)
Wheat	76557	Fodder	11988
Barley	30336	Fodder	4853
Rye	1848	Fodder	388
Oat	2881	Fodder	428
Corn	174575	Sap	235676
		Grainless corncob	90779
Cotton	316856	Stem	209125
		Carding waste	80798
Olive	274985	Residue Oil	137492
		Pruning	40585
Sunflower	1212	Stem	1957

When this ratio is too high, prevention of gas outlet is seen. The solid matter rates; 5-25% of the cattle manure, 10-90% of chicken manure, approximately 30% of the sheep manure.

In case too much water is used during collection of animal wastes, TS ratio may be decreased to 2-5%. This decreases the system efficiency due to that too much energy is used for heating the water.

The waste amounts at the animal wastes vary according feeding regimes of the animals, their sizes and climate conditions. The obtainable waste amount also varies depending on the breeding types. If animals are tied only at nights, obtainable waste is to be calculated as 50% of the total waste. When they are kept in a shed of which base is soil, collecting the waste is getting harder. If a base plate is used, the fodder is to be maximum 2-3 cm and unfermented sawdust is not to be used. The collected waste amount and therefore biogas production decreases at summer months when animals kept untied are brought to the pasture in the summer.

Period of staying in the shed of the animals is 65% for dairy cattle, 25% for beef cattle, 99% for poultry and 13% for ovine animals.

The energy sustainability is basis at all enterprises for making production. If energy of the enterprise is bound to biogas production, it is required to continuously buy gas from biogas facilities. Otherwise, the enterprise may not maintain its activity.

Table 7. Waste properties and biogas efficiencies by animal species (Yokuş, 2011)

Animal Species	Alive Weight (kg)	Fresh Waste Amount		TS (%)	UK (Volatile Solid) (%)	Usability Period of Staying in the Shed (%)	Biogas Efficiency l/kgUK
		Percentage of the Weight	Kg/day				
Bovine	135-800	5-6	10-20	5-25	75-85	Milk 65 Meat 25	200-350
Ovine	30-75	4-5	2	30	20	13	100-310
Coop **Egg** **Et**	1,5-2,0	3-4	0,08-1,00	10-35 50-90	70-75 60-80	99	310-620 550-650

RESULTS AND DISCUSSIONS

The waste amounts that may be acquired from various animals are given at Table 8. The values stated at Table 7 are get benefit at the calculations. 450 kg was taken as basis for alive weight of the bovine animals, 50 kg for ovine animals and 2 g was taken as basis for chicken.

As percentage of alive weight, the daily fresh waste amount was calculated as 6% for bovine animal, 5% for ovine animal and 4% for poultry. By taking the period of staying the shed, usability of the waste was selected as 50% for bovine animal, 13% for ovine animal and 99% for poultry.

Table 8. The waste amounts that may be acquired depending of the animal species (Yokuş, 2011)

Animal species	Fresh waste production (kg/ day.animal)	Solid matter ratio (%)	Solid matter waste production (kgKM/day.animal)	Total TS waste amount that may be acquired (kg/ day.animal)
Bovine	27.00	15	4.050	2.0250
Ovine	2.50	30	0.750	0.0975
Poultry	0.08	35	0.028	0.0277

Table 9. Biogas potential of Aydın province from animal wastes

Animal species	Animal Number	Fresh waste amount (ton/year)	Waste amount (tonKM/year)	Obtainable solid manure amount (ton/year)	Obtainable biogas (m^3/year)	Calorific value (GJ/year)
Bovine	343465	3384847	507727	253863	50772600	1152612
Ovine	259548	236707	71012	9222	1844400	41870
Poultry	2960594	86419	30246	29946	5989200	135963
Total	3563607	3707973	608985	293031	58606200	1330445

Table 10. Calorific value of Aydın province field crops

Products	Wastes	Production (ton)	Area (ha)	Usable wastes (ton)	Availability (%)	Unit calorific value (Mj/kg)	Total calorific value (Gj)
Wheat	Fodder	76557	22100	11988	15	17.9	214585
Barley	Fodder	30336	10221	4853	15	17.5	84927
Rye	Fodder	1848	921	388	15	17.5	6790
Oat	Fodder	2881	1030	428	15	17.4	7447
Corn (Grain)	Stem	174575	15933	235676	60	18.5	4360006
	Grainless corncob			90779	60	18.4	1670333
Cotton	Stem	316856	58880	209125	60	18.02	3768432
	Carding waste			80798	80	15.65	1264488
Sunflower	Stem	1212	404	1957	60	14.2	27789

By getting benefit from solid matter ratios, the solid waste amount that may be acquired from an animal per day was calculated as 2,02 kg for bovine animal, 0.098 kg for ovine animal and 0.028 kg for poultry. By getting benefit from these values, values of biogas potential from animal wastes calculated from Aydın province is given at Schedule 9. At the calculations, the biogas amount acquired from 1 ton solid animal waste was accepted as 200 m^3 and calorific value of the biogas was accepted as 22.7 MJ/m^3.

As seen at Table 9, annual wet waste potential from the animals brought in Aydın is 3,707,973 tons. The obtainable solid waste amount according to the dry matter ratios and fattening environment is 293,032 tons/year. In Aydın province, annual biogas amount that is obtainable from bovine, ovine and poultry animals is 58,606,200 m^3 and energy is equal to 1,330,445 GJ. The biggest share among the animal waste amounts belongs to bovine animal. The share of bovine animals among the total wet waste amount is 86% and its share among the obtainable solid waste amount is 86%. Therefore, bovine livestock raising has the biggest share with the rate of 86% among the biogas potential of the animal wastes in Aydın.

Obtainable wet waste amount was determined by multiplying daily fresh waste amount and period of staying in the shed. The specific mass was taken as 975 kg/m^3 at calculation of volumetric amount of the waste. The water amount that is necessary for transforming the waste of which solid matter rate is accepted as 15% into 9% solid matter ratio was calculated. By adding daily wet waste and waster amount to be added, material amount to be fed to the enterprise daily was determined.

If we review the calorific value equivalents of different agricultural wastes in Aydın in Table 10, we see that corn gives 235,676 tons usable waste acquired from its stem against 15933 ha land when cultivated are and waste amounts are compared. If we proportion cultivation to usable waste amounts, cotton gives approximately 3.5 times waste while corn gives approximately 14.8 times waste. The product waste of which usability is the highest one among the field crops is carding waste of cotton plant with the rate of 80% and then corn stem and corncob with 60% and sunflower stem and cotton stem follows. Total calorific value of annual waste amount of the field crops is approximately 11.5 PJ.

CONCLUSIONS

According to estimated calculations, it is observed that there is 13 PJ annual energy potential of animal and vegetative wastes in Aydın where animal and vegetative production is done. Provided that convenience of biogas production from wastes is revealed out with the assessment of its environmental, economic and sociocultural effects in detail, it is an important way of supply of regional energy need. The biogas energy that is acquired in indirect ways may be get benefit in heat and power production as well as that it may be used in obtaining hot water and air by directly being burned, cooking in the bakeries and lighting.

The basis material obtained from biogas enterprise output is organic substance containing manure. This fermented manure is purified from pathogens and may be used for organic substance at the vegetative production.

Obtaining biogas and fermented manure by assessing the animal waste after being anaerobic fermentation will allow for decreasing the environmentally hazardous waste amounts and waste management cost as well as that it will allow for production and use of renewable energy.

When it is taken into hand economically, it shows biogas systems as an expensive alternative energy resource that first investment cost is high. It is estimated that small scaled biogas enterprises may amortize themselves within approximately 8-10 months when they are operated with full efficiency. But at the first stage, there is a financing need for establishment of the enterprise. This financing may be supplied with state funded credit or may be met by private individuals who have users. In so many countries, programs are started by the state by considering benefits of the biogas technology in terms of environment and health. The biogas systems are tried to be popularized by decreasing the cost with applied incentives and credits.

Designing high efficiency biogas systems of which investment costs are low and installation, use and maintenance is easy will allow for development of biogas technology in our country by taking climate conditions and production opportunities into consideration.

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MORPHO-ANATOMY AND ADAPTATION TO SOME ROMANIAN AQUATIC ENVIRONMENTS OF *Nymphoides peltata* (GMEL.) O. KUNTZE (*Asterales*: *Menyanthaceae*)

Emilia Brînduşa SĂNDULESCU, Gina VASILE SCĂEŢEANU, Tudor ŞCHIOPU, Nicoleta OLTENACU, Mala-Maria STAVRESCU-BEDIVAN

University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Agriculture, 59 Marasti Blvd., 011464, Bucharest, Romania

Corresponding author email: mala_stavrescu@yahoo.com

Abstract

The adaptative changes to the aquatic environments are noticed in yellow floating heart, by anatomical analysis of its vegetative organs and reported herein. Also, in order to follow the preference of this plant species for physical-chemical parameters of the studied habitat, some water analyses were performed such as: pH, chemical oxygen demand, total hardness, ammonium nitrogen (N-NH_4^+), nitrite nitrogen (N-NO_2^-), nitrate nitrogen (N-NO_3^-) and phosphate phosphorus (P-PO_4^{3-}). With respect to pH values, the results indicated that both sampling areas (Bugeac Lake, North Dobrudja and Crişan, in the Danube Delta Biosphere Reserve) are within recommended range for the ecological status of Nymphoides peltata.

Key words: *astrosclereids, cross section, Nymphoides peltata, vegetative organs, water parameters.*

INTRODUCTION

Yellow floating heart or fringed water-lily, *Nymphoides peltata* (Asterales: Menyanthaceae) (Gmel.) O. Kuntze is a typical floating-leaved aquatic plant native to Eurasia (Li et al., 2010). This perennial species, dispersed by rhizomes, is characterized by long-stalked, heart-shaped, natant leaves; five-petaled, bright-yellow, actinomorphic, hermaphrodite flowers, with bloom time from May to October; ellipsoid fruit, ripening when submerged (http://archive.org/stream/). Two to five flowers arise from each peduncle (http://nas.er.usgs.gov/queries/greatlakes/). It grows in lakes, ponds, slow-moving rivers and streams (Campbell et al., 2010).
This aquatic herb is an invasive species, with rapid growth, reducing the biodiversity, diminishing the aesthetic value and decreasing the water quality and flow (http://invasivespeciesireland.com/).
It is already known that floating-leaved plants developed adaptation mechanism to help the plant tolerate the environmental stress (Li et al., 2010). Džigurski et al. (2014) have been reported that there are some key factors, as pH, alkalinity and phosphorus content that affect the development and abundance of macrophyte phytocenoses.
Lately, some studies (Du et al., 2015) present the antitumor effects of *N. peltata* secondary metabolites. So far, it was carried out tests against human prostate cancer and osteosarcoma cell and the results are promising.

MATERIALS AND METHODS

Area description

Bugeac Lake also known as Gârliţa is situated in the South-West of Dobrudja. Bugeac Lake together with Oltina, Dunăreni and Vederoasa lakes are fluvial lakes used intensively in fish farming and, therefore, water quality must be monitored permanently (Romanescu et al., 2013). Bugeac Lake presents an artificial connection with Danube River and has an area of 15.9 km^2, 1.71 m depth, 7.5 km length and 3 km width (Păsculescu, 2010). The presence of *N. peltata* in Bugeac Lake has been previously reported by Dinu and Radu (2004).
On the other hand, Crişan is a channel of so-called "fluvial delta" on the western half of the Danube Delta Biosphere Reserve (Tőrők, 2009). The presence of yellow floating heart in the flora of fresh running waters of the Danube

Delta was reported by several authors (Tőrők, 2001; Ciocârlan, 2011; Cuzic and Cuzic, 2013).

Biological material

For this study, we used preserved material belonging to *Nymphoides peltata*. The aquatic plants were sampled from two different Romanian ecosystems: Bugeac Lake from Northern Dobruja (44°05'30.6"N, 27°25'45.2"E, summer of 2014) and Crişan from the Danube Delta, (45°10'21.5"N, 29°23'47.2"E, spring of 2015). Yellow floating heart carpeting the water surface in Bugeac Lake is shown in Figure 1.

The field-collected material was fixed in ethanol and was used to analyze numerous hand cross sections made through different vegetative organs (stem petiole, leaf, peduncle, sepals and petals), using razor blades.

Morpho-anatomical characteristics of the yellow floating heart were examined with an ML-4M IOR microscope. The detailed measurements of the sclereids from the vegetal organs were made with an ocular micrometer (Săndulescu et al., 2014) and are presented in Tables 1 and 2.

Figure 1. Carpeting aquatic plant *Nymphoides peltata* on Bugeac Lake (August 2014)

Water sampling and chemical analyses

Water samples were collected from Bugeac Lake and Danube Delta at the same moment with aquatic plant collection. Water samples were taken at about 30 cm below surface layer in plastic bottles. The samples were subsequently stored at 4°C for as short a time as possible before analysis to minimize physical and chemical changes. Chemical analyses were conducted within 48 hours of collection. The samples were allowed to stay until they reached room temperature before analysis. The chemical analysis of water samples was performed by using methods similar to those recommended for drinking water (Mănescu et al., 1994), presented in detail elsewhere (Stavrescu-Bedivan et al., 2015).

The assessment of all species was performed in triplicates and the presented results are the average of three similar values of each sample determinations. The results of the analyses are presented in Table 3. The concentrations of phosphate, nitrate, ammonium and nitrite species were determined by spectrophotometric means with the aim of Metertek SP830 Plus apparatus. The pH was determined potentiometrically using Inolab WTW pH-meter with combined glass electrode after the water samples reached room temperature. Total hardness was determined by complexometric method meanwhile chemical oxygen demand was assessed by manganometry.

RESULTS AND DISCUSSIONS

The morpho-anatomic structure of the vegetative organs in *N. peltata* from the Bugeac Lake

The following material belongs from few plants sampled from the Bugeac Lake, Northern Dobrudja (August 2014) (Figure 2).

Figure 2. *Nymphoides peltata* from Bugeac Lake

The stem (rhizome) is thick and long. In cross section, it has unistratified epidermis with no stomata. The cortical parenchyma is crossed by aeriferous canals in arranged in many rows and there are numerous and well-developed astrosclereids (Figure 3).

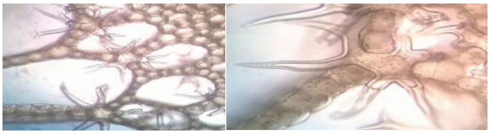

Figure 3. Astrosclereids (in rhizome cross section) of *N. peltata*

Astrosclereids are common in Menyanthaceae, being associated with the mechanical support or defence functions of the roots (Seago et al., 2005). Abundant aerenchyma and astrosclereids in the stem of *Nymphoides* species were previously mentioned by Martinez and Sanchez (2006). These crystal-like structures support each other, forming an efficient support system, which prevents flattening or close them.

The stem is monostelic with endodermis formed by bulky cells, many with Casparian strips. In cross section, the petiole has unistratified epidermis and poorly developed cortical parenchyma. Among the multitude of well developed aeriferous canals by different sizes (larger toward the centre, smaller to the edge), arranged in many rows, can be noticed the liberian and wooden fascicles, surrounded by endodermis and flanked by sclerenchyma caps (Figure 4). The petiole is a polistelic organ. There are numerous astrosclereids arranged on the edge of the aeriferous canals.

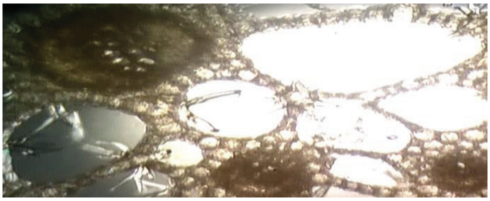

Figure 4. Cross section of the petiole in *N. peltata*

The bifacial leaves have a dorsiventral, heterofacial structure. The palisadic tissue, placed beneath the upper epidermis, is formed by three-four elongated layers of cells. In the lacunar tissue, there are mechanic sclerenchymatous cells, named idioblasts, which gives the leaves required resistance. An astrosclereid from the leaf of *N. peltata* is shown in Figure 5.

Figure 5. *N. peltata*: astrosclereids in the leaf

In cross section, the peduncle has epidermis formed by a single row of cells covered by an obvious cuticle. The cortical parenchyma is rich in aeriferous canals with astrosclereids (Figure 6). The aeriferous canals are separated from each other by a single row of cells. The central cylinder has numerous conducting fascicles.

In cross section, the sepals have both unistratified epidermises, covered by a thin cuticle. The mesophyll is formed by parenchyma rich in chloroplasts. The aerenchyma is present over the entire length of the sepals. The conducting tissue is poorly developed, represented by liberian and wooden fascicles with the wood displaced toward the upper face and the phloem toward the lower face (Figure 7). From place to place there are idioblasts.

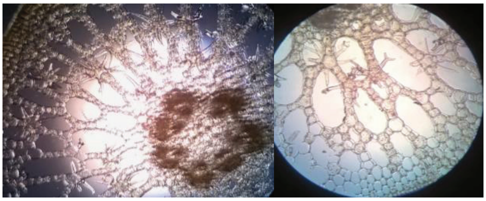

Figure 6. *N. peltata*: cross sections of the peduncle

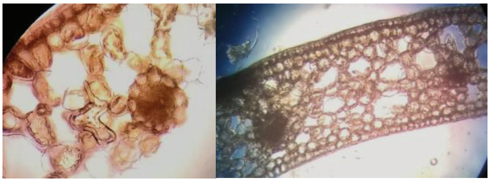

Figure 7. *N. peltata*: cross sections of the sepals

The upper epidermis of the petals is transformed in papillae (Figure 8) with the external wall rounded-conical. Both types of epidermis are covered by a thin cuticle. Between the upper and lower epidermis, the mesophyll is formed by parenchyma cells with various sized intercellular spaces (aerenchyma), present mainly around the rib. Reduced liberian and wooden fascicles are embedded in the mesophyll.

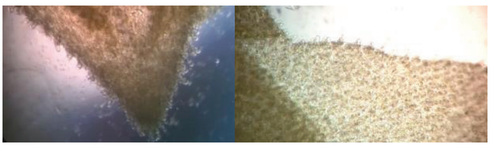

Figure 8. *N. peltata*: cross sections of the petals

The measurements (in µm) for the astrosclereids from the different vegetal organs of the *Nymphoides peltata* sampled in the Bugeac Lake are shown in Table 1.

Table 1. The astrosclereids size from different vegetal organs of *Nymphoides peltata*, Bugeac Lake

Anatomic feature (microscope objective)	**Mean value (µm)**
Stem (10x)	432
Petiole (10x)	360
Leaf (10x)	576
Peduncle (Stalk) (10x)	360
Sepals (10x)	288

The morpho-anatomic structure of the vegetative organs in *N. peltata* from Crişan

The second biological material belongs from yellow floating heart sampled from Crişan, located in the Danube Delta Biosphere Reserve. The stem is rhizomatic, long and thick. In cross section, the stem presents unistratified epidermis where there are no stomata.

The cortical parenchyma is well developed, crossed by aeriferous canals. The astrosclereides are rare but well developed. The monostelic stem has endodermis formed by bulky cells, many with Casparian strips. In cross section, the leaf's petiole has a unistratified epidermis while cortical parenchyma has big aeriferous canals of varying sizes, arranged in many rows. The astrosclereids, few in number, are arranged on the edge of the aeriferous canals. The petiole of *N. peltata* is polistelic, with endodermis delineating each conducting fascicle (Figure 9).

The bifacial leaf with dorsiventral structure presents two or three rows of palisadic cells and lacunar tissue (Figure 10). In epidermis there are stomata. In mesophyll, we noticed very few astrosclereids. The conducting tissue is poorly developed.

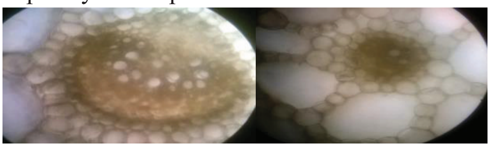

Figure 9. Cross sections showing the conducting fascicle in petiole of *N. peltata*

In cross section, the peduncle (stalk) presents epidermis formed by a single row of cells covered with an obvious cuticle layer. The collenchyma is formed by three-four rows of cells. The cortical parenchyma is rich in aeriferous canals with astrosclereids. The aeriferous canals are delimited between them by a single row of cells. The central cylinder has numerous conducting fascicles while endodermis has bulky cells.

Figure 10. Lacunar tissue in the leaf of *N. peltata*

In cross section, the sepals of *N. peltata* have narrower extremities, the rest of which being wider. The lower and upper epidermis is unistratified, covered by a thin cuticle. The mesophyll is formed by parenchyma cells rich in chloroplasts. The aerenchyma is present in the entire length of the sepals. The reduced conducting fascicles are surrounded by eight cells from the mesophyll. From place to place there are idioblasts, sclerenchymatous cells. In cross section, the petals have the upper epidermis transformed in papillae with the external wall rounded-conical. Both types of epidermis are protected by a thin cuticle. Between the upper and lower epidermis, the mesophyll is formed by parenchyma cells with various sized intercellular spaces (aerenchyma), present especially around the rib. In mesophyll are embedded the reduced liberian and wooden fascicles (Figure 11).

The measurements (in µm) for the astrosclereids from the different vegetal organs of the *Nymphoides peltata* sampled in the Danube Delta are shown in Table 2.

Figure 11. The conducting fascicle in the petal of *N. peltata*

There are several studies on sclereids distribution and size in Menyanthaceae family. Foliar sclereids, associated with the aerenchyma and founded as the form of idioblasts were analyzed by Kuo-Huang et al. (2000) in *N. coreana*. Martinez and Sanchez (2006) described and measured the astrosclereids in *N. indica* and *N. fallax*, two species from Mexic. Also, Willey (2012) reported astrosclereids and anatomical features of *N. mexicana* and *N. cristata* sampled from Florida.

Table 2. The astrosclereids size from different vegetal organs of *Nymphoides peltata*, Crişan - Danube Delta

Anatomic feature (microscope objective)	Mean value (µm)
Stem (10x)	432
Petiole (10x)	360
Leaf (10x)	720
Peduncle (Stalk) (10x)	360
Sepals (10x)	432

In this survey, we noticed that the yellow floated heart specimens collected from Bugeac Lake presents numerous astrosclereids than those collected from Crişan; the larger length of sclereid was 720 µm (leaf), in *N. peltata* sampled from the Danube Delta. As Willey (2012) hypothesized, fewer and smaller sclereids could indicate a flaccid nature of leaves in *Nymphoides* species. Khatun and Mondal (2011) indicated lower values for astrosclereid measurements in leaves of *N. cristatum* collected from Indian waters.

According to Khatun and Mondal (2011) who recorded sclereids in *Nymphoides cristatum*, the different morphology of these elements has taxonomical significance, the ecological function and evolutionary implications being also important.

Results of water analyses

The results of analyses of water samples collected from the Danube Delta (Crişan) and Bugeac Lake are presented in Table 3. For comparison, in Table 4 are presented quality classes for surface waters imposed by Order 161/2006.

The analyses indicated that pH values for both sampling points are within recommended range for surface waters (6.5-8.5). According to literature (Howarth and Marino, 2006; Petzoldt et al., 2006; Withers et al., 2014), nutrient over-enrichment of water known as eutrophication is generated by high levels of nitrogen and phosphorus, this leading to harmful algal blooms and harming aquatic life (Enache et al., 2009). Water samples collected from Danube Delta (Crişan) were found free of nitrite, nitrate and phosphate (below the detection limit of the used methods), this indicating low level of pollution. However, Schneider (2009) suggested that *N. peltata* could be considered as an indicator species even for hypertrophic conditions in a lake complex from Danube Delta. In the case of Bugeac Lake, results of chemical analyses indicated low levels of nutrients. According to Smits et al. (1988), *N. peltata* occurs mainly in alkaline habitats. Total hardness of the analyzed samples reveals that are classified as soft waters. Usually, total hardness of freshwater is between 15-375 mg $CaCO_3$/L (http://www.tvdsb.ca/uploads/).

Table 3. Physico-chemical parameters for water samples

Chemical analysis		Danube Delta (Crisan)	Bugeac Lake
pH		6.6	7.4
Chemical oxygen demand (COD) (mg O_2/L)		6.39	9.03
Total hardness	mg CaO/L	9.83	11.31
	mg $CaCO_3$/L	17.54	20.18
Ammonium nitrogen, N-NH_4^+ (mg/L)		0.233	0.073
Nitrite nitrogen, N-NO_2^- (mg/L)		<DL	0.028
Nitrate nitrogen, N-NO_3^- (mg/L)		<DL	0.056
Phosphate phosphorus , P-PO_4^{3-} (mg/L)		<DL	0.045

DL - detection limit of the method

Table 4. Quality classes for surface waters according to Order 161/2006

Parameters / Classes	I	II	III	IV	V
pH	6.5-8.5				
COD (mg O_2/L)	5	10	20	50	>50
N-NH_4^+ (mgN/L)	0.4	0.8	1.2	3.2	>3.2
N-NO_2^- (mg N/L)	0.01	0.03	0.06	0.3	>0.3
N-NO_3^- (mg N/L)	1	3	5.6	11.2	>11.2
P-PO_4^{3-} (mg P/L)	0.1	0.2	0.4	0.9	>0.9

Also, some authors (Enache et al., 2009) reported values of total hardness between 9-10 mg CaO/L for Danube water samples collected from Brăila.

CONCLUSIONS

The cross sections made throughout all the vegetative organs of yellow floating heart showed relevant adaptations for living in the aquatic environments, like the presence of astrosclereids and well-developed aerenchyma.

The astrosclereids from the vegetal organs in *Nymphoides peltata* collected from Bugeac Lake are numerous, compared with those sampled from Crişan - fewer but larger, especially those from leaves and sepals. Our findings could be consistent data for morpho-anatomical studies about sclereids size and distribution, regarding also the leaf texture in different aquatic plant species.

The physico-chemical water parameters may influence the ecological status of phytocenoses where *N. peltata* appears.

Future research works are needed in order to understand the growth response and habitat requirements of *N. peltata* in different environmental conditions.

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PROSPECTS FOR THE UTILIZATION OF THE *Miscanthus giganteus* AND *Polygonum sachalinense* FOR SOLID BIOFUEL PRODUCTION IN THE REPUBLIC OF MOLDOVA

Victor ŢÎŢEI[1], Andrei GUDÎMA[2], Alexandru MUNTEAN[2], Mihai GADIBADI[2], Aurelia LUPAN[1]

[1]Botanical Garden (Institute) of the Academy of Sciences of Moldova, Chişinău, 18 Padurii str., MD 2002 Republic of Moldova
[2]State Agrarian University of Moldova, Chişinău, 56 Mircesti str., MD 2049 Republic of Moldova

Corresponding author email: victitei@gmail.com

Abstract

Energy production from renewable sources plays an important role. To determine crops which are the most suitable for energy production, its thermophysical properties, ecological impact and production economy must be investigated thoroughly. The hybrid Miscanthus giganteus and the cultivar Gigant of Polygonum sachalinense, which were cultivated in the experimental plot of the Botanical Garden (Institute) of the ASM, served as object of study, control variant – wheat straw Triticum aestivum. It has been established that stems of Polygonum sachalinense stems defoliated and dehydrated faster than Miscanthus giganteus, the bulk density of the chopped material 181 kg/m^3 and 146 kg/m^3, respectively. Wheat straw is characterized by the lowest bulk density (83 kg/m^3). The specific density of briquettes made from milled chaffs (20 mm and 10 mm) of Polygonum sachalinense reaching values 799-841 kg/m^3, Miscanthus giganteus 869-882 kg/m^3, but Triticum aestivum 733-740 kg/m^3. The *Polygonum sachalinense* and *Miscanthus giganteus biomass were distinguished high gross calorific values (19.3-19.8 MJ/kg) and moderately ash content (2.23-2.51%), but wheat straw low calorific value (17.0 MJ/kg) and high content of ash (5.08%).*

Key words: *biomass, briquettes, Miscanthus giganteus,* Polygonum sachalinense, thermophysical properties.

Energy is one of the most important commodities in today's world to ensure socio-economic development of the country. Due to increasing energy demands and pollution problems caused by the use of fossil fuels, it has become necessary to introduce alternative energy sources into the global energy turnover. Energy production from renewable sources plays an important role in European energy policies. The biomass takes a priority among the energy fuels. High potential lies in herbaceous biomass, which has been on rise in recent years. To determine crops which are the most suitable for energy production, its thermo physical properties, ecological impact and production economy must be investigated thoroughly.

In recent years, the Moldovan Parliament adopted a series of legislative acts in the energy field, including the Energy Strategy of the Republic of Moldova (2013), the law on the use of renewable energy (2007), and the law on energy efficiency (2010). In 2009, Moldova became a member of the Energy Community, which extends the EU internal energy market to South-East Europe and beyond through a legally binding framework. In the period 2010-2014, the EU allocated €14 million for the production of renewable energy from local biomass (e.g. straw) as part of a EuropeAid project, helping to reduce dependence on imported natural gas.

Scientific research conducted in the Botanical Garden (Institute) of the ASM in the last 65 years aimed at mobilization, improvement and implementation of new non-traditional plant species with multiple uses, which use efficiently water, photosynthetic active radiation and land resources. The biomass research activities are relatively new (Ţîţei, Teleuţă, 2012; 2014; Marian et. al. 2014)

Some promising herbaceous perennial plant species belong to *Poaceae* Barnhar. and *Polygonaceae* Juss. families.

The giant knotweed or Sakhalin knotweed, *Polygonum sachalinense* F.Schmidt [*Fallopia sachalinense* (F. Schmidt ex Maxim.) Ronse Decr., *Reynoutria sachalinense* (F. Schmidt ex Maxim.) Nakai], *Polygonaceae* family, is a herbaceous perennial plant growing up to 2-4 m tall, with strong, extensively spreading rhizomes forming large clonal colonies, native to North-East Asia: the northern Japan and the Russian Far East. It appeared in Europe the second half of the 19th century, being implemented in culture during the 20th century due to its tolerance and stable productivity, serving as fodder from early spring until late autumn, but also as raw material for the different industries. This species has been investigated over more than 30 years in Moldova. Being selected adapted forms to local soil and climate conditions, the *Polygonum sachalinense* cultivar *Gigant* was created and registered in 2012 in the Catalogue of plant varieties of the Republic of Moldova, it reproduces by pieces of rhizomes and rooted cuttings, or seedling about 25 thousand/ha (Ţîţei, 2014). One of the most commonly used energy crops from *Poaceae* family is *Miscanthus giganteus* Greef et Deu., a sterile tetraploid hybrid, with parental forms *Miskanthus sinensis* Andersson and *Miscanthus sacchariflorus* (Maxim.) Franch., belonging to C_4 photosynthetic pathway plant group, native to tropical and subtropical regions of Africa, Southeast Asia. The hybrid *Miscanthus giganteus* is propagated asexually, usually by dividing the rhizomes and by tissue culture. It is characterized by a rapid growth and development, ultimate height 4.5 metres, is tolerant to soil and environmental conditions, being widely used for fuel production in Europe since the 80s of the last century (Lewandowski et. al., 2000).

Miscanthus giganteus has produced more than double the biomass of another grass species. The objective of this research was to evaluate some thermophysical properties of the biomass and briquettes of the hybrid *Miscanthus giganteus* and the cultivar *Gigant* of *Polygonum sachalinense* in Moldova's conditions.

MATERIALS AND METHODS

The hybrid *Miscanthus giganteus* and the cultivar *Gigant* of *Polygonum sachalinense*, which were cultivated in the experimental plot of the Botanical Garden (Institute) of the ASM, the 4th growing season, served as object of our study, having as control variant wheat straw *Triticum aestivum*.

Harvesting of the hybrid *Miscanthus giganteus* and *Polygonum sachalinense* was done manually in the first days of March. Harvestable stems of *Miscanthus giganteus* and *Polygonum sachalinense* and wheat straw bales were chopped into chaff with the use of stationary forage chopping unit. The obtained chaffs of mean dimension from 7 to 35 mm, were milled in a beater mill equipped with a sieve with diameter of openings of 20 mm and 10 mm. Scientific researches on the biomass for the production of solid biofuel were carried out: the moisture content of plant material was determined by CEN/TS 15414 in an automatic hot air oven MEMMERT100-800; the content of ash was determined at 550ºC in a muffle furnace HT40AL according to CEN/TS 15403; automatic calorimeter LAGET MS-10A with accessories was used for the calorific value determination, according to CEN/TS 15400; the cylindrical containers were used for determination of bulk density, calculated by dividing the mass over the container volume; the briquetting was carried out by hydraulic piston briquetting press BrikStar model 50-12; the mean compressed (specific) density of the briquettes was determined immediately after removal from the mould as a ratio of measured mass over calculated volume.

RESULTS AND DISCUSSIONS

We could mention that, in the conditions of the Republic of Moldova, in the first year of vegetation, *Miscanthus giganteus* developed, in the underground part, the root system and new rhizomes, and the 3-5 shoots can reach 152-183 cm tall, with high leaf content. It was established that during the first month, *Polygonum sachalinense* grew and developed slowly and formed 3-5 leaves in the aerial part, during the next month, the development of the stem with internodes began. So, at the end of August, the plants reached 164-170 cm, the first six internodes were already wooden; in the underground part of the stem, it was observed the appearance of dormant buds which next year would contribute to the formation of new shoots.

In the following years, the regrowing season for the species *Polygonum sachalinense* started in the first half of March and for the hybrid *Miscanthus giganteus* – in April, 12-25 shoots grew, which by the end of vegetation reached 3.0-4.5 m tall, the root system reached 2 m depth, the number of rhizomes increased considerably.

A more detailed research on biomass was carried out in the 4th year of vegetation. It is known that moisture and leaf contents in harvested biomass influence the costs of transport, storage, drying and processing, and the thermophysical properties of solid biofuel.

The moisture and leaf contents of plant material of the tested species varied significantly at the end of the growing season (Table 1). The highest moisture content was determined in the biomass of *Polygonum sachalinense* (about 72%), in comparison with *Miscanthus giganteus* (about 52%), but the leaf and panicle contents in the biomass of the latter was high (37.12%).

Over 35-40 days, *Polygonum sachalinense* stems were completely defoliated, while the *Miscanthus giganteus* leaves were kept for a long period of time (in March, the leaves constituted 0.93% of biomass). After the establishment of temperatures below 0ºC, the studied species were distinguished by the pace of dehydration of tissues, *Polygonum sachalinense* in field dehydrated faster than *Miscanthus giganteus*. At the end of December, the humidity of the stems of *Polygonum sachalinense* reduced to 26 %, in the middle of January – below 20%, and in early March – 14%, but in *Miscanthus giganteus* – 38%, 27% and 11%, respectively. Similar results were presented by other authors (Lisowski et. al., 2010; Sypula et. al., 2010; Stolarski et. al., 2014).

The low density of biomass materials poses a challenge for the handling, transportation, storage and combustion processes. These problems may be addressed through densification, a process that produces solid fuel with denser and more uniform properties than the raw biomass.

It has been established that the bulk density of the chopped material of *Miscanthus giganteus* constitutes 146 kg/m^3 and of *Polygonum sachalinense* is higher - 181 kg/m^3, while wheat straw is characterized by the lowest bulk density - 83 kg/ m^3 (Table 2).

Table 1. Plant material moisture and leaves contents of the *Miscanthus giganteus* and *Polygonum sachalinense*

Period	*Miscanthus giganteus*		*Polygonum sachalinense*	
	moisture content, %	leaves content, %	moisture content, %	leaves content, %
7 October	51.65	37.12	71.92	19.34
27 October	50.80	32.98	71.29	2.96
10 November	45.80	28.44	60.00	1.25
20 November	45.10	24.13	46.20	0
18 December	42.20	12.11	31.70	0
30 December	38.53	10.24	25.84	0
16 January	26.89	7.17	19.60	0
5 March	10.89	0.93	13.63	0

Table 2. Bulk density of biomass and briquettes of the studied species

Variants	*Triticum aestivum*		*Miscanthus giganteus*		*Polygonum sachalinense*	
	bulk density of biomass, kg/m^3	specific density of briquettes, kg/m^3	bulk density of biomass, kg/m^3	specific density of briquettes, kg/m^3	bulk density of biomass, kg/m^3	specific density of briquettes, kg/m^3
chopped chaffs 7 -35 mm	83	715	146	594	181	732
milled chaffs 20 mm	86	733	153	869	202	799
milled chaffs 10 mm	93	740	167	882	216	841

Distinct differences in bulk density between chopped and milled chaffs were found. These differences amounted to 7-21 kg/m^3 in *Miscanthus giganteus* and 21-35 kg/m^3 in *Polygonum sachalinense,* with 3-10 kg/m^3 in wheat straw.

We could mention that the specific density of briquettes made from chopped material of *Miscanthus giganteus* was low, of 594 kg/m^3, but it increased significantly if milled chaffs where processed into briquettes, reaching values of 869-882 kg/m^3.

The specific density of briquettes made from milled chaffs of *Polygonum sachalinense* was 799-841 kg/m^3, but of *Triticum aestivum* was 733-740 kg/m^3.

The ash content of different types of biomass is an indicator of slagging behaviour of the biomass. The greatest level of this component was contained in *Triticum aestivum* - 5.08%, while the lowest – in *Miscanthus giganteus* - 2.23% (Table 3). Ash content of wheat straw pellets reach 6.33 % and negatively influences the combustion efficiency (Ivanova et. al. 2015).

Table 3. Ash content and calorific value of biomass

Indices	*Triticum aestivum*	*Miscanthus giganteus*	*Polygonum sachalinense*
ash content,%	5.08	2.23	2.51
calorific value, MJ /kg	17.0	19.8	19.3

The investigation showed that *Miscanthus giganteus* and *Polygonum sachalinense* had high gross calorific values between 19.8 MJ/kg and 19.3 MJ/kg respectively, but wheat straw had very low ones (17.0 MJ/kg), probably because of the high content of ash.

For Poland, the respective gross calorific values of *Miscanthus giganteus* and *Polygonum sachalinense* were 19.09 MJ/kg and 19.00 MJ/kg (Stolarski et. al., 2014). According to Havrland et al. (2013), in Czech Republic the energy yield of *Miscanthus giganteus* is around 531.9 GJ/ha and of *Reynoutria x bohemica* 387.7 GJ /ha.

CONCLUSIONS

The studied species *Miscanthus giganteus* and *Polygonum sachalinense* were varied significantly by the moisture and leaf contents of plant material at the end of the growing season, rhythm stems defoliation and dehydration after the establishment of temperatures below 0ºC. *Polygonum sachalinense* stems defoliated and dehydrated faster than *Miscanthus giganteus*.

The specific density of briquettes made from chopped material (7-35 mm) of *Miscanthus giganteus* was low - 594 kg/m^3.

The specific density of briquettes made from milled chaffs (20 mm and 10 mm) of *Polygonum sachalinense* reaching values 799-841 kg/m^3, *Miscanthus giganteus* – 869-882 kg/m^3, but *Triticum aestivum* – 733-740 kg/m^3.

Polygonum sachalinense and *Miscanthus giganteus* were distinguished high gross calorific values 19.3 -19.8 MJ/kg, but wheat straw low - 17.0 MJ/kg, probably because of the high content of ash (5.08%).

Miscanthus giganteus and *Polygonum sachalinense* are very promising crops for the production of high quality bio-fuel in Moldova's conditions.

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DETERMINATIN OF PESTICIDE RESIDUES IN TOMATOES COLLECTED FROM AYDIN PROVINCE OF TURKEY

Melis YALÇIN, Cafer TURGUT

Adnan Menderes University, Faculty of Agriculture, Plant Protection Department,
Aydın – 09100, Turkey

Corresponding author email: cturgut@adu.edu.tr

Abstract

Aydın is mainly an agricultural city of Turkey with its tomatoes, figs, olives, cottons, grapes. These crops are economically very important and frequently damaged by diseases and pests. This leads to yield and food quality losses. The intensive usage of pesticides to protect the crops from pests and diseases causes great concerns about the pesticide residues. The aim of this study was to evaluate the residue level of pesticides in tomatoes collected from different markets in Aydın province of Turkey. Samples were taken in different time intervals and analysed by GC-MS/MS. The concentration of all analysed pesticides were between 0.04 ppm and 1.4 ppm. The concentration of Acetamiprid, Endosulfan and Chlorpyrifos were detected above the maximum residue level in November. The level of Acetamiprid, Endosulfan beta and Chlorpyrifos in tomatoes were above the MRL in December, and only chlorpyrifos was above the MRL in January. In February all the insecticides were below the limit and in March, Tetradifon was above the MRL limit. The possible sources of pesticide residues in tomatoes are not to account into preharvest intervals, uncontrolled pesticide usage at recommended dosage.

Key words: *maximum residue limit (MRL), pesticide residues, tomato.*

INTRODUCTION

Turkey is the fourth biggest tomato production in the world with a tomato production of 11.3 milyon tons (Anonymous, 2014). The annual tomato consumption in Turkey per capita is over 80 kg because of the vitamin and mineral content, nourishment habits, cheap price and suitable ecological conditions (Keskin et al., 2010). In 2014 totaly 4.8 million hectare tomato cultivation is done in the world with China being the largest producer by 50 milyon ton production followed by India (17.5 milyon ton), USA (13.2 milyon ton) and Turkey (11.3 milyon ton) respectively. Tomatoes account for 38 percent of all vegetable production in Turkey and 30 % of Turkish tomato production is processed in to products such as tomato juice, tomato puree, tomato paste, ketchup and chapped tomatoes. Tomato paste is the leading export among fruit and vegetable sector. Fresh consumption of tomatoes grown in Mediterranean region, especially in greenhouses (Nelson and Çakiroğlu, 2009).

The increase in the demand for tomatoes led to the use of more pesticide. Pesticides are using to kill pests, diseases and weed but they also results residues on food (Rehber and Turhan, 2002; Turgut et al., 2011). Pesticide residues is an important subject for human health, aquatic and soil organisms and environment (Turgut 2006; 2007). Some pesticides are persistent and can be seen in soil, water or foods. Food and Agriculture Organization of the United Nations (FAO) and World Health Organization (WHO) organized a workshop about the principles and methods of risk assessment: 'Maximum residue levels (MRLs) for pesticides and Veterinary Drugs' (FAO/WHO, 2006). MRL is the amount of residue accepted according to the consumption of food. For example, a 68 kg man would have to eat 3000 heads of lettuce every day in his life to exceed the residue level which has no effect on laboratory animals (Anonymous, 2015). Practically one MRL is set for one pesticide and one crop. It also shows farmers to use the best suited pesticide for the crop. Such as table grapes' and wine grapes' maximum residue limit for acetamiprid is 0.5 ppm while tomatoes' maximum residue limit for acetamiprid is 0.2 ppm. When the results of

the 2007 and 2010 European Union-coordinated control programs (EFSA, 2013) for tomato samples compared, the percentage of samples without detectable residues decreased from 68% in 2007 to 51% in 2010. The percentage of tomato samples exceeding the MRLs increased from 0.9% to 1.2% in 2007 and 2010 respectively (Lozowicka et al., 2015).
The aim of this study was to investigate the concentrations of pesticide residues in tomatoes collected from local and chain markets and evalulate possible source of pesticide residues in tomatoes.

MATERIALS AND METHODS

Tomato fruits were collected from local and chain markets in Aydın province of Turkey. Totaly 100 tomato samples were taken between November to March, stored at -20°C and sampled as the procedure outlined in European Union Directive 91/4/4/EC.
Chemicals were purchased from different companies. Bondesil sorbents (rimary and secondary amine, PSA) were purchased from Varian. Pesticide standarts (99%) were obtained from Dr. Ehrensdorfer GmbH, Germany, Sodium chloride, $MgSO_4$, acetonitrile (high-performance liquid chromatography grade) were obtained from Merck, Germany.
QuEChERS method was used for extraction and analysis (Anastassiades et al., 2003).this method was developed the quick, easy, cheap and effective (QuEChERS) method to extract the pesticides (Anastassiades et al., 2007; Diez et al., 2006).
The tomato samples were weighed 10 g in a 50 ml fluoroethylenepropylene centrifugation tube and 10 ml acetonitrile was added then 15 sn shaken by vortex. 4 g $MgSO_4$ and 1 gram Sodium acetate was added to sample and shaken by vortex for 1 minute. The contents were centrifuged at 4000 rpm for 2 min. 2 ml was taken from the supernatant to a tube and 0.15 g $MgSO_4$ and 0.05 g PSA was added to a tube then vortex by 30 s. and centrifuged at 4000 rpm for 2 min again. The supernatant was taken to a tube again and filtered by PTFE filters. The final volume was put in vials.
The repeatability of the experiment and recoveries were evaluated with pesticide standarts. A varian gas chromatography (GC)-mass spectrometry (MS)-MS was used for analysis. The carrier gas was Helium with a constant flow at 1.2 ml min^{-1}. The temperature of oven programmed as 70°C held in 2 min, ramped to 220°C at 30°C/min, at the end ramped to 260°C at 45°C/min and held 10 min. The MS transfer line was at 280°C. The mass spectrometry was used to determine the pesticides in tomatoes.

RESULTS AND DISCUSSIONS

The most frequently found pesticides were acetamiprid (3 samples), endosulfan β (2 samples), chlorpyrifos (3 samples) and tetradifon (1 samples) (Table 1). The concentration of all detected pesticide residues found in 100 tomato samples was compared by maximum residue levels set by the European Comission (EC, 2005) (Table 1). The most pesticide residues in tomato samples were evaluated in November and January. No pesticide residues were detected on February and only 1 sample was found above maximum residue level on March.
Acetamiprid which is one of the most applied pesticide is a neonicotinoid insecticide in 4A group of IRAC (Insecticide resistance action committe). The persistence of acetamiprid in some crops such as tomatoes, tea, mustard has been mentioned by Barrakat et al. (2015), EFSA (2011), Gupta and Shanker (2008), Sanyal et al. (2008), Paramanik et al. (2006), Din et al. (2012). In November, 22 tomatoes samples were taken from local and chain markets and only 4 of them were contained pesticides and 2 of the 4 samples acetamiprid maximum residue level was above the MRL level. In December, 9 tomato samples were taken from local and chain markets and 4 of them found with pesticide residues. One of the 4 samples has 0.2 ppm acetamiprid residue which is above the maximum residue level (Table 1).
Endosulfan is a organochlorine pesticide and used globally since 1954. Although It is banned in more than 60 countries because of its persistency, its toxic and accumulation properties, some countries continue to use it. . Endosulfan has classified as a persistent

organic pollutants (POPs) and identified as a priority hazardous substances (EC, 2008). In some countries endosulfan and its metabolits were observed in human placenta and breast milk (Cerrillo et al., 2005; Shen et al., 2007; Çok et al., 2012) The commercial endosulfan consists of 70% endosulfan α and 30% endosulfan β. They have similar insecticidial activity while they have different chemical properties (Anonymous, 2010). The results showed that while endosulfan α wasn't above the maximum residue level, endosulan β was above the maximum residue level with the concentration of 0.9 ppm and 1.4 ppm in November and December respectively and no residues were found between January and March both for endosulfan α and endosulan β. According to the results residue levels were higher in winter time and the lower degradation of pesticides in winter time can explain this situation. In one study analysis of endosulfan residue levels in tomatoes of Ghana were 0.30 mg/kg and 0.43 mg/kg for endosulfan α and endosulan β respectively. In Ghana markets it can be concluded that tomatoes are safety (Essumang et al., 2008).

Chlorpyrifos is used to control Diptera, Homoptera, Coleoptera and Lepidoptera to protect the vegetable crops, maize, cotton and citrus (Aysal et al., 1999). It is an acetylcholinesterase inhibitor and found in organophosphates group (IRAC, 2016). It is moderately toxic to humans and affects the central nervous, cardiovascular and respiratory system. The maximum residue level of chlorpyrifos is 0.2 ppm. The residue levels of chlorpyrifos was obtained higher in November, December and January with the values of 0.4 ppm, 0.2 ppm and 0.3 ppm respectively.

Tetradifon is a non systemic acaricide that penetrates through the leaf tissue. It has larvicidial and ovicidial action against phtophagous mites and it can be used on many fruits, cotton and vegetables. In the experiment on November, December and February no residue value was established while on January 0.2 ppm and on March 0.5 ppm residue was detected. According to the MRL level of tetradifon (0.5 ppm), on March the residue level was found above the MRL limits. For example in Bangladesh 14 tomato samples were investigated and five of the samples were contaminated with cypermethrin residues ranging from 0.002 to 0.55 mg/kg and one sample was contaminated with chlorpyrifos (0.34 mg/kg) and none of the samples were contaminated with diazinon. According to this experiment cypermethrin wasn't found in the samples while chlorpyrifos residue values are same with Chouwdhury's experiment (Chowdhury et al., 2013).

Cypermethrin is a pyrethroid insecticide and acts as contact and stomach insecticide. It has wide scale use in vegetables, fruits, cotton, cereals etc. It was synthesized in 1974 and start to marketing in 1977. Although rapid degradation property of cypermethrin, its residues have been found in cucumber samples at the residue level between 0.03-0.2 mg/kg (Ahmed et al., 2014), in tomato samples taken from Sudan markets at the residue level between 0.08-0.6 mg/kg (Shinger et al., 2011). According to the tomato samples taken from Aydın markets cypermethrin residue levels weren't found above the maximum residue limits. The highest residue level was found 0.3 ppm on January (Table 1).

Table 1. Pesticide residues in tomatoes collected from markets in Aydın

Pesticides	November	December	January	February	March	MRL (ppm)	Above the MRL values
Acetamiprid	n.d.-0.2	n.d.-0.2	n.d.	n.d.	n.d.	0,1	3
Endosülfan α	n.d.-0.2	n.d-0.3	n.d-0.2	n.d.	n.d.	0,5	-
Endosülfan β	n.d.-0.9	n.d.-1.4	n.d.	n.d.	n.d.	0,5	2
Chlorpyrifos	n.d.-0.4	n.d.-0.2	n.d.-0.3	n.d.	n.d.-0.06	0,2	3
Tetradifon	n.d.	n.d.	n.d.-0.2	n.d.	n.d.-0.5	0,5	1
Cypermethrin	n.d.	n.d.	n.d.-0.3	n.d.	n.d.	0,5	-
Chlorpyrifos methyl	n.d.	n.d.	n.d.	n.d.	n.d.-0.04	0,2	-

ND = not detectable.

CONCLUSIONS

Results indicate that some concentrations of pesticide residues in tomatoes collected from local and chain markets in Aydın were above the maximum residue limits. According to the time intervals the concentration which were above the MRL levels were experimented between November to January. It can be concluded that because of the low degradation of pesticides in winter these pesticides can be more persistent. However, the prohibited pesticides were detected in tomatoes collected from Aydın such as endosulfan α, β and tetradifon so there is need for urgent action to control the use of some prohibited pesticides.

On the other hand, the residue levels of these pesticides on tomatoes can pose a serious toxicity to the consumers. To minimize the health risks and to reduce the toxicity to the environment we need to give importance to the pesticide monitoring system and pesticide regulations.

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DETERMINING THE LOCATION OF THE ASSEMBLY CENTER FOR EXTRUSION THE WASTE FROM ROSE PRODUCTION IN REPUBLIC OF BULGARIA

Ivan ZAHARIEV, Dimitar KEHAYOV

Agricultural University - Plovdiv, 12 Mendeleev Blvd, Department of "Mechanization of Agriculture", Plovdiv, Bulgaria

Corresponding author email: zaharievbgr@abv.bg

Abstract

In 3 areas of southern Bulgaria are grown over 2800 ha of roses. Waste of this production is about 20,000 tons. To use this waste is necessary to determining location of the processing factory. To solve this complex task is using a method to measure short distance as a limitation on the maximum distance during transport.

Key words*: remnants of roses, optimization transport.*

INTRODUCTION

In our country and around the world using residues from agricultural production (straw, corn stalks, etc.) (Mitkov, 2014) for extraction of fuel and energy for home and industrial use.
In our country rose oil is know from long time. Production of rose oil is important to livelihood of people living in these areas for the production of roses. These regions are called by the people "Valley of Roses".
For the production of rose oil in Republic of Bulgaria used 2800 ha, as the trend is increasing and in the near future about 4000 ha. The culture is grown in poor soils and specific climatic conditions. By plants using only flowers for making oil. Branches from contour pruning are not used. The stems and branches of roses are having great energy and biological potential. This is not researched to this moment.
Undefined are mass of roses stems, received per unit of area after pruning and the possibility for their collection and their use in heating systems.

MATERIALS AND METHODS

The aim of this study was the determination of the areas, suitable for installation of waste biomass. The areas are with the potential to build a manufacturing plant. In the plant through the press is makes solid fuel from plant biomass remaining fragmented (the roses) in the form of wood chips. For making of information made visits the Regional Directorates "Agriculture" in regional cities in Bulgaria (RD “Agriculture”, 2015).
Information about distances in kilometres between the communities in these Bulgarian areas are receive from web (http://www.bgmaps.com/ and http://www.viamichelin.com/) through the short distance criterion (Komitov, 2013).
The information submitted from Regional Directorates "Agriculture" and electrons sites by municipalities was introduced in a specialized database and processed mathematically.

RESULTS AND DISCUSSIONS

The obtained results of are presented in the below tables and graphics.
In Table 1 are not marked the municipalities without grown or areas occupied with small fields of roses. They do not represent interest for construction of facilities for processing of residues from the manufacture of rose. Those territories are economically disadvantageous. Transport of biomass for other municipalities is connected with additional costs for transport. From table 2 we can see that the rose oil grown in three Bulgarian areas. Two in the South Central Region - Plovdiv and Pazardzhik and one in the eastern region of South- Stara

Zagora. The municipalities with most roses plants are Pavel Banya with 3827 t (19.14%), Kazanlak 3200 t (16.00%), Strelcha 2954 t (14.77%) and Karlovo 2204 t (11.02%). Other municipalities are much less than 10%, with exception of Kaloianovo 1861 t (9.30%) and Brezovo 1519 t (7.59%).

Table 1. Distances in kilometers between different municipalities, km

Municipality	Belovo	Bratsigovo	Pazardjik	Panagyurishte	Peshtera	Strelcha	Asenovgrad	Brezovo	Kaloianovo	Karlovo	Plovdiv	Sopot	Saedinenie	Hisar	Br. Daskalovi	Gurkovo	Kazanlak	Maglizh	Nikolaevo	Pavel Banya	Stara Zagora	Chirpan
Belovo	0	47	27	66	44	73	84	107	83	123	64	127	55	108	130	210	174	189	208	150	158	123
Bratsigovo		0	23	67	7	67	59	82	64	98	44	102	44	83	105	184	149	164	183	125	132	97
Pazardjik			0	44	20	44	57	80	56	96	37	100	25	81	103	183	147	160	181	123	131	96
Panagyurishte				0	63	14	99	101	57	81	76	86	57	57	116	172	135	147	169	119	157	119
Peshtera					0	65	61	84	67	100	46	104	44	85	107	187	152	164	185	127	135	100
Strelcha						0	92	89	45	76	64	72	45	45	104	160	123	135	157	107	142	107
Asenovgrad							0	59	57	90	22	94	48	75	56	136	126	117	135	104	84	46
Brezovo								0	36	54	38	59	54	44	15	104	67	80	101	43	68	31
Kaloianovo									0	41	25	45	32	18	51	132	94	107	129	77	103	68
Karlovo										0	59	5	69	24	70	93	56	69	90	41	89	101
Plovdiv											0	63	25	44	56	141	104	117	138	84	92	51
Sopot												0	73	28	74	98	61	74	95	46	94	105
Saedinenie													0	59	73	156	119	132	153	101	109	74
Hisar														0	59	106	69	81	103	53	102	77
Br. Daskalovi															0	87	70	68	85	46	52	16
Gurkovo																0	39	26	5	62	44	93
Kazanlak																	0	13	35	22	33	82
Maglizh																		0	22	35	25	74
Nikolaevo																			0	61	41	90
Pavel Banya																				0	51	62
St. Zagora																					0	40
Chirpan																						0

Table 2. Total distance in kilometers between municipalities and indicator t*km

	Areas with damask rose, [ha]	Total distance of all points of the municipality [km]	Average value to the distance [km]	Quantity on areas in % for municipality, relative to the total for the country [%]	Quantity waste plant biomass [t]	Parameter t*km for each municipality [t*km]
Belovo	27	2350	106.8	0.982	196.449	2524264
Bratsigovo	50	1926	87.5	1.819	363.795	2102873
Pazardjik	6.3	1814	82.5	0.229	45.838	1990511
Panagyurishte	32	2002	91.0	1.164	232.829	1864303
Peshtera	9.3	1947	88.5	0.338	67.666	2135178
Strelcha	406	1826	83.0	14.770	2954.016	1646880
Asenovgrad	0.4	1701	77.3	0.015	2.910	1862844
Brezovo	208.7	1396	63.5	7.592	1518.481	1131271
Kaloianovo	255.7	1387	63.0	9.302	1860.448	1219379
Karlovo	302.9	1525	69.3	11.019	2203.871	1046270
Plovdiv	0.2	1390	63.2	0.007	1.455	1440378
Sopot	31.3	1605	73.0	1.139	227.736	1113531
Saedinenie	3.1	1547	70.3	0.113	22.555	1603846
Hisar	81.7	1401	63.7	2.972	594.441	1028759
Bratia Daskalovi	93.7	1543	70.1	3.409	681.752	1273304
Gurkovo	81.5	2418	109.9	2.965	592.986	1808460
Kazanlak	439.8	1870	85.0	16.000	3199.942	1153675
Maglizh	58	1999	90.9	2.110	422.002	1352467
Nikolaevo	31.4	2366	107.5	1.142	228.463	1758504
Pavel Banya	526	1639	74.5	19.136	3827.125	982724
Stara Zagora	98.5	1882	85.5	3.583	716.676	1509912
Chirpan	5.3	1652	75.1	0.193	38.562	1528330
Total	2748.8 ha			100 %	20000 t	

The above tables are very well visualized in following Figures 1 and 2.

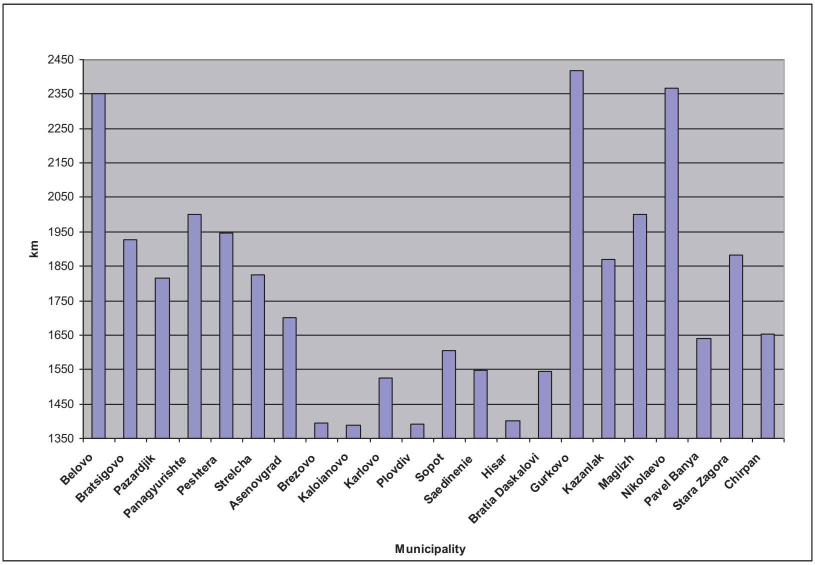

Figure 1. Distribution of the overall distances in kilometers to each municipality, km

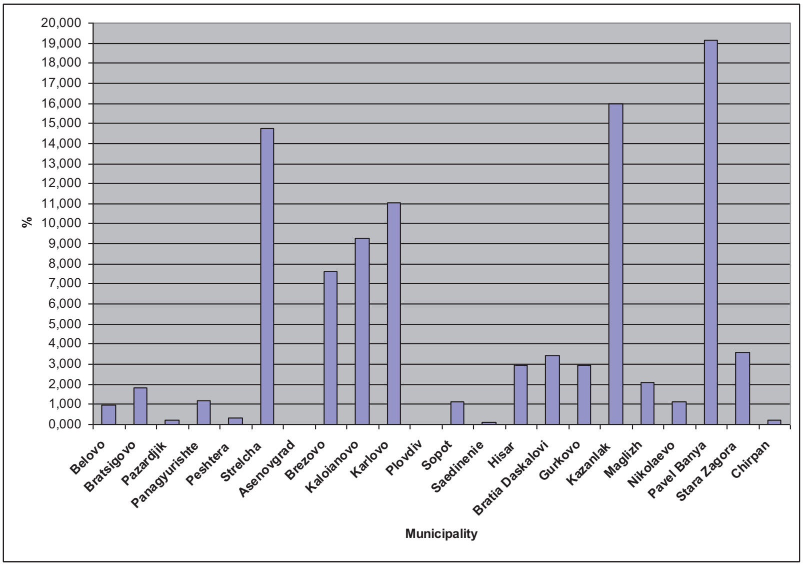

Figure 2. Distribution of areas with oilseed roses by municipalities in Bulgaria, %

To reduce transport costs, which represent the biggest item in the formation of the value of the finished product is a municipality in which the selected indicator [t*km] is the least value. This municipality is Pavel Banya.

Another condition for the selection of the location of the assembly center for the use of residual biomass from the production of roses is farthest municipality is no more than 80 km from it.

Table 1 show that the municipality with the largest share (19.14% or 3827t) is Pavel Banya from all municipalities in the region of Pazardzhik and two municipalities in the area of Plovdiv (Plovdiv and Asenovgrad) are separated by more than 100 km.

Having regard to the above conditions, the geographical location of municipalities, road infrastructure, the possibility of combining freight, freight movements in the country and the possibility of power generation capacity for use with an alternative type of plant biomass is good to give not one but two collection center.

After the mathematical tiling in table 1 and 2 found that these two collection centres are Pavel Banya and Strelcha displayed in figures 3 and 4, as well as the data referred to in table 3 and 4.

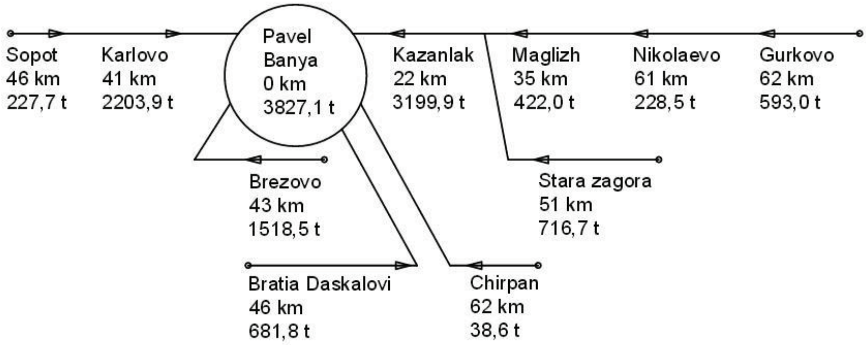

Figure 3. Collecting center Pavel Banya - kilometers and tons

Table 3. Comparsing the performance of Pavel Banya, Kazanlak and Brezovo

	Percentage of total [%]	Quantity waste plant biomass [t]	Pavel Banya [km]	Kazanlak [km]	Brezovo [km]	Pavel Banya [t*km]	Kazanlak [t*km]	Brezovo [t*km]
Brezovo	7.592	1518.481	43	67	0	65294.67	101738.21	0
Karlovo	11.019	2203.871	41	56	54	90358.70	123416.76	119009
Sopot	1.139	227.736	46	61	59	10475.84	13891.88	13436
Br.Daskalovi	3.409	681.752	46	70	15	31360.59	47722.64	10226
Gurkovo	2.965	592.986	62	39	104	36765.13	23126.46	61671
Kazanlak	16.000	3199.942	22	0	67	70398.72	0	214396
Maglizh	2.110	422.002	35	13	80	14770.08	5486.03	33760
nikolaevo	1.142	228.463	61	35	101	13936.26	7996.22	23075
Pavel Banya	19.136	3827.125	0	22	43	0.00	84196.74	164566
St.Zagora	3.583	716.676	51	33	68	36550.49	23650.32	48734
Chirpan	0.193	38.562	62	82	31	2390.86	3162.11	1195
Total	68.29%	13657.596	469	478	622	372301	434387	690069

Pavel Banya municipality is located near the junction of main roads in the national numbering №6 (E871 - European numbering) also called "sub-Balkan highway" road №56, which together with the nearest road connecting the District Plovdiv №64 pass Shipka, north and central regions of Bulgaria and the Danube bridge checkpoint at Rousse.

The road №6 are arrays of the municipalities Sopot, Karlovo, Kazanlak, Nikolaevo and Gourkovo.

Near the road №56 is located in the municipalities of Plovdiv, Brezovo and Br. Daskalovi.

Near to Kazanlak municipality are crossing roads №6 (E851) and №5 (E85).

Route №5 (E85) passes on the territory of the municipality of Stara Zagora and the pass of the Republic (Haynbuaz), as part of crossborder North-South (Danube Bridge limit and Kapitan Andreevo border checkpoint).

In Pavel Banya municipality has a well developed road network of second and third class between the settlements.

In figure 3 you can see that this distribution in the most remote municipalities in the collection center is at a distance of 65 km. From Pavel Banya municipality is collecting 68.29% (13658t) from residual biomass rose production in Bulgaria.

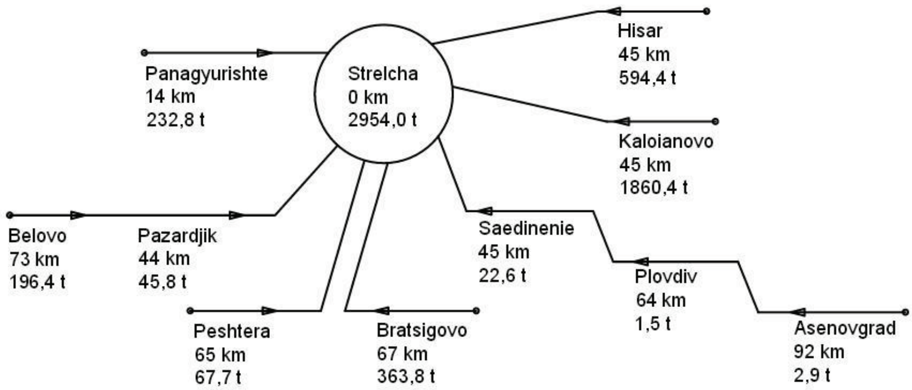

Figure 4. Collecting center Strelcha - kilometers and tons

Table 4. Comparsing the performance of Strelcha, Kaloianivo and Hisar

	Percentage of total [%]	Quantity waste plant biomass [t]	Strelcha [km]	Kaloianovo [km]	Hisar [km]	Strelcha [t*km]	Kaloianovo [t*km]	Hisar [t*km]
Belovo	0.982	196.449	73	83	108	14340.80	16305.30	21216.5
Bratsigovo	1.819	363.795	67	64	83	24374.27	23282.89	30195.0
Pazardjik	0.229	45.838	44	56	81	2016.88	2566.94	3712.9
Panagyurishte	1.164	232.829	14	57	57	3259.60	13271.25	13271.2
Peshtera	0.338	67.666	65	67	85	4398.28	4533.61	5751.6
Strelcha	14.770	2954.016	0	45	45	0	132930.73	132930.7
Asenovgrad	0.015	2.910	92	57	75	267.75	165.89	218.3
Kaloianovo	9.302	1860.448	45	0	18	83720.17	0	33488.1
Plovdiv	0.007	1.455	64	25	44	93.13	36.38	64.0
Saedinenie	0.113	22.555	45	32	59	1014.99	721.77	1330.8
Hisar	2.972	594.441	45	18	0	26749.85	10699.94	0
Total	31.71%	6342.404	554	504	655	160236	204515	242179

Strelcha municipality is situated in Pazardzhik. It has the highest percentage of residual biomass from the production of roses in comparison with the other municipalities in the area.

This includes municipalities of Hisar, Kaloianovo, Saedinenie, Plovdiv and Asenovgrad in Plovdiv region. They are located near to Strelcha, than to Pavel Banya. The Hissar and Kaloyanovo are near the main road №56 (in Plovdiv Karlovo Pavel Banya). They have a border with the municipality of Strelcha. In Kaloyanovo is 9.30% (1860t) of total waste, but the indicator [t * km] is a bigger in value than Strelcha.

This sheme except Asenovgrad (92 km), the other points are located less than 80 km from an assembly center there.

The reasons for inclusion of Asenovgrad in this group are remoteness from Pavel Banya (104 km), paltry quantity of biomass 0.015% (2.91t) and the ability to be combined with the compound from Plovdiv.

The above good preview on next figures 5 and 6.

On Figure 5 are presented middle arithmetic values to a collection center. Here there is a big difference between the variants with one or with two collection centers.

In the scheme with two centers Strelcha plus Pavel Banya the middle arithmetic value of kilometers larger than scheme Kaloianovo plus Kazanlak. The next Figure 6 shows that the parameter t*km in the first scheme is less than the second. Where the parameter t*km is with smaller values, and then the transport costs are lower. It follows that the scheme Strelcha plus Pavel Banya is better, despite a bigger average distance.

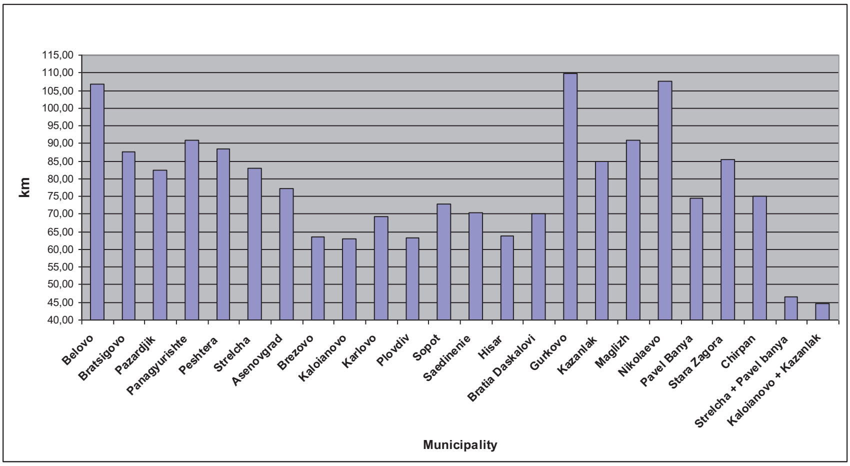

Figure 5. Arithmetic average to a collection center, km

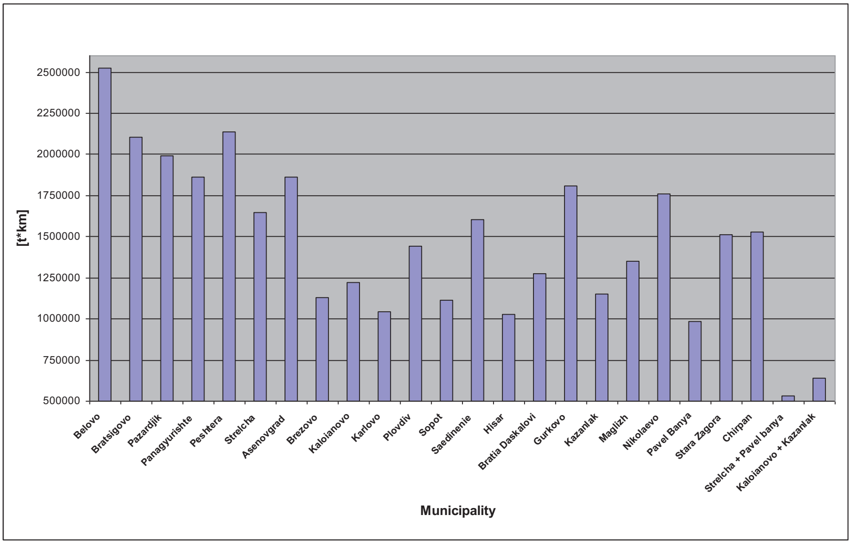

Figure 6. Parameter t*km of assembly centers, t*km

CONCLUSIONS

On the basis of the above, can be formulating the following conclusions:

1. Judging by the location of cultivated areas, the amounts of biomass and distribution by municipalities is best to develop two collection centres for the processing of residual biomass from the production of roses;
2. Municipalities in which can be established centres for the processing of residual biomass of sticks from roses are Pavel Banya municipality and the municipality of Strelcha.

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