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RESEARCHES CONCERNING EFFECTIVENESS OF THE SUNFLOWER SEEDS TREATMENT FOR CONTROLLING OF THE MAIZE LEAF WEEVIL (*Tanymecus dilaticollis* Gyll), IN SOUTH-EAST OF THE ROMANIA

Emil GEORGESCU[1], Maria TOADER[2], Lidia CANĂ[1], Carmen MINCEA[3]

[1]NARDI Fundulea, 1 Nicolae Titulescu, Calarasi, Romania
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, 011464, Bucharest, Romania
[3]Research and Development Institute for Plant Protection, 8 Ion Ionescu de la Brad Blvd, District 1, 013813, Bucharest, Romania

Corresponding author email: emilgeorgescu2013@gmail.com

Abstract

Maize leaf weevil (Tanymecus dilaticollis Gyll) is the main pest of the sunflower crops, mainly in south and south-east of the Romania. Each year, around one half million hectares cultivated with sunflower is attacked by this pest, with different level of the attack intensities. This paper presents some results of the researches concerning the effectiveness of the sunflower seeds treatments with imidaclopird, clothianidin and thiamethoxam active ingredients, for weevils control, in the climatic conditions from south-east of the Romania, at NARDI Fundulea experimental field. Both, in 2018 and 2019, there weren't registered significant statistical differences between weevils attack at treated plots. Highest statistical differences concerning weevils attack intensity it has registered between untreated and treated plots ($p<0.05$). In 2018, at treated plots, saved plants percent ranged from 89.59 to 93.47% while in 2019, the percentage of saved plants, at treated plots, presented lower values comparative with previous year, ranged from 51.67 to 64.17%. A possible reason for this fact is because of higher attack of turnip moth larva (Agrotis spp.) at sunflower plants in 2019 comparative with 2018.

Key words*: sunflower, pests, seed treatment, control.*

INTRODUCTION

In last years, Romania has more than 1.0 million hectares cultivated with sunflower which represents the highest area within the EU28 (Eurostat, 2018; MADR data, 2018; Romanian Statistical Yearbook, 2018). According Chiriac et al. (2018), in 2016, sunflower cultivated area represented 12.37% of Romania's total cultivated area compared to 4.20% in 1990. Higher areas with this crop are located in south and south-east of the country (Maria et al., 2017; Kaya, 2019). Maize leaf weevil (*Tanymecus dilaticollis* Gyll) is the main pest of both, maize and sunflower crops, mainly in south and south-east of the Romania (Paulian et al., 1969; 1974; Voinescu et al., 1985; Barbulescu et al., 1991; 1995; 2001a; Popov, 2002; Popov et al., 2004; 2005; 2006a). Each year, around one half million hectares cultivated with sunflower is attacked by this pest, with different level of the attack intensities (Popov et al., 2007a). The pest is dangerous when sunflower crops are in early vegetation stages, from plants emergence until four leaves stage (Barbulescu et al., 1991; Rosca et Rada, 2009). Same authors mentioned that, after BBCH 14 stage, weevils have feeding only with leaf margins and damages are less economically important. In same time, weevils attack in early vegetation stages can be dangerous because insects can cut plants stem during feeding process and sunflower seedlings can be destroyed. However, in some cases, weevils attack can occur before plants emergence above soil surface, causing high yield losses, sometimes compromising not only maize crops, but also sunflower and sugar beet (Barbulescu et al., 2001b). Data from the literature make in evidence that in south-east of the Romania, yield losses ranged between 10 and 26 %, in case of moderate weevils attack at sunflower untreated plants (Barbulescu et al., 1993c; 1994; Barbulescu, 1995; 1997; 2001; Popov, 2003). Same authors mentioned that in

case of high weevils attack at sunflower untreated plants, yield losses ranged between 32 and 60%. Barbulescu et al. (1991; 1993a) make in evidence that in spring of the years 1990-1992, in south east of the Romania, pest density at sunflower crops ranged between 7.5 to 35.0 weevils/m^2, while at Tulcea County it has recorded 58 weevils/m^2. In same time, in Moldavia plateau and West Plane, pest density was low (0.5-1.5 weevils/m^2). Researches made at NARDI Fundulea revealing that higher biological reserve of the maize leaf weevil (*T. dilaticollis*) it has registered in case of maize monoculture and sunflower cultivated after maize (Paulian, 1972; Barbulescu and Voinescu, 1998; Voinescu and Barbulescu, 1998). In some cases, even if the sunflower was sowed in plots with low pest reserve, the weevils can migrate from neighborhood plots that were sowed with maize in previous years (Barbulescu, 1996; Popov and Barbuescu, 2007). As result of both, increasing area cultivated with sunflower and decreasing number of economically effective crops, in favorable pest area from south and south-east of the Romania, farmers couldn't make a proper rotation, in many cases sunflower is sowed after maize (Dachim, 2016; Lup et al., 2017; Popescu et al., 2019). Maize leaf weevil is a thermo and xerophilous insect specie, being spreading especially in arid and semi-arid areas from Romania (Sisesti and Staicu, 1958, cited by Paulian, 1972). According Popov et al. (2006b) weevils are very active at high air temperatures and low humidity, registered in period when sunflower plants are in early vegetation stages while low air temperatures and high rainfall amount represent unfavorable conditions for weevils activity. Diffenbaugh et al. (2008) mentioned that climate changes will increase the prevalence of insect pests in maize and sunflower agro-ecosystems from Central and South-East of the Europe, including Romania. Other long term studies confirm this theory (Olesen, et al., 2011; Bebber et al., 2014; Pietrapertosa et al., 2018; Choudhary et al., 2019). In the climatic conditions from south and south-east of the Romania, seeds treatment with systemic insecticides is the most effective method to control maize leaf weevil (*T. dilaticollis*) attack at sunflower crop (Barbulescu, 1995; 1997; 2001; Barbulescu et al., 1993c; 1994; 2001; Popov, 2002; 2003; Popov et al., 2007b; Popov and Barbulescu, 2007; Georgescu et al., 2015; 2018; Trotus et al., 2018). After European Commission Regulations 218/783, 218/784 and 218/785, the use of imidacloprid, clothianidin and thiamethoxam active ingredients for all field crops, both like seeds treatment and foliar application will be total banned in UE, from 2019 (Official Journal of the European Union, 2018a; 2018b; 2018c). As result no insecticides will remain available for sunflower seed treatment against *T. dilaticollis* in Romania. According Ionel (2014), lack of the seeds treatment alternatives for spring crops, including sunflower, can have negative impact in Romanian agriculture in following years. Kathage (2018) mentioned that after ban of seeds treatment with neonicotinoids of the maize, sunflower and oilseed rape in EU, farmers use foliar and soil treatments that are more expensive comparative with seeds treatment. Same author mentioned that further studies is required to assess the effectiveness and sustainability of these alternatives compared with the restricted insecticides. In this paper it has presented some results of the researches concerning the effectiveness of the sunflower seeds treatments with imidaclopird, clothianidin and thiamethoxam active ingredients, for controlling of the maize leaf weevil (*T. dilaticollis*), in climatic conditions from south-east of the Romania, at NARDI Fundulea.

MATERIALS AND METHODS

The experiment were carried out at the experimental field of the Plants and Environment Collective, from National Agricultural Research Development Institute (NARDI) Fundulea, Calarasi County, Romania (latitude: 44° 46'; longitude: 26° 32'; altitude: 68 m), between 2018 and 2019.

Table 1. Active ingredients used in this research

Variant no.	Active ingredient (concentration)	Rate (l.c.p./t)*
1	control (untreated)	—
2	imidacloprid (600 g/l)	10.0
3	clothianidin (600 g/l)	9.0
4	thiamethoxam (350 g/l)	10.0

*litter commercial product per ton seeds

Active ingredients used in this study were listed on table 1. Experimental plots were arranged

according randomized blocks scheme. Each plot has 10 m length and 4.2 m wide as result plot area was of 42 m^2. In 2018 sunflower was sowed on 23 April and plants emergence occurred on 5 May while in 2019 sunflower was sowed on 12 May and plants emergence occurred on 18 May. For this experience it has used Performer sunflower hybrid. In both years, sunflower was sowed after maize. Distance between rows was 0.7 m. For this experience it has used lower plants density. On each plot it has sowed 180 sunflower seeds, that correspond on a density of 42857 seeds/ha. The purpose for using of lower plants density in this experience is to assure better conditions for weevils attack.

Pest density was rated two times, before sowing and when sunflower plants are in BBCH 14 stage. These assessments were made with metric branch, after noon, when air temperatures were higher, sky was without clouds or less clouds and wind was lower or absent. This weather conditions are favorable for weevils activity on soil surface. At each plot it has made 10 assessments with metric branch for determine weevils density per square meter.

Attack intensity of weevils was assessed when sunflower plants arrive in four leaves stage (BBCH 14). At each plot it has marked 20 plants, from four central rows (5 plant/row). Before assessment, the plants were marked with sticks, in stair system. Weevils attack was rated on a scale from 1 to 9, as follows:

- Note 1: plant not attacked;
- Note 2: plant with 2-3 simple bites on the leaf edge;
- Note 3: plants with bites or clips on all leafs edge;
- Note 4: plants with leafs chafed in proportion of 25%;
- Note 5: plants with leafs chafed in proportion of 50%;
- Note 6: plants with leafs chafed in proportion of 75%;
- Note 7: plants with leafs chafed almost at the level of the stem;
- Note 8: plants with leafs completely chafed and beginning of the stem destroyed;
- Note 9: plants destroyed, with stem chafed close to soil level.

Saved plant percent was rated at 30 days from sunflower emergence, by counting all the emerged plants from a plot and comparing them with the number of sowed sunflower seeds/plot.

Plants height at 50 days from sunflower emergence was rated at same plants that, previously, it has assessed attack intensity.

Meteorological data were collected from automatic weather stations (iMethos), placed in the field at 100 meters from the experimental plots. It has registered average air temperature, soil temperature at 5 cm depth and daily rainfalls amount.

The data were **statistical analyzed** using Student - Newman - Keuls (SNK) test for multiple comparisons used to identify sample means that are significantly different from each other (Student, 1927; Neuman, 1939; Keuls, 1952).

RESULTS AND DISCUSSIONS

At experimental field from NARDI Fundulea, average air temperatures registered, both in April and May, 2018 were over multiyear average with a positive deviation of +4.7°C (April) and +2.5°C (May). Contrarily, average air temperatures registered, both, in April and May, 2019 were slightly over multiyear average, with a positive deviation of +0.1 °C in April and + 0.3°C in May (Figure 1).

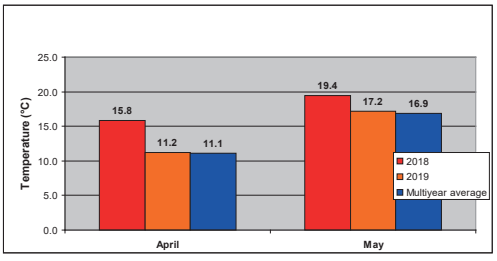

Figure 1. Average air temperature registered in April and May, 2018 and 2019, at NARDI Fundulea

In April, 2018, in south-east of the Romania, rainfalls amount level was close to zero. At experimental field from NARDI Fundulea, in April, 2018, it has registered only 3.0 mm of rains, while multiyear average for this month is 59.0 mm. In May, 2018, rainfalls amount was below multiyear average, with a negative deviation of 29.5 mm (Figure 2). In 2019, at NARDI Fundulea experimental field, rainfalls amount registered in April were higher then multiyear average with a positive deviation of

11.6 mm, while in May it has registered double rainfalls amount comparative with multiyear average, with a positive deviation of 125.1 mm. Overall weather conditions from spring period, at NARDI Fundulea, were favorable for *T. dilaticollis* attack at sunflower plants in 2018 and less favorable in 2019. However, weevils attack was higher in 2019 and lower in 2018.

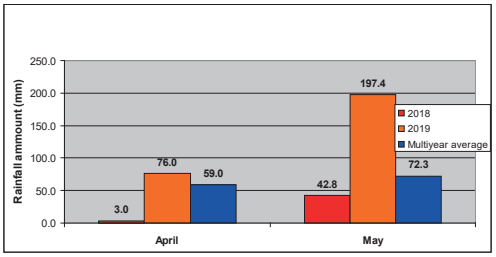

Figure 2. Rainfalls amount registered in April and May, 2018 and 2019, at NARDI Fundulea

Possible explication for lower weevils attack, at sunflower plants, in May 2018 is because of daily weather conditions evolution. Even if total rainfalls amount registered in this month was below multiyear average and average air temperature were higher, however between 8 and 18 May, when sunflower plants were in early vegetation stages (BBCH 10-14), the most susceptible period for pest attack, air and soil temperatures were lower while rainfalls amount where higher (Figure 3). In this period, daily weather conditions weren't favorable for weevils attack, because insects activity on soil surface was lower as result feeding process of the weevils were low and sunflower untreated plants presented low damages.

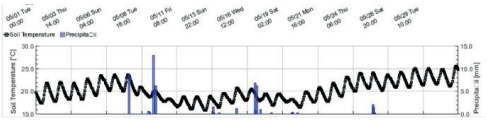

Figure 3. Daily soil temperatures and rainfalls amount recorded in May, 2018, at NARDI Fundulea, during early sunflower vegetation stages (BBCH 10-14)

In May, 2019, at experimental field of NARDI Fundulea, from sowing until emergence of sunflower plants it has registered 45.4 mm of rains. As result plants emergence it has occurred at 6 days after sowing, comparative with 12 days in 2018. In same time, daily average air temperatures were lower comparative with multiyear average. From plants emergence (BBCH 10) until four leaves stage (BBCH 14) it has registered 20.2 mm of rains, while average air temperatures were higher then previous period. Weather conditions registered in early stages of sunflower plants were favorable for weevils activity on the soil surface. As result intensity of feeding process was high and damages at untreated sunflower plants was higher. On 31 May it has registered 72.0 mm of rains (Figure 4). Rainfalls amount registered in last day of May it was slight equal with multiyear average for all this month (72.3 mm). However rainfalls from 31 May didn't influence weevils attack, because sunflower was less sensitive for pest attack (BBCH 15-16).

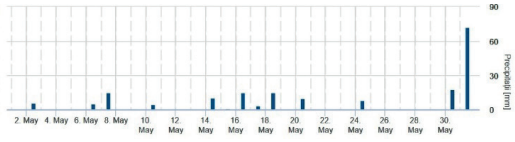

Figure 4. Daily rainfalls amount recorded in May, 2019, at NARDI Fundulea, during early sunflower vegetation stages (BBCH 10-14)

Bozo (2011) mentioned that precipitation evolution in Central and South-East of Europe show a decreasing trend, especially in spring period, but increasing precipitations is visible as a shorter term tendency. In last years, at NARDI Fundulea it has observed short periods with higher rainfalls amount, especially in May (Georgescu et al., 2014). This atypically evolution of weather conditions, especially when sunflower plants were in early vegetation stages (BBCH 10-14), can have effect on weevils activity (Georgescu et al., 2015). Further studies are necessary to evaluate daily weather conditions influence on both, *T. dilaticollis* activity and host plants reaction.

In 2018 and 2019, at experimental field from NARDI Fundulea, located in south-east of the Romania, before sowing of sunflower and when plants were in four leaves stage (BBCH 14) it has made assessments concerning weevils density. In last 10 days of the April, 2018, pest density has slight variability, ranged from 6.70 to 6.82 weevils/m^2. At second assessment, made in same day with those concerning attack intensity, it has noticed that at untreated variant pest density decreasing, at

5.35 weevils/m^2 while at treated variants, pest density decreasing bellow 3.50 weevils/m^2 (Figure 5). According Student - Newman - Keuls (SNK) test, there weren't registered significant statistical difference between pest densities, at treated variants. In same time there were significant statistical differences between treated and untreated variants ($p<0.05$).

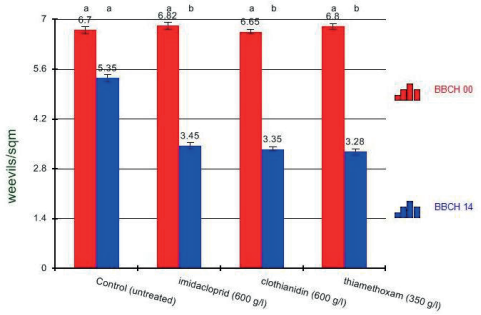

Figure 5. Weevils density, at experimental field from NARDI Fundulea, in 2018

Pest density was higher in 2019 comparative with 2018 (Figure 6). At first assessment, made at 12 May, before sowing of sunflower (BBCH 00), it has registered minimum 8.81 weevils/m^2 and maximum 9.43 weevils/m^2. At second assessment, made when sunflower was at BBCH 14 stage, pest density, at untreated variant was 8.65 weevils/m^2 while at treated variants ranged from 5.41 to 5.59 weevils/m^2.

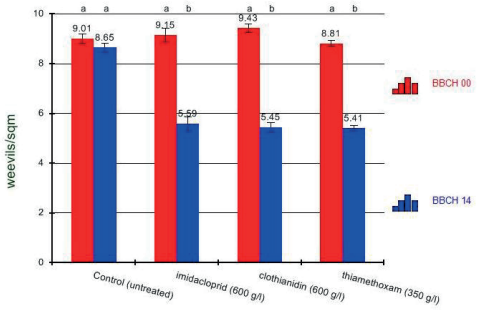

Figure 6. Weevils density, at experimental field from NARDI Fundulea, in 2019

In both years from this research, seeds treatment with imidacloprid, clothianidin and thiamethoxam active ingredients has result in decreasing of weevils density. Possible explication for higher pest reserve in 2019 comparative with 2018 is both, because of increasing pest reserve from one year to another and migrations of weevils from neighbor plots. Also, daily weather evolution between 8 and 18 May, 2018, was less favorable for weevils feeding process.

Table 2. Attack intensity of *T. dilaticollis* at sunflower plants, in field conditions, at NARDI Fundulea

Active ingredient (concentration)	**Rate** (l.c.p./t)	**Attack intensity (1-9)**			
		2018		**2019**	
control (untreated)	—	3.09	a	5.09	a
imidacloprid (600 g/l)	10.0	2.29	b	3.51	b
clothianidin (600 g/l)	9.0	2.18	b	3.58	b
thiamethoxam (350 g/l)	10.0	2.25	b	3.60	b
LSD P=0.05		0.399		0.560	
Standard deviation (SD)		0.250		0.350	
Variation coefficient (C.V.)		10.18		8.88	

*Means followed by same letter or symbol do not significantly differ ($p<0.05$, Student - Newman - Keuls test)

According Rosca et Rada (2009) in normal climatic conditions, economic threshold of *T. dilaticollis* is 5 weevils/m^2. In spring of 2018 and 2019, before sowing of the sunflower, pest density was higher then economic threshold. Also, in 2019, when sunflower plants were in BBCH 14 stage, even if the pest density were lower then at assessment made before sowing, however it was higher then 5 weevils/m^2. In same time, pest density registered at experimental field from NARDI Fundulea, both in 2018 and 2019 was lower then densities mentioned by Barbulescu (1991; 1993a).

Data from Table 2 ascertained that weevils attack intensity at sunflower plants, on a scale from 1 to 9, was lower in spring of 2018 and higher in spring of 2019. In both years from this study, at treated variants, attack intensity was lower comparative with untreated variant. According Student - Newman - Keuls (SNK) test, there weren't registered significant statistical differences between weevils attack at treated variants ($p<0.05$). In same time, in both years, in the climatic conditions from experimental location, it has registered significant statistical difference between weevils attack at sunflower plants from treated variants comparative with untreated variant ($p<0.05$). Also variation coefficient (CV) has a slight variation in the two years of this study.

Data from Table 3 make in evidence that, in 2018, at treated plots, saved plants percent, at 30 days from sunflower emergence, ranged from 89.59 to 93.47%.

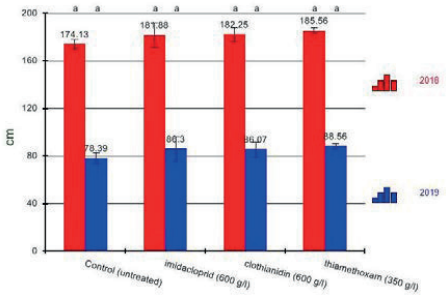

Figure 7. Plants height at 50 days after sunflower emergence, NARDI Fundulea (2018-2019)

Table 3. Influence of the seeds treatment, concerning saved plats percent, at 30 days from sunflower emergence (NARDI Fundulea)

Active ingredient (concentration)	**Rate** (l.c.p./t)	**Attack intensity (1-9)**			
		2018		**2019**	
control (untreated)	—	84.59	a	51.25	a
imidacloprid (600 g/l)	10.0	89.59	a	51.67	a
clothianidin (600 g/l)	9.0	93.48	a	64.17	a
thiamethoxam (350 g/l)	10.0	89.86	a	57.50	a
LSD P=0.05		10.117		22.418	
Standard deviation (SD)		6.325		14.016	
Variation coefficient (C.V.)		7.08		24.96	

*Means followed by same letter or symbol do not significantly differ ($p<0.05$, Student - Newman - Keuls test)

In 2019, the percentage of saved plants, at treated plots, presented lower values comparative with previous year, ranged from 51.67 to 64.17%. In both years there weren't registered significant statistical differences between experimental variants ($p<0.05$). However there were higher differences concerning saved plants percent in 2018 comparative with 2019. Also, variation coefficient (CV) was higher in 2019 comparative with 2018. Similar situation it has registered in case of plants height at 50 days from emergence (Figure 7). Possible explication for this is because of both, higher rainfalls amount from summer period of 2018 and high attack of turnip moth larva (*Agrotis* spp.) at sunflower plants from experimental field of NARDI Fundulea, in spring of 2019. In different climatic conditions from spring period, at experimental field of NARDI Fundulea, located in south-east of the Romania, sunflower seeds treatment with imidacloprid, clothianidin and thiamethoxam active ingredients provide effective protection of the sunflower plants against maize leaf weevils (*Tanymecus dilaticollis* Gyll) attack. Further researches are necessary for finding possible alternatives of sunflower protection after permanent ban in EU of the neonicotinoid insecticides used both, for seed treatment and foliar application. Also, new researches are necessary for evaluate effect of the climate changes concerning attack of the *Agrotis* spp. and other similar pests at sunflower plants in Romania.

CONCLUSIONS

In the climatic conditions from south-east of the Romania, at experimental field from NARDI Fudulea, *T. dilaticollis* attack at sunflower plants, in early vegetation stages (BBCH 10-14) was lower in spring of the year 2018 and higher in spring of the year 2019.
Weevils density was lower in spring of the year 2018 and higher in spring of the year 2019.
Seeds treatment with imidacloprid, clothianidin and thiamethoxam active ingredients has effect in a reduction of both, weevils density and attack intensity at sunflower plants.

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REFERENCES

Barbulescu, A. (1995). Results obtained in 1994 in the research on diseases and pests of cereals and some industrial and forage crops. *Problems of Plant Protection*, *23*(2), 125–170.

Barbulescu, A. (1996). Results obtained in 1995 in the research on diseases and pests of cereals and some industrial and forage crops. *Problems of Plant Protection*, *24*(2), 87–142.

Barbulescu, A. (1997). Results obtained in 1996 in the research on diseases and pests of cereals and some industrial and forage crops. *Problems of Plant Protection*, *25*(2), 99–164.

Barbulescu, A., Voinescu, I. (1998). Influence of the crop rotation on the evolution of *Tanymecus dilaticollis*. *Annals of I.C.C.P.T. Fundulea, 65*, 321–326.

Barbulescu, A. (2001). Results obtained in 2000, regarding the diseases and pests of cereals and some

industrial and forage crops. *Problems of Plant Protection*, *29*(2), 123–178.

Barbulescu, A., Ciurdarescu, G., Mateias, M.C., Popov, C., Gheorghe, M., Pelaug, A., Pelmus, V., Rugina, M., Voinescu, I., Bigiu, L., Costescu, P., Bratu, R., Vonica, I., Kozinschi, T. (1991). Evolution of some diseases and pests of grain industrial and forage crops in our country during 1990. *Problems of Plant Protection*, *19*(1-2), 57–73.

Barbulescu, A., Mateias, M.C., Popov, C., Rugina, M., Guran, M., Voinescu, I., Bratu, R., Vonica, I., Kozinschi, T. (1993a). Evolution of some diseases and pests of cereal, industrial and forage crops in our country during 1992. *Problems of Plant Protection*, *21*(1), 47–68.

Barbulescu, A., Popov, C., Voinescu, I., Mateias, M.C. (1993b). The impact of chemical control of pests and diseases in cereals and some industrial and forage plants, on the environment. *Problems of Plant Protection*, *21*(1), 67–98.

Barbulescu, A., Mustea, D., Sapunaru, T., Sendru, T., Burdea, T., Emilia, B., Ignatescu, I., Mateias, M. C., Popov, C., Rosca, I., Alister, C., Elena, B., Csep, N., Goga, N., Valeria, I., Dana, M., Felicia, M., Elena, N., Bratu, R., Lucica, P., Emilia, P., Marta, R., Stoica, V., Elena, T., Angela, U., Florina, V., Voicu, M., Voinescu, I., Emilia, L., Laura, M., Maria, O., Aurelia, S., Doina, C. (1993c). Results obtained in 1992 in the research on diseases and pests of cereals and some industrial and forage crops. *Problems of Plant Protection*, *21*(2), 149–170.

Barbulescu, A., Mustea, D., Sapunaru, T., Sendru, T., Burdea, T., Emilia, B., Ignatescu, I., Mateias, M. C., Popov, C., Rosca, I., Elena, B., Csep, N., Goga, N., Valeria, I., Dana, M., Felicia, M., Elena, N., Lucica, P., Emilia, P., Marta, R., Stoica, V., Elena, T., Angela, U., Florina, V., Voicu, M., Voinescu, I., Emilia, L., Laura, M., Maria, O. (1994). Results obtained in 1993 in the research on diseases and pests of cereals and some industrial and forage crops. *Problems of Plant Protection*, *22*(2), 143–216.

Barbulescu, A., Mateias, M.C., Popov, C., Guran, M., Voinescu, I., Stanciu, M., Raranciuc, S. (1995). Evolution of some diseases and pests of grains, industrial and forage crops in our country during 1994. *Problems of Plant Protection*, *23*(1), 75–92.

Barbulescu, A., Popov, C., Mateias, M.C., Voinescu, I., Guran, M., Raranciuc, S., Spiridon, C., Vasilescu, S., Valasn, D. (2001a). Evolution of some diseases and pests of grains, industrial and forage crops in our country during 2000. *Problems of Plant Protection*, *29*(1), 1–16.

Barbulescu, A., Voinescu, I., Sadagorschi, D., Penescu A., Popov, C., Vasilescu, S. (2001b). Cruieser 350 FS-A new product for maize and sunflower seed treatment against *Tanymecus dilaticollis* Gyll. *Romanian Agricultural Research*, *15.* 77–87.

Bebber, D.P., Holmes, T., Gurr, S.J. (2014). The global spread of crop pests and pathogens, *Global Ecology and Biogeography*, *23*(12), 1398–1407.

Bozo, L. (2011). Climate change in Central Europe: Observations and Model Scenarios. *Agrisafe final conference Climate change: Challenges and Opportunities in Agriculture*, 9–11.

Chiriac, A.R., Cristea, S., Popescu, M., Rasnoveanu, L. (2018). The evolution of sunflower crops in Romania in the context of the pre-and post-accession to the European Union, *In Agrarian Economy and Rural Development-Realities and Perspectives for Romania. 9th Edition of the International Symposium*, 156–162.

Choudhary, J.S., Madhumita, K., Fand, B.B. (2019). Linking insect pest models with climate change scenarios to project against future risks of agricultural insect pests. *CAB Reviews*, *14*(055), 1–13.

Dachin, A. (2016). Structure of production costs for field crops in Romania–a regional analysis. *Competitiveness of Agro-Food and Environmental Economy*, 101–109.

Diffenbaugh, N.S., Krupke, C.H., White, M.A., Alexander, C.A. (2008). Global warming presents new challenges for maize pest management. *Environmental Research Letters*, *3*(4), 1–9.

Georgescu E., Cana L., Popov C., Gargarita, R., Rasnoveanu, L., Voinea, L. (2014). Maize leaf weevil (*Tanymecus dilaticollis* Gyll) in the context of neonicotinoid seed treatment restriction. *Annals of N.A.R.D.I. Fundulea*, *82*. 251–277.

Georgescu, E., Cana, L., Gargarita, R., Voinea, L., Rasnoveanu, L. (2015). Atypically behavior of the maize leaf weevil (*Tanymecus dilaticollis* Gyll) on maize and sunflower crops, in climatic conditions of the Year 2014, in South-East of Romania. *Agriculture and Agricultural Science Procedia*, *6*, 9–16.

Georgescu, E., Toader, M., Ionescu, A.M., Cana, L., Rasnoveanu, L. (2018). Researches concerning sunflower seeds treatment against *Tanymecus dilaticollis*, in green house conditions, "*Agriculture for Life, Life for Agriculture" Conference Proceedings*, *1*(1), 64–71.

Ionel, I.I. (2014). Regulation implications on banning the treatment of seeds with neonicotinoid insecticides on the seed market in Romania. *Scientific Papers Agricultural Management*, *16*(2), 223–228.

Kathage, J., Pedro, C., José, L.A.P., Manuel, G.B., Emilio, R.C. (2018). The impact of restrictions on neonicotinoid and fipronil insecticides on pest management in maize, oilseed rape and sunflower in eight European Union regions. *Pest management science, 74*(1), 88–9.

Kaya, Y. (2019). An overview of sunflower production in the Balkan region. *Oilseeds Focus*, *5*(1), 40–41.

Keuls, M. (1952). The use of the "studentized range" in connection with an analysis of variance. *Euphytica*, *1*, 112–122.

Lup, A., Miron, L., Alim, I.D. (2017). Studies and strategies regarding the evolution of crop yields per unit of land area in Romania, studies. *Scientific Papers Series Management, Economic Engineering*

in Agriculture and Rural Development, *17*(2), 227–233.

Maria, M.C., Teeodor, M., Nicoleta, A.A., Nicoleta, M.S. (2017). Evolution of cultivated areas and yield in the main crops in Romania. *Agricultural Management, Scientific Papers, Series I*, *19*(3), 299–304.

Newman, D. (1939). The distribution of range in samples from a normal population, expressed in terms of an independent estimate of standard deviation. *Biometrika*, *31*(1), 20–30.

Olesen, J.E., Tmka, M., Kersebaumc, K.C., Skjelvågd, A. O., Seguine, B., Peltonen-Sainiof, P., Rossig, F., Kozyrah, J., Micalei, F. (2011). Impacts and adaptation of European crop production systems to climate change. *European Journal of Agronomy*, *34*(2), 96–112.

Paulian, F., Popov, C., Marcela, D.P. (1969). The corn leaf weevil (*Tanymecus dillaticolis* Gyll.) in Romania and its control. *Contemporary Agriculture*, *5-6*, 643–652.

Paulian, F. (1972). Contribution at knowledge of the development, ecology and control of the *Tanymecus dilaticollis* specie (Contribuţii la cunoaşterea dezvoltării, ecologiei şi combaterii speciei *Tanymecus dilaticollis*). *Doctoral thesis, I.A.N.B. Bucharest*, pp. 300.

Paulian, F., Ciurdarescu, G., Mateias, M.C., Brudea, V., Caea, D., Ignatescu, I., Perju, T., Peteanu, S., Sapunaru, T., Sandru, I. (1974). Actual problems concerning diseases and pest of the forages. *Problems of Plant Protection*, *2*(1), 76–109.

Pietrapertosa, F., Valeriy, K., Salvia, M., Carmelina, C. (2018). Climate change adaptation policies and plans: A survey in 11 South-East European countries. *Renewable and Sustainable Energy Reviews*, *81*, 3041–3050.

Popescu, A., Stoian, E., Serban., V. (2019). Oil seeds crops cultivated area and production in the EU-28 - trends and correlations, 2008-2018. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, *19*(4), 265–272.

Popov, C. (2002). Researches concerning the protection of the cereals, leguminous for grains, technical and forage plants against pathogen agents and pests, year 2001. *Problems of Plant Protection*, *30*(2), 109–190.

Popov, C. (2003). Researches regarding the protection of cereals, leguminous for grains, industrial and fodder crops to pathogens and pests performed in 2002 year. *Problems of Plant Protection*, *31*(2), 7–84.

Popov, C., Guran, M., Raranciuc, S., Rotarescu, M., Spiridon, C., Vasilescu, S., Gogu, F. (2004). Phytosanitary state of cereals, leguminous for grain, industrial and fodder crops in Romania in 2003. *Problems of Plant Protection*, *32*(1), 1–23.

Popov, C., Guran, M., Raranciuc, S., Rotarescu, M., Spiridon, C., Vasilescu, S., Gogu, F. (2005). Phytosanitary state of the cereals, leguminous for grains, forage and technical crops from Romania, year 2004. *Problems of Plant Protection*, *34*(1-2), 15–37.

Popov, C., Guran, M., Raranciuc, S., Rotarescu, M., Spiridon, C., Vasilescu, S., Gogu, F. (2006a). Phytosanitary state of the cereals, leguminous for grains, forage and technical crops from Romania, year 2005. *Problems of Plant Protection*, *33*(1-2), 7–30.

Popov, C., Trotus, E., Vasilescu, S., Barbulescu, A., Rasnoveanu, L. (2006b). Drought effect on pest attack in field crops. *Romanian Agricultural Research*, *23*, 43–52.

Popov, C., Raranciuc, S., Spiridon, C., Vasilescu, S., Cana, L. (2007a). Phytosanitary state of the cereals, leguminous for grains, forage and technical crops from Romania, year 2006. *Problems of Plant Protection*, *35*(1), 1–24.

Popov, C., Barbulescu, A., Raranciuc, S. (2007b). Seed treatment a modern, efficient and less pollutant method for field crops protection. *Annals of N.A.R.D.I. Fundulea*, *74*, 133–139.

Popov, C., Barbulescu, A. (2007). 50 years of scientific activity in field protection domain against diseases and pests. *Annals of N.A.R.D.I. Fundulea*, *75*, 371–404.

Rosca, I., Rada, I.. (2009). *Entomology* (Agriculture, Horticulture, Forest). *Alpha Mdn Publishing House*, 699 pp (pg. 119-123).

Trotus, E., Mincea, C., Dudoiu, R., Pintilie, P.L., Georgescu, E. I. (2018). The preliminary results regarding the impact of the neonicotinoids insecticides, applied at rape, sunflower and maize seed treatment, on the harmful entomofauna and honey bees. *Annals of N.A.R.D.I. Fundulea*, *87*, 251–260.

Student (1927). Errors of Routine Analysis, *Biometrika*, *19*(1/2), 151–164.

Voinescu, I. (1985). Maize seed treatment with carbamic insecticides, effective method for controlling of the weevil *T. dilaticollis* Gyll. *Problems of Plant Protection*, *13*(2), 151–156.

Voinescu I., Barbulescu A. (1998). Evolution of maize leaf weevil (*Tanymecus dilaticollis* Gyll.) in various crops depending on the preceding crop, *Proceedings of International Symposium on Integrated Protection of Filed Crops*, Vrnja~ka Banja, 157–164.

***EUROSTAT. (2018).
http://ec.europa.eu/eurostat/data/database

***MADR data (2018). https://www.madr.ro/culturi-de-camp/plante-tehnice/floarea-soarelui.html

***Official Journal of the European Union. (2018a). Commission implementing regulation (EU) 2018/783 of 29 May 2018 amending Implementing Regulation (EU) No 540/2011 as regards the conditions of approval of the active substance imidacloprid. 61(L132), 31-34, ISSN 1977-0677. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.132.01.0031.01.ENG&toc=OJ:L:2018:132:FULL

***Official Journal of the European Union (2018b). Commission implementing regulation (EU) 2018/784

of 29 May 2018 amending Implementing Regulation (EU) No 540/2011 as regards the conditions of approval of the active substance clothianidin. 61(L132), 35-39, ISSN 1977-0677. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.132.01.0035.01.ENG&toc=OJ:L:2018:132:FULL

***Official Journal of the European Union (2018c). Commission implementing regulation (EU) 2018/785 of 29 May 2018 amending Implementing Regulation (EU) No 540/2011 as regards the conditions of approval of the active substance thiamethoxam. 61(L132), 40-44, ISSN 1977-0677. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.132.01.0040.01.ENG&toc=OJ:L:2018:132:FULL

***Romanian Statistical Yearbook (2018). Chapter "Agriculture and Silviculture", 489-528.