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RESEARCH REGARDING INFLUENCE OF FERTILIZATION ON SUNFLOWER CROPS IN THE SOUTHERN PART OF ROMANIA

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Abstract

Sunflower (Helianthus annuus L.) is the most important oil crop in Romania. Fertilization of sunflower crops has as a system a complex basic fertilization (NPK or NPK+S+Mg), used in preparing the seedbed and planting, who supports the normal coverage of the critical period of nutrition and laying the foundation of total yield.
The aim of this research is to analyse the behaviour of sunflower under the influence of the degree of fertilization and also of the pedoclimatic conditions in the Oltenia Plain.
Research was performed in the year 2018, in the southern part of Romania, within the Agricultural Research and Development Station Caracal (44°06' N latitude and 24°21' E longitude) in Olt County. For setting up the experience, the NEOMA hybrid was used in 6 test variants as follows: V1 - $N_0P_0K_0$ (control); V2 - $N_{90}P_0K_0$; V3 - $N_{90}P_{60}K_0$; V4 - $N_{90}P_{60}K_{60}$; V5 - $N_{90}P_{60}K_{60}$ plus 1.5 liters/hectare of Fertigrain foliar fertilizer; V6 - $N_{120}P_{60}K_{60}$. The doses used are in kg/ha of active substance. Plant population was 57.000 plants per hectare and the determinations were performed throughout the entire vegetation period of the plant, including the harvest period where the yield value was between 2.234 kg/hectare and 4.035 kg/hectare. Climatic conditions during the vegetation period were favorable, as the average temperatures have registered values between 16.3 and 24.3°C. The total rainfalls was 378.8 mm, those been sufficient for the favorable development of the sunflower crop.

***Key words**: sunflower, fertilization, hybrid, climatic condition, yield.*

INTRODUCTION

In Romania, sunflower was introduced for oil production, around the mid-19th century in Moldavia, being the main vegetable oil producing plant (Panaitescu et al., 2010).
Compared to other crop plants, the sunflower is a big consumer of nutrients and when it comes to provisioning the soil it is very demanding in potassium, demanding in nitrogen and moderately demanding in phosphorus. Therefore, the degree and the type of fertilization have a special importance in achieving a significant but also a qualitative production.
Sunflower recovered less fertilizer than other crops because its root system with a high capacity to extract nutrients and soluble harder combinations mineral fertilizers are less valued and that seed has a small share of the plant biomass is formed (sixth or seventh of biomass epigenous), and in some areas and in some years hydric soil improperly makes mineral fertilizers to be less valued by short seeds. (Moisii et al., 2012).
Sunflower has well-developed and branched root system, and maintains open stomata under condition of high evaporation demands that usually prevail in hot arid and semi-arid regions (Abubaker et al., 2014).
Judicious and timely application of fertilizers at critical growth stages of sunflower can increase its yield considerably.
Several studies showed the positive response of sunflower to fertilization under irrigation and rain fed conditions in the central clay plains of Sudan (Elhassan et al., 2006; Lotfie & Salah, 2013).
Other studies indicated that increase in growth and yield of sunflower and other crops is dependent upon the adequate supply of nitrogen (Ali et al., 2004) and phosphorus (Weiss, 1983) and their ratio (Bi et al., 2013).
Malligawad et al. (2004) had reported that 100 kg N ha^{-1} was suitable for nitrogen fertilization of sunflower.

Nitrogen (N) and Phosphorus (P) are mineral nutrients often limiting plant growth because they are required in large amounts in relation to their availability in soil (Harpole et al., 2011, quoted by Ekwe, 2015).
However, nitrogen fertilization is very variable and it depends on the amounts of the element already present in the soil and the potential yield of the environment (Lauretti et al., 2007).
The first phase of vegetation is a critical period for nutrition with N, P and K, and the negative impact of their failure cannot be corrected later, even if it provides the best nutritional conditions.
Therefore, ensuring a good supply of sunflower plants with all the nutrients from the emergence is one of the main conditions for obtaining high yields.
The average yield per hectare at national level depends very much on the evolution of the climatic conditions and soil natural fertility (Bîlteanu, 2003).
Organic substances, such as: protein hydrolysates of animal origin (composed of peptides, ureide and amino acids - glycine, alanine, phenylalanine, proline, asparagine, glutamine, arginine, histidine, lysine, serine, threonine, valine) and protein hydrolysates of vegetal origin (algae extracts) can be successfully used to obtain new fertilizers formulas (Mihalache et al., 2014).
The relative efficacy of these fertilizers is determined by the rate and size of nutrient transport in plant (Cioroianu et al., 2009, quoted by Mihalache & Stanescu, 2017).
Agriculture of the future does not only have to be sustainable, but also performant and this is achieved only through the correct application of all the technological links specific to agricultural crops from various ecological areas of the country.
The specific consumption of sunflower for 100 kg of seeds, plus the production of roots, leaves, stems and inflorescences is 1.8-3.5 kg Nitrogen, 0.29-0.7 kg Phosphorus, 0.38-1.65 kg Potassium, 0.11 kg Calcium, 0.18-0.23 kg Magnesium (Hera et al., 1998).
Soils recommended for sunflower crops are those in clay or sandy-clay ones, averagely aerated, deep rich in humus and nutrients with a high usable water-retention capacity (Bîlteanu et al., 1988).

MATERIALS AND METHODS

The experiment was set up on illuvial- clay soil, decarbonated soil, typical, with a well-defined profile and insignificant differences regarding the physical, hydric and chemical attributes.
In its arable layer, soil has a cleyey texture, an apparently normal density (1.32 g/cubic centimetres) total satisfying porosity (51%) and a low ram degree (penetration resistance 28 kgf/mc) (Bălănescu & Ilinca, 2001).
In the next horizon, the texture becomes clay-clayey, volumetric weight increases quite a lot (1.57 g/cmc), and total porosity, as well as other attributes record low values, appearing an accentuated ram (penetration resistance reaches 63 kgf/mc).
Following the chemical properties, soil has a medium - hummus content in the arable layer (2.20%); it is poorly supplied with Nitrogen (0.104% N total), medium to good with Phosphorus (47 ppm P mobile) and good to very good supplied with Potassium (244.5 ppm K mobile), and the PH (in the water) is 7.6. The ground water depth is 8 up to 10 m.
The sunflower experiment was set up using the block method. Each experimental variant had a surface of 28 m^2: 2.8 x 10 m with a distance between rows of 0.7 cm over the course of three randomized repetitions.
The density of sunflower plants was 5.7 plants/m^2 (57.000 plants/ha).
For the sunflower crop, the hybrid who was used was Neoma hybrid, which is a simple hybrid, semi-early with an extraordinary and stable potential for production, resistant to the Express herbicide.
There were a number of 6 test variants used, as follows: V1 - $N_0P_0K_0$ (control); V2 - $N_{90}P_0K_0$; V3 - $N_{90}P_{60}K_0$; V4 - $N_{90}P_{60}K_{60}$; V5 - $N_{90}P_{60}K_{60}$ plus 1.5 liters/hectare of Fertigrain foliar fertilizer; V6 - $N_{120}P_{60}K_{60}$.
The works commenced on the fall of 2017. The first step in preparing the land was to make the ploughting at a depth ranging between 25 and 30 cm.
In the spring, the works continued with the soil disking in 2 passes, process executed using a heavy disc.

The final work in preparing the seedbed was performed using a combiner before planting the sunflower crop.
Fertilization was administered manually under the type of complexes before planting and the ammonium nitrate difference has been applied in vegetation.
Sowing took place on 23.04.2018. After that, Dual Gold 960 EC (active substance S-metolachlor 960 g/l) preemergent herbicide was used in a dose of 1.2 l/ha.
When the sunflower crop formed 4-6 leaves, the Select Super 120 EC (active substance Clethodim 120 g/l) herbicide was applied to annual and perennial monocotyledons weeds in a dose of 1.5 l/ha.
On the 8-10 leaves stage, a treatment made of Reveller fungicide (active substances Cyproconazole 80 g/l + Picoxystrobin 200 g/l) 0.6 l/ha and Decis Mega 50 EW insecticide (active substance Deltamethrin 50 g/l) 0.15 l/ha was applied.
Application of the foliar fertilizer occurred in 2 stages. The first application stage was conducted when the plants had formed 4-6 leaves, and the second stage before blooming period, in a dose of 1.5 l/ha.
Biometric determinations were performed on the sunflower plants, including the following: plant size and calatidium diameter.
The tests made on the sunflower seeds aimed at their quality, expressed by morphological indexes, such as: Thousand Kernel Weight TKW) and the hectolitre mass (HM).

RESULTS AND DISCUSSIONS

Climatic conditions registered in the 2017/2018 agricultural year by the weather station of Agricultural Research and Development Station Caracal were among the most favourable over the past 30 years.
The annual average of the temperature (Table 1) was between 0.8°C and 24.3°C registered in January and August, respectively.
Also, the multiannual average of temperatures ranged between 0.3°C and 23.9°C, resulting a difference of +1.1 ^{0}C between the annual and multiannual average.
While the monthly rainfall sum (Table 2) ranged between 6.8 and 147.8 mm, and the monthly average was between 26.3 and 69.7 mm, the difference between the rainfall sum and the monthly average was +301.9 mm.

Table 1. Temperatures registered at Agricultural Research and Development Station Caracal during the 2017/2018 agricultural year

Specifications	**Temperature °C**		
Month	**Monthly average**	**Multiannual media (last 30 years)**	**Deviation**
October	12.3	11.7	+ 0.6
November	6.5	5.4	+ 1.1
December	3.1	0.3	+ 2.8
January	0.8	1.3	+ 0.5
February	1.0	0.8	+ 0.2
March	3.8	6.0	- 2.2
April	16.3	12.0	+ 4.4
May	19.6	17.7	+ 1.9
June	22.1	21.6	+ 0.5
July	22.8	23.9	- 1.1
August	24.3	23.5	+ 0.8
September	19.6	18.1	+ 1.5
Total Average	**12.7**	**11.6**	**+ 1.1**

Table 2. Rainfall registered at Agricultural Research and Development Station Caracal during the 2017/2018 agricultural year

Specifications	**Rainfall (mm)**		
Month	**Monthly sum**	**Multiannual media (last 30 years)**	**Deviation**
October	144.6	46.0	+ 98.6
November	73.0	37.0	+ 36.0
December	63.8	39.1	+ 24.7
January	33.8	30.8	+ 3.0
February	56.4	26.3	+ 30.1
March	86.4	34.2	+ 52.2
April	10.6	47.8	- 37.2
May	55.6	58.6	- 3.0
June	134.2	69.7	+ 64.5
July	147.8	62.1	+ 85.7
August	30.6	46.6	- 16.0
September	6.8	43.5	- 36.7
Total Average	**843.6**	**541.7**	**+ 301.9**

The year 2018 turned out to be a climatically favourable year regarding the growth and development of the sunflower crop in the Oltenian plain.
Sunflower is a mesothermal plant, relatively demanding in heat which, to go through the

vegetation stages, needs at least 2,350°C ($T > 0°C$) or 1,600°C ($T \geq 5°C$) (Bîlteanu et al., 1988).
During the research period, the sum of temperature degrees was 3,223.30°C, enough to meet the sunflowers biological demands.
The average of the air temperatures (Figure 1), between 16.3 and 22.1°C, recorded during the time span between emergence and inflorescence and those comprised between 22.8 and 24.3°C, registered since flowering until fruit-forming, were optimal temperatures to cover the vegetation period of the sunflower experiment.

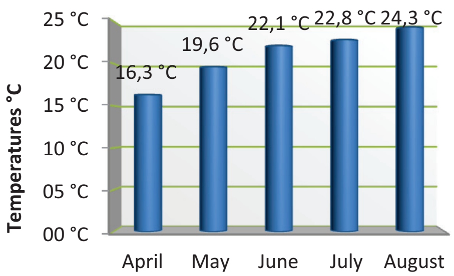

Figure 1. The average of temperatures during the vegetation period of sunflower

The humidity requirements for the sunflower are average, the rainfall estimated for the whole vegetation period being 400-500 mm (Bojan, 1986, quoted by Hera et al., 1989)
Rainfall average (Figure 2) was comprised between 10.6 and 55.6 mm between emergence and inflorescence emergence and 134.2 and 147.8, between flowering and fruit forming.

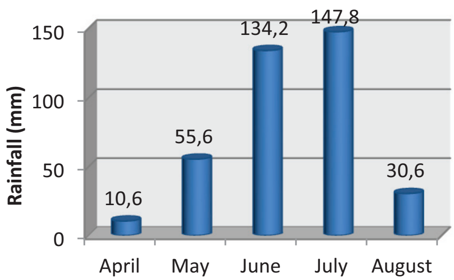

Figure 2. The average of rainfalls during the vegetation period of sunflower

The influence of fertilization on sunflower crop had a distinctly significant contribution regarding yield.

The yield differences (Tabel 3) between the variant $N_{90}P_{60}K_{60}$ plus Fertigrain foliar fertilizer and the variant $N_{90}P_{60}K_{60}$ is of 509 kg/ha, and compared to the control variant, it is of 1,801 kg/ha for the variant $N_{90}P_{60}K_{60}$ plus 1.5 liters/hectare of Fertigrain foliar fertilizer and 1,292 kg/ha for variant $N_{90}P_{60}K_{60}$.

Table 3. Yield differences between fertilization variants

B \ A	V1	V2	V3	V4	V5	V6
	(A-B) kg/ha					
V1 - N0P0K0 (Control)	-	+ 706	+ 1110	+ 1292	+ 1801	+ 1410
V2 - N90P0K0		-	+ 404	+ 586	+ 1095	+ 704
V3 - N90P60K0			-	+ 182	+ 691	+ 300
V4 - N90P60K60				-	+ 509	+ 118
V5 - N90P60K60 plus foliar fertilizer					-	-391
V6 - N120P60K60						-

The best result was achieved by the variant $N_{90}P_{60}K_{60}$ plus foliar fertilizer, where the yield was 4,035 kg/ha, turning out to be the best fertilization variant, thanks to the foliar fertilizer used. Bellow this value was the variant $N_{90}P_{60}K_{60}$ with a production of 3,526 kg/ha (Table 4).
Even if at the variant 6 of fertilization, where $N_{120}P_{60}K_{60}$ was used, the yield obtained was 3,644 kg/ha, the yield difference of + 118 kg/ha, compared to variant $N_{90}P_{60}K_{60}$, is not significant, the higher amount of ammonium nitrate cannot be justified.
Very significant results (***) were also achieved at variant 3, where $N_{90}P_{60}K_0$ was applied. Therefore, the yield achieved was 3,344 kg/ha, exceeding the control variant with 1,110 kg/ha.
The distinctly significant difference (**), compared to the unfertilized control variant, was obtained at variant 2, where $N_{90}P_0K_0$ was applied. The registered yield was 2,940 kg/ha, recording a plus of 706 kg/ha.

Table 4. Influence of fertilization on the sunflower crop

Variant	Yield kg/ha	%	Differences	Signification
V1 - $N_0P_0K_0$ (control)	2,234	100	*Ct*	-
V2 - $N_{90}P_0K_0$	2,940	132	706	**
V3 - $N_{90}P_{60}K_0$	3,344	150	1,110	***
V4 - $N_{90}P_{60}K_{60}$	3,526	158	1,292	***
V5 - $N_{90}P_{60}K_{60}$ plus 1.5 l/ha of Fertigrain foliar fertilizer	4,035	181	1,801	***
V6 - $N_{120}P_{60}K_{60}$	3,644	163	1,410	***
	Kg/ha		%	
LSD 5%	273		12	
LSD 1%	413		19	
LSD 0,1%	664		30	

In terms of biometric determinations regarding plant size and head diameter (Table 5), which were carried out at flowering, they were different according to the fertilization degree.
The highest sizes were recorded at the following fertilization variants: $N_{90}P_{60}K_{60}$ plus foliar fertilizer variant, 184 cm, and $N_{120}P_{60}K_{60}$ variant, 176 cm.
Head diameter varied between 15.3 and 25.0 cm, the highest values was highlighted at variants $N_{90}P_{60}K_{60}$ plus foliar fertilizer, 25 cm, and $N_{120}P_{60}K_{60}$, 23.3 cm. The average achieved by variants was 20.2 cm, only 3 variants exceeding this result.

Table 5. Influence of fertilization on plant size and head diameter

Fertilization variant		Plant size (cm)	%	Head diameter (cm)	%
V1	$N_0P_0K_0$ (control)	151	100	15.3	100
V2	$N_{90}P_0K_0$	161	106	17.3	113
V3	$N_{90}P_{60}K_0$	168	111	19.3	126
V4	$N_{90}P_{60}K_{60}$	172	114	21.0	137
V5	$N_{90}P_{60}K_{60}$ + foliar fertilizer	184	121	25.0	163
V6	$N_{120}P_{60}K_{60}$	176	116	23.3	152
Average		**168.8**		**20.2**	

Determinations on the Thousand Kernel Weight (TKW) and the hectolitre mass (HM) turned out to be directly proportional to the fertilization degree.
Values regarding TKW were between 58.3 g at the unfertilized control variant and 64.3 g at the fertilization variant 5, where, besides $N_{90}P_{60}K_{60}$, foliar fertilizer was also applied.
The hectolitre mass (HM) registered values between 40.8 kg/hl at the control variant and 46.2 kg/hl at the fertilization variant $N_{90}P_{60}K_{60}$ plus 1.5 liters/ha of Fertigrain foliar fertilizer, (Table 6).

Table 6. Effect of fertilization on TKW and HM quality indicators

Fertilization variant		TKW (g)	HM (kg/hl)
V1	$N_0P_0K_0$ (control)	58.3	40.8
V2	$N_{90}P_0K_0$	60.9	41.5
V3	$N_{90}P_{60}K_0$	62.8	42.8
V4	$N_{90}P_{60}K_{60}$	63.2	43.5
V5	$N_{90}P_{60}K_{60}$ + foliar fertilizer	64.3	46.2
V6	$N_{120}P_{60}K_{60}$	63.4	44.5
Average		**62.1**	**43.2**

CONCLUSIONS

Sunflower is a plant who can adapt to various environmental conditions. In order to harness the biological potential of the plant, favourable ecological conditions need to exist, as well as a suitable agricultural practice.
Climatic conditions on the plain of Oltenia have proven to be some of the most favourable for the sunflower crop, both in terms of temperatures and precipitations, vegetation phases being strongly influenced by temperature.
The 2017/2018 agricultural year highlighted the results achieved behind fertilization by various fertilization doses.
Following the application of various fertilization doses to the sunflower crop, both very significant and distinctly significant results, were highlighted compared to the control variant.
The maximum level of production was recorded by variant $N_{90}P_{60}K_{60}$ plus foliar

fertilizer, where a total of 4,035 kg/ha was obtained. The smallest production, compared to the unfertilized control variant, was obtained by the variant $N_{90}P_0K_0$ with 2,940 kg/ha, and the differences as against to the unfertilized control variant were between 706 and 1,801 kg/ha.

Also, the same variant $N_{90}P_{60}K_{60}$ plus foliar fertilizer registered the highest values in TKW and HM: 64.3 g and 46.2 kg/hl, respectively, compared to the unfertilized control variant.

It can be observed that the basic fertilization (NPK) in combination with the foliar fertilizer brings a significant production increase, detaching itself visibly from the other variants in terms of both production and seed quality.

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