THE EFFECTS OF DIFFERENT FOLIAR TREATMENTS ON THE SUNFLOWER CROP

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Abstract

The use of foliar fertilizers and biostimulators can be an important tool for increasing the yielding capacity of the sunflower plants and their ability to support stress factors, especially in these times when climate change has become the biggest global challenge for agriculture and food production. Foliar fertilizers are very useful in meeting the plant's requirements for various macro and micronutrients, and foliar biostimulators are very useful in improving and stimulating plant life processes. Starting from this aspects, the purpose of this paper is to present the effect of different foliar treatments (foliar fertilizers and biostimulating products) on sunflower plants in the specific growing conditions of south-eastern Romania. In this sense, research was carried out in the specific growing conditions of the South-East of Romania in climatic conditions in the years 2022 and 2023. The experimental variants were represented by two foliar fertilizers (YaraVita Brassitrel Pro and Lebosol Nutrifos), and two biostimulating products (Seactiv Gold and Atonik). Seactiv Gold biostimulator stood out with the highest grain yield associated with the smallest plant height, but the highest number of leaves per plant.

Key words: sunflower yield, plant height, leaves per plant, foliar fertilizer, biostimulator

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is an oilseed crop having short growing season which completes its production cycle in 90-120 days and can be grown twice a year. It fits well in existing cropping systems and can be grown without replacing any major crop (Ahmad et al., 2009).

Sunflower has uses in human nutrition and animal feed, industrial and energy uses, to which are added a number of specific uses (Ion, 2021). Among oil-producing crops, sunflower is a major source of edible oil in the world, which is preferred due to its high content of unsaturated fatty acids (Leland, et al., 1996). Its oil contains a high percentage of polyunsaturated fatty acids (60%) under the form of linoleic acid which is an omega-6 fatty acid.

The sunflower sector has managed to maintain its competitiveness through continuous innovation in genetics, cultivation practices and value-added research that has led to greater market segmentation (Pilorgé, 2020). As agro-meteorological conditions have a significant impact on yield (Nedealcov et al., 2016), climate change has led to a significant decrease in sunflower production (Babec et al., 2021). In its traditional production areas, sunflower crop will be exposed to major climate change and potentially impacted by water and temperature stresses (Prodan et al., 2021).

The use of fertilizers is essential for plant growth (Negi P. et al, 2022) in general, but especially under present climatic and economic global conditions. Fertilization is one of the major factors that could increase

sunflower yield (Shoghi-Kalkhoran et al., 2013). Nutrient management is one of the main factors that influence sunflower achene yield, achene oil content, and fatty acid composition (Mahmood, 2021), its importance being increasing in the current climate change.

Foliar fertilization is very useful in meeting the plant's requirements for various macro and micronutrients. Foliar fertilizers immediately provide nutrients to tissues and organs of the plants through application of liquid fertilizers. Leaves are green factories where photosynthesis produces compounds necessary for growth. So, the nutrients are absorbed right where they are used, acting quickly. For example, 80% of phosphorus applied through conventional fertilizers can be fixed in the soil, but up to 80% of foliar-applied phosphorus is absorbed directly (Reisdorph & Koster, 1999).

Foliar fertilization determines a large number of positive effects in the plant, mainly at the physiological level (respiration and photosynthesis), at the morphological level (root length and leaf area index) and on the yield of different crops (Tejada and Gonzalez, 2003; Tejada et al., 2016). Foliar application of fertilizers improves the uptake of nutrients that are immobile and difficult for plant roots to absorb, thus reducing plant deficiency symptoms and can be used as a remedy for drought affecting sunflower in the vegetative stage to maximize yield (Asare et al., 2023).

Foliar application of specific organic matter proved to be a powerful tool for stimulating the plant to a more intense but balanced vegetative development (Gheorghe et al., 2014). Biostimulants are increasingly integrated into production systems with the aim of modifying physiological processes in plants to optimize productivity (Yakhin et al., 2017).

Plant biostimulators are various non-toxic substances, mostly of natural origin, that improve and stimulate plant life processes in a different way than fertilizers or phytohormones. Their influence on plants consists in improving plant metabolic processes without altering their natural pathway (Malgorzata et al., 2016).

Because of the climate, which is constantly changing, in general but especially when it comes to the South-East of Romania, which is one of the poorest areas in the country in terms of precipitation, it is essential to adapt and find the best and most effective solutions of fertilization and help plants to surpass the water stress. Starting from this reality, the purpose of this paper is to present the effect of different foliar treatments (foliar fertilizers and biostimulating products) on sunflower plants in the specific growing conditions of south-eastern Romania.

MATERIALS AND METHODS

The research was carried out in the Dobrogea region of South-Eastern Romania, in the Cerna commune of Tulcea county, and consisted of field experiments carried out under climatic conditions in the years 2022 and 2023.

The field experiments were based on the method of subdivided plots into 3 replications. The experimental factor was the foliar treatment which the following graduations:

- YaraVita Brassitrel Pro;
- Lebosol Nutrifos;
- Seactiv Gold;
- Atonik;

The basic fertilization was done with the product NPK 20-20-0 in a dose of 350 kg/ha which provided 70 kg/ha of nitrogen and 70 kg/ha of P_2O_5. NPK 20-20-0 is produced by Azomureș Company and it is a classic fertilizer with a content of 20% nitrogen

under the form of NH_4^+ (11.3%) and NO_3^- (8.7%), and 20% phosphorus under the form of 63% water soluble.

YaraVita Brassitrel Pro is produced by Yara Company and it is a balanced combination of essential micronutrients, particularly suitable for field crops and vegetables. It has the following chemical composition: Nitrogen (N) - 69 g/l, Boron (B) - 60 g/l, Calcium oxide (CaO) - 125 g/l, Manganese (Mn) - 70 kg/l, Oxide of magnesium (MgO) - 118 g/l, Molybdenum (Mo) - 4g/l.

Lebosol Nutrifos is produced by Lebosol Company and it is a foliar fertilizer developed based on phosphorus and zinc, supplemented with nitrogen. It is necessary to be applied to crops with low availability of phosphorus and zinc elements, in the case of acidic or very alkaline (calcareous) soils, with low humus or high iron content, in conditions of increased humidity and low temperatures. It has the following chemical composition: 30% total phosphorus in the form of water-soluble P_2O_5 (450 g/l P_2O_5), 7% total zinc in the form of water-soluble zinc oxide (105 g/l Zn), 3 % total nitrogen in the form of urea nitrogen soluble in water (45 g/l N).

Seactiv Gold is produced by Timac Agro Company and it is a foliar biostimulator with a mixture of trace elements based on seaweed and plant extracts, with the effect of intensifying metabolic processes and stress tolerance, intended for sunflower and rapeseed crops. The chemical composition is the following: Boron (B) soluble in water - 5.7%, Molybdenum (Mo) soluble in water - 0.35%, plus the Seactiv organic complex which improves the ability of crops to manage stress.

Atonik is produced by Aectra Company and it positively influences most of the vital processes in plants, positively influencing the generative growth of plants (stimulating the fertility of flowers, by increasing the percentage of fertile pollen grains and by lengthening the pollen tube) and increasing the accumulation of biomass. Atonik has the highest percentage of stimulation of nitrate-reductase activity, a very important enzyme for nitrogen accessibility/utilization by plants. It contais 0,2% ortonitrofenolat de sodiu, 0,3% aranitrofenolat de sodiu, and 0,1% 5 - nitroguaiacolat de sodiu.

All the foliar treatments were applied in the growth stage of 8 leaves of the sunflower plants, in the following rates: 3 l/ha for YaraVita Brassitrel Pro, 6 l/ha for Lebosol Nutrifos, 3 l/ha for Seactiv Gold, and 0.6 l/ha for Atonik.

Each experimental variant had a size of 67.2 m^2 consisting of 12 rows of sunflower plants with 70 cm between rows resulting in a width of 8.4 m and a length of 8 m along the rows.

The previous crop was maize. Tillage in the experimental field consisted of harrowing after harvesting the previous crop, and in October ploughing was carried out at a depth of 20 cm. The ploughing was followed in the fall by harrowing and in the spring the seedbed preparation was carried out before sowing with a cultivator.

Sowing was carried out on April 9, 2022 and May 3, 2023. The ensured plant density was 64,000 plants per hectare.

The sunflower hybrid used in the research was SY Onestar CLP, which is created by the Syngenta Company, being characterised as a hybrid with exceptional production potential, adaptable and stable in different growing conditions.

Weed control was achieved by applying the herbicide Pulsar 40 (Imazamox 40 g/l) in a rate of 1.2 l/ha in the growth stage of 6 leaves of sunflower plants.

For controling sunflower diseases, the fungicide Pictor Active (Boscalid 150 g/l and Pyraclostrobin 250 g/l) was applied in a rate

of 1 l/ha in the growth stage of 8 leaves of sunflower plants.

The results in this paper refer to seed yield (kg/ha) calculated at a moisture content of 9%, to the plant height and number of leaves per plant. Calculation and interpretation of results were done based on analysis of variance.

The geographical coordinates (44°59'15.3"N 28°22'07.0"E) of the location where the research takes place determine its inclusion in the temperate continental climate zone. Therefore, the climate is characterized by high temperatures in summer and sometimes very low in winter. The average annual temperature is around 10.8ºC.

Regarding the temperatures recorded during the vegetation period of sunflower plants, compared to the year 2022, in the year 2023 the months of March, July and August were warmer, while the months of April, May and June were colder (Table 1). As average values for the period March-August, the year 2023 with 17.2ºC was warmer than the year 2022 with 16.8ºC.

Regarding the precipitation recorded during the vegetation period of sunflower plants, the year 2022 with 162 mm was drier than the year 2023 with 250 mm. In 2023, after a dry March with 8 mm of precipitation, a rainy April with 125 mm followed. Consequently, in 2023 sowing was significantly delayed compared to the usual sowing period for the study area, which is between the end of March and the beginning of April. Thus, in the year 2023, sowing was carried out on May 3. In both experimental years, the month of July, but especially August, was characterized by a low amount of precipitation.

Table 1. Climatic conditions during sunflower plant's vegetative period at Cerna, Tulcea county, Romania

Month	Temperature (ºC)		Rainfall (mm)	
	2022	2023	2022	2023
March	3.4	7.8	32	8
April	11.1	10.2	15	125
May	16.8	15.5	49	36
June	21.8	19.8	34	41
July	23.5	24.7	20	25
August	24.2	25.4	12	15
Average/Sum	***16.8***	***17.2***	***162***	***250***

RESULTS AND DISCUSSIONS

The highest grain yield were obtained In both experimental years in the case of using Seactiv Gold biostimulator, with differences compares to average grain yield in the experiment assuaged statistically as being positive significant in 2022 and positive distinct significant in the more favourable year 2023 (Table 2). The positive effect on the grain yield was associated with the smallest plant height in the experiment in both experimental years (Table 3), but also with the highest number of leaves per plant in the experiment in both experimental years, especially in 2023 when the difference compared to the experimental average was positive distinct significant (Table 4).

The smallest grain yield was obtained in both experimental years in the case of Lebosol Nutrifos foliar fertilizer, especially in the more favourable year 2023 with a difference compared to average experiment being negative significant (Table 1). Lebosol Nutrifos foliar fertilizer determined the highest plant height in 2022 (129 cm), one of the highest plant height in 2023 (129 cm) (Table 3). It also determined the smallest number if leaves per plant in 2023, with difference compared to experiment average being negative distinct significant (Table 4).

It has to be underline that the results obtained in the case of the Seactiv Gold

biostimulator which determined the best results and Lebosol Nutrifos foliar fertilizer which determined the smallest effects were more effective in the more favourable year 2023, with more positive effects in the case of Seactiv Gold biostimulator and less positive effects in the case of Lebosol Nutrifos foliar fertilizer.

The Atonik biostimulator was more effective in the less favourable year 2022, while Yara Brsassitrel Pro was more effective in the more favourable year 2023.

The values of the obtained results are specific for the water stress conditions, with and average grain yield of 1852 kg/ha, with an average plant height of 126.25 cm and with an average number of leaves per plant of 29.7.

Table 2. Sunflower grain yield at different foliar product treatments in South-East of Romania (2022-2023)

Experimental factor (Applied product)	Yields obtained in 2022			Yields obtained in 2023			Average yield in 2022-2023 (kg/ha)
	Yield (kg/ha)	Differences to control		Yield (kg/ha)	Differences to control		
		kg/ha	%		kg/ha	%	
Yara Brsassitrel Pro	1702	-69	-3.90	1904	-29	-1,50	1803.0
Lebosol Nutrifos	1691	-80	-4.52	1655	-278 º	-14,38	1673.0
Seactiv Gold	1926	155 *	8.75	2351	418 **	21,62	2138.5
Atonik	1764	-7	-0.40	1821	-112	-5,79	1792.5
Average	*1771*	*Control*	-	*1933*	*Control*	-	1852.0

$LSD_{5\%}$ = 147.35 kg
$LSD_{1\%}$ = 214.38 kg
$LSD_{0.1\%}$ = 322.11 kg

$LSD_{5\%}$ = 235.24 kg
$LSD_{1\%}$ = 342.25 kg
$LSD_{0.1\%}$ = 514.24 kg

Table 3. Sunflower plant height at different foliar product treatments in South-East of Romania (2022-2023)

Experimental factor (Applied product)	Plant height in 2022			Plant height in 2023			Average plant height in 2022-2023 (cm)
	Plant height (cm)	Differences to control		Plant height (cm)	Differences to control		
		cm	%		cm	%	
Yara Brsassitrel Pro	124	-2	-1.6	123	-3.5	-2.8	123.5
Lebosol Nutrifos	129	3	2.4	129	2.5	2.0	129.0
Seactiv Gold	123	-3	-2.4	124	-2.5	-2.0	123.5
Atonik	128	2	1.6	130	3.5	2.8	129.0
Average	126	Control	-	126.5	Control	-	126.25

$LSD_{5\%}$ = 8.27 cm
$LSD_{1\%}$ = 12.04 cm
$LSD_{0.1\%}$ = 18.09 cm

$LSD_{5\%}$ = 6.52 cm
$LSD_{1\%}$ = 9.48 cm
$LSD_{0.1\%}$ = 14.25 cm

Table 4. Number of leaves per sunflower plant at different foliar product treatments in South-East of Romania (2022-2023)

Experimental factor (Applied product)	No of leaves per plant in 2022			No of leaves per plant in 2023			Average no of leaves per plant In 2022-2023
	No of leaves per plant	Differences to control		No of leaves per plant	Differences to control		
		No	%		no	%	
Yara Brsassitrel Pro	28.3	-0.6	-2.1	30.3	-0.2	-0.7	29.30
Lebosol Nutrifos	28.7	-0.2	-0.7	28.7	-1.8 ^{oo}	-5.9	28.70
Seactiv Gold	30.0	1.1	3.8	32.3	1.8 **	5.9	31.15
Atonik	28.7	-0.2	-0.7	30.7	0.2	0.7	29.70
Average	28.9	Control	-	30.5	Control	-	29.7
		$LSD_{5\%}$ = 1.33 $LSD_{1\%}$ = 1.93 $LSD_{0.1\%}$ = 2.91			$LSD_{5\%}$ = 1.08 $LSD_{1\%}$ = 1.58 $LSD_{0.1\%}$ = 2.37		

CONCLUSIONS

For the study conditions and among the study products, Seactiv Gold biostimulator with the highest grain yield stood out, this determining the smallest plant height, but the highest number of leaves per plant.

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