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Sunflower Yield Depending on the Application of Micronutrients

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ABSTRACT

Background: The article presents the results of field experiments on the use of micro fertilizers on sunflower. The object of the study was a hybrid of sunflower Fausto from the company “Strube DandS GMBH”. Field experiments were carried out with micro fertilizers of the German company “Lebozol”, the Russian “Polydon Agro” and the Lithuanian “Acoustic Biotechnologies (brand Humic Land”).

Methods: Foliar application with micronutrients and their treatment of sunflower seeds and their combination were studied. As studies have shown, the variant with the use of micronutrients for seed dressing against the background of foliar application showed the greatest effectiveness. Foliar application without treating seeds with trace elements did not significantly increase the yield and oil yield. Also, the oil content of the seeds according to the variants in the years of research did not differ significantly. In general, the condition of sunflower plants during the years of research before harvesting was satisfactory. At the same time, it should be noted that in 2022 abnormal precipitation affected the quality of sunflower seeds.

Result: The analysis of the obtained results indicates the need for further search for optimal ways of using micronutrients to increase the yield of sunflower and its quality. It should also be taken into account the fact that according to economic calculations, the costs of applying micro fertilizers during seed treatment will not exceed 10 rubles/ha and with àoliar application they will amount to 1300-2300 rubles/ha. accordingly.

Key words: Field experiments, Sunflower, Trace elements, Vegetation.

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is quite demanding on the nutrient regime of the soil. In the first period of growth, it especially needs iron, zinc, magnesium and manganese, boron, copper, molybdenum are needed closer to the flowering phase.

Having a powerful root system, sunflower provides itself with moisture and nutrients quite independently. Therefore, the effectiveness of micronutrients used as leaf feedings and in seed treatment requires study in field experiments (Avdeenko, 2018; Astafurova *et al*., 2014; Goncharuk *et al*., 2018). In modern sunflower cultivation technologies, it is important to use trace elements, microbiological preparations and plant growth regulators of a new generation that ensure the production of high-quality products. In plants, micro-fertilizers are included in the metabolism, activate biochemical processes, as a result, the growth and development of plants accelerates, their resistance to adverse weather conditions and productivity increases and the quality of products improves. (Astafurova *et al*., 2015; Savelyev, 2019; Tsykalov *et al*., 2013). They are used for seed treatment or spraying plants. The modern market of micronutrients and growth regulators offers many preparations, but attention should be paid only to preparations that have been experimentally tested repeatedly on different varieties and in different climatic zones (Dospekhov, 1985; Fedotov *et al*., 2020; Gulidova *et al*., 2019).

The purpose of this study was to study the effect of various preparations with trace elements on the growth, development and quality of the sunflower crop. To achieve this goal, issues with the selection of relevant and promising drugs, the laying of field experiments and the comparative characteristics of the results obtained with a positive effect on the yield and quality of sunflower were solved.

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MATERIALS AND METHODS

Field experiments were carried out in 2020-2022 years on the basis of the experimental field of the company “Strube Rus” in the Voronezh region, Russia. The object of research is a hybrid of sunflower Fausto from the selection of the German company “Strube D and S GMBH”. Field experiments were carried out with micro fertilizers of the German company “Lebozol”, the Russian “Polydon Agro” and the Lithuanian “Acoustic Biotechnologies (brand Humic Land”. Foliar application with micro fertilizers and their treatment of sunflower seeds and their combination were

studied. The repeatability of the experiments is 3-fold, the area of the plot is 20 m^2.

The generally accepted technology for sunflower of the "sulfo" type was used in field experiments. The predecessor is spring soft millet. Since autumn, $N_{60}P_{60}K_{60}$ has been introduced for plowing in the form of 3.75 c/ha of nitrogen. In the phase of 4 real leaves, the crops were treated with herbicide Express - 45 g/ha (FMS manufacturer). The herbicide Panther - 1 l/ha (manufacturer of YPL) was used against cereal weeds. To protect against diseases, the fungicide Pictor active - 0.8 l/ha (BASF producer) was used.

In 2020 year, the phytosanitary condition of sunflower crops was satisfactory. With a seeding rate of 63 thousand seeds per 1 ha, the left germination rate was 90-92%. The density of standing plants for harvesting was 51-54 thousand / ha. That is, the survival rate of plants was more than 93%.

Scheme of experience, in 2020 year:

1) Control (without micro-fertilizers).
2) Lebozol seed treatment (Lebozol Full care 5 l/t).
3) Lebozol leaf dressing (5-7 days after herbicide Express: Lebozol Trimax 1 l/ha + Lebozol Boron 0.5 l/ha + Lebozol Molybdenum 0.1 l/ha).
4) Lebozol seed treatment + leaf feeding (Lebozol Full care 5 l/t) + leaf feeding 5-7 days after herbicide Express (Lebozol Trimax 1 l/ha + Lebozol Boron 0.5 l/ha + Lebozol Molybdenum 0.1 l/ha).
5) Polydon seed treatment (Polydon Amino Start 0.5 l/t + Alfastim 0.05 l/t).
6) Polydon seed treatment + leaf feeding 1 (Polydon Amino Start 0.5 l/t + Alfastim 0.05 l/t) + leaf feeding (1st: Alfastim 0.05 l/ha with herbicide Express; 2nd: Polydon Complex 1 l/ha + Polydon Bond 0.05 l/ha after 5-7 days after herbicide Express; 3rd: Polydon Calcium 0.5 l/ha + Polydon Bo-ron 1.0 l/ha + Polydon Bond 0.1 l/ha in budding).
7) Polydon seed treatment + leaf feeding 2 (Polydon Amino Start 0.5 l/t + Alfastim 0.05 l/t) + leaf feeding (1st: Alfastim 0.05 l/ha with herbicide Express; 2nd: Polydon Amino Mix 1 l/ha + Polydon Bond 0.05 l/ha *via* 5-7 days after Ex-press herbicide; 3rd: Polydon Amino plus 0.5 l/ha + Polydon Calcium 0.5 l/ha + Polydon Boron + 1.0 l/ha + Polydon Bond 0.1 l/ha in budding).
8) Polydon leaf dressing 1 (1st: Alfastim 0.05 l/ha with herbicide Ex-press; 2nd: Polydon Complex 1 l/ha + Polydon Bond 0.05 l/ha 5-7 days af-ter herbicide Express; 3rd: Polydon Calcium 0.5 l/ha + Polydon Boron 1.0 l/ha + Polydon Bond 0.1 l/ha in budding).
9) Polydon leaf dressing 2 (1st: Alfastim 0.05 l/ha with herbicide Ex-press; 2nd: Polydon Amino Mix 1 l/ha + Polydon Bond 0.05 l/ha 5-7 days after herbicide Express; 3rd: Polydon Amino plus 0.5 l/ha + Polydon Calcium 0.5 l/ha + Polydon Boron + 1.0 l/ha + Polydon Bond 0.1 l/ha in budding).

RESULTS AND DISCUSSION

The weight of the seeds in the basket was maximum on variants with the use of micronutrients -65-67 g. On the control, the weight of the baskets was lower by 6.5-8.2%-61 g. The minimum weight of the basket was noted on variants No. 5 and 9-58-59 g, when processing seeds Polydon and foliar application Polydon 2.

The results of the studies showed that foliar application with Lebozol fertilizers did not show effectiveness - the increase in yield was 1.2%. With Polydon 1 foliar application, the yield increase was 1.8% and with Polydon 2, the yield fell by 5.3%.

The most significant increase in yield was noted during the processing of seeds with micro fertilizers "Lebozol full care", as well as against the background of the subsequent use of foliar application -6.2 - 6.5%, here the yield was 3.60-3.61 t ha^{-1}. A slightly lower increase in yield was obtained on the Polydon variant of seed treatment + leaf feedings 1-5.9%. It should be noted that there was no significant difference between the best variants of the experiment (Table 1).

In general, the effectiveness of sunflower foliar application has not been revealed. At the same time, a greater effect was obtained with the use of micronutrients in the treatment of seeds with the Lebozol variant.

The maximum oil content of the seeds was noted in the variants of processing seeds and plants with micro-fertilizers "Polydon" - 54.2-55.1%. The exception was the Polydon leaf feeding option 1-49.5%, which was the minimum result in the experiment.

The oil yield at the control was 1.72 t ha^{-1}. In the variants with the use of only foliar application "Lebozol" or "Polydon" and Polydon seed treatment, the oil yield was also minimal -1.71-1.75 t ha^{-1} (Table 2).

The maximum oil yield was obtained from the Polydon variant of seed processing + foliar application 1 - 1.95 t ha^{-1} or 13.4% higher than the control. The second in terms of oil output was the option of Lebozol + leaf feedings - 1.88 t/ha and the third place was taken by the option of Lebozol seed treatment -1.87 t ha^{-1}.

The research was continued and other options were selected. The density of plants for harvesting during the two years of research practically did not differ (Table 3).

At the same time, in 2022 year, the weight of the seeds in the basket was significantly higher than in 2021 year - 71 g versus 63-69 g. The reason for this is most likely a fairly high level of precipitation that fell during the growing season of sunflower.

The yield of sunflower seeds in 2021 increased from the use of micro-fertilizers "Lebozol". In 2022 year, the yield was significantly higher from the use of organic micro fertilizers Humin Land (Table 4).

On average, over two years of research, there was no significant in-crease in yield from the use of micronutrients. The increase in yield was 0.12-0.14 t ha^{-1}.

A more accurate picture is observed when determining the oil content on the studied variants and the oil output. The oil content of the seeds ac-cording to the variants in the years of research did not differ significantly (Table 5).

The maximum oil yield was noted on variants with the use of micro–fertilizers - 1.79 t ha^{-1}, against 1.71 t ha^{-1} on the control. However, the increase in oil output was in the limit of 5% (experimental error), which makes it impossible to fully assert the effectiveness of micro-fertilizers.

Table 1: The density, weight of the basket and yield of sunflower depending on the micro-fertilizers "Lebozol" and "Polydon", 2020 year.

Experience options	Plant density for harvesting, thousand units/ha	Weight of seeds in a basket, g	Seedling yield at 7% humidity, t ha^{-1}	Increase in yield to control	
				t ha^{-1}	%
Control (without micro-fertilizers)	54	61	3.39	-	-
Lebozol seed treatment	54	65	3.61	0.22	6.5
Lebozol leaf feeding	51	66	3.43	0.04	1.2
Lebozol seed treatment + leaf feeding	54	66	3.60	0.21	6.2
Polydon seed treatment	53	58	3.15	-0.24	-7.1
Polydon seed treatment + leaf feeding 1	53	67	3.59	0.20	5.9
Polydon seed treatment + leaf feeding 2	53	62	3.35	-0.04	-1.2
Polydon leaf feeding 1	53	64	3.45	0.06	1.8
Polydon leaf feeding 2	53	59	3.21	-0.18	-5.3
CD (P 0.05)			2.26		

Table 2: Oil content and oil yield depending on the micro-fertilizers "Lebozol" and "Polydon", 2020.

Experience options	Oil content in terms of dry matter, %	Oil output, t ha^{-1}	Increase in control t ha^{-1}	%
Control (without micro-fertilizers)	50.8	1.72	-	-
Lebozol seed treatment	51.9	1.87	0.15	8.5
Lebozol leaf feeding	50.8	1.74	0.02	1.2
Lebozol seed treatment + leaf feeding	52.1	1.88	0.16	9.3
Polydon seed treatment	54.9	1.73	0.01	0.6
Polidon seed treatment + leaf feeding 1	54.2	1.95	0.23	13.4
Polidon seed treatment + leaf feeding 2	55.1	1.85	0.13	7.6
Polydon leaf feeding 1	49.5	1.71	-0.01	-0.6
Polydon leaf feeding 2	54.4	1.75	0.03	1.7
CD (P 0.05)	2.37	0.82		

Table 3: The density and weight of the sunflower basket depending on the micro-fertilizers "Lebozol" and "Humic land", 2021-22.

Experience options	Plant density, pcs./ha			Weight of seeds in a basket, ha^{-1}		
	2021 r.	2022 r.	Mid.	2021 r.	2022 r.	Mid.
Control (without leaf feeding)	49	51	50	68	73	71
Lebozol (according to the background twice in the phase of 4 leaves and budding: Lebozol Rapsmix 3 l/ha + Lebozol full care 1 l/ha + Lebozol boron 1 l/ha)	51	52	52	69	73	71
Humik land (1 l/ha in the phase of 4 leaves + 1 l/ha in budding)	52	51	52	63	78	71

Table 4: Sunflower yield depending on micro fertilizers "Lebozol" and "Humic land", 2021-22.

Experience options	Yield, t/ha			Increase in yield to control	
	2021 r.	2022 r.	Mid.	t ha^{-1}	%
Control (without leaf feeding)	3,31	3,73	3,52	-	-
Lebozol (according to the background twice in the phase of 4 leaves and budding: Lebozol Rapsmix 3 l/ha + Lebozol full care 1 l/ha + Lebozol boron 1 l/ha)	3,52	3,80	3,66	0,14	4,0
Humik land (1 l/ha in the phase of 4 leaves + 1 l/ha in budding)	3,30	3,97	3,64	0,12	3,4

Table 5: Oil content and oil yield depending on the micro-fertilizers "Lebozol" and "Humic land", 2021-22.

Experience options	Oil content in terms of dry matter, %			Oil output,	Increase in control	
	2021 г.	2022 г.	Mid.	t ha^{-1}	t ha^{-1}	%
Control (without leaf feeding)	49.7	47.6	48.7	1.71	-	-
Lebozol (in accordance with the background twice before 4 leaves and litter: Lebozol Rapsmix 3 l/ha + Lebozol full cure 1 l/ha + Lebozol boron 1 l/ha)	50.4	47.2	48.8	1.79	0.08	4.7
Humik land (1 l/ha in the phase of 4 leaves + 1 l/ha in budding)	50.9	47.5	49.2	1.79	0.08	4.7

In general, the condition of sunflower plants in the years of research before harvesting was satisfactory. At the same time, it should be noted that in 2022 year, abnormal precipitation affected the quality of sunflower seeds.

CONCLUSION

Thus, we can make a preliminary conclusion that the option with the use of micro-fertilizers for seed dressing against the background of foliar application showed the greatest effectiveness. Foliar application without seed treatment with trace elements did not significantly increase the yield and oil yield. It should also be taken into account the fact that according to economic calculations, the costs of using micronutrients in seed treatment will not exceed 10 rubles/ha and with leaf feedings they will amount to 1300-2300 rubles/ha.

Conflict of interest

All authors declare that they have no conflict of interest.

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