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Influence of Mineral Nutrition and Combined Growth Regulating Chemical on Nutrient Status of Sunflower

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Abstract: Fertilizers have a radical impact on the level of providing plants with mineral elements. But the practice shows that not only the fertilizers solve all the issues related to the optimization of nutrient regime. The technological cycle of the sunflower has the most stressful situations in the early growing season, after herbicide application or during a long drought, when moisture deficit occurs due to high level of temperature. In these cases it is necessary to treat plants with growth regulators that minimize the impact of stressful conditions and cause intensive consumption of macro - and micronutrients by plants. The present research is focused our research on all these issues and addressed them this article. Field studies were taking during 2015 – 2016 on ordinary soils with poor humus in the Dry Steppe zone. The experience was based on two-factor scheme, where factor A was the background of mineral nutrition (a test plot without fertilizer; N30P45; N60P90); and factor B was foliar feeding of sunflower plants by the integrated growth regulating growth regulator Khelafit Combi® (produced by the company "Khelafit", Ukraine). The positive effect of the combined growth regulator is always seen in more favorable weather and in climatic conditions of 2016 when the level of the growth regulator influence grew. A double treatment of plants by the Khelafit Combi® showed significant efficiency. In this case, during the use of the growth regulator, the level of the yield was always higher than the indicator HIP05. On average during two years of field research the double processing plants of the sunflower by the growth regulating growth regulator showed that the increase in yield amount on the non fertilized background , N30P45 , N60P90 was 0.22 t ha^{-1} (13.6%), 0.27 t ha^{-1} (14%) and 0.23 t/ha (11,. percent).

Keywords: Sunflower, Fertilizer, Growth regulating, Yield, Nutrient status, Khelafit Combi®

The complex multifactorial influence assessment of natural and economic activities provides the opportunity to examine multi-component parts of links of the natural-territorial complex, to determine the spatial-temporal patterns of transformation of agricultural landscapes in terms of intensive and extensive methods of its cultivation and to study the modern soil-climatic and ecological potential of the area for cultivation various crops (Lisetskii 2016, Lisetskii and Pichura 2016). The influence of agro-climatic conditions and farming has a significant impact on the agrochemical condition of the soil, and obtaining the actual crop. Agrochemical principles of qualitative land evaluation are particular relevant in the absence or lack of effective management or of resource-saving economic activities of land users. The main agrochemical parameters, characterize fertility and energy potential of the soil, are the content of humus and mobile elemental forms of power (Lisetskii et al 2017). Regulating the nutrient content in the soil, their absorption by plants at different ratios there is a nutrient regime system. It has a radical impact on the level of plant supply with mineral elements. But the practice shows that not only the fertilizers solve all the issues related to the nutrient regime optimization. During the vegetation period the plants are under stress for quite a long time and their nutrition under the following environmental conditions is not effective. The farmer's task is to create appropriate conditions for the fastest elimination of plants out from stress conditions (Bazaliy et al 2015). Under these conditions, it is necessary to use multifunctional growth regulating which have a complex of micro-elements, distinguished by a fungicidal action, activate the microorganisms and stimulate the growth processes. From this point of view, the most effective multifunctional growth regulating that meets the requirements of comprehensiveness, is Khelafit Combi®. which contains highly absorbable minerals in balanced for all stages of organogenesis of Khelafit form (Fe, B, Mg, Mn, Zn, Mo, Cu); spores and cell cultures-producers (*Bacillus submits*, *Pseudomonas* and *Trichoderma*) which gives fungicidal qualities as well as multifunctional stimulators and growth regulators (auxins, cytokine's, gibberellins, humic and fulvic and amino acids) (Bazaliy 2016, Domaratskiy 2017). Balanced formulation also includes effective organic solvents and adhesives which allow to stay longer on the surface of the plant until complete absorption of the solution.

Due to the fact that Khelafit Combi® does not cause resistance in phytopathogens, the growth regulator has a stable effect for many years. The technological cycle of the sunflower has the most stressful situations in the early growing season, after herbicide application or during a long drought, when moisture deficit occurs due to high level of temperature. In these cases it is necessary to treat plants with growth regulators that minimize the impact of stressful conditions and cause intensive consumption of macro - and micronutrients by plants. The present research is focused on all these issues

MATERIAL AND METHODS

Field studies conducted during 2015-2016 in the Elanetsky district of the Mykolayiv region. Soil research field was ordinary black h with a humus content of hydrolyzed nitrogen 1.5 – 1.8; easy digestible phosphorus 4.5-7.0 and exchangeable potassium 12 – 15 mg 100 g^{-1} of soil. The experiment was based on two-factor , where factor A was the background of mineral nutrition (a test plot without fertilizer; $N_{30}P_{45}$; $N_{60}P_{90}$); and factor B was foliar feeding of sunflower plants (hybrid- Zaklyk) of the integrated growth regulating Khelafit Combi® (produced by the company “Khelafit”, Ukraine). Mineral fertilizers were used during the main processing of the soil by surface spreading using the fertilizer spreader. Treatment of sunflower plants with Khelafit Combi® conducted an aerial sprayer at 4 – 6 real leaves and the budding phase. The growth regulator was used @ 1 l ha^{-1}, and a working fluid 250 l ha^{-1}. The size of the research plot was 31360 m^2. The experiment was repeated four times. Soil moisture was determined by the thermostat-weight method. Volume weight of soil was taken from soil acerto and humidity resistant drying was determined experimentally (for soil layer 0 – 30 cm it was equal to 12,5%, and for the layer 0 – 100 cm was 11,8%) (Vadyunina 1986, Gnatenko 2002). Harvesting was performed by the combine threshing method from the accounting area of the plot. It was used a harvester KLAAS with four rows console for sunflower. The collected harvest was counted for the basic presence of humidity (8%) and taking into account the presence of impurities. Experimental data were processed by the method of multifactor variance analysis (Dospekhov 1985). Modeling of yield formation was carried out using the licensed software "Statistica 8.0".

RESULTS AND DISCUSSION

The Zn and Mn microelements in soil ranged between of 0.4– 0.5 mg^{-1} and 9 – 12 mg 1 kg^{-1} of soil. Data of soil analysis shows a high need for improving agrochemical indicators by using additional norms of mineral fertilizers. Nitrogen deficiency was observed from the first stages of ontogenesis and in the future, despite the nitrogen fixing activity for the soil micro-flora, the tendency to a shortage of this element remains (Table 1).

Using the complex of growth regulating Khelafit Combi® in foliar feeding for the sunflower was accompanied by the increasing the level of total biomass, at the same time it had not lead to a corresponding decrease of hydrolyzed nitrogen in the soil. There was a tendency to increase the level of this index in the most critical periods of the growing season, due to the anti-stress effect of the Khelafit. Mitigating the negative effects of stress and reducing the time of it allows you to optimize the conditions of supply of agrocenosis in sunflower and reduce the release of nitrogen from the soil. When mineral fertilizers tended to reduce the positive effects of the growth regulating growth regulator on the release of nitrogen from the soil, even though its positive effect did not disappear.

Table 1. Dynamics of the hydrolyzed nitrogen content according to fertilizers and the growth regulating growth regulator, mg/100 g soil (Average of 2015-2016)

Fertilizer	Growth regulator	Phenophases			
		Shoots	Beginning of the formation of the baskets	Flowering	Full Ripeness
Without fertilizers	Test	2,91	3,31	2,53	2,40
	Khelafit Combi® (once)	2,91	3,46	2,71	2,58
	Khelafit Combi® (twice)	2,91	3,50	2,68	2,49
$N_{30}P_{45}$	Test	3,82	4,01	3,49	3,19
	Khelafit Combi® (once)	3,82	4,24	3,49	3,30
	Khelafi tCombi® (twice)	3,82	4,20	3,58	3,26
$N_{60}P_{90}$	Test	4,69	5,27	3,97	3,90
	Khelafit Combi® (once)	4,69	5,21	4,07	3,81
	Khelafit Combi® (twice)	4,69	5,26	4,04	3,87

Table 2. Dynamics of the content of easily digestible phosphorous acid depending on fertilizers and the growth regulating growth regulator, mg/100 g soil (Average of 2015-2016)

Fertilizer	The growth regulator	Phenophases			
		Shoots	Beginning of the formation of the baskets	Flowering	Full Ripeness
Without fertilizers	Test	5,5	5,7	5,3	5,1
	Khelafit Combi® (once)	5,5	5,9	5,6	5,1
	Khelafit Combi® (twice)	5,5	6,0	5,4	5,2
$N_{30}P_{45}$	Test	6,3	6,5	5,7	5,8
	Khelafit Combi® (once)	6,3	6,8	6,3	6,0
	Khelafit Combi® (twice)	6,3	6,7	6,0	5,9
$N_{60}P_{90}$	Test	6,8	7,0	6,4	6,3
	Khelafit Combi® (once)	6,8	7,3	6,8	6,2
	Khelafit Combi® (twice)	6,8	7,2	6,6	6,0

The increase in the crop yield did not affect the reducing of nutrients in the soil. As for the content of easily digestible phosphorus in the soil the results of field studies had different dynamics (Table 2).

When the plants reach the phase of complete ripeness the content of P2O5 in all the variants is aligned and Khelafit Combi® doesn't lead for increasing the levels of this element of supply in the soil. Important is the fact that the main spending of the analyzed elements of supply, which were spent by the sunflower plants on the formation of 100 kg of dry biomass, had a low level depending on the growth regulatory Khelafit Combi® (Table 3).

The dependence of major unit costs of nutrients from the growth regulator, but according to this indicator there are no significant changes observed. All these fixing a certain feature of sunflower plants concerning to the removal of nutrients from the soil (Table 3). This plant shapes its level of removal of macro - and micronutrients from the soil depending on the background of the supply. The sunflower yield is the integrated background impact of the mineral nutrition indicator and the growth regulating growth regulator action of Khelafit Combi® (Table 4). The results of the studies confirm a clear trend to a positive impact of fertilizers and in all cases it has received an increase of the yield level. The general conclusion is complicated to make regarding to the influence of the growth regulatory growth regulator Khelafit Combi® because in some versions of the experiment the obtained increase was within the error of experiment (in 2015

Table 3. Cost of nutrients for the formation of 1 kg of dry biomass of sunflower (without making basic fertilizer, (Average of 2015-2016)

Research options	Removal (kg ha^{-1})		Yield of dry biomass, (t ha^{-1})	Cost for 100 kg of dry biomass kg	
	N	P_2O_5		N	P_2O_5
Test	39,5	12,0	5,38	0,67	0,22
Khelafit Combi® (once)	35,1	12,6	5,64	0,62	0,22
Khelafit Combi® (twice)	40,3	11,4	5,78	0,69	0,20

Table 4. Effect of Khelafit Combi® application on sunflower yield (t ha^{-1})

Fertilizer	The growth regulator	Year		Average for years of research
		2015	2016	
Without Fertilizers	Test	1,54	1,70	1,62
	Khelafit Combi® (once)	1,69	1,83	1,76
	Khelafit Combi® (twice)	1,74	1,93	1,84
$N_{30}P_{45}$	Test	1,82	2,01	1,92
	Khelafit Combi® (once)	1,94	2,11	2,05
	Khelafit Combi® (twice)	2,12	2,25	2,19
$N_{60}P_{90}$	Test	1,95	2,13	2,04
	Khelafit Combi® (once)	1,99	2,31	2,15
	Khelafit Combi® (twice)	2,10	2,44	2,27
HIP_{05}		A – 0,14 B – 0,09 AB – 0,16	A – 0,15 B – 0,11 AB – 0,18	-

it was with both fertilizer backgrounds, and in 2016 – with the variant without fertilization).

The positive influence of the combined growth regulator has always been observed. Particularly significant efficiency showed a double treatment of plants by the growth regulator Khelafit Combi®. On average during the two years the increase yield at the control, N30P45 and N60P90 was 0.22 t ha^{-1} (13.6%), 0.27 t ha^{-1} (14%) and 0.23 t ha^{-1} (11.1%).

CONCLUSION

Analysis of the study results showed that the soil nutrient status at cultivating sunflower can be optimized only when the combination of mineral fertilizers with the double treatment of foliar feeding by the multi-functional combined growth regulator Khelafit Combi®. Further use of the research results will provide the opportunity for multifaceted study and determine the impact of influence of new growth regulator and growth stimulants of plants for the optimization of the nutrient status of sunflower and their application during the crop cultivation in agro-climatic conditions of the Steppe zone of Ukraine.

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