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THE FORMATION OF SUNFLOWER PRODUCTIVITY DEPENDING ON THE ELEMENTS OF GROWING TECHNOLOGY IN THE CONDITIONS OF THE RIGHT-BANK FOREST STEPPE OF UKRAINE

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The article demonstrates the conclusions of an experimental field study on the influence of different types of fertilizers on the dynamics of growth and development of sunflower hybrid plants. During the experiment, the characteristics of changes in biometric indicators of plants depending on fertilizer were investigated. A comparative assessment of the influence of mineral fertilizers on the yield of sunflower was carried out. The purpose of the research was to study the influence of mineral fertilizers (nitroammophoska, ammophos) on the growth and development of sunflower and its yield. The research was conducted at the experimental site of the Agronomichne Research Farm of the Vinnytsia National Agrarian University, located in the village of Agronomichne, Vinnytsia district of Vinnytsia region. For the field experiment, hybrids of the Swiss selection Sumiko, Alcantara and the French selection LG 59580 A were chosen; mineral fertilizers - nitroammophoska ($N_{60}P_{60}K_{60}$) and amphos $(NH_4)_2HPO$.

Based on the assessment of the hydrothermal regime of multi-term sunflower crops, the possibility of using sunflower in variants with mineral nutrition was analyzed. The general stress resistance and adaptability of this species to use in variants of different application of mineral fertilizers were determined. The role of hydrothermal conditions during the growing season on the formation of the biochemical components of the yield was evaluated, which ultimately made it possible to formulate prognostic options for the formation of the indicator depending on the variability of weather conditions, the dynamics of the formation of the amount of precipitation and the level of average daily temperatures. Conclusions were made regarding the value of sunflower for multipurpose use on gray forest soils in conditions of unstable moisture, which allows for the development of agro-technological solutions in the field of using sunflower as the main oil crop on the basis of this.

Key words: *sunflower, growing season, mineral fertilizers, seeds, fertilizing, yield, heavy metals, oil quality.*

Table 1. Fig. 3. Lit. 15.

Statement of the problem. The main and irreplaceable source of vegetable oil is the one-year sunflower or Helianthus annus. For the 2024 harvest, sunflower has already been sown on 5 million 123.9 thousand hectares (96.9%) and it is the leader among spring crops this year (for comparison, in second place among spring corn, the sowing of which has already been completed and under which 3 million 895.2 thousand ha) [1, 3, 10]. The assortment of sunflower hybrids, both of foreign and domestic production, leaves Ukrainian producers with a wide choice for the conditions of each farm [2, 4, 6, 9]. Modern hybrids have a significant yield and oil potential. Each element of crop cultivation technology plays its own unique role in shaping the yield of sunflower seeds in the conditions of the Steppe of Ukraine. In production, the potential of varieties and hybrids is not sufficiently revealed, therefore one of the ways to increase the yield of sunflower is to improve the elements of cultivation technology [7, 13, 14].

Relevance of the topic. Post-sowing fertilization plays an important role in any sunflower fertilization system. Most often, complex mineral fertilizers, double or complete, are used for this. A traditional complex fertilizer for post-sowing application is nitroamophoska. However, if the soil is well supplied with potassium, it is more effective to use ammophos, which is confirmed by previous studies [5, 8, 11].

Therefore, the purpose of our research was to determine the effect of various forms of post-sowing complex fertilizers on the formation of sunflower seed yield and to determine the most effective of them.

The purpose and tasks of the research. The experiment was a two-factor field experiment. The scheme of the experiment included six options in triplicate. According to factor A, three hybrids were studied: Sumiko, LG 59580, Alcantara. The peculiarities of the formation of varietal productivity by factor were studied in two forms of fertilizers for post-sowing fertilization: traditional nitroammophos (control) and ammophos [7, 12, 15].

To compare the use of two forms of mineral fertilizers for post-sowing sunflower fertilization and to determine the best one for recommendation to agricultural production, approved according to this purpose:

- to study the formation of the yield of sunflower seeds depending on different forms of fertilizers for post-sowing fertilization;
- to determine the structural indicators of seed yield, formed under the influence of nitroammophos and ammophos.

Conditions and methods of research. Research was conducted at the VNAU experimental field during 2023-2024 on gray forest soils. The soil cover was represented by gray forest soils with the average potential of soil fertility conditions with the following agrochemical indicators: humus content - 2.68%, easily hydrolyzed nitrogen - 81.9 mg/kg of soil, mobile phosphorus - 155.5 mg/kg of soil, exchangeable potassium – 105.7 mg/kg of soil, pHкcl – 5.8. The mechanical composition of the soil is medium loam. Analysis of the results of a study conducted in 2023-24 on the influence of different forms of mineral fertilizers used for pre-sowing fertilization on the formation of sunflower seed yield. In general, the weather conditions for the 2023-2024 research years were favorable for sunflower cultivation, weather factors did not have a significant impact on the formation of a high yield and quality of sunflower seeds, except for 2024, since the heat that began in July suppressed part of the crops.

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Presentation of the main research material. The level of productivity is largely determined by the structure of the reproductive organs. The structural

indicators include, in particular, the diameter of the cob, the number of seed rows and the number of seeds in each row. The last two indicators are closely correlated with the diameter of the cob, so let's consider this important indicator. Determining the diameters of sunflower inflorescences of studied hybrids by year showed the influence of the use of different forms of mineral fertilizers on the formation of generative organs of sunflower.

The indicators obtained in Table 3.1 show that the size of the sunflower basket was influenced by both weather conditions and fertilizers of the year: in 2023, which was more favorable for these hybrids, the diameter ranged from 20.7 to 28.4 cm; in 2023, the diameter ranged from 20.7 to 28.4 cm; in 2023 the basket was larger than in 2023 because weather conditions were more favorable for these hybrids. LG 59580 hybrids had the largest baskets, according to the yield - from 27.2 to 28.4 cm. The inflorescence of the Sumiko hybrid was 2 cm smaller in diameter, and the inflorescence of the Alcantara hybrid barely exceeded 20 cm. When spraying with amphos, the inflorescences of Alcantara hybrids were almost 2 cm larger than when spraying with nitroammophos. The least sensitive in this respect were the Sumiko hybrids, the head diameter of which varied little depending on the type of fertilizer, and the difference between the first and second varieties was less than 1 cm.

Annual differences in the head diameter of hybrids caused by different pre-sowing fertilizers were ambiguous. For example, the heads of the Sumiko hybrid between 2023 and 2024 differed by only 0.3-0.5 cm, which means that this hybrid is more tolerant to weather conditions; for hybrid LG59580, heads in 2024 were smaller by 0.6-1.0 cm than in the previous year; for hybrid LG59580, heads in 2024 were smaller by 0.6-1.0 cm than in the previous year. For hybrid Alcantara, the difference was 1.9-3.1 cm. In other words, hybrids were most affected by weather conditions during the growing season .

The plants from the last cross not only had the smallest heads, but were also the least responsive to fertilizer changes. The difference between the two varieties with different fertilizers was only 0.7 cm. The response of the other two hybrids was the same: 1.6 cm. Thus, for many years it was not understood that the diameter of the head depends on the type of fertilizer. The next two indicators, the number of rows of seeds in a head and the number of seeds in a row, directly depend on the previous indicator - the diameter of the head. Thus, the maximum number of rows in 2023 was 66-67 for the LG 59580 hybrid head, the Sumiko hybrid had 2-3 fewer rows, and the Alcantara hybrid had the lowest number - 54-55. Hybrid Sumiko responded more significantly to the form of fertilizer than the other two investigated hybrids.

In 2023, the number of rows was also reduced by one or two for all hybrids due to smaller heads. Of the three hybrids used in the experiment, the LG 59580 hybrid turned out to be the most plastic, which was almost independent of the year's conditions. So, the number of rows in 2023 was 66-67, while in 2024 - 65-66. This cross also turned out to be the most tolerant to the type of pre-sowing fertilizer, while the other studied hybrids reacted more significantly, changing this indicator by two lines.

Table 1

Morphological indicators of sunflower hybrids depending on the application of mineral fertilizers

hybrids	fertilizers	Diameter of heads, cm				Number of rows in the head, pcs.				Number of seeds in a row, pcs.			
		2023		2024		2023		2024		2023		2024	
		diameter	difference to control	diameter	difference to control	row	difference to control	row	difference to control	number of seeds	difference to control	number of seeds	difference to control
Sumiko	Nitroamofoska	25,7	-	25,2	-	63	-	61	-	22	-	21	-
	Amophos	26,5	*0,8*	26,8	*1,6*	65	*2*	63	*2*	25	*3*	23	*2*
LG 59580	Nitroamofoska	27,2	-	26,2	-	66	-	65	-	28	-	26	-
	Amophos	28,4	*1,2*	27,8	*1,6*	67	*1*	66	*1*	30	*2*	28	*2*
Alkantara	Nitroamofoska	20,7	-	18,8	-	54	-	52	-	21	-	20	-
	Amophos	22,6	*1,9*	19,5	*0,7*	55	*1*	54	*2*	24	*3*	22	*2*

source: formed on the basis of own research

The number of seeds per row in 2023 ranged from 21 to 30. Hybrid LG 59580 had the highest number of seeds formed at 28 to 30. The other hybrids were almost at the same level, with an estimated number of 21-25 seeds per row. Sumico and Alcantara hybrids responded more significantly to forms of fertilizers, forming three seeds in a row on ammophos than on nitroamophos; LG 59580 was more plastic; LG 59580 was more plastic, forming three seeds in a row on amophos than on nitroamophos; and LG 59580 was more plastic, forming three seeds in a row on nitroamophos than on amophos. In 2024, the number of seeds in a row was 1-2 seeds less and amounted to 20-28 seeds in a row. The largest number of seeds, as in the previous year, was formed by the hybrid LG 59580 - 26-28 seeds. The other two hybrids had similar indicators - from 20 to 23 seeds in a row. All hybrids reacted equally to forms of fertilizers, forming two more seeds in a row when using ammophos than when using nitroamofoska. Since the indicators varied greatly between years of research, to determine the dependence of the morphological parameters of the sunflower head on the form of pre-sowing fertilizer application, average data for two years were obtained. The results of the calculations are shown in Figure 1. As can be seen from the figure, the hybrid LG 59580 was characterized by the highest level of indicators, the diameter of the inflorescences of this hybrid was 26.7-28.1 cm, and the number of seeds in a row reached 27-29 pieces.

Alcantara hybrid was noted for the lowest level of development of morphological indicators, its plants had an average diameter of the head at the level of 19.8-21 cm with the number of seeds in each row at the level of 20-23 pieces.

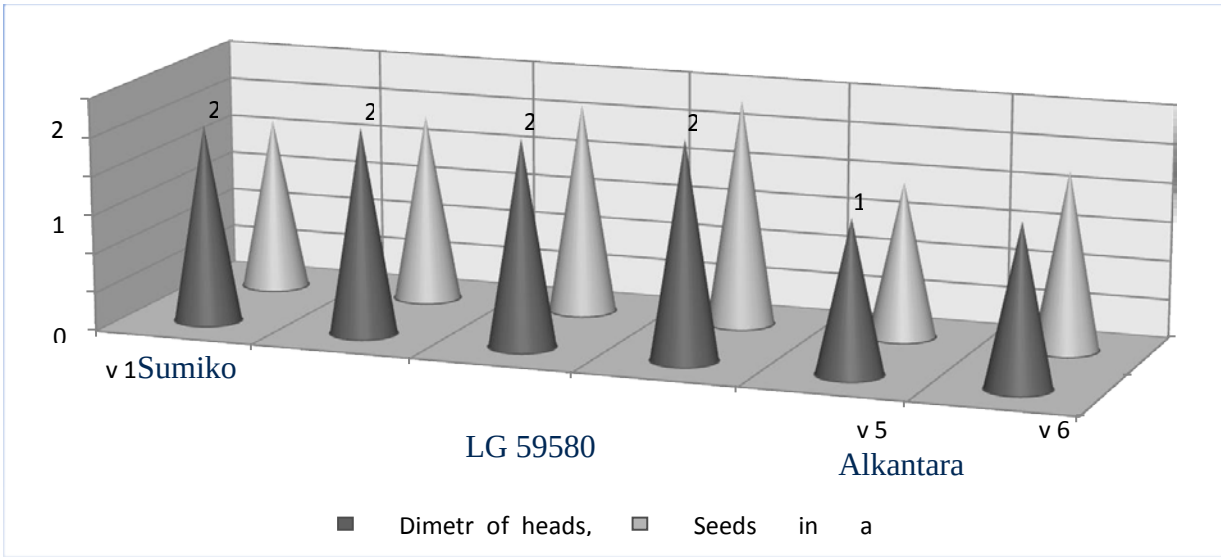

Fig. 1. Average morphological indicators of sunflower heads over two years
source: formed on the basis of own research

The Sumiko hybrid reacted most noticeably to the change in the form of the post-sowing fertilizer, when adding ammophos, its diameter increased by 1.4 cm and the number of seeds by 2 per row. The hybrid LG 59580 was the most plastic.

The analysis of the seed mass determination data of 2024 shows that the main trends of influence are maintained. For all varieties, the indicators were lower than the similar indicators of 2023. This confirms that each hybrid reacts differently to growing conditions. The amount of precipitation during the growing season has a particularly significant impact. Even with the same amount of precipitation, the varieties showed different results. The weight of 1000 seeds in hybrid LG 59580 was the highest. Here, the weight of 1000 seeds was 67.9 g when applying amphos and 64.0 g when using nitroamofoska; in second place - Alcantara hybrid; in third place - hybrid LG 59580; in fourth place is the LG 59580 hybrid.

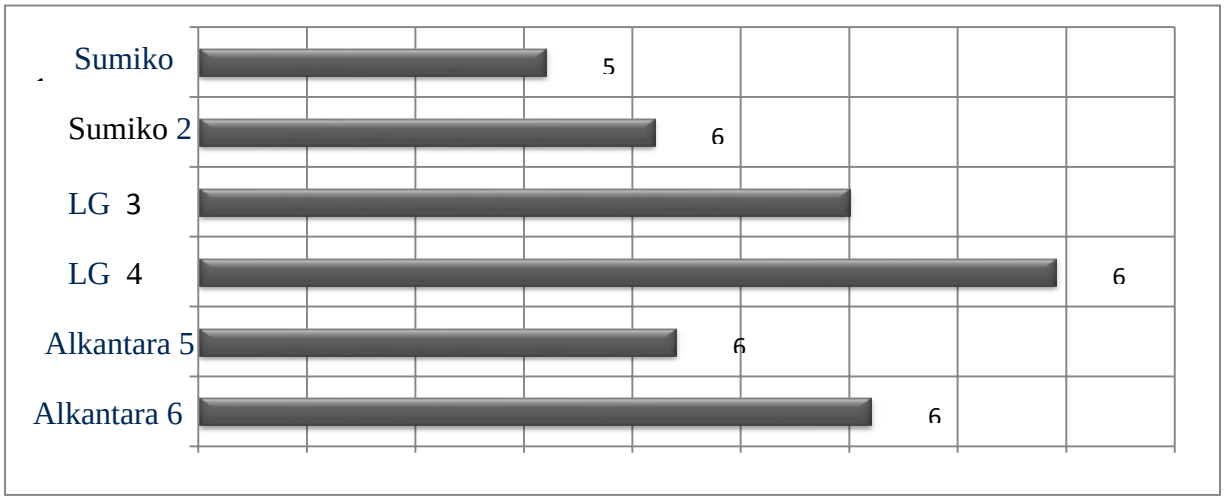

Fig. 2. The average weight of 1000 sunflower seeds over two years, g
source: formed on the basis of own research

The response to pre-sowing forms of fertilizers in both of the above-mentioned hybrids was similar, and it was 3.8 g and 3.6 g higher to amphos and nitroamophos than to nitroamophos, respectively. The average weight of 1000 seeds in the Sumiko hybrid was not significantly different from the Alcantara hybrid, but the response to the form of pre-sowing fertilizer in this hybrid was less pronounced and it was plastic to this factor. The difference between the two forms was on average 2.0 g. The best results were obtained when applying ammophos. Thus, it can be seen that the LG 59580 hybrid proved to be the best in performance over two years of research on average. The average indicators for the years of research confirmed the dependence found in individual years. The most productive was the hybrid LG 59580, in an average of two years it produced a seed yield at the level of 3.2-3.4 t/ha. Alcantara hybrid had the lowest indicators, the yield in the last two variants according to the scheme varied between 2.6-2.7 t/ha. Amophos applied at sowing had a better effect than nitroamophos.

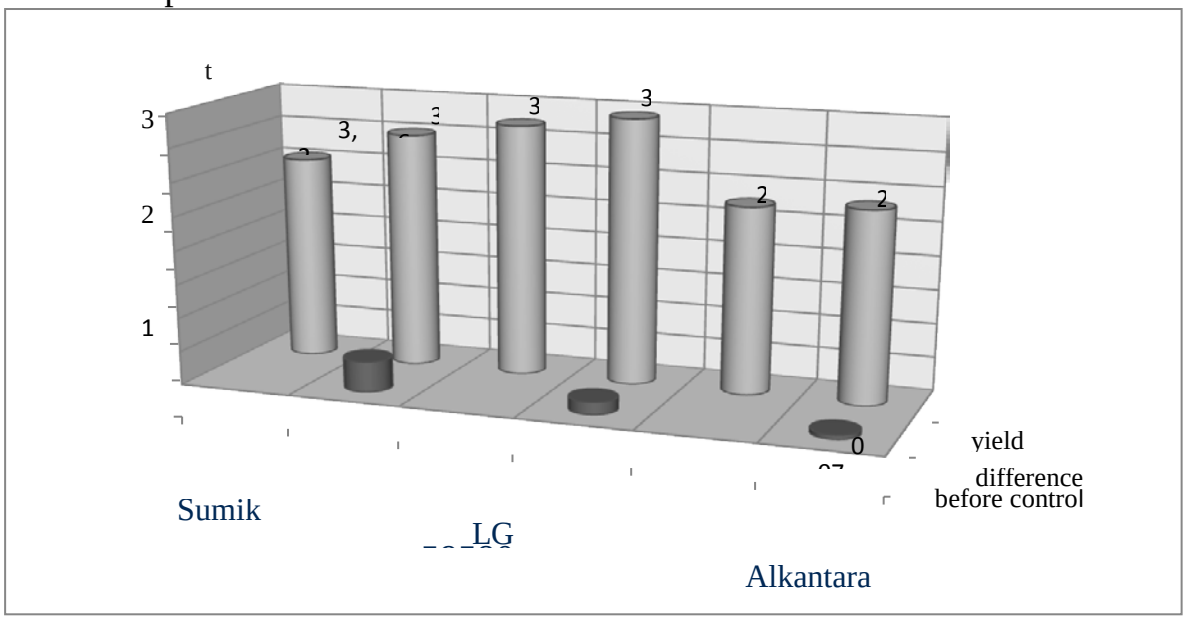

Fig. 3. Average yield of sunflower seeds over two years, t/ha
source: formed on the basis of own research

The difference to the control was 0.3 t/ha for Sumiko, twice that of LG 59580 and 6.6 times that of Alcantara hybrid. The last hybrid was practically indifferent to the forms of fertilizers in post-sowing application.

Based on the results of determining the yield of sunflower hybrids depending on the form of post-sowing fertilizer, the following conclusions can be drawn: the highest level of productivity is characteristic of the LG 59580 hybrid.

The most sensitive to the form of the seeding fertilizer was the Sumiko hybrid, for the Alcantara hybrid, the form of the seeding fertilizer was not of significant importance. Amophos is significantly better as a seeding fertilizer.

The hybrids were characterized by other dependencies in the indicators for fertilizer application. In addition, the highest fat content was obtained on variants with the use of nitroamofoska. And it was 52.0 in the Sumiko hybrid.

Table 2

Sunflower seed quality indicators, average for 2023-2024, %

№	Fertilizer options	Content, % fat	Hybrids		
			Sumiko	LG 59580	Alkantara
1	nitroammophoska		52,0	51,4	49,2
2	amophos		50,5	48,7	47,8
$\overline{X}$	$\pm S\,x$		50,90 49,0		
V, %			*5,11*		

source: formed on the basis of own research

Such dynamics were observed in all the hybrids we studied, on all fertilizer options. LG 59580 provided a reduction in fat content of 0.6% depending on the test variant and hybrid.

Previous studies have proven that the influence on the profile of fatty acids causes a change in their quantitative composition. At the same time, a change in the ratio between unsaturated and saturated fatty acids is observed. And this, first of all, changes the chemical properties of the obtained oil and determines its further use. In sunflower and rapeseed oils, this ratio increases, which causes an increase in the iodine number, that is, will lead to a decrease in the resistance of the oil to oxidation processes.

Conclusions and prospects for further research. The Sumiko hybrid reacted most noticeably to the change in the form of the post-sowing fertilizer, when adding ammophos, its diameter increased by 1.4 cm and the number of seeds by 2 per row. The hybrid LG 59580 was the most plastic. According to factor A, the hybrid LG 59580 has the best biological potential. Its indicators of the weight of 1000 seeds differed from the other examined hybrids Sumiko and Alcantara by 7.4-5.6 and 3.4-3.2 g, respectively. The LG 59580 hybrid had an average of 392-435 more seeds than the Sumiko hybrid and 675-682 more seeds than the Alcantara hybrid over two years.

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АНОТАЦІЯ

ФОРМУВАННЯ ПРОДУКТИВНОСТІ СОНЯШНИКУ ЗАЛЕЖНО ВІД ЕЛЕМЕНТІВ ТЕХНОЛОГІЇ ВИРОЩУВАННЯ В УМОВАХ ПРАВОБЕРЕЖНОГО ЛІСОСТЕПУ УКРАЇНИ

Стаття демонструє висновки експериментально-польового дослідження щодо впливу різних видів добрив на динаміку росту й розвитку рослин гібридів соняшника. Під час експерименту досліджено характеристику змін біометричних показників рослин залежно від удобрення. Проведено порівняльну оцінку впливу мінеральних добрив на врожайність соняшника.

Метою досліджень - було вивчити вплив застосування мінеральних добрив (нітроамофоска, амофос) росту й розвитку соняшника і його урожайність. Дослідження проводились на дослідній ділянці Науково-дослідного господарства «Агрономічне» Вінницького національного аграрного університету, що знаходиться у с. Агрономічне, Вінницького району Вінницької обл. Для польового експерименту було обрано гібриди швейцарської селекції Суміко, Алькантара та французької селекції LG 59580 А; мінеральні добрива – нітроамофоска ($N_{60}P_{60}K_{60}$) та амофос $(NH_4)_2HPO$.

Проаналізовано, на підставі оцінки гідротермічного режиму різностроковихпосівів соняшнику, можливість використання соняшнику у варіантах з мінеральним живленням. Визначено загальну стресостійкість і адаптивність цього виду до використання у варіантах різного внесення мінеральних добрив. Проведено оцінку ролі гідротермічних умов періоду вегетації на формування біохімічних складових сформованої урожайності, що дозволило у підсумку сформулювати прогностичні варіанти формування показника залежно від мінливості погодних умов, динаміки формування суми опадів і рівня середньодобових температур. Зроблено висновки щодо цінності соняшнику до багатопрофільного використання на сірих лісових ґрунтах в умовах нестійкого зволоження, що дозволяє розробляти на підставі цього агротехнологічні рішення у сфері використання соняшнику як основної олійної культури

Ключові слова: *соняшник, вегетаційний період, мінеральні добрива, насіння, підживлення, урожайність, важкі метали, якість олії.*

Табл. 1. Рис. 3. Літ. 15.

Відомості про авторів

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