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Sunflower hybrids productivity depending on the rates of mineral fertilizers in the south of Ukraine

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Abstract: Areas of sunflower cultivation in Ukraine, Europe, and the world have significantly increased over the past decade, along with an increase in crop yield, largely due to the development of new varieties and hybrids resistant to various abiotic stresses and extreme environmental conditions. The mineral nutrition background is also an important element of sunflower cultivation technology. The influence of mineral fertilizer rates on the productivity of new early-maturing and medium-early sunflower hybrids was the focus of research conducted during 2020–2021 on dark chestnut soils in the southern region of Ukraine. The results of the study showed that optimization of the mineral nutrition background contributed to increased plant height and leaf area. Both indicators were maximized for the cultivation of Alambra KS and Blyutuz hybrids with the application of fertilizers at the rate of $N_{90}P_{60}$. These experimental variants also ensured the formation of the maximum level of seed yield (3.05 t/ha for Alambra KS hybrid; 3.39 t/ha for Blyutuz hybrid) and the highest indicators of profitability per 1 kg of active substance of fertilizers (0.35 tons for Alambra KS hybrid; 0.45 tons for Blyutuz hybrid). The mineral nutrition background had little effect on the oil content in sunflower seeds. With an increase in the nitrogen fertilizer rate on the phosphorus background, the oil content in the seeds slightly decreased. However, the experimental variants differed in terms of conditional oil output per hectare of sunflower cultivation. Among early-maturing hybrids, the Alambra KS hybrid showed a higher value for this indicator, while among medium-early hybrids, it was the Blyutuz hybrid. The most effective rate of mineral fertilizers in terms of oil output was determined to be $N_{90}P_{60}$. Based on the results of the study on dark chestnut soils in the southern region of Ukraine, it is recommended to cultivate the Alambra KS hybrid among early-maturing sunflower hybrids and the Blyutuz hybrid among medium-early hybrids, with the application of mineral fertilizers at the rate of $N_{90}P_{60}$.

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1 Introduction

Sunflower is considered a versatile crop. Its oil is widely used in the food and processing industries, meal, cake, baskets, green mass – in the livestock industry (Domaratsky 2021). Sunflower husks are used to produce food and technical alcohols, feed yeast, and furfural for plastics. There is a stable demand for sunflower husks from processing plants as a source of alternative energy (Shaukat et al. 2021). In addition, sunflower is an important honey plant (Brumă et al. 2021) and an economically attractive crop (Kvashin et al. 2019).

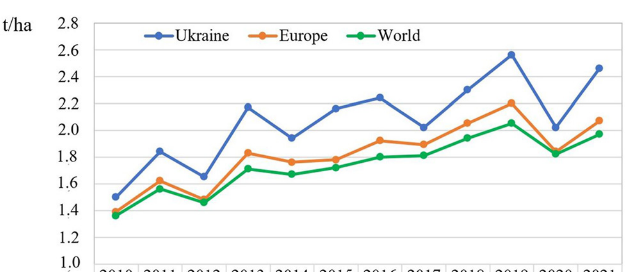
The oil content in the seeds is one of the most important quality indicators of sunflower, which is associated with the chemical composition and technological qualities of the seeds. Sunflower oil contains an average of 90 % unsaturated fatty acids (linoleic, oleic) and up to 10 % saturated (palmitic, stearic). The most valuable for the body is polyunsaturated linoleic acid, the content of which is 55–70 %, and the mass fraction of oleic acid is 30–31 % of the total fat acids. Sunflower oil contains a significant amount of vitamin E (tocopherol), which provides the oil with antioxidant properties. The oil of high-oil sunflower varieties contains more linoleic acid and vitamin E compared to low-oil varieties. Sunflower oil contains phospholipids and fat-soluble vitamins A, E, D, K. The phospholipids isolated from oil of higher varieties are used as emulsifiers (Adeleke and Babalola 2020; Belugina et al. 2022).

According to FAOSTAT data, from 2010 to 2021, sunflower sown areas worldwide increased by 28 %, in Europe – by 49 %, and in Ukraine – by 1.5 times (Figure 1).* At the same time, one-third of all sunflower sown areas in Europe are located in Ukraine (28.2–33.7 % for 2010–2021).

Figure 1: Sunflower sown areas in Ukraine, mln ha (*according to the Food and Agriculture Organization of the United Nations, 2010–2021).

The increase in cultivation areas is accompanied by an increase in seed yields. According to FAOSTAT data, the average world yield increased from 1.36 t/ha in 2010 to 2.05 t/ha in 2019, which is 1.5 times higher. The average seed yield of sunflower in Europe for 2010–2021 was 1.82 t/ha, which is 0.08 t/ha or 4.6 % higher than the global average (1.74 t/ha). In pre-war times, the seed yield of sunflower in Ukraine exceeded global and European indicators, as shown in Figure 2.* Despite Russian aggression, Ukraine remains a leading exporter of sunflower oil in the global market (Glauben et al. 2022) and maintains stable positions in terms of natural honey exports, which have significantly increased over the past decade (Parkhomenko et al. 2022).

Significantly increasing the production volumes of sunflower seeds is possible by creating an optimal nutritional background for plants. Grown hybrids are capable of fully realizing their genetic potential only with a sufficient amount of easily digestible forms of nutrients in the soil, which is ensured by the application of mineral fertilizers. However, recommended rates of mineral fertilizer application for sunflower cultivation vary significantly, and scientists do not have a unified opinion on this matter. This is due to different soil and climatic conditions, characteristics of grown hybrids, and production goals. For example, to achieve maximum yield of sunflower in the conditions of Western Polissia, it is recommended to apply mineral fertilizers at a rate of $N_{90}P_{60}K_{120}$ and conduct two foliar feedings with the growth stimulator Vimpel, while the maximum oil content is ensured by a fertilizer rate of $N_{60}P_{30}K_{90}$ (Kurach et al. 2023). In the Steppe zone of Ukraine, under conditions of insufficient moisture, the maximum level of yield is ensured by applying mineral fertilizers at a rate of $N_{115}P_{15}K_{120}$ (Yeremenko 2017). Therefore, this issue requires further in-depth research, especially for the cultivation of poorly researched modern sunflower hybrids.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Ukraine	1.50	1.84	1.65	2.17	1.94	2.16	2.24	2.02	2.30	2.56	2.02	2.46
Europe	1.39	1.62	1.48	1.83	1.76	1.78	1.92	1.89	2.05	2.20	1.84	2.07
World	1.36	1.56	1.46	1.71	1.67	1.72	1.80	1.81	1.94	2.05	1.82	1.97

Figure 2: Comparative diagram of sunflower seed yields in Ukraine, Europe, and the world, t/ha (*according to the Food and Agriculture Organization of the United Nations, 2010–2021).

1.1 Statement of the problem

Sunflower is one of the most profitable crops in Ukraine, which makes its production a strategically important direction for the development of the agricultural sector of Ukraine (Pinkovskyi and Tanchyk 2020; Chuiko et al. 2021). Therefore, the technologies for growing this crop are constantly improving. Special attention is paid to breeding work, in particular, the creation of hybrids tolerant to herbicides, resistant to false powdery mildew (*Plasmopara helianthi Nov.*) and broomrape (*Orobanche cumana Wallr.*). The selection of breeding material is aimed at high seed yield and oil quality; plant endurance to adverse factors, primarily heat and drought; resistance to broomrape (*O. cumana Wallr.*), false powdery mildew (*P. helianthi Nov.*), and other diseases (Babych et al. 2021; Melnyk et al. 2020). It is predicted that in the coming years, the areas under cultivation of sulfo hybrids of sunflower, genetically resistant to tribenuron-methyl from the sulfonylurea chemical class, will increase. A promising direction of breeding work is the creation of new hybrids of sunflower resistant to various abiotic stresses and extreme environmental conditions, which are increasingly observed due to climate change caused by global warming (Hladni et al. 2022).

One of the important elements of sunflower cultivation technology is the background of mineral nutrition, as plants require an optimal and balanced amount of nutrients for maximum seed yield (Modanlo et al. 2021; Sydiakina and Pavlenko 2021).

According to experimental studies conducted on sandy loam soils in the Polissya region of Ukraine, the Grand Admiral sunflower hybrid produced maximum yield with the application of P_5K_{55} + N_{46} at 2.37–2.55 t/ha depending on soil cultivation methods (Lyabach 2022).

In the Khmelnytskyi region of Ukraine, the application of $N_{40}P_{40}K_{60}$ mineral fertilizers resulted in a 53 % increase in yield for the Talsa hybrid and a 58 % increase for the Pronto and Golden hybrids compared to unfertilized control. Increasing the fertilizer rate to $N_{80}P_{80}K_{120}$ further increased yield by 75 %, 73 %, and 81 %, respectively, but also resulted in a decrease in seed oil content (Sakharchuk and Garbar 2018).

In the Poltava region of Ukraine, the highest seed yield for the Oreal and Drive sunflower hybrids was achieved with the application of $N_{60}P_{80}$ mineral fertilizers at 3.41 and 3.58 t/ha, respectively (Hanhur et al. 2021).

The application rates of mineral fertilizers should be established taking into account the soil and climatic conditions. For example, for sunflower cultivation on heavy granulometric soils in the Forest-Steppe zone, it is recommended to apply nitrogen-phosphorus fertilizers at a rate of $N_{60-100}P_{40-60}$, and in the Steppe zone of Ukraine – $N_{50-90}P_{30-50}$ (Sidorov and Tsehmeistruk 2021).

Establishing the appropriate application rates of mineral fertilizers requires conducting an agrochemical analysis of the soil to determine the availability of nutrients for plant uptake and to ensure optimal plant nutrition. This will also allow for more efficient use of mineral fertilizers and reduce their negative impact on the environment. In order to increase the yield and quality of seeds of sunflower hybrids with different maturity rates, we conducted research on studying the conditions of mineral nutrition of this valuable oil crop.

1.2 Research scheme and methodology

The study on determining the impact of plant mineral nutrition background on the yield and quality of early and mid-early sunflower hybrids was conducted during 2020–2021 at the VIKO farm located in the Novotroitsky district of the Kherson region.

The purpose of the research is to improve the technology of growing early and mid-early sunflower hybrids through the optimization of plant mineral nutrition background on dark chestnut soils in the south of Ukraine.

The research is two-factor. Factor A – sunflower hybrids: early Alambra KS (Kossad Semans, France), Marvin (Voskor-Agro LLC, Ukraine), and mid-early Blyutuz (V.Ya. Yuriev Institute of Plant Production, National Academy of Agrarian Sciences of Ukraine, Selection and Genetics Institute – National Seed Science and Variety Research Center, Ukraine), Flormaster IR (Maisadour Semans, France). Factor B – mineral nutrition background: no fertilizers, $N_{45}P_{60}$, and $N_{90}P_{60}$. Ammonium nitrate (NH_4:NO_3 – 1:1; N – 34,4 %) and double granulated superphosphate ($Ca(H_2PO_4)_2 \times H_2O$; P_2O_5 – 43 %) were applied as mineral fertilizers. Phosphorus fertilizers were applied during primary soil cultivation, nitrogen fertilizers – during pre-sowing cultivation according to the research scheme.

At the time of the experiment, the humus content in the arable layer of the soil was 2.8 % (according to Tyurin), nitrate nitrogen was 27 mg/kg (according to Tyurin-Kononova), available phosphorus P_2O_5 was 18 mg/kg (according to Machigin), and exchangeable potassium K_2O was 468 mg/kg of soil (according to Machigin). Based on the content of available nutrients, the soil of the experimental plot was characterized by very low nitrogen content, average phosphorus content, and high potassium content. Overall, such a characteristic is typical for dark chestnut soils in southern Ukraine.

The weather conditions during the vegetation period of sunflower in 2020 were characterized by a significant amount of precipitation, high relative humidity, and typical temperature regime for the research zone, except for the first two weeks after emergence when cold weather was observed. The 2021 research year was more arid, but due to significant spring rainfall, soil moisture reserves at the time of sunflower planting contributed to the uniform and timely emergence of the crop. The summer vegetation period was dry, especially in August when atmospheric temperatures rose to 38–40 °C with almost no precipitation, but by the time the rainless period began, the flowering phase had already ended, and no significant yield losses were observed.

The quality indicators were determined by extracting oil content from the seeds using a Soxhlet apparatus. The oil yield per hectare of crops and the profitability of 1 kg of active substance of mineral fertilizers in increasing sunflower seed yield were calculated using a computational method. The harvest data was statistically processed using the analysis of variance method with the help of the computer program "Agrostat".

1.3 Research methods

Visual and measurement-weight – for observing the phases of plant development and determining biometric indicators of plants and their productivity; biochemical – for determining seed quality indicators; chemical – for determining soil agrochemical indicators; hypotheses, analysis, synthesis, abstraction – when formulating the purpose and objectives of the research, generalizing the obtained results, and substantiating the conclusions; mathematical-statistical – for assessing the reliability of the obtained research results.

1.4 Elements of scientific novelty

The growth and development of modern early and mid-early sunflower hybrids were studied, the reaction of plants to mineral nutrition background was determined, the most productive sunflower hybrids and optimal rates of mineral fertilizers for their cultivation in the conditions of the south of Ukraine were proposed.

1.5 The results of the study

The application of mineral fertilizers contributed to an increase in the height of sunflower plants during the period of full seed maturity, compared to the unfertilized control (Table 1). Among the early-maturing hybrids, plants of the Alambra KS hybrid increased in height the most (15.5–29.0 cm or 12.3–23.0 %), while among the mid-early hybrids, plants of the Blyutuz hybrid increased in height (13.2–22.8 cm or 9.4–16.2 %). The maximum plant height for all cultivated hybrids was achieved with the application of mineral fertilizers at the rate of $N_{90}P_{60}$. On average, it exceeded the unfertilized control by 17.6 %.

Table 1: Influence of mineral nutrition background on the height of sunflower plants of different maturity groups, 2020–2021, cm.

Fertilization variants	Early-maturing hybrids		Mid-early hybrids	
	Alambra KS	Marvin	Blyutuz	Flormaster IR
Without fertilizers	126.3	126.8	140.5	139.5
$N_{45}P_{60}$	141.8	139.8	153.7	151.4
$N_{90}P_{60}$	155.3	149.8	163.3	158.2

The leaf surface of plants is the main organ of photosynthesis, and photosynthesis, in turn, is the main source of biomass formation in plants. Moreover, it provides energy for all growth and energy exchange processes, as well as thermal and water balance in the entire biosphere. There is a close correlation between leaf surface area and yield level of many agricultural crops, including sunflower. Optimization of plant nutrition background increases the leaf surface area. Improved nitrogen conditions enhance plant growth, ensuring the formation of a powerful assimilation apparatus with a high leaf surface area and net photosynthetic productivity, while improved phosphorus and potassium nutrition increases photosynthetic intensity. On the other hand, high rates of mineral fertilizers contribute to the development of excessively large leaf surfaces, leading to mutual shading of plants in crops (Domaratsky 2021; Polyakov et al. 2020). Therefore, in order to create optimal conditions for plant photosynthetic activity, it is necessary to determine the optimal rates of mineral fertilizers, which we have done in our research for sunflower hybrids of different maturity groups.

The results of the conducted research (Table 2) showed that the applied mineral fertilizers increased the leaf surface area of sunflower plants. During the formation of the basket, this increase averaged 18.5–30.0 % across the factors, and during flowering, it ranged from 13.4–24.9 %. The maximum assimilation surface area for all hybrids was determined in the variant with the application of $N_{90}P_{60}$. Among the early-maturing hybrids, plants of the Alambra KS hybrid formed a larger leaf surface area regardless of the nutrition background, while among the mid-early hybrids, plants of the Blyutuz hybrid did so.

The results of the conducted research (Table 3) showed that in the unfertilized variant, the seed yield of the Marvin hybrid was 2.40 t/ha, 2.52 t/ha for the Alambra KS hybrid, 2.71 t/ha for the Blyutuz hybrid, and 2.44 t/ha for the Flormaster IR hybrid. The application of mineral fertilizers allowed for an increase in seed yield by

Table 2: Leaf surface area of sunflower hybrids in different fertilization variants, 2020–2021, thousand m^2/ha.

Sunflower hybrids	Basket formation				Flowering			
	Without fertilizers	$N_{45}P_{60}$	$N_{90}P_{60}$	Average across factor	Without fertilizers	$N_{45}P_{60}$	$N_{90}P_{60}$	Average across factor
Marvin	10.1	12.0	12.8	11.6	29.5	33.3	36.2	33.0
Alambra KS	13.1	15.6	17.3	15.3	37.3	42.4	47.0	42.2
Blyutuz	16.2	19.2	21.4	18.9	42.8	48.7	53.8	48.4
Flormaster IR	12.5	14.9	16.2	14.5	33.2	37.5	41.3	37.3
Average across factor	13.0	15.4	16.9	15.1	35.7	40.5	44.6	40.2

0.26–0.45 t/ha or 10.8–18.8 % for the Marvin hybrid, 0.31–0.53 t/ha or 12.3–21.0 % for the Alambra KS hybrid, 0.40–0.68 t/ha or 14.8–25.1 % for the Blyutuz hybrid, and 0.28–0.47 t/ha or 11.5–19.3 % for the Flormaster IR hybrid. In other words, all fertilized variants increased yield compared to the unfertilized control.

On average, the unfertilized variant provided a seed yield of 2.52 t/ha. The application of mineral fertilizers at the rate of $N_{45}P_{60}$ increased the seed yield to 2.83 t/ha, exceeding the unfertilized variant by 0.31 t/ha or 12.3 %. The maximum seed yield was achieved with the application of mineral fertilizers at the rate of $N_{90}P_{60}$ – 3.05 t/ha, which was higher than the control by 0.53 t/ha or 21.0 % (Figure 3).*

Among the early-maturing hybrids, the Alambra KS hybrid showed higher yield. The increase in yield compared to the Marvin hybrid was 0.12 t/ha or 5.0 % in the unfertilized variant, and 0.17–0.20 t/ha or 6.4–7.0 % in the fertilized variants. When comparing mid-early hybrids, the Blyutuz hybrid had higher seed yield. The increase compared to the Flormaster IR hybrid was 0.27 t/ha or 11.1 % in the unfertilized variant, and 0.39–0.48 t/ha or 14.3–16.5 % in the fertilized variants. The difference in yield between mid-early hybrids was significant, while for early-maturing hybrids, it was within the margin of error.

On average across factors, the Marvin hybrid provided a seed yield of 2.64 t/ha, Alambra KS – 2.80 t/ha, Blyutuz – 3.07 t/ha, and Flormaster IR – 2.69 t/ha (Figure 4).*

To confirm the feasibility of applying the studied rates of nitrogen-phosphorus fertilizer, we decided to calculate the profitability of one unit of active substance of fertilizer by increasing the yield. The calculations showed that the highest profitability of 1 kg of active substance of fertilizer for sunflower seeds in all cultivated hybrids was found in the variant with the application of $N_{90}P_{60}$ (Table 4).

Table 3: Seed yield of sunflower hybrids of different maturity groups depending on the mineral nutrition background, 2020–2021.

Fertilization variants	Sunflower hybrids					Increase in yield compared to the unfertilized variant, %			
	Marvin	Alambra KS	Blyutuz	Flormaster IR	Average across factor	Marvin	Alambra KS	Blyutuz	Flormaster IR
Without fertilizers	2.40	2.52	2.71	2.44	2.52	–	–	–	–
$N_{45}P_{60}$	2.66	2.83	3.11	2.72	2.83	10.8	12.3	14.8	11.5
$N_{90}P_{60}$	2.85	3.05	3.39	2.91	3.05	18.8	21.0	25.1	19.3
Average across factor	2.64	2.80	3.07	2.69	2.80	–	–	–	–
LSD_{05}, t/ha	2020: by factor A – 0.20; by factor B – 0.17; by the interaction of AB factors – 0.25 2021: by factor A – 0.18; by factor B – 0.17; by the interaction of AB factors – 0.22.								

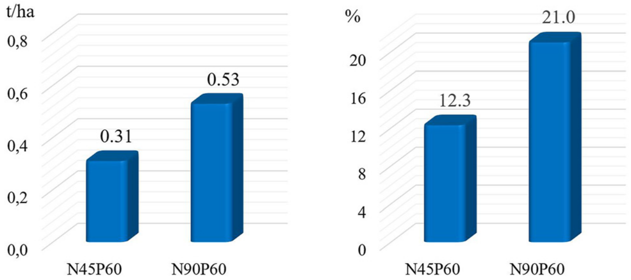


Figure 3: Increase in seed yield of sunflower compared to the unfertilized variant on average across factors, 2020–2021 (*author's calculations).

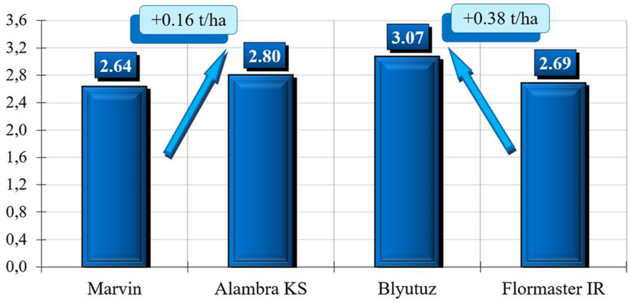


Figure 4: Sunflower seed yield on average for the factor, 2020–2021, t/ha (* author's calculations).

The profitability indicators on average for the studied factors are shown in Figure 5.*

As can be seen from the data provided, the profitability for the $N_{45}P_{60}$ nutrition background was 0.30 tons, and for the $N_{90}P_{60}$ background, it increased to 0.35 tons, which is an increase of 16.7 %. On average for the factor, the profitability of 1 kg of active substance of mineral fertilizers for the Marvin and Flormaster IR hybrids was minimal in the study and amounted to 0.28–0.29 tons. The cultivation of the Alambra KS hybrid increased this indicator to 0.33 tons. The highest profitability indicator in the study was demonstrated by the medium-early Blyutuz hybrid – 0.42 tons of seeds.

The results of our research showed that the background of mineral nutrition practically did not affect the oil content in sunflower seeds. Only a tendency to a slight decrease in this indicator with an increase in the nitrogen fertilizer rate on the phosphorus background was observed (Table 5).

Table 4: Profitability of 1 kg of active substance of mineral fertilizers by increasing sunflower seed yield, 2020–2021, tons.

Fertilization variants	Sunflower hybrids			
	Marvin	Alambra KS	Blyutuz	Flormaster IR
$N_{45}P_{60}$	0.25	0.30	0.38	0.27
$N_{90}P_{60}$	0.30	0.35	0.45	0.31

Table 5: Influence of nutrition background on oil content in sunflower hybrid seeds and its conditional output per hectare of crops, 2020–2021.

Fertilization variants	Early-maturing hybrids			Mid-early hybrids		
	oil content, %	conditional oil output, t/ha	conditional oil output as a % of the variant without fertilizers	oil content, %	conditional oil output, t/ha	conditional oil output as a % of the variant without fertilizers
	Marvin			Blyutuz		
Without fertilizers	45.5	1.09	100.00	47.2	1.28	100.00
$N_{45}P_{60}$	45.4	1.21	110.79	47.1	1.46	114.44
$N_{90}P_{60}$	45.3	1.29	118.44	47.0	1.59	124.48
	Alambra KS			Flormaster IR		
Without fertilizers	46.0	1.16	100.00	47.8	1.17	100.00
$N_{45}P_{60}$	45.8	1.30	111.74	47.7	1.30	110.89
$N_{90}P_{60}$	45.7	1.39	120.16	47.6	1.39	118.39

At the same time, it should be noted that due to the higher yield, the conditional oil output in the fertilized variants of the study for all cultivated hybrids significantly exceeded the control variant. The maximum conditional oil output per hectare of sowing was provided by the application of mineral fertilizers at the rate of $N_{90}P_{60}$. It amounted to 1.29 t/ha for the Marvin hybrid, 1.39 t/ha for the Alambra KS hybrid, 1.59 t/ha for the Blyutuz hybrid, and 1.39 t/ha for the Flormaster IR hybrid. Thus, among early-maturing hybrids, the Alambra KS hybrid provided a higher conditional oil output per hectare of sowing, and among medium-early hybrids – the Blyutuz hybrid. The conditional oil output on average for the studied factors is shown in Figure 6.*

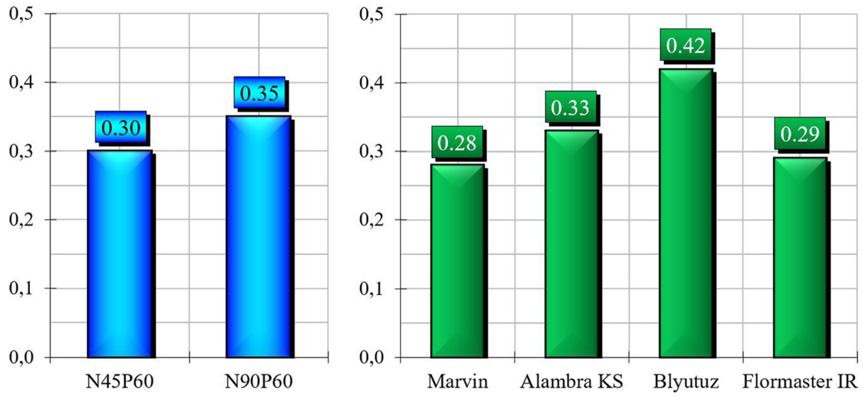


Figure 5: Profitability of 1 kg of active substance of mineral fertilizers by increasing sunflower seed yield on average for the studied factors, 2020–2021, tons (* author's calculations).

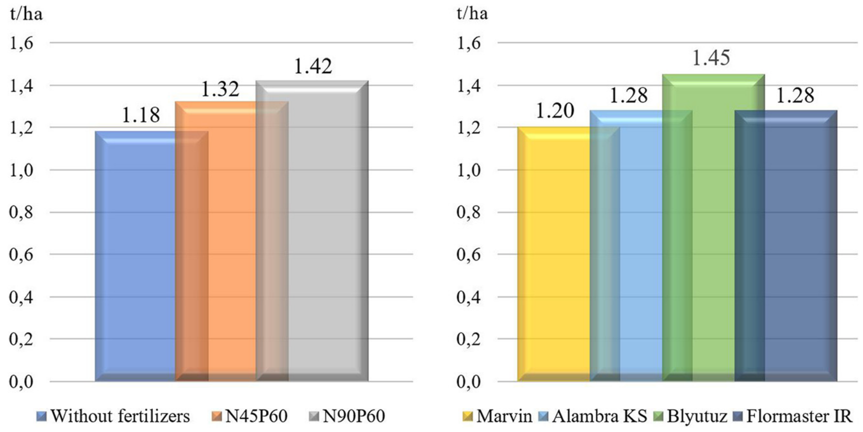


Figure 6: Conditional oil output per hectare of sowing on average for the studied factors, 2020–2021, t/ha (*author's calculations).

2 Conclusions

The application of mineral fertilizers increased the height and leaf surface area of sunflower plants. The highest values of these biometric indicators were achieved by cultivating the early-maturing Alambra KS hybrid and the medium-early Blyutuz hybrid in variants with the application of mineral fertilizers at the rate of $N_{90}P_{60}$.

The lowest sunflower seed yield among all studied hybrids was obtained in the unfertilized background. The application of fertilizers increased it by 0.26–0.53 tons/ha or 10.8–21.0 % for the cultivation of early-maturing hybrids and by 0.28–0.68 tons/ha or 11.5–25.1 % for the cultivation of medium-early hybrids. The highest yield was achieved with the application of mineral fertilizers at the rate of $N_{90}P_{60}$. On this nutrition background, the maximum profitability of 1 kg of active substance of fertilizers per sunflower seed was determined. Among early-maturing hybrids, the Alambra KS hybrid showed higher yield and profitability with fertilizers, while among medium-early hybrids, it was the Blyutuz hybrid. The difference in yield indicators for medium-early hybrids was significant, while for early-maturing hybrids, it was within the margin of error.

With an increase in the nitrogen fertilizer rate on the phosphorus background, there was a tendency towards a slight decrease in oil content in the seeds of all cultivated sunflower hybrids. However, due to higher yield, the conditional oil output in the fertilized variants significantly exceeded the control variant without fertilizers. The maximum conditional oil output per hectare of sowing was achieved with the application of mineral fertilizers at the rate of $N_{90}P_{60}$: 1.20 t/ha for the Marvin hybrid, 1.28 t/ha for the Alambra KS hybrid, 1.45 t/ha for the Blyutuz hybrid, and 1.28 t/ha for the Flormaster IR hybrid. Among early-maturing hybrids, the Alambra KS hybrid showed a higher conditional oil output per hectare of sowing, while among medium-early hybrids, it was the Blyutuz hybrid.

The conducted research and calculations allow us to recommend cultivating the Alambra KS hybrid among early-maturing sunflower hybrids and the Blyutuz hybrid among medium-early hybrids on dark chestnut soils in the southern region of Ukraine. It is also recommended to apply mineral fertilizers at the rate of $N_{90}P_{60}$. This nutrition background will ensure a seed yield of 3.05 tons/ha for early-maturing hybrids and 3.39 t/ha for medium-early hybrids, as well as maximum indicators of conditional oil output per hectare of sowing.

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