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Original article

CULTIVATION OF SUNFLOWER HYBRIDS DEPENDING ON TREATMENT WITH AGROCHEMICALS IN CONDITIONS OF THE SOUTHERN PART OF THE NON-BLACK EARTH REGION OF THE RUSSIA

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Abstract

Background. For the first time in conditions of the southern Non-Black Earth Region, comprehensive researches were carried out to study the influence of microbiological fertilizers Phosphatovite, Baikal EM, Azotovite on the productivity of promising hybrids NK Neoma, SI Bacardi in conditions of a training experimental field of Ryazan State Agrotechnological University Named after P.A. Kostychev, Ryazan region, Russia.

Purpose. The purpose of the work was to identify the efficiency of agrochemicals in agrocenoses of various sunflower hybrids in conditions of Ryazan region.

Materials and methods. The two-factor field experiment was launched in 2022 and 2023. The studies were carried out according to the experimental design: 1. Control (without treatment); 2. Microbiological fertilizer Phosphatovite; 3. Microbiological fertilizer Baikal EM; 4. Microbiological fertilizer Azotovite.

Results. The average yield of sunflower seeds in options with hybrid SI Bacardi was lower (23.4-26.4 dt/ha) than in hybrid NK Neoma (24.0-26.8 dt/ha). On average, the maximum yield was found for the option with the action of Azotovite, 1 l/ha on plots with hybrid NK Neoma, and amounted to 26.8, which was 2.8 dt/ha more than the control option. Qualitative analysis of seeds showed that the microbiological fertilizers used did not significantly affect the oil content of sunflower. Let us highlight the higher oil content of hybrid SI Bacardi: 47.4-49.3%, which was 1.5-2% higher than that of hybrid NK Neoma. The maximum fat yield was obtained in options NK Neoma + Azotovite (1 230.1 kg/ha) and SI Bacardi + Baikal EM (1

258.0 kg/ha), where the indicator depended mainly on seed productivity. The maximum oil content was obtained with Phosphatovite + SI Bacardi option (49.3%).

Conclusion. In the conditions of the Ryazan district of the Ryazan region, it is recommended to grow sunflower hybrids SI Bacardi, NK Neoma with the use of microbiological fertilizers Azotovit, Phosphatovit and Baikal EM in culture cultivation technology as seed treatment before sowing and application during the growing season in the period of 4-8 real leaves.

Keywords: sunflower; hybrid; variety; agrochemicals; microfertilizers; yield; quality; oil content

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Научная статья

ВЫРАЩИВАНИЕ ГИБРИДОВ ПОДСОЛНЕЧНИКА В ЗАВИСИМОСТИ ОТ ОБРАБОТКИ АГРОХИМИКАТАМИ В УСЛОВИЯХ ЮЖНОЙ ЧАСТИ НЕЧЕРНОЗЕМНОЙ ЗОНЫ РОССИИ

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Аннотация

Обоснование. Впервые в условиях южного Нечерноземья, проведены комплексные исследования по изучению влияния микробиологических удобрений Фосфатовит, Байкал ЭМ, Азотовит на продуктивность перспективных гибридов НК Неома, СИ Бакарди в условиях учебного опытного поля Ryazan State Agrotechnological University Named after P.A. Kostychev, Рязанской области, Россия.

Цель. Цель исследования – выявить эффективность действия агрохимикатов в агроценозах различных гибридов подсолнечника в условиях Рязанской области.

Материалы и методы. Полевой двухфакторный опыт был заложен в 2022 и 2023 годах. Исследования проводили согласно схеме опыта: 1.Контроль (без обработки); 2. Микробиологическое удобрение Фосфатовит; 3. Микробиологическое удобрение «БайкалЭМ»; 4. Микробиологическое удобрение Азотовит.

Результаты. В среднем, урожайность семян подсолнечника на вариантах с гибридом СИ Бакарди была ниже (23,4-26,4 ц/га), чем по гибриду НК Неома (24,0-26,8 ц/га). В среднем, максимальная урожайность выявлена по варианту с действием Азотовит, 1 л/га на делянках с гибридом НК Неома, и составила 26,8, что на 2,8 ц/га больше контрольного варианта. Качественный анализ семян показал, что применяемые микробиологические удобрения существенно не оказали влияние на масличность подсолнечника. Выделим более высокую масличность по гибриду СИ Бакарди 47,4-49,3%, что на 1,5-2% выше, чем у НК Неома. Максимальный выход жира получен на вариантах НК Неома + Азотовит (1230,1 кг/га) и СИ Бакарди + БайкалЭМ (1258,0 кг/га), где показатель зависел, в основном, от семенной продуктивности. Максимальная масличность была получена на варианте Фосфатовит + СИ Бакарди (49,3%).

Заключение. В условиях Рязанского района Рязанской области рекомендуется выращивать гибриды подсолнечника СИ Бакарди, НК Неома с применением в технологии выращивания культуры микробиологических удобрений Азотовит, Фосфатовит и Байкал ЭМ в качестве обработки семян до посева и применении по вегетации в период 4-8 настоящих листьев.

Ключевые слова: подсолнечник; гибрид; сорт; агрохимикаты; микроудобрения; урожайность; качество; масличность

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Introduction

The consumption of vegetable oil by the population of many countries of the world is increasing, and animal fats are decreasing, which is explained by a number of benefits of vegetable fats for human health. In addition, the production of vegetable oil is more economically profitable than the production of animal fats, especially butter [1-5].

Husks and threshed baskets are excellent food for animals. Threshed baskets contain up to 3.5-4% fat, 5-8% protein, 14-17% fiber and up to 60% nitrogen-free extractives.

Over the past 20 years, an unfavorable situation has developed in the production of oilseeds, and especially sunflower. The production of vegetable oil in Russia is experiencing increasing difficulties caused by an increasing shortage of raw materials. As a result of this, our country has changed from being

an exporter of vegetable oil to becoming a permanent importer. There are no objective reasons for this, since oilseeds have long been widely cultivated in Russia. It should be noted that with the transition to market relations, the sunflower area in the country increased by 1.5 times [6-10].

Currently, to solve the problem of increasing the production of oilseeds, it is necessary to accelerate the creation of new, more productive and adaptive sunflower varieties and hybrids. And the promotion of sunflower to more northern, non-traditional zones of its cultivation through the introduction of ultra-early ripening varieties and hybrids will make it possible to more widely develop the production of vegetable oil in these areas and reduce, and possibly completely stop, the import of vegetable oil [11-15].

The introduction of such macroelements as N and K leads to some decrease in oil content, and phosphorus fertilizers do not have any significant effect on this indicator. Mineral nutrition conditions also affect the quality composition of the oil. Many scientific data have revealed that increasing the level of nitrogen and potassium nutrition helps to increase the content of oleic acid, while simultaneously decreasing linoleic acid. It is noted that varieties and hybrids belonging to different morpho biological groups respond approximately equally to fertilizers. Scientists have found that the application of microfertilizers and agrochemicals has a better effect on the balance of the fatty acid composition of sunflower seeds, compared to the application of macroelements [16-21].

Despite the relatively large number of studies conducted on the effect of fertilizers on sunflower yields and product quality, it should be recognized that the problem was and remains relevant. Zonal differences in the sunflower fertilizer system have not been determined, agrochemically effective varieties and hybrids have not been identified, and there is no clarity in theoretical approaches. Often, with a very large NPK removal from the crop, sunflower responds poorly to increased doses of fertilizers. The problem of using fertilizers in the northern sunflower growing regions is especially unclear.

Since the yield of sunflower largely depends on the amount of moisture in the 150-200 cm layer of soil, it should not be placed immediately after crops that strongly dry out the soil to a great depth (alfalfa, sugar beets, Sudan grass). After such crops, sunflower can be sown no earlier than after 2-3 years.

Based on this, it became an urgent need to conduct comprehensive research to develop the basic elements of sunflower cultivation technology in the crop nutrition system in conditions of the south of the Non-Black Earth Zone of Russia; a broad study of the varietal composition of sunflower of various se-

lections in order to select the most suitable lines for our conditions, taking into account that there is not enough regional research in the State Variety Network of Russia [21-24].

We state that early studies with these microbiological fertilizers were carried out on such crops as potatoes, winter and spring wheat, spring barley and soybeans. From the oilseed group of crops, work on the study of the action of agrochemicals Azotovite and Phosphatovite was carried out on crops of white mustard, spring rapeseed, oilseed flax and spring wheat. In domestic scientific sources, there are no studies with the desired microbiological fertilizers in sunflower agrocenoses, including in the Non-Chernozem region.

New promising microbiological fertilizers Azotovite and Phosphatovite provide plants with nitrogen and phosphorus nutrition, increase productivity, suppress phytopathogenic microflora, increase the effectiveness of nitrogen mineral fertilizers, reduce the toxic effect of fungicides on plant seedlings, restore soil fertility. Strains of beneficial microorganisms contained in Baikal EM-1 and other fertilizers under study, after preliminary preparation in a nutrient solution, activate the activity of beneficial microflora, accelerate the processes of humus formation, to some extent, due to the competition of the nutrient medium, suppress the reproduction of pathogens of fungal and bacterial plant diseases. A solution based on EM preparations is used to create more favorable conditions for plant growth, increase overall immunity, reduce the growth of pathogenic microflora, watering the soil or any organic residues (in a compost heap or a layer of organic matter in beds): to accelerate the decomposition of peelings, peel, green mown grass and hay, small branches, straw, tree bark, tops. As a result, nutrients in the soil become more accessible to plants.

The scientific novelty of the research consisted in the studied effect of microbiological fertilizers Azotovite, Baikal, Phosphatovite on sunflower productivity in the conditions of the south of the Non-Chernozem region for the first time in the region. The paper reveals the nature of the development of crop hybrids by phases of development, in addition to yield, an analysis of the fat content and economic efficiency of cultivation according to research options is also proposed, recommendations for production on the introduction of the most effective experience options are given.

The study of the elements of biologization, using fertilizers such as Azotovite, Phosphatovite and Baikal, in such a complex, taking into account chemicalization, intensive technology for growing sunflower oil seeds is an important factor in the balance of ecological equilibrium, which helps to reduce the adverse environmental impact on the environment. The desire to find a new, rela-

tively cheap and environmentally safe way to increase the yield of such a highly profitable crop as sunflower has determined the direction of our research.

Materials and methods

Research methods and methodology for studying sunflower agrocenoses were based on a generalization of scientific sources by domestic and foreign authors, laboratory and field studies, phenological observations, records, in accordance with recommendations and generally accepted methods, using correlation and statistical analysis of the experimental data obtained. Microsoft Office Excel 10 was used for statistical work.

A two-factor field experiment was carried out in 2022 and 2023 on gray forest soils. The object of the research included sunflower hybrids NK Neoma, SI Bacardi (factor B).

According to factor A, microbiological fertilizers Phosphatovite, Baikal EM, Azotovite were used for sunflower.

The experimental design was as follows: 1. Control (without treatment); 2. Microbiological fertilizer Phosphatovite. Pre-sowing seed treatment, agrochemical consumption - 0.5 l/t of seeds, working solution consumption - 10 l/t, as well as foliar feeding: 1st - in the phase of full germination, 2nd - in the phase of 6-8 leaves, agrochemical consumption – 1.0 l/ha, working solution consumption – 300 l/ha; 3. Microbiological fertilizer Baikal EM (products of the EM series) brand: Baikal EM (aqueous solution). Pre-sowing seed treatment, agrochemical consumption – 2.0 l/t of seeds, working solution consumption – 10 l/t. Foliar feeding: 1st - in the phase of full germination, 2nd - in the phase of 6-8 leaves, agrochemical consumption - 6.0 l/ha, working solution consumption - 300 l/ha; 4. Microbiological fertilizer Azotovite. Pre-sowing seed treatment, agrochemical consumption - 0.5 l/t of seeds, working solution consumption - 10 l/t, as well as foliar feeding: 1st - in the phase of full germination, 2nd - in the phase of 6-8 leaves, agrochemical consumption – 1.0 l/ha, working solution consumption – 300 l/ha.

Agrotechnical measures for sunflower cultivation were in accordance with existing zonal recommendations.

After harvesting the forecrop (winter wheat) in all variants of the experiment, peeling was carried out to a depth of 6-8 cm, then, as weeds grew, disking was carried out to a depth of 8-10 cm. Fertilizers were applied for pre-sowing cultivation. Ammonium nitrate, potassium sulfate, and ammophos were used in terms of the active ingredient. Phosphorus-potassium fertilizers were applied at a dose of 60 kg of active substance and plowing was to a depth of 24-26 cm.

In the spring, to destroy weed seedlings, the soil was cultivated in two layers. For all variants, background $N_{135}P_{45}K_{45}$ was used.

Hybrids NK Neoma and SI Bacardi were studied. Sowing was carried out in a dotted manner with row spacing of 70 cm to a depth of 6-8 cm. The sowing time was the 1st decade of May (May 1-5). The seeding rate was 45.0 thousand viable seeds per 1 ha.

Sunflower cultivation was carried out using Clearfield technology, using herbicide Nopasaran, 1 l/ha and Dash adhesive, 1 l/ha. Harvesting was carried out in September individually, in the phase of full ripeness; the plants were previously desiccated.

During the growing season, phenological observations and measurements of the main linear and photosynthetic parameters were carried out. Biometric and yield data were processed by analysis of variance.

The area of the experimental plot was 100 m^2, the registration plot was 75 m^2, the number of replications was four.

Results and discussion

The seasonality of the year was well expressed in Ryazan region, as in other regions of the temperate zone. The duration of the growing season was about 140 days a year. The sum of active temperatures was 2 200 – 2 300 degrees. The hydrothermal coefficient ranged from 1.1 to 1.2 units. Indicators hydrothermal coefficients characterizing weather conditions of Ryazan region during the experiment are presented in Figure 1.

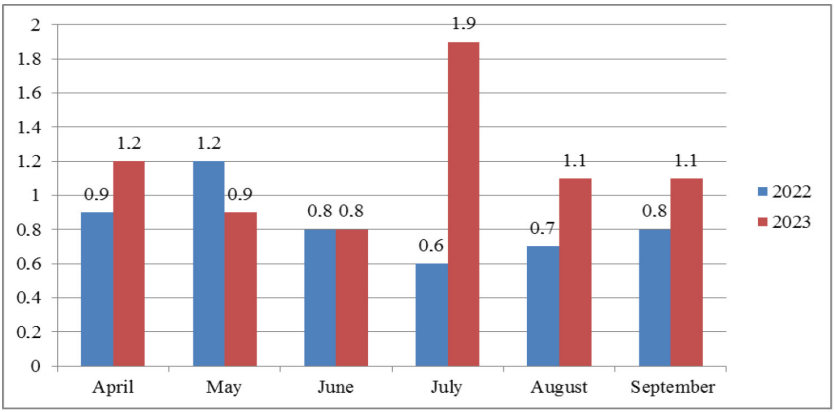

Figure 1. Hydrothermal coefficients for growing seasons of spring grain crops, in 2022, 2023

The weather conditions of the sunflower growing seasons during the experiments were characterized by sharp temperature changes and unstable moisture regimes. Thus, the HTC of the growing season of 2022 was characterized as dry (0.84), while in the period of 2023 sufficient moisture was observed, its values reached 1.18.

There were no significant differences in the development of plants according to the experimental options, until the second treatment was carried out in the phase of 6-8 true pairs of leaves of the crop (Table 1).

Table 1.

The beginning of phenological phases of sunflower development depending on the variant of microbiological fertilizer (using the example of hybrid NK Neoma)

Option	Sowing date	Seedlings	1-2 pairs of leaves	3-4 pairs of leaves	5-7 pairs of leaves	Budding	Basket development	Flowering	Seeds formation	Filling	Ripening	Harvesting
Control	06.05	17.05	23.05	01.06	15.06	24.06	08.07	24.07	12.08	30.08	08.09	30.09
Phosphatovite	06.05	16.05	22.05	30.05	18.06	28.06	11.07	27.07	16.08	02.09	10.09	30.09
Baikal EM	06.05	16.05	22.05	30.05	17.06	29.06	14.07	29.07	18.08	04.09	14.09	30.09
Azotovite	06.05	16.05	22.05	30.05	18.06	30.06	13.07	29.07	19.08	05.09	15.09	30.09

Foliar feeding of Azotovite, Phosphatovite and Baikal EM, carried out at this time, taking into account the first treatment, contributed to more intensive plant development, the duration of the interphase periods of budding - seed formation increased by 2-6 days from the control. In options treated with Baikal EM, the flowering period of sunflower was 2-4 days longer than in the control, this allowed the crop plants to form larger seeds and more of them, in options with Azotovite the period was longer by 5 days, in options with Phosphatovite - by 2-3 days.

In general, it was noted that pre-sowing seed treatment and foliar feeding of plants with aqueous solutions of microbiological fertilizers contributed to an increase in the duration of the sunflower growing season by 3-9 days, depending on the fertilizer option used. Note that the growing season of NK Neoma was 4-8 days longer than ripening of hybrid SI Bacardi.

During phenological observations, the phytosanitary condition of crops was noted. During the observation period, such pests were identified as the gray beet weevil, sunflower long-horned beetle, herbivorous bugs, all pests within the

EPV. Heavy rainfall in the first two decades of July provoked the development of downy mildew, which was noted on single sunflower plants. No dependence of the intensity of disease development on plant treatments with microbiological fertilizers Baikal EM, Azotovite and Phosphatovite was identified. Annual dicotyledonous and cereal weeds were represented by white pigweed, tenacious bedstraw, knotweed, chicken millet, green bristle grass.

An analysis of the crop structure showed that the maximum plant height (171.1 cm) and the number of seeds per basket (1 046.4 pcs.), on average over two years, were in options with hybrid NK Neoma (Figure 2, Table 2).

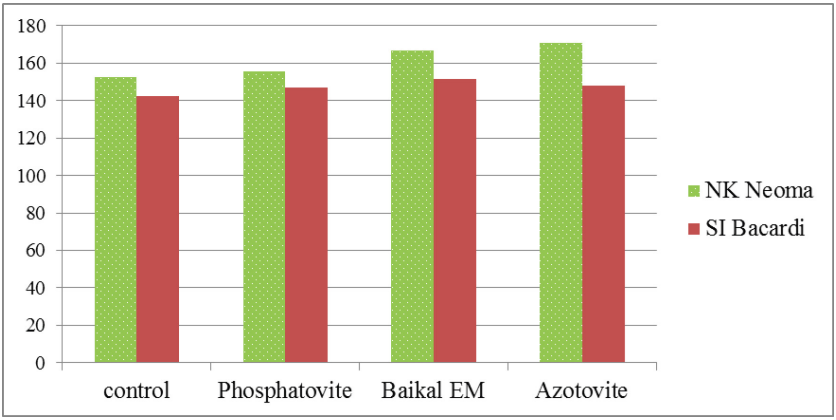

Figure 2. Height of sunflower plants depending on the factors studied, cm

Table 2.

The structure of the sunflower harvest of hybrid NK Neoma depending on the microbiological fertilizer treatment option, average 2022-2023

№	Option	Height of plants, cm	Maximum area of leave, thousand m^2/ ha	Diameter of the basket, cm	Seeds from the basket, pcs.	Weight of 1 000 seeds, g	Safety of plants before harvest, thousand pcs/ha
1.	Control	152.7	21.8	20.4	933.4	53.7	42.3
2.	Phosphatovite	155.7	22.4	20.8	965.2	54.7	42.2
3.	Baikal EM	166.6	23.8	22.9	1025.6	53.5	44.0
4.	Azotovite	171.1	23.6	22.8	1046.4	53.0	43.5

In general, NK Neoma turned out to be the taller hybrid (152.7-171.1 cm), which was 9.6-23.1 cm higher than SI Bacardi, depending on the treatment option with microbiological fertilizers.

At the same time, the diameter of the basket, depending on the hybrid studied, was relatively the same (20.4 – 24.2 cm). The maximum diameter of the basket was found in the option of hybrid SI Bacardi + Baikal EM, and amounted to 24.2 cm. A larger radius of the sunflower basket stimulated the appearance of more seeds. Microbiological fertilizers stimulated an increase in the diameter of the basket compared to the control (Figure 3).

Treatment options (according to the experimental design):
1 – control (without treatment); 2 – Phosphatovite; 3 – Baikal EM; 4 – Azotovite
Figure 3. Typical baskets of options in an experiment to study microbiological fertilizers (using the example of hybrid NK Neoma)

The maximum leaf area was revealed in the option with treatment with Baikal EM and Azotovite - 23.8 and 23.6 thousand m^2/ha, respectively (NK Neoma); and when treated with Baikal EM - 21.0 thousand m^2/ha (SI Bacardi).

The weight of 1 000 sunflower seeds varied between 53.0-54.7 g (NK Neoma) and 49.9-52.5 g (SI Bacardi), and did not significantly depend on the factor of treatment with microbiological fertilizers.

When the phase of complete seed ripening and favorable weather set in, we began harvesting sunflowers and calculating the seed yield (Table 3).

The average yield of sunflower seeds in options with hybrid SI Bacardi was lower (23.4-26.4 dt/ha) than with hybrid NK Neoma (24.0-26.8 dt/ha). On average, the maximum yield was found for the option with the action of Azotovite, 1 l/ha on plots with hybrid NK Neoma, and amounted to 26.8, which was 2.8 dt/ha more than the control option.

Table 3.

Yield (dt/ha) of sunflower by options in the experiment

№	Treatment option	Hybrid	Yield, dt/ha			Yield increase, dt/ha
			2022	2023	aver-age	
1.	Control	NK Neoma (Control)	23.9	24.1	24.0	-
		SI Bacardi	23.0	23.8	23.4	-0.6
2.	Phosphatovite	NK Neoma	24.2	26.9	25.6	+1.6
		SI Bacardi	24.4	26.6	25.5	+1.5
3.	Baikal EM	NK Neoma	25.5	27.0	26.2	+2.2
		SI Bacardi	24.7	27.6	26.1	+2.1
4.	Azotovite	NK Neoma	25.3	28.3	26.8	+2.8
		SI Bacardi	25.4	27.4	26.4	+2.4
LSD_{05} interaction AB, dt/ha			3.02	2.33		

Note that crop yields in 2023 were higher than in 2022, which could be explained by better climatic conditions, warmer and more humid weather. The maximum yield by year was identified in 2023 on hybrid NK Neoma with Azotovite treatment, 1 l/ha (28.3 dt/ha).

Analysis of sunflower oil content depending on the factors studied is presented in Table 4.

Table 4.

Oil content of seeds (%) of sunflower hybrids depending on the microbiological fertilizer, average for 2022-2023

№	Option	Oil content, %	
		NK Neoma	SI Bacardi
1.	Control	46.6	48.6
2.	Phosphatovite	46.4	49.3
3.	Baikal EM	46.7	48.2
4.	Azotovite	45.9	47.4
LSD_{05} interaction AB, %		2022 – 2.28; 2023 – 3.17	

Qualitative analysis of the seeds showed that the microbiological fertilizers used did not significantly affect the oil content of sunflower. Let us highlight the higher oil content of hybrid SI Bacardi: 47.4-49.3%, which is 1.5-2% higher than that of hybrid NK Neoma. The maximum fat yield was obtained in the options NK Neoma + Azotovite (1 230.1 kg/ha) and SI Bacardi + Baikal EM (1 258.0 kg/ha), where the indicator depended mainly on seed productiv-

ity. The maximum oil content was obtained with Phosphatovite + SI Bacardi option (49.3%).

The economic efficiency of the studied techniques was calculated based on the price of sunflower (1 ton/23 thousand rubles). Note that until 2023, the price of sunflower remained twice as high. The costs of the studied microbiological fertilizers ranged from 460-530 rubles per 1 hectare, and did not bring significant costs in technology (Table 5).

Table 5.

Economic efficiency of growing sunflower according to experimental options

№	Treatment option	Hybrid	Yield, dt/ha	Expenses, rub/ha	Gross income, rub/ha	Net income (profit), rub/ha	Profitability,%
1.	Control	NK Neoma (Control)	24.0	36 900	55 200	18 300	49.6
		SI Bacardi	23.4	36 900	53 820	16 920	45.8
2.	Phosphatovite	NK Neoma	25.6	37 100	58 880	21 780	58.7
		SI Bacardi	25.5	37 100	58 650	21 550	58.1
3.	Baikal EM	NK Neoma	26.2	37 400	60 260	22 860	61.1
		SI Bacardi	26.1	37 400	60 030	22 630	60.5
4.	Azotovite	NK Neoma	26.8	37 100	61 640	24 540	66.1
		SI Bacardi	26.4	37 100	60 720	23 620	63.7

Calculations showed that Azotovite treatment option with hybrid NK Neoma not only provided the highest yield, but was also the most efficient. The net income in this case was 24 540 rubles/ha, and the profitability level of sunflower production was 66.1%. The lowest economic result and profitability of 45.8% was provided by the option without fertilizer treatment on Bacardi SI hybrid.

Conclusions

Pre-sowing treatment of seeds and foliar feeding of plants with all aqueous solutions of microbiological fertilizers contributed to an increase in the duration of the sunflower growing season by 3-9 days, depending on the fertilizer used. The growing season in the experiment with hybrid NK Neoma was 4-8 days longer than the ripening period for hybrid SI Bacardi. The maximum indicators for plant

height (171.1 cm) and the number of seeds per basket (1 046.4 pcs.), on average over two years, were in options with hybrid NK Neoma. In general, hybrid NK Neoma turned out to be the taller hybrid (152.7-171.1 cm), which was 9.6-23.1 cm higher than hybrid SI Bacardi, depending on the treatment option with the microbiological fertilizer. The maximum diameter of the basket was found in the variant of hybrid SI Bacardi + Baikal EM, and amounted to 24.2 cm. The mass of 1 000 sunflower seeds varied between 53.0-54.7 g (NK Neoma) and 49.9-52.5 g (SI Bacardi), and did not significantly depend on the factor of treatment with microbiological fertilizers. The maximum leaf area was revealed in the variant with treatment with Baikal EM and Azotovite - 23.8 and 23.6 thousand m^2/ha, respectively (NK Neoma); and when treated with Baikal EM - 21.0 thousand m^2/ha (SI Bacardi). On average, the yield of sunflower seeds in options with hybrid SI Bacardi was lower (23.4-26.4 dt/ha) than in hybrid NK Neoma (24.0-26.8 dt/ha). On average, the maximum yield was found for the option with Azotovite, 1 l/ha on plots with NK Neoma hybrid, and amounted to 26.8, which was 2.8 dt/ha more than the control option. Qualitative analysis of the seeds showed that the microbiological fertilizers used did not significantly affect the oil content of sunflower. Let us highlight the higher oil content of SI Bacardi hybrid: 47.4-49.3%, which was 1.5-2% higher than that of NK Neoma. The maximum fat yield was obtained in options NK Neoma + Azotovite (1 230.1 kg/ha) and SI Bacardi + Baikal EM (1 258.0 kg/ha), where the indicator depended mainly on seed productivity. The maximum oil content was obtained with Phosphatovite + SI Bacardi option (49.3%). The Azotovite treatment option on hybrid NK Neoma not only provided the highest yield, but was also the most efficient. The net income in this case was 24 540 rubles/ha, and the profitability level of sunflower production was 66.1%. The lowest economic result and profitability of 45.8% was provided by the option without fertilizer treatment on hybrid SI Bacardi.

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