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EFFECT OF MINERAL FERTILIZERS AND BIOLOGICAL PREPARATIONS ON SUNFLOWER PRODUCTIVITY

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Abstract

Intensive varieties and hybrids of sunflower are characterized by increased requirements for nutritional conditions and only with a full and balanced supply of nutrients can fully realize their genetic potential. An important condition in the technology of sunflower cultivation is the use of mineral fertilizers and microbial strains for the treatment of crop seeds before sowing. Biologicals for crop production have been in increasing demand among producers in recent years. Application of basic fertilizers in the dose of $N_{20}P_{52}K_{52}$, and when sowing sunflower application of nitrogen fertilizers in the dose of N_{46}, bacterization of sunflower seeds with biological products Bionorm Phosphorus and Bionorm Nitrogen contributes to seed yield early-maturing sunflower hybrid NK Roki at the level of 2,78 t/ha, and medium-early hybrid sunflower NK Delphi, respectively, 3,11 t/ha.

Keywords: Sunflower, mineral fertilizers, biological products, growth, seeds, yield.

Formulation of the problem.

Ukraine is one of the countries with high potential for agricultural development, so crop production has acquired a special status in its national economy, where the oil and fat industry is basic, and the leading place among oilseeds is occupied by sunflower (Helianthus L.), whose sown area has now reached 5 million hectares and about 11 million tons of gross seed harvest. Further increase in sunflower seed production should be due to increased yields by increasing the adaptability of the agrobiocenosis of oilseeds [12].

Increasing the production of sunflower seeds is possible with the introduction of modern technologies for growing new hybrids of intensive type, which can provide a fuller realization of the genetic potential of the crop. An intensive system of sunflower cultivation is impossible without a clear implementation of the measures provided by the technology: the introduction of scientifically sound standards of fertilizers, effective pesticides, microfertilizers, growth regulators, etc [10].

Currently, much attention in the cultivation of sunflower is paid to mineral fertilizers and biological products. The practical interest in biological drugs is due to the fact that they are created on the basis of microorganisms isolated from natural biocenoses, do not pollute the environment and are safe for animals and humans. In addition, bacterial preparations based on microorganisms that fix nitrogen and mobilize phosphorus, improve nitrogen and phosphorus nutrition, stimulate growth, increase plant immunity [4, 5].

To effectively use the biological potential of varieties and hybrids and natural and climatic conditions of the right-bank Forest-Steppe, it is important to develop and implement new adaptive, biological and varietal technologies for growing oilseeds, including sunflower. An important condition is the improvement of modern and development of domestic scientific and technological measures, the introduction of new varieties, microbial strains for seed treatment, spraying crops with growth-regulating drugs of microbial origin. Therefore, only a comprehensive study of bioorganic and agronomic measures of sunflower growing technology will justify ways to increase its yield and improve seed quality.

Analysis of recent research and publications.

Modern technologies for the production of competitive crop products are a way of functioning of sustainable farming systems that promote more efficient use of the potential of varieties and hybrids, increase yields and their quality. Improving the efficiency and stability of the crop sector is possible only with the introduction of intensive technologies for growing crops, which contribute to the optimization of production costs taking into account the environmental safety of the environment and maintain the relative balance of agroecosystems.

Crops, especially modern intensive varieties, fully reveal their potential with optimal diets and moisture. Mineral fertilizers should become a kind of balance between the removal of nutrients from the soil by plants and the level of the evolutionary mode of maintaining fertility [8].

Systematic application of a large amount of mineral fertilizers, unbalanced ratio of N: P: K leads to significant disturbances in the biogeochemical cycle of nutrients in the natural environment. As a result of such activities there are significant and sometimes even irreversible changes in the structure and functions of the soil cover.

Sunflower absorbs a fairly large number of batteries in a short period of time. The amount of absorbed nutrients is determined by the genetic characteristics of plants and depends on the presence and availability of these elements, the presence of moisture, temperature, weather conditions, etc.

Analysis of recent research and publications.

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There is almost no sufficient amount of nutrients in easily accessible form in the soil, so to obtain a high yield when growing sunflowers, it is necessary to apply mineral fertilizers. Intensive varieties and hybrids are characterized by increased requirements for nutritional conditions and only with a full and balanced supply of nutrients can fully realize their genetic potential.

For the formation of 1 ton of seeds and the proper volume of vegetative organs, sunflower removes from the soil nitrogen - 40-55 kg, phosphorus -15-25 kg, potassium - 100-150 kg and a significant amount of trace elements. It is able to absorb phosphorus and potassium from insoluble soil compounds and fertilizers [2].

Scientists have paid a lot of attention to the study of the amount of mineral fertilizers under sunflower. Thus, it was determined that the most productive is their application in the range of $N_{30-60}P_{60-90}K_{60-90}$, and the dose of fertilizers depends on the type of soil, weather conditions, its nutrient regime and so on.

High unbalanced doses of fertilizers, in particular nitrogen, are one of the reasons for the increase in white and gray rot of sunflower. In addition, nitrogen fertilizers activate the soil microflora, enhance the processes of mineralization of organic matter. Therefore, the timing of nitrogen fertilizers should be as close as possible to the period of intensive consumption by plants to increase their efficiency.

It is known that the soil contains a significant amount of mineral elements, but some of them are inaccessible to plants and can be used only by bacterial strains. The current mineral fertilizers do not fully meet the nutrient needs of plants. However, in the case of the use of micronutrients, the plant organism can receive the necessary nutrients. Scientists believe that the use of microfertilizers and biological products reduces the dependence of the crop on environmental factors [1].

Along with mineral and organic fertilizers, biological products play an important role. The microorganisms on which they are based not only fix nitrogen from the atmosphere or dissolve soil phosphates, but also produce restorative compounds, amino acids and antibiotics that inhibit the development of phytopathogens, do not harm animals and humans, do not pollute the environment. These are environmentally friendly drugs of complex action. In recent years, Ukraine has produced about 100 thousand hectares of biological products, Hungary - more than 200 thousand, Britain and Poland - 500 thousand, Romania - more than 1 million, India - 3 million, Canada - 4 million, and in Australia - about 6 million hectare norms. It should be emphasized that in the US, the needs of agriculture in nitrogen are covered by 31% due to mineral fertilizers, 24% - organic fertilizers and 45% - biological nitrogen fixation [11].

Complex application of microbial biologicals has a combined biological activity to increase the resistance of plants to biotic and abiotic stresses. The latest competitive biological products provide an increase in crop productivity while reducing production costs and maintaining the ecological condition and fertility of soils. Most of them meet the requirements of organic farming and have the appropriate Organic Standart certificate, approved for use in farms with an organic farming system, the area of crops in which is constantly growing in Ukraine.

Certain species of bacteria, which have always been considered indicators of fertile soils, are now on the verge of extinction. They are replaced by microorganisms that perform atypical functions - instead of optimizing root nutrition, they parasitize on the plant body. The consequences are known: even with sufficient fertilization of the soil, the crop is not able to realize its genetic potential. However, technologically it is quite possible to artificially introduce agronomically useful microorganisms "in the right place, in the right amount, at the right time."

The idea of using microbial preparations in ecologically safe technologies of growing crops is based on this. The need to create complex biological products is dictated by the fact that previously created microbial drugs, for all environmental and economic feasibility of their use, in adverse climatic conditions (eg, sharp cooling or low soil moisture) may not ensure proper formation of nitrogen-fixing symbioses and associations. accordingly, do not positively affect the level of crop yields.

According to statistics, the probability of positive action of microbial drugs of complex action in the case of their use is 65-70% of cases. In this regard, the Institute of Agricultural Microbiology and Agricultural Production has created biological products of complex action, which, in addition to the bacterial component, contain physiologically active substances of biological origin, including phytohormones. Under favorable conditions, the components of biological products act synergistically on the plant; for adverse - when the action of the bacterial component can be offset, the production process of the culture is affected by the physiologically active component.

For many years, scientists have been studying the peculiarities of plant nutrition depending on the influence of rhizosphere microorganisms. This area of research is of particular importance for overcoming the deficit of nitrogen and phosphorus in plant nutrition, improving the efficiency of arable land, soil fertility, reducing the cost of purchasing synthetic fertilizers and more. Biologicals based on phosphate-mobilizing microorganisms have a certain antibiotic effect and significantly reduce plant morbidity. In contrast to nitrogen-fixing, they are less demanding on temperature, moisture supply and acidity, but require a sufficient amount of organic matter in the soil [7].

The use of effective compositions of bacterial strains that fix nitrogen and mobilize phosphorus, due to which the prevalence of diseases will decrease by 50-60%, grain productivity will increase by 20-25% and soil fertility of the right Forest-Steppe of Ukraine will be stabilized [3].

Positive in terms of the use of biological products is the fight against certain plant diseases. Beneficial microorganisms, inhabiting the root system, for some time inhibit the infection of plants with pathogens. An important aspect of these drugs is to increase plant resistance to adverse environmental factors - lack of moisture, high and low temperatures, phytotoxic effects

of pesticides, pest damage and disease, which ultimately contributes to higher yields and improved product quality [13].

The development of advanced sunflower cultivation technology will allow to use more widely the potential of this crop in the right-bank forest-steppe of Ukraine, and the use of microbial drugs can reduce the application of mineral fertilizers, which is an important reserve for their savings. Therefore, today the use of biological products should not be considered as a separate or additional agricultural measure, but as an integral part of advanced technologies for agricultural production.

The purpose of the research is the theoretical substantiation and development of intensive technologies of sunflower cultivation on the experimental field of VNAU of the village of Agronomichne.

Presenting main material.

The introduction of new varieties and hybrids of sunflower does not reduce fluctuations in seed yield due to fluctuations in weather conditions. Under the constant or periodic influence of adverse environmental conditions, the high biological potential of productivity remains unrealized. The degree of negative influence of the anomalous factor on the formation of the crop depends not only on the intensity and duration of its action, but also on its manifestation at the stages of plant ontogenesis. In sunflower it is established that the flowering phase is the most sensitive to high temperatures.

Early-maturing hybrids and varieties, as a rule, are somewhat inferior to medium-ripe and medium-early in terms of seed yield and oil content. The height of their plants reaches 135-165 cm. In Ukraine, they ripen 6-10 days earlier than medium.

Medium-early forms of sunflower are characterized by high plant productivity and a significant oil content in the seeds. Plants 147-195 cm tall, seeds are black or dark gray with barely noticeable stripes of slate hue, with dark stripes on the ribs. Most of the hybrids and varieties on the market are resistant to lupus and sunflower moth.

One of the most important among the main technological methods of cultivation, which has the greatest impact on the growth and development of crops, including sunflower, is the optimization of plant nutrition. Particular attention should be paid to this issue in recent years due to the deterioration of the main indicators of soil fertility, when they are gradually depleted and depleted of nutrients.

Widespread use of biological products created by domestic microbiologists is a significant resource to increase crop productivity in conditions when Ukrainian agriculture operates in a state of negative balance of humus, as well as phosphorus, nitrogen and other nutrients. In recent years, the list of biotechnological products, microbial preparations for the crop industry has expanded significantly and includes their creation on the basis of free-living, associative, symbiotrophic nitrogen-fixing, phosphate-mobilizing microorganisms, as well as binary drugs, a combination of various microorganisms or bacteria and bacteria.

An important indicator in the formation of sunflower yield productivity is the ability of plants to fully undergo all phenological phases, which further affects crop yields. The onset of phenological phases and their duration largely depends on the soil and climatic conditions of the growing season.

The following phases of growth and development are observed in sunflowers: seedlings, the first pair of leaves, the second pair of leaves, the third pair of leaves, inflorescence formation, flowering, achene formation, achene filling, achene ripening. In the program of agrometeorological measurements, observations are made on the following phases of development: seedlings, the second pair of leaves, inflorescence formation, flowering, ripening, harvesting maturity.

Stairs. The first shoots - in some places the cotyledons, which appeared on the surface of the soil, unfolded, but the lines were not marked; mass stairs - the same for most of the site, the lines are clearly marked.

Another pair of leaves. The appearance of the first pair of true leaves. It is necessary to clearly distinguish true leaves from cotyledons.

Inflorescence formation. This is the phase of formation of the "basket", its outer leaves form a multirayed star among the upper leaves.

Flowering. Tubular flowers, which are located at the edge of the basket, have opened. If you touch them, yellow pollen remains on your fingers.

Maturation. In the middle part of the basket, the skin of the grains acquired the color characteristic of this variety (gray, black-violet, etc.), a nucleus was formed, most of the leaves and ligulate flowers dried up, and the inner part of the basket turned yellow. Harvest maturity. Drying the back of the basket.

Phenological observations record the main phases of development and growth of plants, but they do not reflect all the complex organ-forming processes occurring in the interphase periods. The whole process of organogenesis of plants takes place in stages on the basis of certain stages of development, so, having established at what stage is a particular stage of organogenesis, you can then by the state of stages of organogenesis with a relatively high degree of reliability to judge the stage of development.

In the conditions of researches sunflower plants developed normally, passed all stages of organogenesis. At the beginning of the vegetation of sunflower plants, the rate of onset of developmental phases is influenced by the amount of precipitation and temperature. The duration of the period of sowing-emergence of sunflower hybrids NOT Rocky and NK Delphi on average is from 8 days after sowing. The duration of the interphase periods of germination - the formation of baskets in the early-ripening sunflower hybrid NK Rocky, depending on the research options lasted from 27 to 32 days. It should be noted that in the control areas, without fertilizers and treatment, this figure lasted the least and was 27 days. It should be noted that the application of mineral fertilizers in the main fertilizer and when sowing the application of urea in the normal consumption affected the duration of this period, increased by 1 day and lasted 30 days, which is longer than the control options by 1 day.

In the period from the formation of baskets to the flowering of sunflowers there is a fairly close direct relationship between its duration and the sum of temperatures. Interphase flowering period - full maturity in plants of early-maturing sunflower hybrid NK Rocky lasts an average of 37 - 43 days. During this period, sunflowers need a fairly large amount of water. In dry weather, during flowering, even the fall of flowers can be observed, which significantly reduces crop yields.

The longest period of the flowering phase - full maturity was observed in areas where mineral fertilizers were applied and before sowing sunflower seeds were treated with biological products Bionorm Phosphorus + Bionorm Nitrogen - 43 days. As a result of research it is noted that the duration of interphase periods is significantly influenced by bacterization of seeds with biological products and application of mineral fertilizers.

The duration of the growing season of early-maturing sunflower hybrid NK Rocky lasted within 90-107 days, the middle-early hybrid sunflower Delphi this period was longer and lasted 107-118 days. Treatment of sunflower seeds with biological products significantly increased the duration of vegetation of the crop. Thus, treatment of seeds with the biological product Bionorm Nitrogen prolonged the vegetation of sunflower plants by 5 days, compared with control areas. The longest vegetation period of NC Delphi sunflower was observed in the areas where mineral fertilizers were applied, and before sowing the seeds were bacterized with biological products Bionorm Phosphorus + Bionorm Nitrogen - 118 days (Table 1).

As a result of the conducted researches it is possible to note positive effect of carrying out bacterization of sunflower seeds of both hybrids by biological products, and introduction of mineral fertilizers in norm of use $N_{20}P_{52}K_{52} + N_{46}$.

Table 1

Duration of interphase periods of plant development sunflower, days (average for 2019-2020)

Experiment options	Sowing - the emergence of seedlings	Stairs - the formation of baskets	Basket formation - flowering	Flowering - full maturity	Duration of the growing season
NK Rocky					
Control (without fertilizers and treatments)	8	27	18	37	90
$N_{20}P_{52}K_{52} + N_{46}$ (Background)	8	30	20	38	96
$N_{20}P_{52}K_{52} + N_{46}$ (Background) + Bionorm Phosphorus	8	31	22	39	100
$N_{20}P_{52}K_{52} + N_{46}$ (Background) + Bionorm Nitrogen	8	31	22	41	102
$N_{20}P_{52}K_{52} + N_{46}$ (Background) + Bionorm Phosphorus + Bionorm Nitrogen	8	32	24	43	107
NK Delphi					
Control (without fertilizers and treatments)	8	29	21	49	107
$N_{20}P_{52}K_{52} + N_{46}$ (Background)	8	32	23	47	110
$N_{20}P_{52}K_{52} + N_{46}$ (Background) + Bionorm Phosphorus	8	33	26	45	112
$N_{20}P_{52}K_{52} + N_{46}$ (Background) + Bionorm Nitrogen	8	34	27	46	115
$N_{20}P_{52}K_{52} + N_{46}$ (Background) + Bionorm Phosphorus + Bionorm Nitrogen	8	34	28	48	118

Thus, when sowing sunflower, special attention should be paid to tillage technologies that promote wet accumulation, preparation of seeds for sowing (bacterization), application of mineral fertilizers, both in the main fertilizer and in the spring.

The productivity of hybrids and varieties of sunflower is a determining factor in the formation of yields and depends on their biological characteristics and meteorological conditions and applied cultivation technologies. It should be noted that the formation of reproductive organs of hybrids and varieties of sunflower, such as basket size, weight of 1,000 seeds, the level of husk will depend on seed yield and quality [9].

Sunflower refers to plants whose stems create certain air, water and light regimes. With increasing plant height due to the thickening of sunflower crops, in conditions of sufficient moisture, the effect of limiting factors, in particular, light and nutrients. The most important morphological features of sunflower, which determine the formation of its productivity, include the height or length of the stem, the diameter of the basket, the size of the leaf surface. These indicators indicate the nature of the interaction between the genotype of the culture and the conditions of its cultivation, reflecting the state of plant development.

The height of plants of early-maturing sunflower hybrid NK Rocky at the beginning of the growing season (phase 4-5 pairs of true leaves) ranged from 24,6 to 26,2 cm, while the height of medium-early hybrid sunflower NK Delphi in this phase was less and ranged from 23,3 to 25,4 cm. Characterizing sunflower hybrids, it can be argued that the early-maturing hybrid NK Roki is characterized by rapid initial growth and development in the initial stages of development.

The highest height of early-maturing sunflower hybrid NK Rocky and medium-early hybrid sunflower NK Delphi in the phase of 4-5 true leaves had plants on average under the action of processing sunflower seeds complex biological products Biolan Phosphorus and Biolan Nitrogen, mineral fertilizers. The height of the plants was greater than the control by 1,6-2,1 cm. From the results of research we note a rapid increase in the height of the sunflower hybrid NK Rocky in the initial stages.

Active growth of sunflower plants was observed during the period of development - budding. At the end of this period, the plant height of the control variant of the NK Rocky hybrid was within 80,0 cm, and the height of the medium-early hybrid NK Delphi was slightly lower and amounted to 78,7 cm. budding phase.

In the phase of full ripeness of sunflower plants of all experimental variants reached the greatest height. The highest height of sunflower plants of early-maturing hybrid NK Roki was in areas where the main fertilizer was applied mineral fertilizers at a dose of $N_{20}P_{52}K_{52}$, sunflower seeds before sowing were treated with bacterial fertilizers sunflowers had a height at full maturity of 176,8 cm.

A corresponding pattern was observed in areas where the middle-early sunflower hybrid NK Delphi was sown. In the phase of development of sunflower plants, the full maturity in the control areas without mineral fertilizers and seed bacterization was 155,7 cm, while in areas where sunflower seeds were bacterized before sowing and mineral fertilizers were used, the height of sunflower plants was within 170,2- 180,6 cm (Table 2).

As a result of research by scientists Girka AD, Tkalich ID, Bochevar OV, show that the height of sunflower plants in the phase of full maturity was the largest in the variants of the experiment, which used pre-sowing seed treatment with AKM, and varied in ranges from 168,7 to 179,9 cm. The largest increase in plant height was in the variant with pre-sowing application of mineral fertilizers in the dose of $N_{30}P_{30}K30$ and Vitastar, 3 kg / ha and treatment of AKM seeds – 16,4 cm, or 10,03% compared to control (without fertilizer application and seed treatment) [6].

Table 2

Height of sunflower plants under the action of bacterization and mineral fertilizers (average for 2019-2020)

Experiment options	Phase of development of sunflower plants			
	4-5 pairs of true leaves	Budding	Full flowering	Full maturity
NK Rocky				
Control (without fertilizers and treatments)	24,6	80,0	151,2	152,5
$N_{20}P_{52}K_{52} + N_{46}$ (Background)	25,8	88,2	160,0	165,4
$N_{20}P_{52}K_{52} + N_{46}$ (Background) + Bionorm Phosphorus	25,9	91,6	163,4	172,0
$N_{20}P_{52}K_{52} + N_{46}$ (Background) + Bionorm Nitrogen	26,0	92,0	165,8	173,5
$N_{20}P_{52}K_{52} + N_{46}$ (Background) + Bionorm Phosphorus + Bionorm Nitrogen	26,2	94,3	168,0	176,8

NK Delphi				
Control (without fertilizers and treatments)	23,3	78,7	154,2	155,7
$N_{20}P_{52}K_{52}$ + N_{46} (Background)	24,2	87,3	163,5	166,3
$N_{20}P_{52}K_{52}$ + N_{46} (Background) + Bionorm Phosphorus	25,1	88,1	168,0	170,2
$N_{20}P_{52}K_{52}$ + N_{46} (Background) + Bionorm Nitrogen	25,2	90,5	170,4	177,0
$N_{20}P_{52}K_{52}$ + N_{46} (Background) + Bionorm Phosphorus + Bionorm Nitrogen	25,4	92,4	174,0	180,6

The number of leaves on the plant of the early-maturing hybrid NK Rocky ranged from 17,2 to 28,8 pieces, and the number of leaves of the middle-early hybrid Delphi ranged from 18,5 to 30,6 pieces. The largest number of leaves was formed by sunflower plants of all studied hybrids during bacterization of seeds before sowing of biological products and application of mineral fertilizers. The maximum effect on this indicator was found in the plants of the middle-early hybrid NK Delphi, which was 30,6 units/plant, which is 12,1 units/plant more than in the control plots.

The diameter of the basket of early-maturing sunflower hybrid NK Rocky in the control areas was the smallest and was 17,5 cm. Application of diammophos in the main fertilizer, bacterization with Bionorm Nitrogen biofertilizer and fertilization with ammonium nitrate in the tillering phase helped to improve the supply of phosphorus to sunflower plants due to which the diameter of the basket increased by 4,3 cm compared to control areas and was 21,8 cm.

The largest diameter of the basket of sunflower hybrids was observed in areas where in addition to mineral fertilizers the seeds were bacterized in a mixture of Bionorm Phosphorus and Bionorm Nitrogen, the diameter of the basket of sunflower hybrid NK Rocky was within 23,6 cm, which is 6,1 cm larger than the control areas, and the diameter of the basket of the hybrid NK Delphi was at the level of 25 cm, which is larger than the control areas by 7,4 cm (Table 3).

The formation of highly productive agrophytocenoses of sunflower implies the availability of resources for its cultivation technologies and favorable climatic conditions. It should also be noted that the meteorological conditions that develop during the growing season, largely determine the effectiveness of technological measures. The results of research on the use of mineral fertilizers and biological products in sunflower crops are aimed at maximizing the biological potential of the crop, which cannot be achieved without taking into account soil and climatic conditions.

Table 3

Indicators of sunflower plant development under the action of biological products and mineral fertilizers (average for 2019-2020)

Experiment options	Phase of development of sunflower plants			
	Number of leaves, pcs/plant	+/- to control	Diameter of a basket, see	+/- to control
NK Rocky				
Control (without fertilizers and treatments)	17,2	-	17,5	-
$N_{20}P_{52}K_{52}$ + N_{46} (Background)	24,1	+ 6,9	21,8	+ 4,3
$N_{20}P_{52}K_{52}$ + N_{46} (Background) + Bionorm Phosphorus	25,0	+ 7,8	22,2	+ 4,7
$N_{20}P_{52}K_{52}$ + N_{46} (Background) + Bionorm Nitrogen	26,1	+ 8,9	22,3	+ 4,8
$N_{20}P_{52}K_{52}$ + N_{46} (Background) + Bionorm Phosphorus + Bionorm Nitrogen	28,8	+ 11,6	23,6	+ 6,1
NK Delphi				
Control (without fertilizers and treatments)	18,5	-	17,6	-
$N_{20}P_{52}K_{52}$ + N_{46} (Background)	26,8	+ 8,3	23,5	+ 5,9
$N_{20}P_{52}K_{52}$ + N_{46} (Background) + Bionorm Phosphorus	27,3	+ 8,8	24,4	+ 6,8
$N_{20}P_{52}K_{52}$ + N_{46} (Background) + Bionorm Nitrogen	28,0	+ 9,5	24,5	+ 6,9
$N_{20}P_{52}K_{52}$ + N_{46} (Background) + Bionorm Phosphorus + Bionorm Nitrogen	30,6	+ 12,1	25,0	+ 7,4

Obtaining stable yields becomes very important and is quite expensive. This requires a revision of the whole concept of crop production and the development of a strategy of adaptive intensification of crop production, which is based on the use of the adaptive potential of all biological components of hybrids or varieties and agroecosystems.

In recent years, many new varieties and hybrids of sunflower have appeared in production, which differ from those grown earlier, precocity, morphobiological characteristics, increased resistance to shading, disease, lodging, higher yields and product quality. The yield of sunflower seeds varied both over the years and according to the variants of the experiment. Thus, in the control plots the yield of sunflower seeds of the early-ripening hybrid NK Rocky on average for two years of research was at the level of 1,15 t/ha, while the hybrid NK Delphi, seed yield was slightly higher and amounted to 1,20 t/ha.

With the application of mineral fertilizers, the yield of sunflower seeds of the NK Rocky hybrid was 1,18 t/ha higher than in the control plots, and the yield of sunflower seeds of the NK Delphi was higher by 1,39 t/ha compared to the control plots.

The highest yield of sunflower seeds was observed in those areas where mineral fertilizers in the dose of $N_{20}P_{52}K_{52}$ were applied to the main fertilizer, and before sowing sunflower seeds the seeds were co-bacterized with Bionorm Phosphorus and Bionorm Nitrogen biological preparations. The yield of hybrids of sunflower seeds on average for two years was in the range of 2,78-3,11 t/ha (Table 4).

Table 4

Yield of sunflower seeds under the action of seed bacterization and mineral fertilizers

Experiment options	Seed yield, t/ha				
	2019 yr.	2020 yr.	average	+/- to control	
				t/ha	%
NK Rocky					
Control (without fertilizers and treatments)	1,23	1,06	1,15	-	-
$N_{20}P_{52}K_{52}$ + N_{46} (Background)	2,46	2,20	2,33	+ 1,18	102,6
$N_{20}P_{52}K_{52}$ + N_{46} (Background) + Bionorm Phosphorus	2,62	2,34	2,48	+ 1,33	115,7
$N_{20}P_{52}K_{52}$ + N_{46} (Background) + Bionorm Nitrogen	2,64	2,38	2,51	+1,36	118,3
$N_{20}P_{52}K_{52}$ + N_{46} (Background) + Bionorm Phosphorus + Bionorm Nitrogen	2,88	2,67	2,78	+ 1,63	141,7
NIR_{05} 1,01 1,20					
NK Delphi					
Control (without fertilizers and treatments)	1,28	1,11	1,20	-	-
$N_{20}P_{52}K_{52}$ + N_{46} (Background)	2,82	2,36	2,59	+ 1,39	115,8
$N_{20}P_{52}K_{52}$ + N_{46} (Background) + Bionorm Phosphorus	2,98	2,61	2,80	+ 1,60	133,3
$N_{20}P_{52}K_{52}$ + N_{46} (Background) + Bionorm Nitrogen	3,10	2,74	2,92	+ 1,72	143,3
$N_{20}P_{52}K_{52}$ + N_{46} (Background) + Bionorm Phosphorus + Bionorm Nitrogen	3,27	2,95	3,11	+ 1,91	159,2
NIR_{05} 1,05 1,04					

Thus, the use of mineral fertilizers and bacterization of sunflower seeds before sowing with biological products in the cultivation of sunflower are necessary basic elements to increase the yield of crop seeds.

Conclusions

1. The duration of the growing season of early-maturing sunflower hybrid NK Rocky lasted within 90-107 days, the middle-early hybrid sunflower Delphi, this period was longer and lasted 107-118 days.

2. The highest height of early-maturing sunflower hybrid NK Rocky and medium-early sunflower hybrid NK Delphi in the phase of 4-5 true leaves had plants on average under the action of sunflower seed treatment with biological products Biolan Phosphorus and Biolan Nitrogen, mineral fertilizers. The height of the plants was greater than the control by 1,6-2,1 cm

3. The number of leaves on the plant of the early-maturing hybrid NK Rocky ranged from 17,2 to 28,8 pieces, and the number of leaves of the middle-early hybrid Delphi ranged from 18,5 to 30,6 pieces. The largest number of leaves was formed by sunflower plants of all studied hybrids during bacterization of seeds before sowing of biological products and application of mineral fertilizers. The maximum effect on this indicator was found in the plants of the middle-early hybrid NK Delphi, which was 30,6 pieces/plant, which is more than in the control areas by 12,1 pieces/plant.

4. The largest diameter of the basket of sunflower hybrids was observed in areas where in addition to mineral fertilizers the seeds were bacterized in a mixture of Bionorm Phosphorus and Bionorm Nitrogen, the diameter of the basket of sunflower hybrid NK Rocky was within 23,6 cm, which is greater than control areas by 6, 1 cm, and the diameter of the basket of the hybrid NC Delphi was at the level of 25 cm, which is 7,4 cm larger than the control areas.

5. Increased yield of sunflower seeds was observed in those areas where mineral fertilizers were

applied in the main fertilizer at a dose of $N_{20}P_{52}K_{52}$, and before sowing sunflower seeds was joint bacterization of seeds with biologicals Bionorm Phosphorus and Bionorm Nitrogen, and at sowing in sunflower N_{46}. The yield of sunflower seed hybrids on average for two years was in the range of 2,78-3,11 t/ha.

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