Ministry of Science and Higher Education of the Russian Federation
FEDERAL STATE BUDGETARY SCIENTIFIC INSTITUTION
"KURSK FEDERAL AGRICULTURAL RESEARCH CENTER"
(structural subdivision)

KURSK RESEARCH INSTITUTE OF AGRO-INDUSTRIAL PRODUCTION

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ACTING DIRECTOR, FSBSI "KURSK FARC"
/Signature/ ______________ L.V. Gostev
" ___ " __________________________ 2020

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RESEARH REPORT

on the topic:

"Study of the effectiveness when using the EKO-SP agrochemicals based on humic substances for soybean crops in the black earth soils of the Kursk region"

for the year 2020

Executors:

Head of the Laboratory of Cultivation Technologies for Field Crops Growing and Lands Environmental Assessment of FSBSI "KURSK FARC", Doctor of Agricultural Sciences, Professor

___________________ */Signature/* __________________ V. I. Lazarev

Junior research assistant */ Signature/* ____________ Zh.N. Minchenko

Kursk 2020

1. Product name:

EKO-SP agrochemical based on humic substances

2. Manufacturer (name, legal address, telephone, fax):

EKOR-SP, LLC, 115516 Moscow, Promyshlennaya Str., 11, bldg. 3, office 21, tel. +7 (495) 477-53-94

3. **Working purpose**: to determine the effectiveness of using the EKO-SP agrochemical based on humic substances on soybean crops, the effect of the product on the yield and quality of grain in the soil and climatic conditions of the Kursk Region

4. Characteristics of the agrochemical.

EKO-SP agrochemical based on humic substances is made from plant materials (lowland peat), it contains humic and fulvic acids, plant hormones, amino and simple organic acids, microelements in chelated form, and useful soil microflora. EKO-SP is an inducer of plant immunity, it has adaptogenic properties and promotes anti-stress resistance of plants to diseases and unfavorable environmental conditions, it also has high chemical purity and solubility and increases productivity and product quality. The product is intended for seed treatment and foliar treatment of plants, it can be used at almost all stages of the growing season (from seed treatment to additional fertilizing in case of the stress of plants).

5. Testing location (agro-climatic zone, region name, company name).

Russia, Central Black Earth Region, Kursk Region, Kursk District, settlement Cheryomushki, FSBSI "Kursk Federal Agrarian Research Center", Structural Subdivision of “Kursk Research Institute of Agroindustrial Production”.

6. Testing time. Agricultural year 2020

7. Agrochemical characteristics of the soil (testing site)

The soil of the testing site is represented by typical thick heavy loamy black soil. The humus content in the arable layer is 6.0-6.2%, mobile phosphorus (according to Chirikov) - 10.1-14.5, exchangeable potassium (according to Maslova) - 16.8-19.0 mg/100 g of soil. The reaction of the soil medium is neutral (pH 6.8-7.0) (Table 1).

Table 1: Agrochemical characteristics of the soil (testing site)

Indicator	Horizon				
	0-10	20-30	50-60	70-80	90-100
Humus,%.	6.2	6.0	5.9	4.3	3.1
pH of water suspension	5.9	6.3	6.6	7.2	7.9
Hydrolytic acidity, meq per 100 g	3.37	3.14			
Total absorbed bases, mg/eq per 100 g	41.8	41.6	39.7	37.1	--
Total nitrogen,%	0.34	0.34	0.26	0.19	0.16
Hydrolyzable nitrogen, mg/kg	75	67	--	--	--
Gross phosphorus,%	0.14	0.14	0.13	0.11	0.13
Mobile phosphorus (according to Chirikov), kg/ha	145	146	101	99	82
Exchangeable potassium (according to Maslova), kg/ha	164	168	146	138	133

8. Meteorological conditions for the growing season of soybeans.

The meteorological conditions of the agricultural year 2020 were satisfactory for the growth and development of soybeans. The amount of precipitation in April was 20.2 mm (their multi-annual amount is 35 mm), with the average daily temperature of this period being 0.6°C below the norm (6.7°C). The average monthly temperature in May was 1.9°C below the norm (13.8°C), and the amount of precipitation was 74.1 mm, or 148.1% of their average multi-annual value (50mm).

The summer of 2020 began on April 25 with the transition of the average daily air temperature through 15°C towards a further increase. On average, in June, the air temperature was 20.7°C, which is 3.4°C higher than the norm, and the amount of precipitation was 46.7 mm, or 79.2.5% of their average multi-annual amount (59 mm). The weather in July was warm and humid, the average monthly temperature in July was 21.0°C with an average multi-annual temperature of 18.9°C, and the amount of precipitation was 72.6 mm, or 102.2% of the norm (the average long-term sum is 71 mm).

The average monthly air temperature in August was 18.7°C, with an average multi-annual temperature of 18.1°C, and the amount of precipitation was 11.8 mm or 18.4% of the norm (64 mm) (Table 2).

Table 2: Meteorological conditions of the agricultural year 2020 (according to the Petrinskaya meteorological station)

Month		Average multi-annual temperature, °C	Average monthly temperature, °C	Average multi-annual precipitation value, mm	Average monthly precipitation value, mm
January	2020	-10.3	-1.1	34	22.2
February		- 8,0	-1.4	33	36.0
March		- 2,9	4.0	32	18.1
April		6.7	6.1	35	20.2
May		13.8	11.9	50	74.1
June		17.3	20.7	59	46.7
July		18.9	21.0	71	72.6
August		18.1	18.7	64	11.8
September		12.4		44	

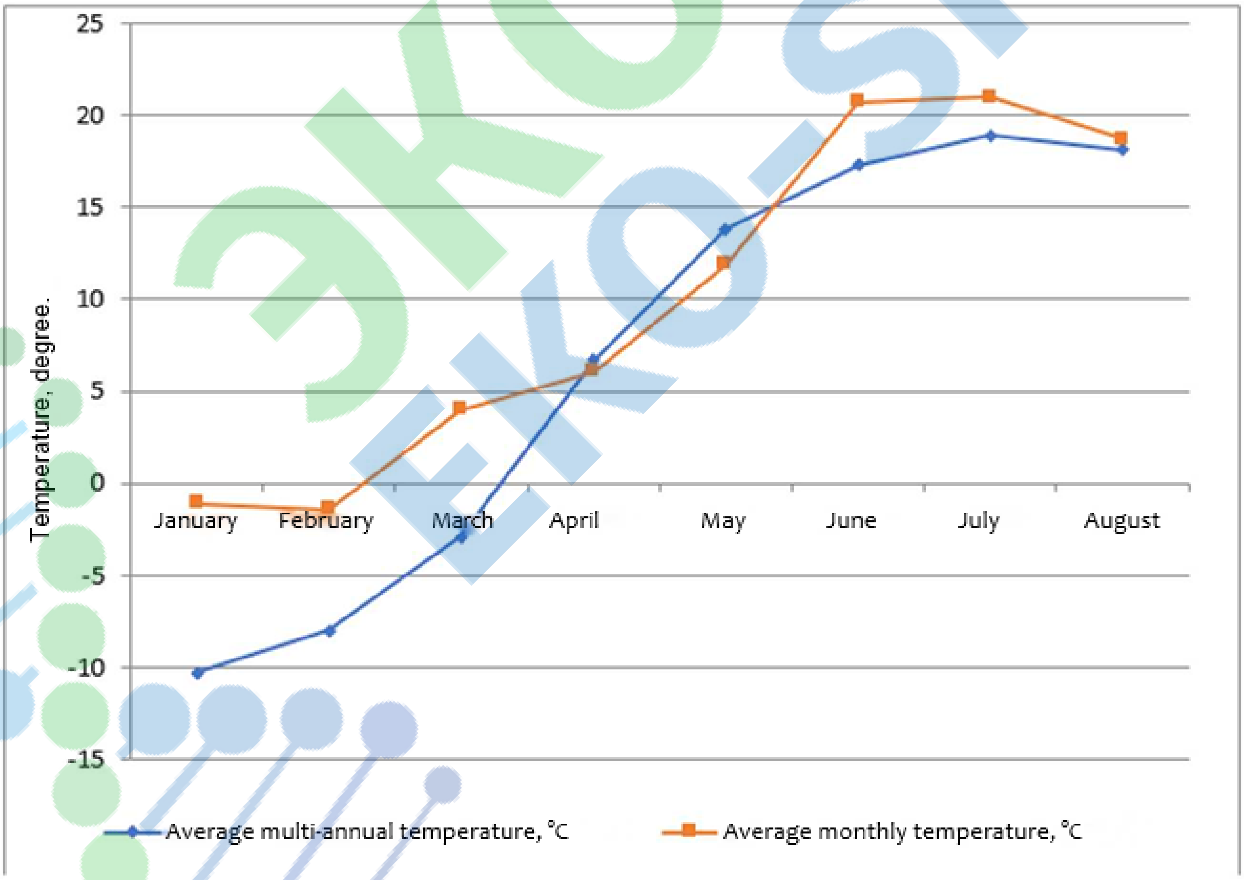

Fig. 1: Dynamics of average monthly air temperatures, 2020

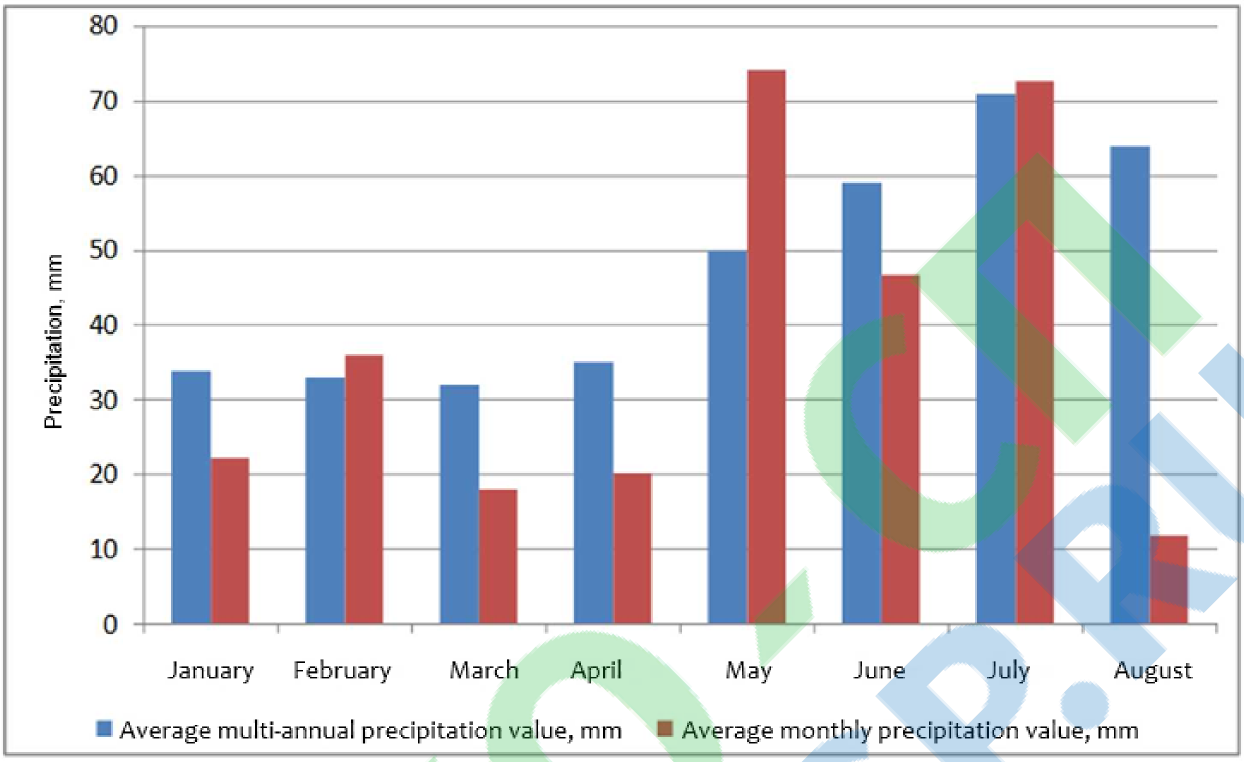

Fig. 2: Precipitation dynamics, 2020

Thus, the average daily temperature of the growing season for soybeans (May-August) in 2020 was 18.1°C, or 1.1°C above the norm (17.0 °C, with a total precipitation value of 205.2 mm, or 84.1% of the norm.

9. Experimental design:

1. Control - no treatments
2. EKO-SP (2.5 l/ha) preplant application + treatment of crops in the 2nd ternate leaf phase of soybeans + EOK-SP (1 l/ha) treatment of crops in the 1st ternate leaf phase + EKO- SP (1 l/ha) treatment of crops in the 6th ternate leaf phase

10. Type of test: laboratory research, field (production) test

11. Study procedure

The field test was carried out in a seeds-hoed crop rotation with the following crop rotation: 1.Spring barley, 2.***Soya***, 3.Spring wheat

The test was repeated 3 times, the variants were arranged systematically in one tier. The working plots were in the shape of an elongated rectangle. Sowing plot size - 5.4 x 50 = 270 m^2, registration plot - 200 m^2 (4x50)

Fieldwork on the test site was carried out in the best agrotechnical terms using the Kazachka soybean variety zoned in the region.

Control

EKO-SP

Fig. 3-4. General view of the test options for studying the effectiveness of an agrochemical based on humic substances EKO-SP on soybean crops, 2020

Variety**KAZACHKA** is a short-season variety. Bred in the FSBSI Donskoy Zonal Research Institute of Agriculture. Included in the State Register for the Central Black Earth Region. Recommended for cultivation in the Kursk region. The growing season is 95-110 days. The plant is of an indeterminate development type, of average height, from erect to semi-erect. The flower is white. Seeds are small - medium in size, elongated-flattened, yellow, with a yellow scar. The time to bloom is from very early to early. The mass of 1,000 seeds is 149.6 g. The average yield in the Central Black Region is 21.7 c/ha, maximum 44.8 c/ha. The protein content in the seeds is 34.0%, the fat content is 24.4%. Plant height is 74.7 cm, attachment height of the lower pod is 12.5 cm.

Soybean cultivation technology corresponded to the recommended one for farms of the Central Black Earth region:

- Tilling: disking in 2 tracks to a depth of 6-8 cm (September), plowing to a depth of 23-25 cm (October), early spring harrowing (April), 1st cultivation (April), 2nd (pre-sowing) cultivation (May).
- Fertilization: diammofoska $N_{10}P_{26}K_{26}$ - in spring for cultivation (1 c/ha, April 10, 2020).
- Sowing rate of seeds: 0.6 million viable seeds per hectare 55-60 kg/ha
- Sowing method: ordinary with 15 cm row spacing.
- Terms of product application: preplant application, treatment of crops in the 1st ternate leaf phase, treatment of crops in the 6th ternate leaf phase.

Fig. 5: Treatment of soybean crops with EKO-SP, 2020

The test included phenological observations of the soybeans growth and development. The following phases of soybean development were noted: full young crops; the appearance of the 1st ternate leaf; the appearance of the 2nd ternate leaf; the appearance of the 3rd ternate leaf; the appearance of the 4th and 5th ternate leaf; the appearance of the 6th ternate leaf; flowering; ripeness.

Control *EKO-SP*

Fig. 6: Soybean plants at the time of the 2nd treatment with EKO-SP (June 15, 2020) phase of the 6th ternate leaf

To determine the structure of the yield one or two days before the start of the harvesting of soybeans, 4 sheaf samples were taken from each plot. After drying the sheaves, the following was determined: the number of beans per plant; the number of grains in 1 bean; the mass of grain from 1 plant; the weight of 1,000 grains.

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Control *EKO-SP*

Fig. 7: Soybean plants before harvest, 2020

The harvesting and accounting of the soybean yield were carried out with a Sampo self-propelled combine by direct combining. The yield was calculated for 100% purity and 14% grain moisture

Fig. 8. Harvesting and accounting of the soybean yield in the experiment on studying the effectiveness of the EKO-SP 2020 product Sampo-500 combine harvester

12. The results of the conducted research (data of accounting and biological effectiveness calculated on their basis, in the form of tables)

***12.1. Laboratory research*.**

The results of soybean seed sprouting in laboratory conditions indicate that the treatment of seeds with the agrochemical based on EKO-SP humic substances at a dose of 0.07 l/t compared with the control variant increased the germination (on the 3rd day of seed sprouting) by 82%, and the laboratory viability (on the 7th day of seed sprouting) - by 68% (Table 3).

Table 3: Influence of EKO-SP organic mineral fertilizer on germination and laboratory germination of soybean seeds

Variant	Germination readiness, % (Number of germinated seeds on the 3rd day)	Laboratory germination,% (Number of germinated seeds on the 7th day)
1. Control (no treatments)	14-	30-
2. Seeds treated with EKO-SP (7.5 ml /1 l of water)	96+82	98+68

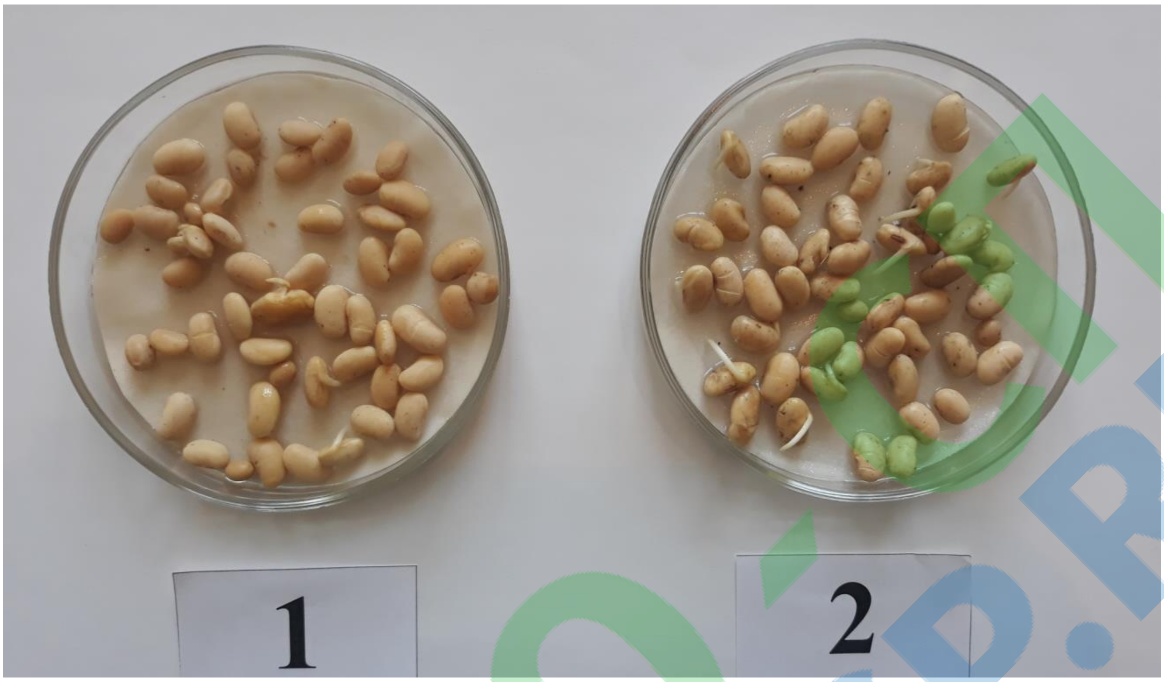

Fig. 9. Soybean seeds on the 3rd day of germination (1- control, 2- treated with EKO-SP)

Fig. 10. Soybean seeds on the 7th day of germination (1- control, 2- treated with EKO-SP)

12.2. Field study

12.2.1. Observation of soybeans growth and development

Soybean sowing was carried out on May 4, 2020. Sproutings appeared on the 12th day after sowing (05/16/2020). The preplant application of the EKO-SP agrochemical based on humic substances at a dose of 2.5 l/ha and repeated treatment of crops at the phase of the 1st and 6th ternate leaf at a dose of 1 l/ha had a stimulating effect on soybean plants, accelerated the beginning of phenological development phases: “flowering” and “grain ripeness” of soybeans for 2 days earlier in comparison with the control variant. (Table 4).

Table 4: The beginning of phenological phases in the development of soybean (Kazachka variety) according to the variants of the experiment, 2020

	Drop-ping	Emer-gence of seed-lings	1st ter-nate leafe	2nd ter-nate leaf	3-4th ternate leaf	5th ternate leaf	6th ternate leaf	Flowering	Ripeness
1	4.05	16.05	1.06	13.06.	26.06.	2.07.	7.07.	3.07	5.09
2	4.05	16.05	1.06	13.06.	26.06.	2.07.	7.07.	1.07	7.09

12.2.2. Influence of the EKO-SP agrochemical based *on humic substances on the* structure of soybean yield.

The use of the EKO-SP agrochemical based on humic substances on soybeans provided a better structure of the yield in comparison with the control. Thus, in the variant the preplant application of the EKO-SP at a dose of 2.5 l/ha and repeated treatment of crops at the phase of the 1st and 6th ternate leaf at a dose of 1 l/ha, the number of beans per plant was 25.6 pcs., (in the control variant -13.5 pcs.), the grain content of the bean - 2.4 pcs. (in the control variant - 2.3 pcs.), the weight of grain per plant - 8.0 g (in the control variant - 3.9 g), the weight of 1,000 grains is 130.3 g (in the control variant - 128.4 g) (Table 5).

Table 5: Influence of epy EKO-SP agrochemical based on humic substances on the elements of the structure of the soybean yield, 2020

Test variants	Stem length, cm	Lower bob attachment height, cm	Number of beans per 1 plant, pcs	Bean graininess, pcs	Grain weight per plant, g	Weight of 1,000 grains, g
1. Control,	58.3	15.6	13.5	2.3	3.9	128.4
2. EKO-SP (2.5 l/ha) preplant application + treatment of crops in the 1st ternate leaf phase (1 l/ha) + treatment of crops in the 6th ternate leaf phase (1 l/ha)	77.0	19.3	25.6	2.4	8.0	130.3

The most important morphological trait of soybeans, which determines the possibility and efficiency of mechanized harvesting, is the height of plants and, especially, the height of lower beans attachment. The use of the EKO-SP agrochemical based on humic substances had a significant impact on these indicators. Thus, the average stem length of soybean plants cultivated in the control variant was 58.3 cm, and in variants with preplant application of the EKO-SP at a dose of 2.5 l/ha and repeated treatment of crops at the phase of the 1st and 6th ternate leaf at a dose of 1 l/ha - 77.0 cm. The height of lower bean attachment to the soybean plant in the variant with the use of the EKO-SP agrochemical based on humic substances was 19.3 cm, in the control variant - 15.6 cm.

12.2.3. Influence of the EKO-SP agrochemical based on humic substances *on the yield and quality of soybean grain*

Higher indicators of the yield structure in the variant with the use of the EKO-SP agrochemical based on humic substances provided a higher yield of soybeans. Thus, the preplant application of the EKO-SP at a dose of 2.5 l/ha and repeated treatment of crops at the phase of the 1st and 6th ternate leaf at a dose of 1 l/ha contributed to an increase in the yield of soybeans by 3.1 c/ha or by 15.9%, in comparison with the control (19.5 c/ha) (Table 6).

Table 6: Influence of the EKO-SP agrochemical based on humic substances on the yield of soybeans, 2020

Variants	Repetition yield, c/ha			Average, c/ha	Addition to control, c/ha
	1	2	3		
1. Control - no treatments	20.8	19.0	18.7	19.5	-
2. EKO-SP (2.5 l/ha) preplant application + treatment of crops in the 1st ternate leaf phase (1 l/ha) + treatment of crops in the 6th ternate leaf phase (1 l/ha)	23.9	21.8	22.5	22.1	3.1 15.9%
LSD05					0.7 c/ha

Thus, the preplant application of the EKO-SP at a dose of 2.5 l/ha and repeated treatment of crops at the phase of the 1st and 6th ternate leaf at a dose of 1 l/ha contributed to an increase in the protein content in soybean grain by 1.3% and increased the oil content of grain by 0.6%.

Table 7: Influence of the EKO-SP agrochemical based on humic substances on the quality of soybean grain, 2020

Variants	Protein (on dry basis)	Oil content,%
1. Control	32.2	22.5
2. EKO-SP (2.5 l/ha) preplant application + treatment of crops in the 1st ternate leaf phase (1 l/ha) + treatment of crops in the 6th ternate leaf phase (1 l/ha)	33.5	23.1

12.2.4. Economic efficiency of the EKO-SP agrochemical based on humic substances on soybean crops

When calculating the economic efficiency of using the EKO-SP agrochemical based on humic substances on soybeans, the following indicators were taken as a basis: cost of the EKO-SP preparation - 160 rubles/l; the cost of soybean grain is 25 thousand per ton.

The use of the EKO-SP agrochemical based on humic substances on soybeans increased its yield, increased the cost of gross production, and given the low cost of the product and low rates of its application, it was economically profitable (Table 8).

Table 8: Economic efficiency of using the EKO-SP agrochemical based on humic substances on soybean crops, 2020.

Variants	Costs per hectare, rubles	Yield c/ha	Increase in yield from the use of the product, c/ha	The cost of the increase, rub.	Conditionally net income per hectare, rubles
1. **Control** - no treatments	-	19.5	-	-	-
2. EKO-SP (2.5 l/ha) preplant application + treatment of crops in the 1st ternate leaf phase (1 l/ha) + treatment of crops in the 6th ternate leaf phase (1 l/ha)	720+3B	22.6	3.1	7750	7030-зв

** 3H - costs associated with the usage of the product*

Thus, the preplant application of the EKO-SP at a dose of 2.5 l/ha and repeated treatment of crops at the phase of the 1st ternate leaf at a dose of 1.0 l/ha + treatment of crops in the phase of the 6th ternate leaf at a dose of 1.0 l/ha contributed to an increase in the yield of soybeans by 3.1 c/ha in the amount of 7,750 rubles/ha. With direct production costs associated with the purchase of products equal to 720 rubles/ha, the value of the conditionally net income amounted to 7,030 rubles/ha minus the costs associated with the actual introduction of the drug.

13. Conclusion on the effectiveness of the agrochemical and proposals on the feasibility of its use in agricultural production.

The results of the tests indicate the high efficiency of the EKO-SP agrochemical based on humic substances on soybeans in the conditions of black soils of the Kursk region.

Thus, the preplant application of the EKO-SP at a dose of 2.5 l/ha and repeated treatment of crops at the phase of the 1st and 6th ternate leaf at a dose of 1 l/ha contributed to an increase in the yield of soybeans by 3.1 c / ha, increase in the protein content in soybean grain by 1.3% and increased the oil content of grain by 0.6%. The use of the EKO-SP product on soybean crops was economically profitable due to its high efficiency, low cost, and low application rates.

In this regard, we recommend using the preplant application of the EKO-SP at a dose of 2.5 l/ha and repeated treatment of crops at the phase of the 1st and 6th ternate leaf at a dose of 1 l/ha.

Mathematical processing of soybean crop data, 2020.

20.8	19	18.7				
23.9	21.8	22.1				
20.8	19	18.7				
23.9	21.8	22.1				
Analysis results						
Variant	Qt-y	Average	Dispersion	Average quarterly deviation Error		Accuracy%
1	3	19.5	1.2899984	1.1357809	0.65574	3.3627868
2	3	22.6	1.29	1.1357816	0.65574	2.9015214
By experience	6	21.049999	3.9149947	1.9786346	0.80777	3.8374071
1						
Other variations	Quarter sum	degree of variance	Dispersion	Pfact	F_Ta6095.	Influence%
Total	19.57481	5				100
Repetitions	5.069989	2				25.900576
Variants	14.415	1	14.415004	320.97433	10.1	73.640572
Random	0.08982	2	0.0449101			0.4588564
	Error. med.=	0.1223521	Experience accuracy %	0.5812454	Error difer.	0.1725165
	Student's test	4.3000002	LSD=	0.7418211		
The test revealed SIGNIFICANT differences in the variants!						
Modeling group ... SNIISH. (8-253) 3-22-04						