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A GOOD ANSWER

THE SHARP RISE IN THE COST OF MINERAL FERTILIZERS AND CHEMICALS FORCES FARMERS TO DEVELOP CROP CULTIVATION TECHNOLOGIES BASED ON IMPORT SUBSTITUTION. REPLACEMENT WITH DOMESTIC PRODUCTS, PLANT GROWTH REGULATORS AND BIOFERTILIZERS FROM THE ECONOMIC POINT OF VIEW BECOMES MORE PROFITABLE AND ENVIRONMENTALLY FRIENDLY

At present, humates are widely used as growth stimulants and biofertilizers. This group of natural high molecular substances is characterized by high physiological activity due to their structural, physical and chemical properties.

FOLLOWING THE TREND

Humates can activate the metabolism and reproduction of useful soil microflora. They boost the plant defence against adverse physical factors, such as heat and cold, chemical factors - salinity, heavy metals, radionuclides, biological factors- fungal, bacterial and viral diseases. Besides, these substances contribute to the formation of high yields of agricultural crops.

The State Catalogue of Pesticides and Agrochemicals Approved for Use in the Russian Federation lists over 70 types of humic acid-based fertilisers. Domestic products

"Humistim", "Potassium Humate Suffler", "EKO-SP",



as well as German and Spanish products - such as EKO-SP, "Fulvigrain Classic" and "Humiful Pro". It is important to determine their impact on yields and quality. The efficiency of these additives on spring barley crops was studied in 2019-2021 in the experiments of laboratory of technologies of cultivation of field crops, FSBSI "Kursk Federal Agrarian Scientific Centre"

TREATMENT OF CROPS WITH HUMIC FERTILIZERS IN THE PHASES OF TILLERING AND THE BEGINNING OF STEM ELONGATION INCREASED THE NUMBER OF PRODUCTIVE STEMS BY 5-10 PCS/M, GRAINS IN AN EAR BY 2.2-2.4 PCS, WEIGHT OF 1000 GRAINS BY 0.9-1.4 G, GRAIN UNIT - BY 1.2-4.7 G/L

Table 1. Effect of humic fertilizers on emergence energy and laboratory germination of spring barley seeds

Variant	Emergence energy on day 3 of sprouting, %	Laboratory germination on day 7 of sprouting, %
Check, without treatment	91	94
"EKO-SP", 0.3 l/t	94	98
"Fulvigrain Classic", 0.8 l/t	93	97
"Humiful Pro", 0.1 kg/t	98	99

UNIVERSAL ASSISTANTS

"EKO-SP" fertilizer is a natural green-labelled product. It is produced from plant raw materials - lowland peat, it contains humic and fulvic acids, plant hormones, amino and simple organic acids, microelements as chelates, useful soil microflora. The product is a plant immunity inducer with adaptogenic properties, promotes anti-stress resistance of plants to

diseases and adverse environmental conditions, it is characterized by high chemical purity and solubility, increases the yield and quality of products. The product is used for seed treatment and foliar spraying of crops and can be applied practically during all vegetation stages - from seed treatment to additional fertilizing after stressed crops. Universal anti-stress agent "Fulvigrain Classic" contains 16% salts of humic acids and 4% of fulvic acids, microelements, amino acids and auxins. The product is used for seed and foliar fertilization, it helps to increase resistance to negative effects of different origin. The additive increases the plant ability to absorb nutrients, ensures the development of vegetative mass through auxin and helps to overcome temperature stresses. The product promotes

Table 2. The effect of humic fertilizers on the development of spring barley leaf diseases, 2019-2021

Variant	Rhynchosporium leaf spot		Helminthosporium blight	
	Development of disease, %	Biological efficiency, %	Development of disease, %	Biological efficiency, %
Check, without treatment	15.1	—	17.4	—
"EKO-SP"	10.8	28.4	13.7	21.2
"Fulvigrain Classic"	10.7	29.1	13.5	22.4
"Humiful Pro"	11.5	23.8	13.9	20.1

cytokinin activity, stimulates cell division, the rudiment of generative organs, and improves grain and seed quality.

Humic and fulvic acid-based "Humiful Pro" is produced by treating brown coal with potassium hydroxide solution and then enriching the extract with macro- and microelements.

The product promotes resistance to

soil structure and enhances crop immunity. Humic acids and monobacteria in its composition stimulate the development of useful soil microflora, providing plants with nutrients in an accessible manner. It is used for seed treatment, foliar and root fertilization, and for soil improvement.

EMERGENCE ENERGY

The test plot soil was represented by typical heavy loamy granulometric composition on carbonate loess-like loam. At

APPLICATION OF HUMIC FERTILIZERS ON SPRING BARLEY CROPS HAD A POSITIVE EFFECT ON GRAIN QUALITY. THUS, REPEATED TREATMENT INCREASED THE SEED SIZE BY 0.7-1.6%, PROTEIN CONTENT BY 0.4-0.8%, STARCH CONTENT BY 0.2-2.3%



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MORE THAN 70 TYPES OF

HUMIC ACID BASED FERTILIZERS
ARE REGISTERED
IN THE STATE CATALOGUE

23.8-29.1%

BIOLOGICAL EFFICIENCY
HUMIC PRODUCTS FOR
RHYNOSPORIUM LEAF SPOT

ON 4.6-5.2

DT/HA

SPRING BARLEY YIELDS
INCREASED WHEN CROPS WERE
TREATED REPEATEDLY WITH
HUMIC FERTILIZERS DURING
TILLERING AND STEM ELONGATION
PHASES

the beginning of the field experiment, the content of humus according to Tyurin in the arable layer was 5.3%, alkaline-hydrolyzable nitrogen - 69 mg/kg, phosphorus and potassium mobile forms according to Chirikov - 8.8 and 14.5 mg/kg, respectively. The soil medium reaction was weakly acidic - the pH was 5.4. The cultivation technology of spring barley corresponded to the recommended one for farms of the Central Chernozem region. The Prometheus variety was used, the sowing rate was 4.5 million germinating seeds per hectare, the background of mineral nutrition was N30P30K30.

As a result of laboratory studies, it was found that the treatment of spring barley seed material with humic

Table 3. The effect of humic products on the elements of spring barley yield structure, 2019-2021

Variant	Number of productive stems, pcs.	Number of grains in the ear, pcs.	Weight of 1,000 grains, g	Grain unit, g/l
Check, without treatment	438	25	33.3	600.3
"EKO-SP"	448	27.3	34.6	605
"Fulvigrain Classic"	447	27.4	34.7	604.7
"Humiful Pro"	443	27.2	34.2	601.5

-with fertilizers, it increased the emergence energy by 2-7% on the third day of sprouting compared with the check variant, and laboratory germination by 3-5% on the seventh day. Thereafter, this operation had a favourable effect on seedling growth. "Humiful Pro" at a dose of 0.1 kg/t had the best stimulating properties; treatment of spring barley seeds increased emergence energy by 7% and laboratory germination by 5%. The agrochemical efficiency, based on "EKO-SP" humic substances in the amount of 0.3 l/t on these indicators was lower and amounted to 94 and 98% with control values of 91 and 94% respectively. A less stimulating effect was demonstrated by "Fulvigrain Classic" at the rate of 0.8 l/t. Its application increased emergence energy by 2% and laboratory germination by 3%.

BIOLOGICAL EFFICIENCY

The phytosanitary condition of spring barley crops in the years of the experiment was characterized by a moderate infection-

background. For instance, plants were affected by rhynchosporium leaf spot and helminthosporium spot disease. As a result, it was found that the use of humic products contributed to the containment of leaf diseases: the first - by 3.6-4.4%, the second - by 3.5-3.9%, while in the check variant their spread reached 15.1 and 17.4%, respectively.

The biological effect of humic preparations for rhynchosporium leaf spot was 23.8-29.1%, helminthosporium spot disease - 20.1-22.4%. "Fulvigrain Classic" and EKO-SP products proved to be the most successful in curbing the development of leaf diseases, while "Humiful Pro" showed a slightly lower result. The relatively high efficacy of the additives is associated with increased growth and development of spring barley. Besides, they helped to produce stronger plants and, resulting in increased immunity to the mentioned diseases.

TO INCREASE YIELDS

Treatment of crops with humic fertilizers in the phases of tillering and the beginning of stem elongation increased the number of productive stems by 5-10 pcs./m, grains in an ear by 2.2-2.4 pcs., weight of 1,000 grains by 0.9-1.4 g, grain unit - by 1.2-4.7 g/l. The best crop structure was provided by the use of agrochemicals based on humus substances "EKO-SP" and humic additive "Fulvigrain Classic": the number of productive stems of spring barley in these variants increased by 9-10 pcs./m, grains in an ear - by 2.3-2.4 pcs., weight of 1000 seeds - by 1.3-1.4 g, grain unit - by 4.4-4.7 g/l. Repeated treatment of crops with humic fertilizers in the similar vegetation phases increased the crop yield by 4.6-5.6 dt/ha at the corresponding

HUMATES CAN ACTIVATE THE METABOLISM AND REPRODUCTION OF USEFUL SOIL MICROFLORA. THEY BOOST THE PLANT DEFENCE AGAINST ADVERSE PHYSICAL, CHEMICAL AND BIOLOGICAL FACTORS, AND ALSO CONTRIBUTE TO A HIGH CROP YIELD

Table 4. The effect of humic fertilizers on the yield and quality of spring barley grain, 2019-2021

Variant	Yield, dt/ha	Increase, dt/ha	Grain size, %	Content, %	
				Protein	Starch
Check, without treatment	36.1	—	95.1	12	43.1
"EKO-SP"	41.3	5.2	96.7	12.8	45.4
"Fulvigrain Classic"	41.7	5.6	96.2	12.7	45.1
"Humiful Pro"	40.7	4.6	95.8	12.6	43.3
HCP ₀₅	—	1.1	—	—	—



the control value of 36.1 dt/ha. The higher productivity of spring barley was ensured by "Fulvigrain Classic" and "EKO-SP" - 41.7 and 41.3

dt/ha, respectively. The efficiency of the repeated operation with "Humiful Pro" was slightly lower: the yield per this type was 40.7 dt/ha.

Application of humic fertilizers on spring barley crops had a positive effect on grain quality. Thus, repeated treatment with products at tillering and beginning of stem elongation increased the seed size by 0.7-1.6%, the protein content in grain - by 0.4-0.8%, starch - by 0.2-2.3%. The efficiency of individual fertilizers on grain quality indicators there was nearly the same. However, there was a tendency of their increase in variants with the use of "EKO-SP" and "Fulvigrain Classic": the grain size after application of these products

increased by 1.1-1.6%, the protein content - by 0.7-0.8%, starch - by 2-2.3% relative to the control.

NET income

Calculations of economic efficiency showed that the use of humic fertilizers on spring barley crops was economically profitable. Thus, repeated treatment in the phases of tillering and the beginning of stem elongation increased the crop yield by 4.6-5.6 dt/ha, thereby increasing the value of gross output by 6900-8400 rub./ha. Considering the low costs of such additives and their possible dissolution in tank mixtures with plant defence products, the use of these produce as foliar fertilizers ensured 34677-35701 rub./ha of qualified net income with 131.4-133% of profitability rate. The highest economic performance was shown by the repeated foliar

fertilization of spring barley with "EKO-SP" and "Fulvigrain Classic" humic fertilizers. The amount of qualified net income from their application was 35,515 and 35101 rub./ha, the profitability rate was 133.5 and 130.7%, respectively. The economic efficiency of a similar operation with "Humiful Pro" was lower: the qualified net income from its use reached 34,677 rub./ha with a profitability of 131.4%. Thus, the study results prove high efficiency of domestic humic fertilizer in the spring barley cultivation compared with the indicators of foreign products. This efficiency provides the basis for the biologization of crop cultivation technologies based on the extensive use of Russian humic fertilizers and prerequisites for import substitution in this industrial sector.

Table 5. Economic efficiency of humic fertilizers on spring barley crops, 2019-2021

Variant	Yield, dt/ha	Cost of gross output, rub.	Production costs, rub.	Cost of production, rub./dt	Net income, rub./ha	Profitability level, %
Check, without treatment	36.1	54 150	25 401	703.62	28 749	113.2
"EKO-SP"	41.3	61 950	26 585	643.7	35 365	133
"Fulvigrain Classic"	41.7	62 550	26 849	643.86	35 701	132.9
"Humiful Pro"	40.7	61 050	26 373	647.98	34 677	131.4