Effect of biological products on spring wheat cultivation

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Abstract. The studies of the meadow-chernozem soil of the Omsk region, showed that biological products are effective when used for spring wheat by seed treatment. When comparing their action, it was noted that a greater effect was obtained from the use of the variants Azotobacterin+Phosphobacterin and Azotobacterin+Phosphobacterin+Humate K. The improvement of the nutritional conditions of plants when applying biological fertilizers and biological products has a positive effect on the content of the number of amino acids in the grain, which without fertilizers increases from 9.59% up to a maximum of 9.92% with Humat K.

1 Introduction

In agricultural production, as a result of a shortage of nutrients and their constant harvest alienation, with a small use of mineral fertilizers, as well as their high cost and the economic condition of farms, there is an objective need to find alternative means and methods to preserve and increase soil fertility. At the same time, organic technologies are actively developing [1–3].

For soil enrichment microbiological and bacterial fertilizers, we use products of highly active microorganisms that improve the nutritional conditions of crops. They contain specific strains of microorganisms, using which the processes of transformation of compounds containing nutrients necessary for plants are activated in the soil. Humic acids and amino acid products have a versatile direction of action such as the activation of bioenergetic processes, stimulation of metabolism, synthetic processes, improvement of the penetration of nutrients through the plasmalemma, intensification of enzymatic systems, increase in the adaptive properties of plant organism. They are used as plant growth stimulators [4–6].

The purpose of the research is to analyze the effectiveness of the use of biological products to increase the yield and improve the quality of grain of soft spring wheat on meadow-chernozem soil.

2 Materials and methods

The experiment was carried out on the experimental field of Omsk State Agrarian University in 2021. The spring wheat of Element 22 variety was used, the soil was meadow-chernozem, thin, low-humus, heavy loamy. The objects of research were: biological fertilizers Azotobacterin and Phosphobacterin; growth stimulants Biostim and humate K. They were used by the method of seed treatment. The content in the soil of N-NO3 – 4.6, P2O5 – 135, K2O – 215 mg/kg. The location of the plots was systematic. The repetition of options was three times. The plot area was 20 m^2; the accounting area was 16 m^2. The used agricultural technology was generally accepted for the zone. In soil samples, the content of nitrate nitrogen was determined with disulfophenolic acid according to Grandval-Lage; mobile phosphorus and potassium content from one extract was determined according to Chirikov (GOST 26204-84). Quality indicators were determined by conventional methods.

The studied growing season, in general, was characterized as warm and dry, while rather anomalous conditions for plants were observed due to a sharp shortage of water content. During this period, 134 mm of precipitation fell, which amounted to only 65% of the long-term average. The average temperature for 4 months was 8.3 higher than the long-term average.

3 Results and discussion

It was found that all biological products had a positive effect on the yield of spring wheat grains on the meadow-chernozem soil of the forest-steppe zone of the Omsk region (Figure 1). With a yield in the control variant of 3.21 t/ha, the use of biological products contributed to the formation of 3.48-3.73 t/ha of spring wheat grain. In the steppe zone, the use of urea (kg a.i./ha) and zinc and copper chelates (g a.i./ha) was studied for foliar top dressing of hulled barley in the tillering phase (Table 1).

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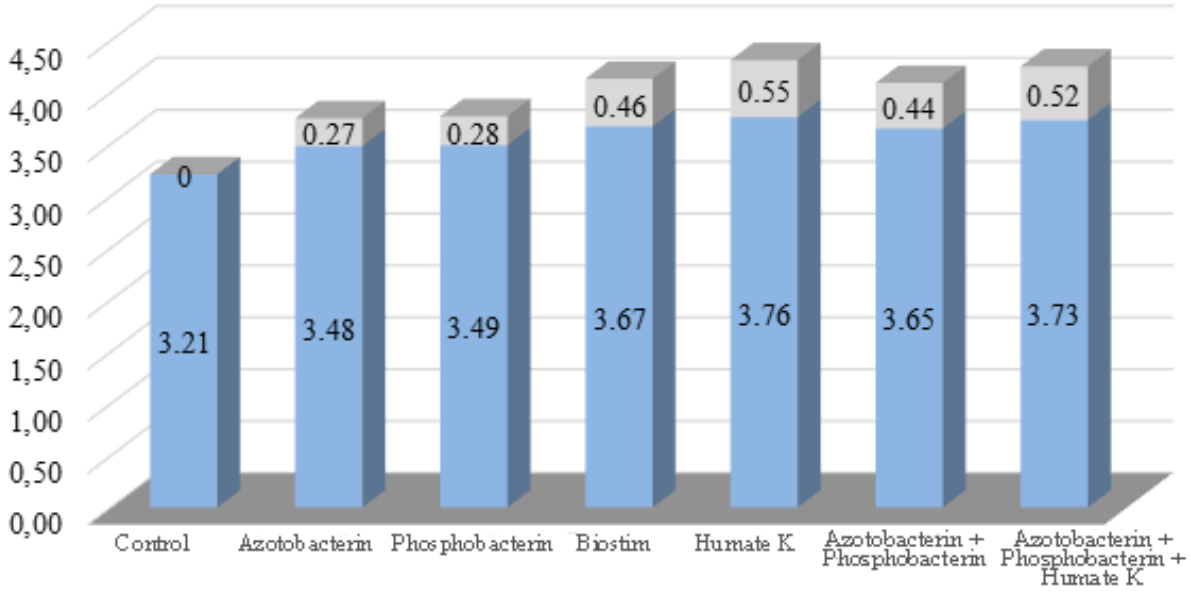

Fig. 1. Yield of spring wheat depending on biological products on the meadow-chernozem soil of the forest-steppe zone.

A noticeable increase in the yield of the variety was observed from the use of Biostim, Humate K, Azotobacterin + Phosphobacterin and Azotobacterin + Phosphobacterin + Humate K: yield increases amounted to 0.44 -0.55 t/ha. The use of Azotobacterin and Phosphobacterin separately also led to a significant increase in the yield of wheat: 0.27 and 0.28 t/ha of grain. The content of mobile forms of nutrients in the soil in Siberian chernozems was often at an insufficient level [7–9].

We studied the effect of biological products in the treatment of seeds on soil fertility (Table 1).

Table 1. Content of mobile forms of nutrients in the soil under spring wheat during the harvesting period, depending on biological products, mg/kg of soil (0–20 cm layer).

Variant	N-NO_3	P_2O_5	K_2O
Control	3.62	130	258
Azotobacterin	4.38	128	250
Phosphobacterin	3.98	138	235
Biostim	3.52	130	240
Humate K	3.62	128	255
Azotobacterin + Phosphobacterin	4.36	136	246
Azotobacterin + Phosphobacterin + Humate K	4.42	138	237

The supply of wheat plants with nitrate nitrogen during the harvesting period under the action of biological products was low (3.62-4.42 mg/kg). It is necessary to note that there is the increase in the level of nitrate nitrogen in the soil layer of 0-20 cm when using azotobacterin, both separately and in combination with other products (Phosphobacterin and Humate K): during the harvesting period, it increased by 0.74-0.80 mg /kg at the content of nitrate nitrogen in the control of 3.62 mg/kg.

The provision of wheat plants with mobile forms of phosphorus (according to Chirikov) during the harvesting period under the action of biological preparations was average (128–149 mg/kg).

The experimental data indicate that when using Phosphobacterin, the content of mobile phosphorus slightly exceeded the variants without its use. Both independently and together with other products, it increased the amount of the element by 6-8 mg/kg. Comparing the considered spring wheat cultivation technologies, it is necessary to note that, on average, according to the options, spring wheat plants cultivated using Azotobacterin, mobile phosphorus – Phosphobacterin are most provided with nitrate nitrogen.

The study of the potassium mode of the culture showed that the content of mobile potassium (according to Chirikov) in the soil during the harvesting period was very high – 412–548 mg/kg. When biological products are introduced, the content of mobile potassium in the soil does not change significantly.

Thus, the use of biologicals in the treatment of seeds has a positive effect on the content of nitrate nitrogen

and mobile phosphorus in the soil. During the use of biological products in this way, their level increases. The content of mobile potassium does not increase. The use of stimulants does not significantly affect the chemical composition of the soil.

Improving the structure of the spring wheat crop depends on the type of soil and nutritional conditions, the improvement of which contributes to the mobilization of the plant's physiological resources and increased yields. The change in yield is accompanied by a change in the elements of the structure of the crop, one of the main ones is productive tillering, the mass of grains from one plant, and the weight of 1000 grains (Table 2).

It was found that the productive tillering capacity with the use of biological products generally increased - from 2.2 to 2.3-2.5 in the variants Biostim, Humate K, and Azotobacterin + Phosphobacterin + Humate K.

The mass of 1000 grains in the harvest increased by 3.1 g when using biological products (Humate K and Azotobacterin + Phosphobacterin), in general, the use of biological products increased this parameter.

Table 2. Structure of spring wheat yield depending on biological preparations.

Variant	Productive tillering capacity	Weight of grains from one plant, g	Weight of 1000 grains, g
Control	2.2	5.7	35.0
Azotobacterin	2.2	5.9	35.3
Phosphobacterin	2.2	5.9	35.9
Biostim	2.3	5.8	36.5
Humate K	2.5	5.8	38.1
Azotobacterin + phosphobacterin	2.2	6.5	38.1
Azotobacterin + phosphobacterin + Humate K	2.5	5.9	36.9

The change in nutrition has a significant impact on the content of raw gluten in the grain [10–12]. Its mass fraction during the introduction of biological products increased (Table 3) to 1.5% (Azotobacterin + Phosphobacterin + Humate K). The content of gluten in the control was 34.4.

The protein content in the grain in the control variant was 17.7%. The use of biological products provided a slight increase in the protein content of grain by 0.2–0.5%.

The analysis of qualitative indicators showed that the grown wheat grain was average natural (760–798 g/l). The highest increase in this parameter was observed in Azotobacterin + Phosphobacterin + Azotobacterin + Phosphobacterin + Humate K: they amounted to 35 and 38 g/l. Hardness was 59–62 and did not depend significantly on biological products.

Table 3. Grain quality of spring wheat depending on biological products.

Variant	Nature, g/l	Protein, %	Hardness,%	Gluten, %
Control	760	17.7	61	34.4
Azotobacterin	762	18.0	61	35.0
Phosphobacterin	764	18.2	62	35.6
Biostim	775	17.9	59	35.4
Humate K	790	18.1	61	35.4
Azotobacterin + phosphobacterin	795	18.3	59	34.6
Azotobacterin + phosphobacterin + Humate K	798	18.0	60	35.9

The amino acid composition of the protein was determined depending on the nutritional conditions in the experiment. Nutritional conditions affected the quantitative content of amino acids (Table 4). Thus, during the study of the effect of biological products on the qualitative characteristics of wheat protein, it was found that the number of amino acids increased without fertilizers from 9.59% to the highest 9.92% in the variant with Humate K (HCP_{05} 0.31). The effect of biofertilizers and biological products on the content of amino acids in grain was positive, the greatest effect was caused by Humate K and Biostim stimulants.

Table 4. Amino acid composition of spring wheat protein depending on biological products in the conditions of the Omsk region, % (2021).

Amino acid	Control	Azotobacterin	Phosphobacterin	Biostim	Humate K	Azotobacterin + Phosphobacterin	Azotobacterin + phosphobacterin + Humate K
Arginine	0.81	0.84	0.82	0.91	0.90	0.82	0.84
Lysine	0.34	0.35	0.33	0.38	0.37	0.36	0.35
Tyrosine	0.40	0.39	0.41	0.42	0.42	0.44	0.37
Phenylalanine	0.65	0.70	0.66	0.72	0.71	0.65	0.69
Histidine	0.32	0.34	0.31	0.33	0.34	0.34	0.33
Leucine+isoleucine	1.60	1.65	1.61	1.66	1.68	1.63	1.66
Methionine	0.30	0.31	0.31	0.32	0.31	0.32	0.30
Valin	0.68	0.74	0.67	0.71	0.71	0.68	0.73
Proline	2.05	2.02	2.03	2.03	2.05	2.04	2.03
Threonine	0.48	0.46	0.46	0.47	0.49	0.47	0.46
Cool	0.77	0.79	0.75	0.75	0.76	0.76	0.79
Alanine	0.51	0.52	0.50	0.53	0.54	0.51	0.52
Glycine	0.68	0.63	0.66	0.63	0.64	0.64	0.63
Amount of amino acids	9.59	9.74	9.52	9.86	9.92	9.66	9.70

We can state that the improvement of plant nutrition conditions when applying biological fertilizers and biological products have a positive effect on the content of the content of amino acids in grains.

4 Conclusion

Thus, all biological products are effective when used under spring wheat by seed treatment. With a yield in the control variant of 3.21 t/ha, the use of biological products contributed to the formation of 3.48-3.73 t/ha of spring wheat grain. When comparing the effect, it was noted that a greater effect was obtained from the use of Azotobacterin + Phosphobacterin + Azotobacterin + Phosphobacterin + Humate K. Biological fertilizers had a positive effect on crop quality indicators. It was found that the number of amino acids without fertilizers increased from 9.59% to the highest 9.92% in the variant with Humate K.

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