Influence of Biological Fertilizers and Growth Stimulants on Yield and Quality of Spring Wheat Grain

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Abstract. In studies on the meadow-chernozem soil of the forest-steppe of Western Siberia, it was found that biological fertilizers and growth stimulants are effective when used for spring wheat by seed treatment. The most stable results were obtained with the use of Azotobacterin + Phosphobacterin and Azotobacterin + Phosphobacterin + Humate K variants, especially in comparison with the separate application of biological fertilizers. In general, the use of biological fertilizers has a positive effect on the content of nitrate nitrogen and mobile phosphorus in the meadow-chernozem soil. When using biological products, their level increases. The content of mobile potassium does not change. The use of stimulants did not significantly affect the chemical composition of the soil. The protein content in the grain in the control was 16.9%. The use of biological fertilizers and growth stimulants provides a slight increase in the protein content of grain by 0.1–0.9%. When studying the effect of biological products on the qualitative characteristics of wheat protein of the OmSAU 100 variety, it was found that the amount of amino acids increases from 9.32% without fertilizers to the highest 10.3% in the variant with Humat K. The effect of biofertilizers and biological products on the content of amino acids in grain is generally positive, the most stable effect of stimulants Humat K and Biostim.

Keywords: Spring wheat · Efficiency · Biological product · Productivity · Amino acids

1 Introduction

At present, the directions of research that have developed in the world show that the solution of environmental roblem sis possible only with the comprehensive biologization of crop production, including the use of biofertilizers and preparations. The level of potential and effective soil fertility is largely determined by the intensity and direction of microbiological processes, which, in turn, is regulated by the number of relevant microorganisms in the soil. For its enrichment, microbiological and bacterial fertilizers are used – these are preparations of highly active microorganisms that improve the

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nutritional conditions of crops. They contain specific strains of microorganisms, with the help of which the processes of transformations of compounds containing nutrients necessary for plants are activated in the soil [1–3].

The most widely used preparations containing nitrogen-fixing microorganisms. Biological nitrogen in the soil accumulates as a result of associative nitrogen fixation. Numerous field studies have shown that if agricultural crops cover 10–20% of their nitrogen needs due to fixation from the atmosphere, then inoculation can make a significant contribution to the nitrogen balance [4–6].

One of the promising directions of biologization of crop production is the use of growth stimulants of organic origin, which contribute to the activation of physiological processes in plants [7–9].

The purpose of the research is to determine the effect of biological fertilizers and growth stimulants on the yield and grain quality of soft spring wheat on meadow-chernozem soil.

2 Methods and Equipment

The experiment was carried out on the experimental field of the Omsk State Agrarian University in 2021. Variety OmSAU 100, the soil is meadow-chernozem, thin, low-humus, heavy loamy soil. The objects of research were: biological fertilizers Azotobacterin and Phosphobacterin; growth stimulants Biostim and humate K. Soil content of N-NO3 – 4,7, P2O5 – 136, K2O – 225 mg/kg (layer 0–20 cm). The location of the plots is systematic. The repetition of options three times. Plot area – 20 m2; accounting – 16 m2. Agricultural technology – 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 – from one hood according to Chirikov (GOST 26204–84). Quality indicators were determined by conventional methods, the content of amino acids in the grain – according to GOST R 55569–2013.

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

3 Results

It was established that all biological preparations 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 (Fig. 1).

A significant increase in the yield of spring wheat variety OmGAU 100 from biological products is observed from the options Azotobacterin + Phosphobacterin and Azotobacterin + Phosphobacterin + Humate K – 0.50 and 0.55 t/ha of grain (control 3.05, NSR – 0.15 t/ha), while the other options also contributed to a significant increase in yield – 0.22–0.39 t/ha of grain (Fig. 1).

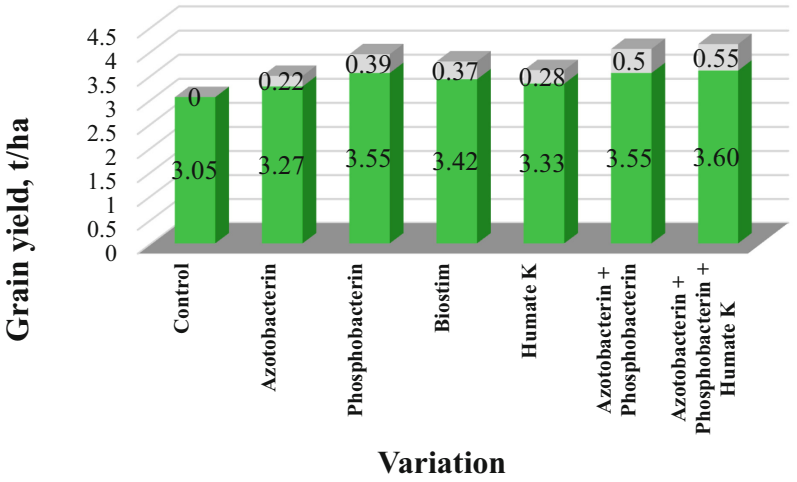

Fig. 1. Yield of spring wheat depending on biological preparations on the meadow-chernozem soil of the forest-steppe zone of the Omsk region

It should be noted that the most stable results were obtained with the use of Azotobacterin + Phosphobacterin and Azotobacterin + Phosphobacterin + Humate K variants, especially in comparison with the separate application of biological fertilizers.

Thus, all types of biological products are effective when used for spring wheat by seed treatment. When comparing the action of biological products, it can be noted that a greater effect was obtained from the use of biological products of the variants Azotobacterin + Phosphobacterin and Azotobacterin + Phosphobacterin + Humate K.

Crop productivity is a function of many factors, one of the main ones being the level of mineral nutrition [8–10]. The content of available nutrients in the soil in chernozems is often at a low level [7–9]. In these experiments, the influence of biological preparations in the treatment of seeds on the fertility of the meadow-chernozem soil was studied (Table 1).

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

Variation	$N\text{-}NO_3$	P_2O_5	K_2O
Control	3.44	134	250
Azotobacterin	4.98	137	243
Phosphobacterin	3.38	149	235
Biostim	3.51	132	238
Humate K	3.34	133	225
Azotobacterin + Phosphobacterin	5.00	146	229
Azotobacterin + Phosphobacterin + Humate K	5.04	142	230

The supply of wheat plants with nitrate nitrogen during the harvesting period under the action of biological preparations is low (3.38–5.04 mg/kg). It should be noted that there is an 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 drugs (phosphobacterin and Humate K): during the harvesting period, it increased by 1.54–1.60 mg /kg at the content of nitrate nitrogen in the control 3.44 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 is average (132–149 mg/kg).

With the use of phosphobacterin, the content of mobile phosphorus slightly exceeded the variants without its use. Both on its own and together with other drugs, it increased the amount of the element by 8–15 mg/kg. Comparing the considered spring wheat cultivation technologies, it should be noted that, on average, according to the options, spring wheat plants cultivated using azotobacterin, mobile phosphorus – phosphobacterin are most provided with nitrate nitrogen.

The control of the potassium regime of spring wheat showed that the content of mobile potassium (according to Chirikov) in the soil during the harvesting period is very high – 225–250 mg/kg. When biological preparations are introduced, the content of mobile potassium in the soil does not change significantly.

In general, the use of biological fertilizers has a positive effect on the content of nitrate nitrogen and mobile phosphorus in the meadow-chernozem soil. When using biological products, their level increases. The content of mobile potassium does not change. The use of stimulants did not significantly affect the chemical composition of the soil.

When cultivating grain crops, nutrition optimization has a significant impact on grain quality [11–15]. In our studies, its mass fraction with the use of biological products increased to 2.4% (variant humate K) with a gluten content in the control of 30.3 (Table 2).

Table 2. Spring wheat grain quality depending on biological preparations on meadow-chernozem soil

Variation	Nature, g/l	Protein, %	Vitreousness,%	Gluten, %
Control	778	16.9	59	30.3
Azotobacterin	780	17.0	60	31.5
Phosphobacterin	788	17.7	61	31.1
Biostim	788	17.5	63	31.2
Humate K	795	17.8	58	32.7
Azotobacterin + Phosphobacterin	802	17.2	58	31.5
Azotobacterin + Phosphobacterin + Humate K	801	17.3	62	31.5

The protein content in the grain in the control was 16.9%. The use of biological fertilizers and growth stimulants provides a slight increase in grain protein content by 0.1–0.9%.

The study of quality indicators showed that wheat grain is medium-sized (778–802 g/l). The greatest increase in this parameter was observed in the variants Azotobacterin + Phosphobacterin and Azotobacterin + Phosphobacterin + Humate K: they amounted to 23 and 24 g/L.

Vitreousness was 58–63 and did not depend significantly on biological products.

In the experiment, the amino acid composition of the protein was determined depending on the nutritional conditions. Nutritional conditions influenced the quantitative content of amino acids (Table 3). Thus, when studying the effect of biological preparations on the qualitative characteristics of wheat protein of the OmSAU 100 variety, it was found that the amount of amino acids increased from 9.32% without fertilizers to the highest 10.3% in the variant with Humat K (HCP05 0.31). The effect of biofertilizers and biopreparations on the content of amino acids in grain is positive, the greatest – stimulants Humat K and Biostim.

Table 3. Amino acid composition of spring wheat protein depending on biological products in the conditions of the Omsk region, % (2021)

Amino acid	Variation						
	Control	Azotobacterin	Phosphobacterin	Biostim	Humate K	Azotobacterin + Phosphobacterin	Azotobacterin + Phosphobacterin + Humate K
Arginine	0.79	0.82	0.80	0.84	0.88	0.86	0.86
Lysine	0.34	0.31	0.38	0.37	0.42	0.35	0.35
Tyrosine	0.49	0.57	0.50	0.46	0.56	0.48	0.48
Phenylalanine	0.69	0.68	0.64	0.65	0.68	0.65	0.65
Histidine	0.30	0.32	0.39	0.33	0.36	0.29	0.29
Leucine + Isoleucine	1.54	1.56	1.60	1.58	1.67	1.60	1.60
Methionine	0.32	0.30	0.34	0.30	0.39	0.29	0.29
Valine	0.65	0.73	0.79	0.78	0.89	0.77	0.77
Proline	1.87	1.89	2.00	2.03	2.00	1.88	1.88
Threonine	0.45	0.48	0.56	0.46	0.45	0.50	0.50
Serene	0.79	0.81	0.86	0.84	0.82	0.83	0.83
Alanine	0.52	0.50	0.50	0.58	0.58	0.51	0.51
Glycine	0.57	0.56	0.59	0.59	0.60	0.57	0.57
Amount of amino acids	9.32	9.53	9.95	9.81	10.3	9.58	9.58

It can be stated that the improvement of plant nutrition conditions when applying biological fertilizers and biological products has a positive effect on the content of the amount of amino acids in the grain.

4 Conclusion

Thus, the studied biological fertilizers and growth stimulants are effective when used under spring wheat by seed treatment. The greatest effect was obtained from the use of the options Azotobacterin + Phosphobacterin and Azotobacterin + Phosphobacterin + Humate K – an increase of 0.50 and 0.55 t/ha of grain, respectively (control 3.05). The use of biological fertilizers has a positive effect on the content of nitrate nitrogen and mobile phosphorus in the meadow-chernozem soil. When using biological products, their level increases. The content of mobile potassium does not change. The use of stimulants did not significantly affect the chemical composition of the soil. Biological fertilizers and growth stimulants had a positive effect on the quality of spring wheat grain. Improving the nutritional conditions of plants when applying biological fertilizers and biological products has a positive effect on the content of the amount of amino acids in the grain, it increases from 9.32% without fertilizers to a maximum of 10.3%, the growth stimulants Humat K and Biostim had the greatest effect.

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