The efficiency of the use of biological products in cultivation of spring wheat in Western Siberia

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Abstract In an experiment on quasi-gleyed agrochernozem in the south of Western Siberia, it was found that biological preparations (biological fertilizers and growth stimulants) are effective when used for spring wheat by seed treatment method. With a yield of 2.41 t/ha in the control variant, the use of biological preparations contributed to the formation of 2.70–2.88 t/ha of grain. The greatest effect is obtained from the use of variants: azotovit + phosphatovit and azotovit + phosphatovit + potassium humate. The use of biofertilizers has a positive effect on the soil nitrate nitrogen and mobile phosphorus content. The use of stimulants did not significantly affect the fertility level. Biological fertilizers and growth stimulants had a positive effect on crop quality indicators. It was revealed that the sum of amino acids increases from 9.24% without fertilizers to the highest 9.81% in the variant with potassium humate.

1. Introduction
In modern conditions in agricultural production, as a result of the shortage of nutrients and their constant alienation with the yield, with a small use of mineral fertilizers, as well as their high cost and economic condition of farms, there is an objective need to search for alternative means and techniques for preserving and increasing soil fertility. In addition, the use of chemicals for soil fertility reproduction and creation of conditions for the formation of yields of cultivated crops is limited by the exhaustion of resources. All these negative phenomena prompt to reconsider the attitude to the basic principles of the development of farming systems [1-3].

Studies show that the solution of these problems is possible only with the comprehensive biologization of crop production, including the use of biofertilizers and growth stimulants. Before using them in a particular region, it is necessary to study their effectiveness in cultivating crops using regional technology. The use of preparations without prior field experiments can lead to a decrease in the amount and quality of the crop [4-6].

The purpose of the study is to analyze the effectiveness of the use of biological products to increase the yield and quality of soft spring wheat grain in the forest-steppe of Western Siberia.

2. Materials and methods
The experiment was conducted at the experimental field of the FSBEI HE Omsk SAU in 2021. The variety of spring wheat Stolypinskaya 2, soil – quasi-gleyed agrochernozem medium-thick rich in humus heavy loamy. The objects of research were: biological fertilizers azotovit and phosphatovit; growth stimulants Biostim grain and potassium humate. They were used by seed treatment method.
The content of N-NO₃ in the soil is 4.8, P₂O₅ is 138, K₂O is 220 mg/kg. The location of plots is systematic. The repetition of variants is threefold. Plot area - 20 m². Agricultural equipment - generally accepted for the zone. In soil samples, the content of nitrate nitrogen with phenoldisulfonic acid was determined by Grandval-Lage method; mobile phosphorus and potassium were determined from one extract by Chirikov. Quality indicators were determined by generally accepted methods.

The growing season is characterized as warm and arid, while quite abnormal conditions for plants were observed due to a sharp moisture deficit. 134 mm of precipitation fell in 4 months, which was only 65% of the average annual value. The average temperature is higher by 8.3 of the average annual indicators.

3. Research results
The studied biological fertilizers and growth stimulators positively affected the yield of spring wheat grain on quasi-gleyed agrochernozem soil of the forest-steppe zone (Figure 1). With a yield of 2.41 t/ha in the control variant, the use of biological preparations contributed to the formation of 2.70-2.88 t/ha of grain.

![Figure 1](image.png)

**Figure 1.** The spring wheat yield depending on biological products on quasi-gleyed agrochernozem soil of the forest-steppe zone.

The increase in the spring wheat yield from the use of biological preparations was significant: 0.29 - 0.47 t/ha (control 2.41). The use of azotovit + phosphatovit and azotovit + phosphatovit + potassium humate variants maximized the yield by 0.47 and 0.43 t/ha of grain.

The content of mobile forms of nutrients in the soil in the chernozems of the region is often at an insufficient level [7-11]. The effect of biological preparations on soil fertility was studied in the experiment (Table 1).

| Variant                        | N-NO₃ | P₂O₅ | K₂O |
|-------------------------------|-------|------|-----|
| Control                       | 3.68  | 135  | 245 |

**Table 1.** The content of mobile forms of fertilizer elements under spring wheat during gathering depending on biological products on quasi-gleyed agrochernozem of the forest-steppe zone, mg/ kg of soil (layer 0-20 cm)
The provision of wheat plants with nitrate nitrogen during harvesting under the action of biological preparations is low (3.68-5.51 mg/kg). It should be noted that the level of nitrate nitrogen content in the 0-20 cm soil layer increases when using azotovit both separately and together with other preparations (phosphatovit and potassium humate): during the harvesting period, it increased by 1.30-1.83 mg/kg with a nitrate nitrogen content of 3.68 mg/kg in the control.

The availability of wheat plants with phosphorus mobile forms during gathering under the action of biological preparations is average (135-146 mg/kg). Experimental data indicate that when using phosphatovit, the content of mobile phosphorus slightly exceeded the options without its application. Both separately and in combination with other preparations, it increased the element amount by 10-11 mg/kg. Comparing the spring wheat cultivation technologies under consideration, it should be noted that, on average, spring wheat plants cultivated using azotovit, mobile phosphorus - phosphatovit are most provided with nitrate nitrogen.

Observations of the potash regime have shown that the content of mobile potassium in the soil during gathering is very high – 226-251 mg/kg. When applying biological preparations, its concentration in the soil does not change significantly.

In total, the use of biofertilizers has a positive effect on the soil nitrate nitrogen and mobile phosphorus content. When using biopreparations in this way, their level increases. The content of mobile potassium does not increase. The use of stimulants did not significantly affect the fertility level.

The change in nutrition level has a significant impact on the grain content [12-14]. The content of raw gluten increased with the introduction of biological preparations (Table 2) up to 1.1% (variant Azotovit + phosphatovit + potassium humate) with content in the control - 30.1.

The protein concentration in the grain in the control was 16.1%. The use of biological products provides an increase in this qualitative indicator by 0.3-1.4%.

A review of the qualitative indicators showed that the resulting grain is medium-sized (775-817 g/l). The highest rates of increase in this parameter were observed in the variants azotovit + phosphatovit and azotovit + phosphatovit + potassium humate: they were 39 and 42 g/l.

The vitreousness was 59-65 and did not depend significantly on biopreparations.

| Variant                                | Nature, g/l | Protein, % | Vitreousness, % | Gluten, % |
|----------------------------------------|-------------|------------|-----------------|-----------|
| Control                                | 775         | 16.1       | 61              | 30.1      |
| Azotovit                               | 785         | 17.2       | 65              | 30.7      |
| Phosphatovit                           | 787         | 17.4       | 62              | 30.5      |
| Biostim grain                          | 789         | 17.5       | 60              | 30.8      |
| Potassium humate                       | 802         | 17.5       | 60              | 31.0      |
| Azotovit + phosphatovit                | 814         | 16.6       | 59              | 31.0      |

Table 2. The quality of spring wheat grain depending on biological products on quasi-gleyed agrochernozem of the forest-steppe zone of the Omsk region.
It was revealed that the sum of amino acids increases from 9.24% without fertilizers to the highest 9.81% in the variant with potassium humate (LSD0.05 - 0.31). The effect of biofertilizers and preparations on the content of amino acids in grain is positive, the greatest — from the stimulants Potassium humate and Biostim grain.

**Table 3.** Amino acid composition of spring wheat protein depending on biopreparations on quasi-gleyed agrochernozem of the forest-steppe zone of the Omsk region, %

| Amino acid           | Control | Azotovit | Phosphatovit | Biostim grain | Potassium humate | Azotovit + phosphatovit | Azotovit + phosphatovit + potassium humate |
|----------------------|---------|----------|--------------|---------------|------------------|--------------------------|---------------------------------------------|
| Arginine             | 0.78    | 0.79     | 0.79         | 0.84          | 0.77             | 0.80                     | 0.84                                        |
| Lysine               | 0.30    | 0.31     | 0.34         | 0.36          | 0.38             | 0.32                     | 0.34                                        |
| Tyrosine             | 0.50    | 0.49     | 0.47         | 0.47          | 0.48             | 0.46                     | 0.48                                        |
| Phenylalanine        | 0.69    | 0.68     | 0.68         | 0.69          | 0.68             | 0.65                     | 0.78                                        |
| Histidine            | 0.32    | 0.34     | 0.35         | 0.39          | 0.35             | 0.33                     | 0.36                                        |
| Leucine+isoleucine   | 1.45    | 1.49     | 1.56         | 1.55          | 1.60             | 1.54                     | 1.58                                        |
| Methionine           | 0.32    | 0.30     | 0.28         | 0.26          | 0.37             | 0.27                     | 0.27                                        |
| Valine               | 0.55    | 0.60     | 0.62         | 0.65          | 0.64             | 0.63                     | 0.60                                        |
| Proline              | 1.98    | 1.99     | 1.91         | 1.90          | 1.98             | 1.89                     | 1.82                                        |
| Threonine            | 0.48    | 0.46     | 0.46         | 0.46          | 0.48             | 0.45                     | 0.50                                        |
| Serine               | 0.80    | 0.79     | 0.79         | 0.77          | 0.85             | 0.78                     | 0.79                                        |
| Alanine              | 0.52    | 0.51     | 0.55         | 0.55          | 0.54             | 0.53                     | 0.58                                        |
| Glycine              | 0.55    | 0.57     | 0.65         | 0.65          | 0.69             | 0.63                     | 0.62                                        |
| Sum of amino acids   | 9.24    | 9.32     | 9.45         | 9.54          | 9.81             | 9.28                     | 9.56                                        |

In the experiment, the amino acid composition of the protein was determined depending on the nutritional conditions. Biopreparations had an effect on the quantitative content of amino acids (Table 3). Thus, when studying their effect on the qualitative characteristics of wheat protein, it was revealed that the sum of amino acids increases from 9.24% without fertilizers to the highest 9.81% in the variant with potassium humate (LSD0.05 - 0.31). The effect of biofertilizers and preparations on the content of amino acids in grain is positive, the greatest — from the stimulants Potassium humate and Biostim grain.

4. Conclusion

All the studied biological products are effective when used for spring wheat by seed treatment method. With a yield of 2.41 t/ha in the control variant, the use of biological preparations contributed to the formation of 2.70-2.88 t/ha of grain. The greatest effect is obtained from the use of variants: azotovit + phosphatovit and azotovit + phosphatovit + potassium humate. The use of biofertilizers has a positive effect on the soil nitrate nitrogen and mobile phosphorus content. The use of stimulants did not significantly affect the fertility level. Biological fertilizers and growth stimulants had a positive effect on crop quality indicators. It was revealed that the sum of amino acids increases from 9.24% without fertilizers to the highest 9.81% in the variant with potassium humate.
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