Influence of microbiological preparations on spring wheat yield

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Abstract. Based on the research carried out on light-gray forest soils of the Chuvash Republic, elements of spring wheat cultivation technology were developed and recommended for production, ensuring the formation of a t/ha yield with an increase of t / ha in relation to control. Evidence-based data on more effective use of microbiological preparations were obtained.

1. Introduction
In the process of reforming Russian agriculture, producers of agricultural products were forced to reduce the use of the necessary doses of chemical fertilizers due to lack of material resources. Today, against the background of intensification and chemization of agricultural production, the question of the impact of chemically aggressive drugs on the quality of the products received and, consequently, on the health of the final consumer is increasingly raised. Working in a market economy, domestic agricultural producers must think about the future of the food market. After all, the production of environmentally friendly agricultural products requires compliance with strict rules prescribed and allowed for use by certifying bodies [1]. Therefore, in modern conditions of agricultural development, the use of both biological and microbiological preparations is of particular relevance. Research has shown that the use of microbiological preparations and growth promoters contributes to increasing the productivity of agricultural crops [2, 3]. In modern conditions, increasing crop yields can be achieved on high crop farming, scientifically justifying the environmentally safe use of fertilizers and pesticides, using advanced technologies and minimizing the means of chemization [4]. According to many scientists, the use of microbiological preparations in combination with modern agricultural technology will allow to realize the soil-climatic potential of the agricultural landscape by 60-80 % (instead of the existing 20-30 %), as well as the biological potential of agricultural plants, which is currently used insufficiently effectively [5].

In addition, the use of microbiological preparations accelerates the initial development of plants and helps to neutralize the partial toxic effect of chemical protectants. Also, the adaptive capabilities of agricultural crops are manifested under the influence of adverse factors of biotic and abiotic nature, improves the digestibility of food elements from the soil and increases the overall immunity of plants [6, 7].

Research in Russia and abroad has shown that the introduction of environmentally oriented agricultural systems with the use of microbiological preparations increases the yield of major agricultural crops. Many experiments have shown an increase in the quality of agricultural products and the profitability of agricultural enterprises by 30-50 % [8, 9].
2. Materials and methods

The object of research is biological fertilizers on crops of spring grains, namely spring wheat of the Moskovskaya 35 variety, elite reproduction.

Placement of variants within repetitions is systematic. Placement of repetitions in the experiment is two-tiered. Repeatability is four-fold, each option is 18 m², and the total area under the experiment is 432 m². All variants had a common background – N₁₆P₁₆K₁₆.

Experience diagram:

- Control;
- Nitrogen bacterial fertilizer (ABU) + Bacterial phosphorus fertilizer (BFU) (ABU (0.5 l / ton of seeds) + BFU (0.5 l / ton of seeds) + BFU (1st foliar feeding 0.4 l / ha) + ABU (2nd foliar feeding 0.4 l / ha);
- Extrasol (1 l / t of seeds during etching + 1 foliar feeding 1 l / ha + 2 foliar feeding 1 l / ha);
- Phosphatovite (F) + Azotovite (A) (F – 2 l/ton of seeds + A – 2 l/ton of seeds) + (A – 1st foliar feeding 1 l/ha + F – 2nd foliar feeding 1 l/ha).

Methods of observation and accounting in the experiment: phenological observations, biometric analysis of plant samples, crop accounting and mathematical data processing were carried out according to generally accepted methods [8, 9]. The economic evaluation of options was carried out by comparing the cost of produced and sold grain with the produced costs per hectare and per 1 ton of produced products based on the standard harvest.

In 2017 and 2019, sowing of spring wheat of the Moskovskaya 35 variety, reproduction of superelita was carried out on May 15, and in 2018 on May 21 to a depth of 5-6 cm, with a seeding rate of 6 million germinating seeds or 260 kg per hectare. The soil of the experimental site is dark gray forest medium loam. The predecessor was the seed peas. Agricultural technology in the experience is generally accepted for the Volga-Vyatka region. According to the plan of agrotechnical measures, all protective treatments of spring wheat seeds and plants against weeds, diseases and pests were carried out in the experiment. According to the scheme of the experiment, before sowing the seeds of spring wheat were etched, 2 foliar treatments were carried out, with the recommended doses of microbiological fertilizers. Cleaning was done on time in August.

In 2017, at the beginning of the growing season (May and June), the growth and development of crops came in conditions of excess moisture (50-60 mm) against the background of a cold temperature regime and close to the average annual norm (17.7-18.8 mm) in the rest of the growing season. In General, during the period of active vegetation of plants (May-August), the average air temperature was 15.7° C, lower than the long-term one by 0.7° C. Precipitation fell 285.9 mm, 139 % of the long-term norm.

2018 was a dry and hot year, which negatively affected crop yields. Growth and development of plants came in conditions of lack of moisture against the background of high temperature conditions during the entire growing season. The amount of precipitation during the entire vegetation period was less than the long-term monthly norm: in May-85%, in June-63%, in July-88%, in August-51%, in September-77%. During the period of active vegetation of plants in 2018, the average air temperature was 18.7°, exceeding the long-term temperature by 5.0°. Precipitation fell 155.3 mm, 72% of the long-term norm.

Weather conditions in 2019 were characterized as unfavorable. Sprouting and tillering of spring wheat occurred in arid conditions, at elevated temperatures. Since mid-May, humid and waterlogged periods began, so that further phases of culture development took place in conditions closer to the average long-term.

3. Results

The use of microbiological preparations in the technology of cultivation of spring wheat helped to increase their productivity. In 2017, when using schemes for the use of microbiological preparations on
spring wheat Moscow 35 in the variant Phosphatovit + Azotovit, the highest yield was observed – 5 t / ha, which is 0.94 t / ha or 23.09% higher than the control (table 1).

Table 1. Economic efficiency of application of microbiological preparations, t/ha.

| Experience options         | Yield, t / ha | Deviation |
|----------------------------|---------------|-----------|
|                            | 2017 year     | 2018 year | 2019 year | average value t / ha | % |
| Control                    | 4.1           | 2.0       | 2.8       | 3.0                   | - |
| ABU + BFU                  | 4.6           | 3.5       | 4.5       | 4.2                   | 1.2  | 40.0 |
| Extrasol                   | 4.5           | 2.6       | 4.1       | 3.7                   | 0.7  | 23.3 |
| Phosphatovite + Azotovite  | 5.0           | 3.9       | 3.4       | 4.1                   | 1.1  | 36.7 |
| NSR 05                     | 0.9           | 0.2       | 0.5       | -                     | - |

The dry conditions of 2018 affected the fact that, although the sowing was carried out later than in the previous year, but maturation in the condition of insufficient moisture and high temperatures of the growing season significantly reduced the period of the growing season. At the same time, it can be clearly stated that the use of microbiological preparations in all variants contributed to the increase in the yield of spring wheat of the Moskovskaya 35 variety.

In 2018, when using schemes for the use of microbiological preparations from suppliers in the Phosphatovite + Azotovite variant, the highest yield was observed – 3.9 t / ha, which is 1.9 t / ha or 95% higher than the control.

In 2019, spring wheat harvesting in the region was carried out on August 26. Dry conditions have influenced the fact that, although the sowing was carried out later than in the previous year, but maturation in the condition of insufficient moisture and high temperatures of the growing season significantly reduced the period of the growing season. At the same time, it can be clearly stated that the use of microbiological preparations in all variants contributed to the growth of the spring wheat crop. ABU + BFU and Extrasol had a significant increase in yield. With yields of 4.5 and 4.1 t / ha, they significantly exceeded the control. Options control and Phosphatovite + Azotovite reliably the same.

The conducted variance analysis of data from a single-factor field experiment with spring wheat did not reveal a significant difference between the variants in 2017, since the value of the smallest significant difference was 0.97 t / ha, i.e. the compared variants have the same effect on the performance indicator. Variance analysis of data from 2018 and 2019 showed that all variants of the experiment significantly exceed the control.

The use of biological products in 2017 slightly reduced the gluten content (table 2). The use of microbiological preparations in 2017 had little impact on the quality of the resulting crop. The highest gluten content was observed in the control version – 26%. Other variants with the use of microbiological preparations showed a slight decrease in this indicator.

Table 2. Indicators of spring wheat gluten depending on the use of microbiological fertilizers, % (according to GOST 13586.1-68).

| Experience options          | 2017 year | 2018 year | 2019 year | Average value |
|-----------------------------|-----------|-----------|-----------|---------------|
| Control                     | 26.0      | 19.0      | 20.0      | 21.7          |
| ABU + BFU                   | 23.5      | 22.0      | 21.0      | 22.2          |
| Extrasol                    | 25.0      | 16.0      | 19.0      | 20.0          |
| Phosphatovite + Azotovite   | 24.5      | 19.0      | 20.0      | 21.2          |
| NSR 05                      | 2.6       | 2.1       | 2.0       | -             |
The use of bio preparations in 2018 with respect to control in some cases contributed to improving the quality of the products obtained. The highest gluten content was observed when using nitrogen-and phosphor-bacterial preparations-22.0%, which is more than 3% control. In the version, using the drug Ektrasol obtained a decrease in gluten by 3 % in comparison with the control.

The use of bio preparations in 2019 revealed a significant difference between the options. Similar results were obtained in 2018, but there was a reduction in the difference. Thus, the use of the ABU + BFU scheme helped to obtain the maximum indicator – 21%, which is more than 1% control, and the scheme of using Extrasol of the minimum indicator-19%, which is less than 1% control.

The dispersion analysis of data from a single-factor field experiment on spring wheat showed that the use of selected biologics in 2017 and 2019, based on the results of the variability in the quality of gluten in the grain, is within the error of the experiment.

According to the results for 2017-2019, it was found that the maximum gluten values were obtained when using the ABU + BFU variant-22.2%, which exceeded the control variant by 0.5%.

4. Conclusions
In the current agro-climatic conditions of the growing season 2017-2019, the results of the study of biological preparations found:
1. Microbiological preparations help to increase the yield of spring wheat to an average of 4.1 t / ha in the variant with the use of Azotovite + Phosphatovite, which gives an additional increase of up to 1.1 t/ha relative to the control.
2. The maximum gluten values were obtained when using the variant with nitrogen-and phosphor-bacterial preparations-22.2%, which gives an excess of the control variant by 0.5%.

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