The influence of microbiological preparations on the quality of winter wheat in the conditions of the northern forest-steppe zone of the Tyumen region

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Abstract. The purpose of the research is to study the effect of microbiological preparations on the quality of winter wheat in the northern forest-steppe zone of the Tyumen region. The article provides the study of the following microbiological preparations: "Double roots" (Healthy roots); "Organic", as well as their combined use. The largest increase in the thousand kernel weight was noted in option 1 "Double roots" (Healthy roots)" and in option 3 "Double roots (Healthy roots) + Organic" by 4.2-2.5 g, which was 7.8-13.3% from the control variant. The highest protein content in winter wheat grain was found in option 1 "Double roots" (Healthy roots) – 13.3%. The rest of the studied options of the experiment were almost at the control level – 12.6-12.7%. According to the grain vitreousness indicator, option 1 "Double roots" (Healthy roots) and option 2 "Organic" dominated – 75 and 72%, respectively. All the studied options exceeded the control in the amount of gluten by 1-4%. The highest amount of gluten in our experiment was noted in option 2 "Organic" – 28.0% and in the first option "Double roots" (Healthy roots) - 27.0%. According to the gluten quality in the units of the gluten deformation index, 1 quality group is marked – good. Microbiological preparations in the conditions of the northern forest-steppe of the Tyumen region showed a positive effect on improving the quality of winter wheat grain. Grain quality indicators were steadily formed within the standards for food grains of 2-3 classes.

1. Introduction
Winter crops are widely used in Russia, and they play an important role in ensuring national food security, as well as in maintaining the competitiveness of the domestic agro-industrial complex on the world market [1].

The quality of wheat grain depends not only on the genetic characteristics of the variety but also on the weather conditions in the cultivation years [2]. Given such extreme weather conditions in the agricultural zones of the Tyumen region, well-adapted varieties are needed here, consistently forming the yield and quality of grain over the years [3, 4].

Currently, to increase the yielding ability of grain crops, great importance is attached to new methods of pre-sowing seed treatment with environmentally safe preparations that improve the sowing and yield qualities of seeds, stimulate growth, increase plant productivity and improve the grain quality [5]. Among them are such microbiological preparations as (Bioelements Agro "Double roots" (Healthy roots) and Bioelements Agro "Organic").

The use of modern chemization means, and in our case, microbiological preparations, allows increasing the yield and improving the grain quality indicator by rationalizing one of the techniques of
wheat cultivation technology [6]. Many scientists are engaged in the issue of improving the quality indicators of grain, and this issue remains relevant to this day.

The purpose of the research: to study the effect of microbiological preparations on the quality of winter wheat grain in the conditions of the northern forest-steppe zone of the Tyumen region.

2. Materials and methods
The research was carried out in 2019-2020 at the experimental field of the Northern Trans-Ural State Agricultural University in laboratory and field conditions of the northern forest-steppe of the Tyumen region. Presowing treatment of seeds was carried out with solutions of the following preparations: Bioelements Agro "Double roots" (Healthy roots) and Bioelements Agro "Organic", as well as with their combined use (Double roots (Healthy roots) + Organic), with a consumption rate of 0.5 kg per 1 ton of seeds. The control variant seeds were treated with distilled water. In the tillering phase, the crops were treated according to the growing season with the preparation "Organic" with a sticking agent, the rate of consumption of the working fluid is 200 l/ha. On June 20, the crops were treated with the systemic fungicide "Alto-turbo" (0.5 l) (rate of application 250 g/l propiconazole+160 g/l cyproconazole) against leaf rust at consumption rate of 300 l/ha.

The soil of the experimental site is leached chernozem. Preceding crop – complete fallow. Sowing in the 1st decade of September. The agrotechnology system was carried out in accordance with the technology recommended for the northern forest-steppe of the Tyumen region, taking into account weather conditions, soil type and features of the studied crop. Sampling, accounting and determination of grain quality indicators were carried out according to standard methods [7]. Mathematical data processing was performed using the method of variance according to B.A. Dospekhov [8]. Studied experimental options:

Control (without the use of microbiological preparations);
Option 1 – "Double roots" (Healthy roots);
Option 2 - "Organic";
Option 3 – "Double roots" (Healthy roots) + "Organic".

3. Results and discussion
One of the most important tasks in the grain crops cultivation is the grain quality control. Grain quality is a complex indicator that is evaluated by numerous characteristics and depends on various factors [9, 10]. One of the promising and highly effective methods that increase the yield and quality of agricultural products is the use of microbiological preparations.

Thousand kernel weight characterizes the density and plumpness of the grain i.e indicates a large supply of nutrients in the grain, providing the yield of grain crops.

In our experiments, according to laboratory studies, the thousand kernel weight in all the studied options exceeded the control by 0.2-4.2 g (Table 1).

| Option                               | Thousand kernel weight, g | Protein content, % | Vitreousness, % |
|--------------------------------------|---------------------------|--------------------|-----------------|
| Control sample                       | 32.0                      | 12.6               | 60              |
| Option 1                             | 36.2                      | 13.3               | 75              |
| Option 2                             | 32.2                      | 12.7               | 72              |
| Option 3                             | 34.1                      | 12.6               | 65              |

Based on the data obtained in Table 1, the largest increase in the thousand kernel weight was noted in option 1 "Double roots" (Healthy roots) and in option 3 "Double roots (Healthy roots) + Organic" by 4.2-2.5 g, and varied from 7.8-13.3% (Fig. 1). A slight excess of the thousand kernel weight (0.2 g) was noted in option 2 with the microbiological preparation "Organic".
The thousand kernel weight gain, depending on the microbiological preparations used, %.

Figure 1. The thousand kernel weight gain, depending on the microbiological preparations used, %.

The protein content is a changeable indicator and can vary greatly from 7-26% depending on the growing conditions. It is believed that if the precursor was fallow land, then the grain will be of higher quality [11].

In food grain production, the influence of agrotechnical factors is manifested by an increased yield of a higher-quality grain of an improved class. According to the authors, Mares D., Mrva K (2008), the higher the protein content in the grain, the more expensive the grain is on the world market [12].

The highest protein content in winter wheat grain was found in option 1 "Double roots" (Healthy roots) – 13.3%, (as per GOST Standard, it can be attributed to the second class), which is higher than the control option by 0.70%.

The rest of the studied options of the experiment were almost at the control level – 12.6-12.7%.

The grain vitreousness indicator is particularly important in the global grain market. This indicator reflects a relatively high protein content in it, while meailness, on the contrary, indicates a low percentage of protein and a predominance of starch. It is used to judge the consistency of the endosperm, kernel hardness, its structure, and the flour yield. The grain vitreousness indicator is particularly important in the global grain market. In the experiment, the highest vitreousness percentage was observed in option 1 "Double roots" (Healthy roots)" and option 2 "Organic" - 75 and 72%, respectively.

One of the main indicators of the wheat grain – gluten protein, which determines the technological properties of flour. Only a larger amount of crude gluten (25% and higher) and its good quality, make it possible to produce fluffy, delicious and healthy bread.

In the world market, trading operations based on the gluten content index are quite rare, usually, a protein content indicator is used, which is very susceptible to natural and climatic conditions of growing. In this regard, the quantity and quality of gluten are the main class-forming indicators for Russian wheat, and protein is an indicator of nutritional value [13].

To obtain graded flour, wheat gluten content should reach at least 23% (requirements of GOST to the third class). In our studies, the amount of crude gluten varied from 24.0 to 28.0%, depending on the experimental option (Table 2).

All the studied options exceeded the control in the amount of gluten by 1-4%. The highest amount of gluten in our experiment was noted in the second option "Organic" – 28.0% and in the first option
"Double roots" (Healthy roots)" - 27.0%. According to the gluten quality in the units of the gluten deformation index, one quality group is marked – good.

Table 2. Influence of microbiological preparations on the quantity and quality of winter wheat gluten

| Option      | Gluten amount, % | Gluten quality, gluten deformation index | Group |
|-------------|------------------|------------------------------------------|-------|
| Control sample | 24.0             | 53                                       | 1     |
| Option 1    | 27.0             | 53                                       | 1     |
| Option 2    | 28.0             | 55                                       | 1     |
| Option 3    | 25.0             | 45                                       | 1     |

Grain quality improving in the intensification of agriculture is an important problem of agricultural production. The lack of high-quality grain – the main raw material for the flour-milling, cereal, baking and macaroni products industries – leads to the search for ways of its stable production. If the content of crude gluten in the grain is 28% or more, this corresponds to 13% of protein and higher, it is possible to bake bread with good porosity and volume yield [14, 15].

One of the factors for improving and preserving the quality of the products obtained is the harvesting of grain crops, since the harvest often coincides with rainy, cold weather, grain can germinate, and therefore the quality of the grown grain is sharply reduced. In our experiment, harvesting of winter wheat grain was carried out on July 28, 2020, in one day, in dry sunny weather by the Terrion 2010 combine harvester, based on this, the winter wheat grain crop has a number of advantages over spring grain crops in terms of grain quality.

We have calculated the gluten-protein ratio. The calculation data on the protein-gluten ratio show that there is a specificity concerning this "gluten-protein" ratio. The average value of the ratio is in the range of 2.2. In our studies, the maximum value of the gluten-protein ratio was in the third option of the experiment – 2.2, the minimum was in the first option – 1.9, and in options 2 and 4, the gluten-protein ratio was 2.0.

4. Conclusion
Microbiological preparations used in the conditions of the northern forest-steppe of the Tyumen region showed a positive effect on improving the quality of winter wheat grain. Grain quality indicators were steadily formed within the standards for food grains of 2-3 classes. The climatic conditions of the Tyumen region during the research years contributed to the production of winter wheat grain with high grain quality indicators.

Thus, according to the totality of winter wheat grain quality indicators, it is possible to determine an increase in the protein content, the thousand kernel weight, vitreousness, quantity and quality of gluten, by applying microbiological preparations in the cultivation of winter wheat in the conditions of the northern forest-steppe of the Tyumen region.

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