The efficiency of some microelement compositions in spring wheat cultivation system

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Abstract. The studies were performed on the experimental field of the Research Institute of Agricultural Sciences of the Northern Trans-Urals - a branch of the Tyumen Scientific Center of the SB RAS in 2019. In the experiment, studies were carried out on the use of biogenic iron hydroxide nanoparticles in various variations on spring wheat for seed treatment before sowing and plants during the growing season in the complex plant protection complex. Records and observations were performed according to standard guidelines adopted in the State variety testing network, crop production and plant protection. The use of biogenic Fe did not affect the initial development of plants and germination. Analysis of seeds for disease damage showed a general infection within 50%, seed treatment with a fungicide disinfectant reduced their infection by 90%, biogenic iron by 34%, which is the threshold for the assessment of PSM. Root diseases caused by helminthosporious and Fusarium infections were suppressed by 71-93% fungicidal protectants and 30-60% by the use of biogenic iron with an increase in plant maturation efficiency. In the conditions of the year of leaf stem diseases the development of septoriosis of the ear and stem prevailed 30-40%, the use of a chemical fungicide had a reception efficiency of 77-82% against the background of fungicidal protectants and the use of compositions in the earing phase and increased by 10% to 89% from treatment in the tillering phase with biogenic iron and biofungicide. Biogenic Fe applied in the tillering phase had a directed effect on the development of the ear increasing its weight by 1.07 g, and resistance to lodging, but there was a decrease in the length of the stem, the development of the leaf blade of the flag leaf by 8.7-12.7%, and the total mass of plants. Increased yield by 9.8-12.4% and gluten content up to 30% contributed to the use of biogenic iron and biofungicide increasing the effectiveness of the chemical fungicide at low rates. The use of biogenic iron is possible in the technology of spring wheat cultivation to reduce the chemical load by regulating the norms of application of the fungicidal direction of the PSM.

1. Introduction
The successful solution of tasks to increase crop productivity requires the creation of optimal conditions for their nutrition with all the necessary elements, including trace elements [1]. According to most researchers, micro-fertilizers under appropriate conditions significantly increase the yield and improve the quality of plant products, as well as protect plants from some diseases, increase the yield of spring wheat and positively affect the technological quality of grain [2-5].

Microelements form organ mineral complex compounds with physiologically active substances, the main function of which is to regulate various parts of the metabolism. Lack of trace elements in soil and plants leads...
to acute physiological disorders, so they should be recognized as the most important factors of plant growth and productivity [6].

Currently under cultivation fertilizers containing cobalt and iron are increasingly used in crops. Cobalt enhances the nitrogen-fixing ability of microorganisms, has a beneficial effect on the synthesis of chlorophyll, protein, carbohydrates, increases crop productivity and the quality of crop products. The most effective methods using biologically active iron compounds to increase the yield of cultivated plants is foliar top dressing with solutions of organic (mainly chelates) or inorganic iron compounds. [7,8]. The use of biogenic iron-based nanoparticles on crops can significantly accelerate the development of the root system, as well as strengthen the protection of seeds from plant pathogens [9-11].

The study of small doses of microelement particles for regulating the development of crop growth and resistance to harmful factors is an urgent issue in the system of obtaining crop products.

The purpose of the study is evaluation of the use of microelement nanoparticles of biogenic iron hydroxide in the system of spring wheat cultivation.

2. Materials and methods

The studies were performed on the experimental field of the Research Institute of Agricultural Sciences of the Northern Trans-Urals - a branch of the Tyumen Scientific Center of the SB RAS in 2019. The soil is dark gray forest, heavy loam. The depth of the humus horizon is 25-27 cm, the humus content is 4.2-5.0 %, the pH of the salt extract is 6.0-6.4. The experiment is based on a small-plot experiment, the plot area is 25 m² in 4 repetitions using the spring wheat variety Aviada breeding RIA Northern Trans-Urals. The predecessor is black steam. In the experiment, studies were carried out on the use of biogenic iron hydroxide nanoparticles by the FIC Krasnoyarsk Scientific Center of the SB RAS in various variations on spring wheat for treating seeds before sowing and plants during the growing season in combination with other drugs (herbicides, fungicides).

Records and observations were performed according to standard guidelines adopted in the state transport Network, crop production and plant protection. Phyto-examination of seeds was carried out by the method of rolls [12]. For this purpose, in the control and invariants with seed treatment, 2 samples of 50 grains were taken and laid out on paper rolls for subsequent germination. The assessment of the development of germinal organs and the infestation of the seed material with various pathogens was carried out on the 7th day.

The development and prevalence of ordinary root rot were determined twice during the growing season according to the method of V.A. Chulkina, 1972, in 2 phases of culture development - the tillering phase and the phase of full ripeness [13]. Accounting for field germination of seeds, plant survival, and structural analysis of the crop were carried out according to generally accepted methods (Methodology of state variety testing of crops, 1989; Experimental fieldwork, 1982) [14,15]. The development of aerogenic infections (brown leaf rust, septoria, powdery mildew) was taken into account from the tillering phase to milk ripeness. In ten places, 10 leaves of a certain tier were selected, then the degree of disease coverage of the leaf surface was determined by universal scales expressed as a percentage. The main registration on the 3rd sheet from above, an ear, a stalk in the phase of milk-wax ripeness. [16].

Yields were taken into account by continuous threshing with a Sampo 130 combine harvester, they were brought to standard humidity and purity according to GOST 13865.5-93 and 30483-97. Grain quality indicators were determined at the centre for analytical research and technological assessment of grain under GOST 12042-80, GOST 10840 - 64, GOST 13586.1-68. Mathematical data processing was performed (Dospekhov, 1985) and using the SNEDECOR V5 application package [17].

The vegetation period of 2019 can be characterized as well provided with precipitation (123% of the norm) and in terms of heat supply, as close to the average long-term norm (99%), with some lack of heat in June (86%) and the first decade of July (88%) Agricultural technology according to the scheme of experience and generally accepted in the region.

The scheme of experience:
1. Fungicide disinfectant, 1.25 l/t
2. Control (without seed treatment)
3. Biogenic iron with cobalt, 1 ml/t + Biogenic iron with cobalt, 1 ml/ha (tillering phase)
4. Biofungicide, 100 ml/ha + biogenic Fe 10 ml/ha + Silicon, 1 ml/ha (tillering phase)
5. Silicon, 1 ml/ha + nutrient Fe 10 ml/ha (earing phase)

3. Results and discussion.

3.1. Accounting for harmful objects and efficiency of means used

When using drugs to regulate growth processes in a plant using seed treatment or during the growing season, their influence on the germination and initial development of the plant is initially taken into account. An increase in seed germination was observed by 3% when treated with a fungicide disinfectant 90% and in the control 87%, the use of nutrient iron did not affect the increase in germination.

The development of the root system, or rather the length of the root of the seedling on day 7, was influenced by the options with the use of a fungicide disinfectant with an increase in root length by 0.9 cm, when processing with biogenic Fe, the excess of control was 0.52 cm with varying lengths from 10.0-10.99 cm.

The length of the coleoptile variety was 5.1 cm, the use of etching with chemical dressing agents reduced the length by 1.0 cm, while the seeds were treated with Biogenic Fe, the length of the coleoptile was at the control level, which determines the absence of its retardant properties. The average length of the sprout in the experiment options was 11.3-11.6 cm, a slight decrease is noted in the options for seed treatment.

The initial infection of the seeds according to Phyto-examination was p. Alternaria - 43%, p. Fusarium - 7%, Bipolaris sorokiniana - 0-2%. Treatment with a fungicide disinfectant reduced the number of pathogens by 92%. The use of the Biogenic Fe preparation affected Alternaria infection of 30% and a decrease in fusarium infection - 51% with an overall efficacy against pathogens of 34%, which is insignificant.

Root rot on spring wheat developed in the tillering phase of 1.4%, spread of 5.6%, by the end of the year the development of the disease reached 15.56% with a spread of up to 50%. The effectiveness of reducing the damage to wheat plants by root rot according to the fungicidal dressing variant in the tillering phase was 71% and at the end of the growing season, root disease control was 93%. The use of Biogenic Fe had a negligible effect on the containment of the disease at the threshold level of 30% and at the end of the growing season, the containment rate was 60% (table 1).

| Option | Tillering phase | before the harvest |
|--------|----------------|--------------------|
|        | Devel opment,% | Spread, % | Reduction, % | Devel opment,% | Spread, % | Reduction, % |
| 1. Fungicide disinfectant, 1.25 l/t | 0.41 | 1.64 | 70.71-70.81 | 0.97 | 3.9 | 93.74 - 92.99 |
| 2. Control - no treatment | 1.40 | 5.62 | - | 15.56 | 55.6 | - |
| 3. Biogenic Fe with Co, 1 ml/t + 1 ml/ha | 0.95 | 3.81 | 34.28-32.19 | 5.71 | 21.4 | 63.27 - 61.43 |

Leaf – stem diseases affected by waxy maturity on unprotected wheat plants were 1-5% (Puccinia recondite), 40% (Septoria tritici) and 30% (Septoria nodorum). Minimum fungicide treatment in a mixture with formulations according to the experimental scheme was carried out on wheat plants in the flag phase - earing.

The use of fungicide reduced the defeat of leaf-stem diseases by 77-89%, the efficacy of reception was at the level of 77-82% when using fungicidal disinfectants and the use of formulations in the earing phase and increased to 89% of the treatment in the tillering phase with biogenic iron and bio fungicide.

The biometric indicators of the green mass of the culture at the end of flowering phase showed the following results since the biogenic iron used in the tillering phase had a directed effect on the development of the spike and increased its weight by 1.07 g, but at the same time, a decrease in the length of the stem and the total mass of leaves was observed and lodging resistance.
Measurement of the development of the flag leaf in the maximum phase of its development according to the variants of the experiment showed that the length and width of the leaf were smaller than in the control when using variations with biogenic iron by 8.7-12.7% and equal to the control development in the application of a fungicidal mordant with a leaf length of 21.6 cm and its width of 1.44 cm.

3.2. Crop accounting and economic efficiency
Productivity in the conditions of the year is quite high 3.2-4.9 t/ha. For most options, the yield was in the range of 4.2–4.9 t/ha; the difference between the options reached 0.4–0.7 t/ha. A significant increase of the presented options was the use of biogenic iron and bio fungicide in the tillering phase in 0.43 - 0.54 t/ha or 9.8-12.4%. The use of fungicide disinfectant did not differ in yield with the option without presowing preparation of seeds and the protection against leaf-stem diseases had a significant effect (table 2).

| Test variants | Yield | + over control | %   |
|---------------|-------|----------------|-----|
| 1. Fungicide disinfectant, 1.25 l/t | 4.37  | +0.02 | 0.4 |
| 2a Control (without presowing treatment of seeds) | 4.35  | - | - |
| 2b. Control (without fungicides) | 3.24  | -1.11 | -25.5 |
| 3. Biogenic Fe with Co, 1 ml/t + Biogenic Fe with Co, 1 ml/ha | 4.78  | +0.43 | 9.8 |
| 4. Biofungicide, 100 ml/ha + Biogenic Fe Fe 10 ml/ha + Silicon, 1 ml/ha (tillering phase) | 4.89  | +0.54 | 12.4 |
| 5. Silicon, 1 ml/ha + nutrient Fe 10 ml/ha | 4.60  | +0.25 | 5.7 |
| NDS<sub>05</sub> | - | 0.22 | - |

According to the results of a structural analysis of wheat plants, a significant number of indicators with a plus are noted for the use of biogenic iron for seed treatment and plant vegetation in the tillering phase. The weight of 1000 grains in the experiment variants varied between 39.7-44.6 g, a significant increase was observed in the variants of the application of fungicide dressing by 1-1.8 g. The protein content in most variants is at the level of 14%, which corresponds to the 1st class of quality, the decrease in protein according to the options for the use of a protectant. The amount of gluten in the grain of the culture varied 26-30%, with an increase in options Biofungicide, 100 ml/ha + nutrient Fe 10 ml/ha + silicon 1 ml/ha - 30%; Biogenic Fe with Co, 1 ml/t + Biogenic Fe with Co, 1 ml/ha - 28.7%, Silicon, 1 mg/ha + biogenic Fe 10 ml/ha applied in the heading phase - 29.34%.

4. Conclusion
As a result of the studies, a positive effect of the fungicide disinfectant on increasing the germination of the culture by 3%, an increase in the length of the root by 1 cm, an effective effect on the reduction of seed diseases by 92% and roots by 71-93% is noted.

Seed treatment nutrient Fe decreased the number of Alternaria in the seeds at 30% and fusarium 50%, controlling the development and spread of root rot during the growing season of culture was at the beginning of vegetation on the threshold level of 30% and at the end of the growing season to 60%.

The use of fungicide during vegetation at minimum rates had a greater restraining effect at an efficiency of 77-89%, in combination with bio fungicide and biogenic Fe in the tillering phase, increasing the efficiency of administration by 10%.

With a crop yield of 3.2-4.8 t/ha, depending on the level of protection, a significant increase of 0.43 - 0.54 t/ha or 5.7-12.4% was obtained for the use of biogenic iron in seed treatment and plant treatment during the tillering phase and in conjunction with bio fungicide, but the fungicide against leaf-stem diseases played a decisive role in increasing the yield.

The use of biogenic Fe had a restraining effect on plant growth, increasing lodging resistance, protection against diseases, and crop productivity.
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