Effect of fungicidal agents on the initial growth of spring wheat plants

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Abstract. This study provides a comparative assessment of the effectiveness of active ingredients of fungicidal preparations and in a mixture with organomineral fertilizers on reducing the infection of seed and the germination of spring wheat plants in the initial phases of ontogenesis. For the research, on 8 different combinations of active ingredients fungicides in pure form and in a mixture with organomineral fertilizer. The application of fungicide did not affect the seed growth energy, but in most cases the germination rate increased by 4%. Seed dressing had a retardant effect on germination of the plant's organs, and the fertiliser stimulating effect was shown in Variant 1 (Protioconazole + Tebuconazole + fertiliser). The efficiency of disinfectants against seed diseases reached 96% against general contamination and 56-93% against pathogenic microflora, and in a mixture with organomineral fertilizer, the efficiency is reduced by 13%. High and stable efficiency was manifested in drugs based on the active substances Tebuconazole + Flutriafol (80 + 80 g/l). Protioconazole + Tebuconazole (250+150 g/l) with net efficiency of 83-93%. As a result of the research, the effect of pickling with fungicides was determined on the basis of various combinations of active substances in pure form and with the addition of organomineral fertilizer as a growth stimulator.

1. Introduction
In the system of crop protection is one of the first and important methods of using seed disinfectants for treatment of seeds and subsequent protection from diseases, as the use of seed disinfectants allows to achieve optimal phytosanitary condition of seeds and sowing [1].

Created a significant number of active substances with a certain quantitative content and combination, which determines the impact on a particular level of infection and species composition of diseases, on the basis of data from phytoresearch of seeds is more correct choice of fungicide inhibitor that later allows you to get healthy shoots, plant development, dense and healthy stem - the main decisive factor in the planned yield [2-6]. A comparative assessment is made of the impact on spores of fungi causing plant damage from germination to maturation of not only chemical pesticides with high efficiency, but also biopesticides based on plant extracts [7].

According to our observations, seed dressing promotes, at optimal sowing times, evenness of crops, resistance to lodging and faster maturation. According to our observations, seed dressing promotes, at optimal sowing times, evenness of crops, resistance to lodging and faster maturation. Different authors speak about the benefits of seed dressing in reducing plant disease and regulating growth, but if the technology is not followed, the opposite effect is possible [8]. Non-compliance with technology in the use of certain drugs in seed dressing can lead to the oppression of sprouts, reduce germination energy
and growth strength, you should also consider the impact of disinfectants on the composition of soil microflora, and the ratio of useful and harmful microorganisms [9].

Since fungicide treatment of seeds can increase the state of rest or affect the growth and intensity of germ cell division, the problem of relieving both biotic and abiotic stress during germination of fungicide-treated seeds is very important and should be addressed comprehensively [10].

The aim of the work is to make a comparative assessment of the effectiveness of disinfectants based on various active substances and in a mixture with organomineral fertilizer on the impact on reducing seed infestation and spring wheat plant development in the first phases of ontogenesis.

2. Materials and methods
Researches are executed in laboratory of protection of plants SRIA for NTUR – Branch of Tyumen Scientific Centre SB RAS. Spring soft wheat seeds were also treated (Triticum aestivum L.) variety Aviada disinfectants with various active ingredients in pure form and in a mixture with organomineral fertiliser.

In the experiment the disinfectants were used based on the following active substances: 1. Diphenoconazole + Ciproconazole (30+6.3 g/l) norm 1.0 l/t; 2. Tebuconazole (60 g/l) norm 0.5 l/t; 3. Protoicoconazole + Tebuconazole (150+20 g/l) norm 0.5 l/t; 4. Tebuconazole + Flutriafol (80 + 80 g/l) norm 0.4 l/t; 5. Tebuconazole + Flutriafol (80+80 g/l) norm 0.5 l/t; 6. Diphenoconazole + Tebuconazole (90 + 45 g/l) norm 0.5 l/t; 7. Protoicoconazole + Tebuconazole (250 + 150 g/l) norm 0.17 l/t; 8. Imazalil + Tebuconazole (100+60 g/l) norm 0.4 l/t and with the addition of organomineral fertilizer “Forsazh” at a rate of 1.0 l/t (composition, g/l: amino acid complex, incl. aminoacetic acid - 150.0, sulfur (SO2) - 30.0, phosphorus (P2O5) - 30.0, total nitrogen (N) - 38.0, humic acids - 10.0, magnesium (MgO) - 1.0, copper (CuO) - 0.5, zinc (ZnO) - 0.5, boron (B) - 0.6, iron (FeO) - 0.2, manganese (MnO) - 0.2, molybdenum (Mo) - 0.5, cobalt (Co) - 0.3, chrome (Cr) - 0.3, lithium (Li) - 0.2, vanadium (V) - 0.2, nickel (Ni) - 0.1, selenium (Se) - 0.1, pH (without dilution) - 6.8 %).

Records and observations were made according to standard guidelines adopted in crop production and plant protection. Phytoexpertise of seeds was carried out by the method of rolls [11,12]. For this purpose, 2 samples of 50 grains each were taken in the control and in the variants with seed treatment. Estimation of infestation of seeds with different pathogens was estimated for the 7th day. Seed treatment was carried out on the basis of 100 g in plastic containers with an exposure of 3 days. Seed treatment was carried out on the basis of 100 g in plastic containers with an exposure of 3 days. In determining the strength of seed growth were guided by state standard [13].

3. Results and discussion
Under laboratory conditions, we treated wheat seeds with various pure disinfectants and added organomineral fertilizer for subsequent step-by-step seed placement to assess the impact on growth, development and regulation of fungal microflora.

One of the first important factors in determining the effectiveness of seed dressing reception for the development of wheat plants is to determine the energy and germination of seeds after treatment with disinfectants [14].

In most variations of seed treatment with disinfectants there was a decrease of energy in comparison with control by 10-20%, the most reduced energy was given to Protoicoconazole + Tebuconazole, 0.5 l/t, Tebuconazole + Flutriafol, 0.4 l/t with energy 50-56%. Seed germination rate for 7 days of germination was 79-91%, there was a general increase in germination against the background of etchant treatment, except for some variations, the use of organomineral fertilizer in a mixture with disinfectants did not affect an even higher germination rate, and in relation to control, the increase was 4%. The next indicator of the influence of disinfectants is the development of embryonic organs (root, coleoptile, sprout), where their retardant effect on the coleoptile, the length of the sprout can be clearly seen. Thus, in the works of the researchers, the preparation based on fludioxonil with diphenoconazole to cover seeds (FSC) stimulated the growth of wheat germ, accelerated root growth and biomass in field trials [15] (Table 1).
Tebuconazole (150+20 g/l) showed a gentler effect on organ development parameters, the organonminerl fertilizer had a positive effect on the development of plant parameters in a mixture with Protioconazole + Tebuconazole (150 + 20 g/l), where etchanting with these products increased organ weight by 0.5-0.8 g and 0.6-0.9 cm of their length.

In terms of control, plant development on the 7th day was inferior in most treatments, and seed treatment with a single organonminerl fertilizer did not affect initial plant development. (Table 2).

Table 1. Influence of fungicide forms on the energy and germination of spring wheat seeds.

| №  | Option                              | Energy, %* | Germination capacity, %** |
|----|-------------------------------------|------------|--------------------------|
| 1  | Diphenocanazole + Ciproconazole, 1.0 l/t | 74         | 89                       |
| 2  | Tebuconazole, 0.5 l/t                | 68         | 85                       |
| 3  | Protioconazole + Tebuconazole, 0.5 l/t | 56         | 79                       |
| 4  | Tebuconazole + flutriafoi, 0.4 l/t    | 52         | 84                       |
| 5  | Tebuconazole + flutriafoi, 0.5 l/t    | 56         | 88                       |
| 6  | Diphenocanazole + Tebuconazole, 0.5 l/t | 53         | 88                       |
| 7  | Protioconazole + Tebuconazole, 0.17 l/t | 50         | 85                       |
| 8  | Imazalil + Tebuconazole, 0.4 l/t     | 57         | 87                       |
| 9  | Control (no processing)              | -          | -                        |
| 10 | Control (Forcing, 1.0 l/t)           | -          | -                        |

* the disinfectant pure; ** the disinfectant in the mixture of organonminerl fertilizer

In our studies, preparations based on Imazalil + Tebuconazole (100+60 g/l), Protioconazole + Tebuconazole (150+20 g/l) showed a gentler effect on organ development parameters, the organonminerl fertilizer had a positive effect on the development of plant parameters in a mixture with Protioconazole + Tebuconazole (150 + 20 g/l), where etchanting with these products increased organ weight by 0.5-0.8 g and 0.6-0.9 cm of their length.

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Table 2. Growth of germ organs of spring wheat plants in 7 days.

| Option                              | Weight, gr | Length root, cm | Length coleoptile, cm | Length sprout, cm |
|-------------------------------------|------------|-----------------|----------------------|------------------|
| Diphenocanazole + Ciproconazole     | -          | 3.03            | 10.6                 | 3.8              |
| Diphenocanazole + Ciproconazole, + fertilizer | 1.57       | 2.86            | 11.1                 | 3.7              |
| - Control option                    | -0.7       | -0.17           | +0.5                 | -0.1             |
| Tebuconazole                        | -          | 2.90            | 11.4                 | 4.5              |
| Tebuconazole + fertilizer           | 1.80       | 2.69            | 11.7                 | 4.0              |
| - Control option                    | -          | -0.21           | +0.3                 | -0.5             |
| Protioconazole + Tebuconazole       | 1.07       | 2.87            | 12.2                 | 4.5              |
| Protioconazole + Tebuconazole, + fertilizer | 1.93       | 3.41            | 12.3                 | 5.1              |
| - Control option                    | +0.86      | +0.54           | +0.1                 | +0.6             |
| Tebuconazole + flutriafoi           | -          | 2.33            | 12.1                 | 3.4              |
| - Control option                    | -          | +0.34           | -1.2                 | +0.3             |
| Tebuconazole + flutriafoi, + fertilizer | 2.05       | 2.34            | 10.8                 | 3.3              |
| - Control option                    | -          | -0.15           | +0.4                 | -0.1             |
| Diphenocanazole + Tebuconazole      | 1.84       | 2.77            | 11.5                 | 3.7              |
| - Control option                    | -          | -0.27           | +0.1                 | -0.4             |
| Protioconazole + Tebuconazole, + fertilizer | 1.41       | 2.75            | 11.6                 | 3.3              |
| - Control option                    | -          | -0.27           | +0.1                 | -0.4             |
| Protioconazole + Tebuconazole, + fertilizer | 1.62       | 2.92            | 11.4                 | 4.3              |
| - Control option                    | +0.21      | +0.17           | +0.1                 | +0.4             |
| Imazalil + Tebuconazole             | 2.00       | 3.78            | 10.5                 | 5.5              |
| Imazalil + Tebuconazole, + fertilizer | 2.10       | 3.97            | 11.6                 | 5.5              |
| - Control option                    | +0.1       | +0.19           | +1.1                 | +0.1             |
| Control (fertilizer, 1.0 l/t)       | 1.64       | 3.69            | 12.5                 | 6.4              |
| - Control option                    | -0.23      | +0.11           | -0.2                 | -0.3             |
| NSR 05                             | 0.2        | 0.10            | 0.25                 | 0.51             |
Drugs based on active ingredients such as prochlorase and diphenoconazole + propyconazole are ineffective in fighting infections r. Fusarium, which causes root rot, is one of the most active triazole fungicides; however, their effectiveness differs from each other [16].

Efficiency of disinfectants in this study against different groups of pathogens varied and amounted to 78-96% against general infection and against pathogenic microflora 56-93%, with the addition of organomineral fertilizer in the working mixture with the disinfectant the efficiency of etchant against general infection of seeds amounted to 72-93%, and against pathogens 50-93% reduction was an average of 8-13% (Table 3).

### Table 3. Influence of fungicide forms on diseases of spring wheat seeds.

| №  | Option                                   | Complete infection of seeds / including pathogenic fungi, % | Efficiency, % |
|----|------------------------------------------|-----------------------------------------------------------|---------------|
| 1  | Diphenochloroconazole + Ciproconazole, 1.0 l/t | 8/3 17/8                                                  | 89.2 / 81.2 / 77.0 / 50.0 |
| 2  | Tebuconazole, 0.5 l/t                     | 16/7 20/8                                                | 78.3 / 56.2 / 72.9 / 50.0 |
| 3  | Prothioconazole + Tebuconazole, 0.5 l/t   | 11/3 16/5                                               | 85.1 / 81.2 / 78.3 / 68.7 |
| 4  | Tebuconazole + flutriafol, 0.4 l/t       | 4/2 7/4                                                | 94.5 / 87.5 / 90.5 / 75.0 |
| 5  | Tebuconazole + flutriafol, 0.5 l/t       | 3/2 5/3                                                | 95.9 / 87.5 / 93.2 / 81.2 |
| 6  | Diphenochloroconazole + Tebuconazole, 0.5 l/t | 10/3 18/4                                            | 86.4 / 81.2 / 75.6 / 75.0 |
| 7  | Prothioconazole + Tebuconazole, 0.17 l/t  | 7/1 12/2                                               | 90.5 / 93.7 / 83.7 / 87.5 |
| 8  | Imazalil + Tebuconazole, 0.4 l/t         | 10/4 15/7                                              | 86.4 / 75.0 / 79.7 / 56.2 |
| 9  | Control (no processing)                   | 74/16                                                   | -              |
| 10 | Control (Forcing, 1.0 l/t)               | 63/14                                                   | -              |

*the disinfectant pure; **the disinfectant l/t in the mixture of organomineral fertilizer

High and stable efficacy has been demonstrated by such active ingredients as Tebuconazole + Flutriafol (80 + 80 g/l), Prothioconazole + Tebuconazole (250 + 150 g/l) with a net efficacy of 83-93% and 75-87% with the addition of an agrochemical.

The use of a fungicide in its pure form had an efficiency at the level of 80-95%, the use of a fungicide in a mixture with an agrochemical showed a decrease in efficiency against seed diseases by 4-13% figure 1.

![Graph showing the effectiveness of fungicides](image)

**Figure 1.** The effectiveness of fungicides.

A slight decrease in the effectiveness of fungicides in a mixture with an agrochemical in the further stage of ontogenesis is compensated by the stimulation of plant growth functions.

An analysis of plant growth strength for 10 days after sowing in quartz sand showed an average of 87% healthy germinated plants with an excess of 1% control and a 0.5% difference between one
fungicide dressing and 0.5% organometallic fertiliser. Plant growth at the time of analysis, the length of a sprout against a pure dressing agent is 18.1 cm and in a mixture with a fertiliser 18.4 cm, with a sprouts weight of 5.10-5.11 g and a greater increase when adding fertiliser to the dressing agent.

Among all variations, Diphenocanazole + ciproconazole (30+6.3 g/l), Tebuconazole (60 g/l), Protioconazole + Tebuconazole (150+20 g/l) with 88-92% of active substances have the highest germination and growth strength.

4. Summary
As a result of research, the application of etchant in most variants increased germination by 4%, slowed down growth functions in the initial stage of plant development, and the negative impact was reduced with the use of fungicide with the active ingredient Protioconazole + Tebuconazole (150 + 20 g/l) and organometallic fertiliser.

The efficiency of fungicidal disinfectants against pathogenic microflora was 56-93%; when treated in a mixture with organomineral fertiliser, the decrease was 8-13%.

High efficiency in suppressing pathogenic fungi and stimulating the development of wheat plants was shown in drugs based on the active substances Tebuconazole + Flutriafol (80 + 80 g/l), Protioconazole + Tebuconazole (250 + 150 g/l), Diphenoconazole + Ciproconazole (30 + 6.3 g/l), Tebuconazole (60 g/l).

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