Formation of productivity of spring barley depending on the use of fungicides in the conditions of black soils of the Volgograd region

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Abstract. The article discusses the results of studies on the study of zoned varieties of spring barley in the zone of black soils and their reaction to the use of fungicides when treating seeds. It was found that in years with different climatic characteristics, there are differences in varieties in the duration of phenological phases. The longest growing season was observed for the Novonikolaevsky variety, and the shortest for the Prairie variety. The best results on germination and safety of plants were obtained on the variant with the Novonikolaevsky variety, while on all varieties it was noted that the use of a three-component fungicide promotes better germination and safety than on options with a single-component fungicide and without the use of fungicides. Analysis of the productivity of varieties showed that the studied varieties had different yields depending on the use of seed protectants. The yield of the Novonikolaevsky variety was the highest in all studied options for using fungicides compared to the Prairie variety. In the variant using the Vial Trio fungicide with the active ingredients Prochloraz 120 g/l, Thiabendazole 30 g/l, Cyproconazole 5 g/l, it was 3.41 t/ha. Thus, it can be recommended that agricultural producers cultivate the spring barley variety Novonikolaevsky, and carry out the main seed treatment with the fungicidal preparation Vial Trio.

1 Introduction

One of the most important areas in human economic activity is the cultivation of plants, such as grain crops. Grain crops are the main food product of the population, raw materials for the production of food industry products, as well as feed for farm animals.

In our country, spring barley has remained a grain feed crop for many years. It is cultivated as a food, industrial and fodder crop. Every year, the share of barley in the total gross grain harvest in the country is up to 23.5%. The area under spring barley currently reaches 2 million hectares, of which about 25% (0.45...0.5 million hectares) is in the Volgograd region.

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To increase the yield and quality of grain, modern cultivation technologies are used, which provide for the mandatory use of new zoned varieties and fungicidal disinfectants.

Scientists and practitioners offer a fairly large number of options for protecting spring barley when cultivating it in various soil and climatic zones of the Russian Federation [1-3]. Recently, biologically based drugs are increasingly being proposed to protect barley from diseases, but chemically based drugs are much more effective and have a wide spectrum of action [4-6].

In this regard, assessing the productivity of spring barley varieties of different genotypic origin on common black soils when using fungicidal preparations is very relevant and has great practical significance, as it will allow recommending optimal application options for production, taking into account the varietal response.

The purpose of the research was to study varietal characteristics and find ways to increase the productivity of adaptive technologies for cultivating spring barley based on the introduction of new crop varieties into production and the use of fungicides to protect plants from pathogens when cultivating on black soils of the Volgograd region. The objectives of the study included:

- Studying the characteristics of growth and development of spring barley varieties.
- Substantiation of the features of the formation of spring barley yield depending on the variety.
- Study of the effectiveness of the use of fungicides.
- Economic justification for the effectiveness of cultivating varieties of spring barley and the use of fungicides for this crop.

2 Materials and methods

In the conditions of black soils of the Volgograd region, a two-factor field experiment was carried out, in which adaptive and promising varieties of spring barley and fungicidal disinfectants with different active ingredients were considered.

During the experiment, the following records and observations were carried out:

- Determination of soil moisture was carried out by thermostat-weight method in triplicate. Soil samples were taken with a soil drill every 0.1 m to a depth of 1 m, during the main phenological phases of spring barley (before sowing, emergence, booting, sweeping, milky ripeness, waxy ripeness, full ripeness).
- Phenological observations of the growth and development of spring barley were carried out according to the methods of the State Variety Network.
- Determination of the elements of the crop structure was carried out according to the generally accepted method of State Variety Testing for each variant of the experiment.
- Biological productivity was taken into account by the method of collecting ears of grain at counting sites, followed by manual threshing and weighing in triplicate for each repetition of the experiment. The accounting of the economic harvest was carried out using the method of continuous threshing using a Nova 340 combine. Yield data was processed using analysis of variance.
- Indicators of the main meteorological elements: temperature, precipitation, air humidity were obtained at the nearest weather station in Novoanninsky.

In the experiment, varieties of spring barley and fungicides for treating seeds were studied, against the background of soil cultivation with a moldboard plow at 0.20-0.22 m.

The experimental design is two-factor and is represented by the following factors:
Varieties (factor A) – Barley variety:
- Prairie (control).
- Novonikolayevsky.

Fungicides (factor B) – Fungicide:
- Without the use of fungicides (control).
- Treating seeds with Bunker (active ingredient Tebuconazole, 60 g/l).
- Treating seeds with Vial Trio (a.v. Prochloraz 120 g/l, Thiabendazole 30 g/l, Cyproconazole 5 g/l).

The location of the plots is systematic, the area of the experimental plot is 720 m² (100 m x 7.2 m), the control plot is 480 m² (6 m x 80 m).

The predecessor is winter wheat, cultivated in pure fallow. Soil cultivation – moldboard plowing (0.20-0.22 m). Spring barley was sown in 2021 on April 18, 2022 on April 24.

3 Results

It is well known that weather conditions have a direct impact on the formation and development of plants. In particular, the determining factor is the amount of precipitation and its distribution, as well as temperature. Over the course of two years of experimentation, it was revealed that instability of weather conditions directly affected differences in the development phases of spring barley.

The data obtained on the growth and development of plants showed that in 2021 there was a longer period of emergence of seedlings, seedlings of Prairie barley appeared on the 10th day, and seedlings of the Novonikolaevsky barley appeared on the 12th day. Tillering began only 22 days later at Prairie and 25 at Novonikolaevsky after the entrances. The reason for this was rainy weather at the beginning of the growing season.

In 2022, seedlings appeared earlier - on days 11-12 for the Prairie variety and 12-13 days for Novonikolaevsky, and tillering occurred on days 13-18 for the Prairie variety and 16-14 for Novonikolaevsky after entry. The yield to the tube in both 2021 and 2022 did not change much and amounted to 12-13 days for the Prairie variety and 13-14 days for Novonikolaevsky. In July 2022, more precipitation was observed, which contributed to the extension of the heading period, as well as milk ripeness by 5-7 days for the Prairie variety and 7-10 for the Novonikolaevsky variety compared to 2021.

Research conducted in 2021-2022 showed that the varieties had some differences in germination and safety for harvesting. These indicators were influenced by the quality of the seed, agricultural technology and the fungicides studied in the experiment. The use of fungicides had a direct impact on field germination; in the experiment it varied from 4.00 to 4.27 million seeds per 1 ha, which is from 88.9 to 94.8%.

Variatel characteristics and quality of seed material also influenced the field germination of the studied crop. Thus, the Prairie variety had less germination than the Novonikolaevsky variety, both without the use of fungicides and with their use. On average, over 2 years of research, the germination of the Prairie variety without the use of fungicides was 4 million seeds per hectare or 88.9%, and for the Novonikolaevsky variety 4.15 million seeds per hectare or 92.1%. A similar situation arose when using fungicides. For example, when using the Bunker fungicide, the germination rate of the Prairie variety was 92.7%, the Novonikolaevsky variety 94.8%, the Bunker fungicide for the Prairie variety 89.4%, and the Novonikolaevsky variety 93.9%.

Variatel characteristics and fungicides also influenced the safety of sprouted plants for harvesting. On average, in the experiment, depending on the year, safety varied from 85.7 to 97.6%. For the Prairie variety it was lower than for the Novonikolaevsky variety. On average, over 2 years, the safety of the Prairie variety was at the level of 85.9-94.9%, for
the Novonikolaevsky variety 88.3-96.0%. The use of fungicides contributed to the prevention of diseases on the studied crop. As a result, the safety of plants for harvesting increased. When using the Bunker fungicide, the average survival rate over 2 years was 89.8% for the Prairie variety and 90.9% for the Novonikolaevsky variety. The use of Vial Trio fungicide due to the three-component active substance ensured greater safety compared to other studied options: on the Prairie variety - 94.9, on the Novonikolaevsky variety - 96%.

Barley is a more drought-resistant crop than wheat, rye, and oats. Due to the short growing season, barley consumes a lot of moisture during the initial stages of tillering and booting. A critical lack of water in the initial phases negatively affects the initial development of the plant.

Research has found that in 2021, before sowing the crop, the moisture content in a meter layer of soil was 140.5 mm, which is 9.4 mm less than in 2022. On average, over 2 years of research, the content of productive moisture before sowing was 145.2 mm. During the growing season, due to constant precipitation, soil moisture was constantly at the optimal level. So, on average for two years, the value of this indicator was as follows: in the phase of emergence - 137.25, booting - 129.05, heading - 107 mm, milky ripeness - 77.15, full ripeness 57.1 mm.

Calculation of the total water consumption showed that on average over 2 years it varied in the experiment from 2313 to 2370 m³/ha, depending on the varietal characteristics and the use of fungicidal disinfectants. The structure of total water consumption was distributed as follows: the largest share was accounted for by atmospheric precipitation 61.6-63.1%, and the share of moisture reserves in the soil accounted for 36.9-38.4%. This distribution is determined, first of all, by the intensity of precipitation during the growing season of the crop under study.

It was found that the water consumption coefficient was more dependent on the fungicides used and varietal characteristics. Thus, for the Prairie variety, the water consumption coefficient varied from 726.6 to 788.5 m³/t, and for the Novonikolaevsky variety 696.3-748.4 m³/t. The option with the fungicide Vial Trio and the Novonikolaevsky variety is the best in terms of water consumption, since the water consumption coefficient is the lowest in the experiment and amounts to 696.3 m³/t.

Spring barley, like many agricultural crops, is susceptible to damage by a number of pathogens. Therefore, to prevent crop loss from diseases, it is necessary to carry out a whole range of preventive measures, which includes seed treatment. In our research, we observed a complex of diseases, but in our work we consider two main diseases - helminthosporium and loose smut. Analysis of the data indicates that the resistance of varieties to helminthosporium and loose smut differs. The Prairie variety had a higher incidence of these diseases - 1.2 and 0.1%, respectively, the Novonikolaevsky variety showed greater resistance - 0.7 and 0.05%. The use of fungicidal disinfectants helped prevent the occurrence of diseases; over 2 years of research, no affected plants were found on the crops, which indicates the high effectiveness of the studied drugs.

Fungicides remain an invariable assistant in achieving this goal, helping to protect plants from pathogens and, as a result, increasing productivity and product quality.

In these studies, yield formation depended on the use of fungicides and varietal characteristics of the crop under study (Table 1). The yield of different varieties of spring barley, depending on the fungicides used during the years of research, varied from 2.94 t/ha for the Prairie variety without the use of fungicides, to 3.41 t/ha for the Novonikolaevsky variety using the Bunker preparation.

Pre-sowing seed treatment had a positive effect on the yield of spring barley. When treating seeds with Bunker, the yield of spring barley increased for the Prairie variety to 2.97-3.15 t/ha, and for the Novonikolaevsky variety to 3.17-3.36 t/ha. The difference with
the option without the use of fungicides by variety was: Prairie - 0.12 t/ha in 2021, and 0.13 t/ha in 2022, Novonikolaevsky - 0.12 t/ha in 2021 and 0.14 t/ha in 2022.

When treating seeds with Vial Trio, the yield of spring barley varied as follows: for the Prairie variety 3.12-3.34 t/ha, for the Novonikolaevsky variety 3.25-3.34 t/ha. The difference with the option without the use of fungicide was: Prairie variety - 0.27 t/ha in 2021 and 0.32 t/ha in 2022, Novonikolaevsky - 0.2 t/ha in 2021 and 0.35 t/ha in 2022.

Table 1. Spring barley yield for 2021-2022.

<table>
<thead>
<tr>
<th>Fungicide (Factor B)</th>
<th>Variety (factor A)</th>
<th>Productivity, t/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2021</td>
</tr>
<tr>
<td>Without the use of fungicides (control)</td>
<td>Prairie (control)</td>
<td>2.85</td>
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<tr>
<td></td>
<td>Novonikolaevsky</td>
<td>3.05</td>
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<tr>
<td>Bunker</td>
<td>Prairie (control)</td>
<td>2.97</td>
</tr>
<tr>
<td></td>
<td>Novonikolaevsky</td>
<td>3.17</td>
</tr>
<tr>
<td>Vial Trio</td>
<td>Prairie (control)</td>
<td>3.12</td>
</tr>
<tr>
<td></td>
<td>Novonikolaevsky</td>
<td>3.25</td>
</tr>
</tbody>
</table>

4 Discussion

The studied varieties have some differences in the dates of the onset of phenological phases and the duration of interphase periods and the growing season. The shortest growing season for the control variety Prairie is 81 days, the longest for the Novonikolaevsky variety is 92 days.

Of the options studied, on average over 2 years of research, the most economical in terms of moisture consumption is the option with the Novonikolaevsky variety, where the Vial Trio fungicide was used, the water consumption coefficient was 696.3 m³/t. In the variant with the Prairie variety, without the use of fungicides, the water consumption coefficient was the highest and amounted to 788.5 m³/t.

The Novonikolaevsky variety is more resistant to helminthosporium and loose smut than the Prairie variety. The studied seed protectants Bunker and Vial Trio provided full protection of spring barley from these diseases.

The formation of productivity elements depends on the varietal characteristics of the crop and the use of fungicidal seed protectants. The best indicators of productivity elements are formed on the Novonikolaevsky variety when using the Vial Trio fungicide: standing density - 4.06 million plants per 1 ha, weight of 1000 seeds - 39.9 g, number of productive stems - 4.31 million pcs./ha, number of grains in an ear – 27.1 pcs.

The use of fungicides in cultivation technology helps to increase the yield of spring barley varieties. Of the studied varieties, the most responsive is the Novonikolaevsky variety; when using the Vial Trio fungicide, it produces a yield of 3.27 t/ha; when using the Bunker fungicide, an average of 3.41 t/ha was obtained over 2 years of research.

5 Conclusion

For the cultivation of spring barley in the zone of black soils of the Volgograd region, the high-yielding Novonikolaevsky variety is recommended for sowing, and Vial Trio with the active ingredients Prochloraz 120 g/l, Thiabendazole 30 g/l, Cyproconazole 5 g/l, providing yields up to 3.41 t/ha and profitability level up to 239.8%.
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