

Phytopathological diseases' monitoring of breeding crops of winter cereals and limitation of their harmfulness

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Abstract. Studies on fungicides' effect on new varieties and lines of winter triticum-wheatgrass hybrids and winter triticale were conducted in the conditions of the Central zone of the Russian Federation. The results showed that the preparations Alto Super, CE and Falcon, CE effectively cope with the suppression of brown leaf rust on new varieties in the dosages recommended by manufacturers. They allow to reduce the prevalence of brown rust by 15.2-35.6%, the development degree of the disease - by 9.9-18.0%. The spread of septoria decreases by 7.7-8.8%, the intensity of plant damage - by 1.0-2.2%. The use of these preparations allowed to increase crop yields by 1.2-1.7 times compared to the option with no fungicidal treatments.

1 Introduction

Winter grain crops cultivated all over the world have several advantages. The main one is yield. Currently, a large number of varieties and hybrids that have significant potential and economic grain yield with high technological qualities have been created. At the same time, widespread cultivation of a small set of popular varieties in large territories led to a decrease in genetic diversity [1-3]. As a result, there have been rapid shifts in the development of the pathogen population [4]. Direct and indirect (hidden) crop losses due to lesion with a complex of fungal diseases estimate to about 10 to 30%; in epiphytotic years, they reach 40% [5,6]. The most effective way to protect crops from pathogens is to create resistant varieties, including by the method of distant hybridization [7,8]. At the same time, the use of chemical protection means in grain crops remains an actual technique of agricultural technology. The study of fungicides' action on new lines, varieties, and hybrids allows the authors to recommend ready-made solutions for the successful cultivation of a particular crop.

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2 Materials and methods

The research was carried out on the basis of the Federal State Budgetary Institution of Sciences Tsitsin Main Botanical Garden of the Russian Academy of Sciences (MBG RAS) in the Department of Distant hybridization (Moscow region, Russia). The objects of the study were: winter wheat varieties (wheat-elimus hybrid) Rubezhnaya, (triticum-wheatgrass hybrid) Snegirevskaya 75 line, and two varieties of winter triticale D10 and D16 by the selection department of distant hybridization of the MBG RAS. The precursor for all the studied cultures was naked fallow. Seed etching before sowing was not carried out.

The field experiment was laid in four-fold repetition according to the methodology of field experiment (B.A. Dospikhov, 1985). The area of the experimental plot was 72 m².

The experimental scheme included three treatment options for each variety and variety sample selected for the study:

1. Control (no treatment).
2. Alto Super, KE 0.4 l/ha (propiconazole 250 g/l + ciproconazole 80 g/l), manufacturer - Syngenta
3. Falcon, CE 0.6 l/ha (spiroxamine 250 g/l + tebuconazole 167 g/l + triadimenol 63 g/l), manufacturer Bayer AG.

The fungicides were introduced manually using a shoulder sprayer in accordance with the regulations, while observing the application standards recommended by manufacturers.

Phytosanitary monitoring of crops to account for plant lesion with septoria and brown leaf rust being the most common mycoses of grain crops in the region was carried out by a route method - assessing plant infestation on standard scales before treatment with fungicides and 10 days after their application. Prevalence, development, and biological efficacy were calculated using standard formulas [10]. Biological yield was determined during sheaf analysis.

Weather conditions of the 2019-2020 growing season (Fig. 1) significantly differed from the average long-term values. It can be seen that during sowing, the air temperature was 2-3 degrees above the average annual values, while the amount of precipitation was significantly lower than the climatic norm. The winter period turned out to be abnormally warm. The average air temperature in December and January often exceeded 0 °C. Observed snow cover was from 1 to 3 cm. Precipitation was mainly observed in the form of rain.

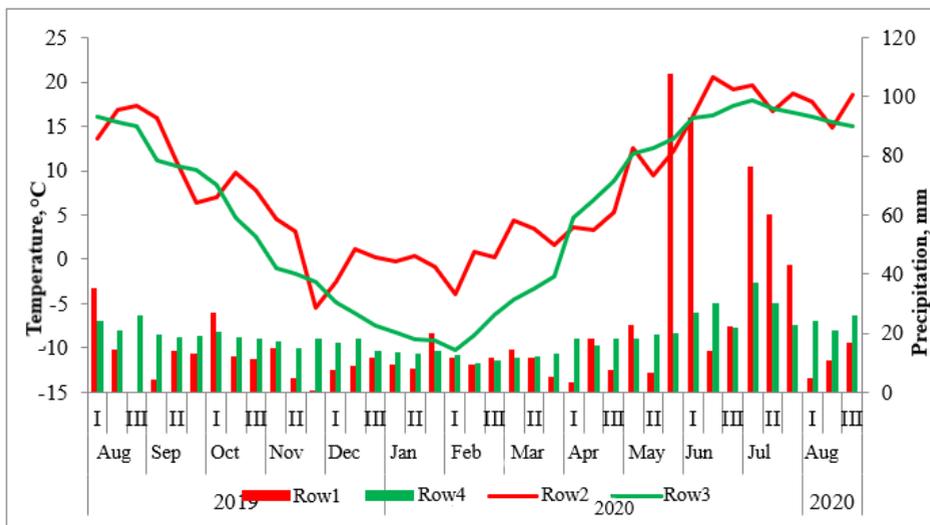


Fig. 1. Meteorological conditions 2019-2020 (data from the Novoyeruslimskaya weather station)

After overwintering and the resumption of plants' vegetation until the 1st decade of June, the temperature values did not exceed the average annual values, and then (from the 2nd decade of June to the 1st decade of July) they exceeded the latter by an average of 2.2°C.

For most of the growing season, the amount of precipitation was at the level of the average annual data; however, in late May-early June, as well as throughout July, an excess of the precipitation norm was 1.9-5.4 times. It is worth noting that an increase in precipitation during this period could create excessive moisture, which led to the intensive development of leaf-stem spots and difficulties in harvesting. At the same time, there was practically no precipitation in August.

3 Results and Discussion

On the studied crops, the manifestation of brown leaf rust and leaf septoria was noted in the phase of flag leaf emergence. Next, as the further phases of vegetation began, the diseases actively developed, which was facilitated by the prevailing meteorological conditions of the growing season (warm weather combined with heavy precipitation).

The prevalence of brown rust on winter wheat and winter triticale before processing often exceeded the economic threshold of harmfulness, which indicated the need for protective measures (Tab. 1). Thus, on winter wheat varieties, the prevalence of the disease was in the range of 18.5-20.8% with the highest value on the Rubezhnaya variety in the control option. Winter triticale was less affected by brown leaf rust: during phytosanitary monitoring, only 16.9-18.3% of plants were affected, while variety sample D10 was affected less than variety sample D16 by 0.2-1.4%. According to the lesion intensity, an inverse relationship was noted. The lowest degree of disease development on winter wheat was observed on the Snegirevskaya 75 variety in 10.3%, the highest – on the Rubezhnaya variety in 11.3%. On winter triticale, this value was in the range of 10.7-11.2%.

Table 1. Prevalence and development (P/R) of brown rust of winter crops before and after application of fungicides, %.

Option	Before treatment				After fungicidal treatment			
	Brown rust				Brown rust			
	R	S-75	D10	D16	R	S-75	D10	D16
Control	20.8/ 10.5	19.6/ 10.4	16.9/ 11.2	18.3/ 10.8	40.1/ 27.5	49.6/ 26.9	32.8/ 25.6	37.2/ 19.9
Alto Super, CE	18.5/ 11.3	18.9/ 10.3	17.6/ 10.7	17.9/ 11.0	12.8/ 9.5	15.3/9.6	17.4/ 9.8	14.3/ 10.0
Falcon, CE	18.9/ 10.7	20.0/ 10.7	17.9/ 10.9	18.1/ 10.8	13.0/ 10.8	14.0/ 7.5	17.6/ 9.0	16.7/ 9.8

Note: R – winter wheat variety Rubezhnaya; C-75 – winter wheat line Snegirevskaya 75.

The preparations used against leaf diseases contributed to the suppression of the prevalence and development of brown rust on crops. The results of phytosanitary monitoring 10 days after fungicides' application showed significant changes in crops' lesion. The prevalence of the disease has increased to 49.6%, lesion degree – to 26.9% (variety sample Snegirevskaya 75). Winter wheat was affected more often and more strongly than winter triticale, on which the number of affected plants did not exceed 37.2% (variety sample D16), and the development of the disease – 25.6% (variety sample D10). Treatment of all crops with fungicides reduced plants' lesion with brown leaf rust. The use of Alto Super, CE on winter wheat allowed to reduce the prevalence and development of the disease by about 3.1 and 2.8 times, respectively. On triticale varieties, the greatest prevalence difference compared to the control was noted on the D16 variety sample (22.9%), while the disease development was more strongly suppressed on the D10 variety sample (15.8%). The use of Falcon, CE inhibited the prevalence and development of the causative brown leaf rust agent; however, the effectiveness of the preparation slightly differed from Alto Super, CE.

In addition to the studied fungicides' effect on the brown rust of winter crops, their effectiveness against plant lesion with septoria was also studied. Before the treatment of crops with pesticides, the prevalence of the disease was at the level of 10.0-10.5% with a development of 2.9-3.6%. In comparison with the control option, treatment with the triazole preparation Alto Super, CE on winter wheat allowed to reduce the prevalence of septoria by 15-18%, the development - by 1.0-2.3%. Results of using Falcon, CE fungicide with active substances from different chemical classes slightly differed from Alto Super, CE. Winter triticale responded worse to chemical measures on plant protection from septoria. The prevalence of the disease during crops' spraying of Alto Super, CE decreased by 7.7% on both variety samples, the damage degree – by 0.2-0.3%. Falcon, CE allowed to reduce the number of affected plants by 8.1-8.8% compared to the control, and the intensity of the lesion amounted to up to 2.2%.

The preparations' biological efficacy against specific diseases within the variety or variety sample had no significant difference, whereas the use of the same fungicide could be quite effective on one variety/variety sample and have low values of this indicator on others. For example, the use of both preparations against septoria on the Rubezhnaya

variety was much higher than on all variety samples, and the pesticide treatment of winter triticale D16 against brown rust was less effective than on D10 and winter wheat.

In general, it is important to note that both Alto Super, CE, and Falcon, CE had high values of biological efficacy against brown leaf rust and showed low values against grain crops' septoria. At the same time, the maximum value of biological efficiency (BE) against brown rust and the minimum BE value against septoria were noted on the Snegirevskaya 75 variety sample. The preparation with active substances out of different chemical classes (Falcon, CE) showed greater biological efficacy in almost all cases compared to the preparation containing active substances out of one chemical class (Alto Super, CE). This can be explained by the multifaceted effect of Falcon, CE on biochemical reactions in pathogen cells, which allows for a more complex effect on pathogen fungi and to consequently obtain a better effect of treatments.

The use of fungicides is primarily aimed at protecting plants from pathogens to preserve the crop. In this regard, it is necessary to assess the yield in studies related to the study of pesticides' effectiveness against harmful organisms.

The lowest yield in all options was shown by the Rubezhnaya winter wheat variety. In it, the values of this indicator were in the range of 4.23-5.80 t/ha, while the yield was lower than in control in the option with Alto Super, KE but had no significant difference. The variety sample Snegirevskaya 75 also did not have a significant increase after treatment with Alto Super, CE; however, the use of Falcon, CE allowed to harvest 0.94 t/ha more than in the option with no chemical plant protection. Other results were obtained on winter triticale. Both variety samples showed greater increments in the use of fungicides than winter wheat. Thus, crop processing with Alto Super, CE allowed to increase the yield by 1.45 cwt/ha on the D10 variety and by 3.69 cwt/ha on the D16 variety. In the option with Falcon, CE crop spraying, the increment for D10 and D16 was 1.64 and 0.46 cwt/ha, respectively.

The use of fungicides gave an increase in yield, yet not in all options and not on all varieties. So, the use of Alto Super, CE steadily increased this indicator only on varieties of winter triticale. At the same time, the use of Falcon, CE made it possible to obtain a significant increment in yield on all crops.

4 Conclusion

The chemical method of protecting winter wheat and winter triticale plants from brown leaf rust is highly effective with the correct selection of fungicides against a particular disease. In the study, pesticides allowed to reduce the prevalence of brown rust by 15.2-35.6%, and the development degree – by 9.9-18.0%. The number of plants affected by septoria after fungicidal treatment decreased by 7.7-8.8%, lesion intensity – by 1.0-2.2%. This allowed to increase the yield by 1.2-1.7 times.

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