Wheat and barley resistance to head smut

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Abstract. In the conditions of the central part of the Krasnoyarsk forest-steppe, the resistance of 114 varieties and lines of spring common wheat and spring barley to regional populations of loose smut *U.tritici* and *U.nuda* was studied for 3 years. The studied samples in the phase of the beginning of flowering were infected by a syringe with a 0.005% suspension of the pathogen chlamydospores. Pathogen damage was recorded according to the VIR scale after the manifestation of visible symptoms of the disease. The sources of resistance to the disease were identified varieties and lines of barley and wheat, the defeat of which by loose smut did not exceed 5%. These are 41 samples of wheat: varieties Rifor 6, Mandaryna, Lutetia, Stepnaya 53, Rifor 1, Aleksandrit, Arabeska, Partyzan, Yubileinaya 60, Saratovskaya 76, KWS Buran, Orenburgskaya Yubileinaya, Maestro, H 16-2, LT-12, Arsey, Anabel, Grechanka, Barakat, LT-8, Krasnoyarskaya 12, Beyskaya, Uyarochka, Altaiskaya 70, Kanskaya, Omskaya 36, Novosibirskaya 31, breeding lines K-733-3, K-790-6, KP-6, KSI-21, K-943-1, K-782-2, K-868-1, K-734-10, K-693-2, KSI-10, KP-5, K-696-7, KP-4. And also 12 samples of barley: varieties Emelya, Kedr, Agul 2, Sobolek, lines D7-7040, D50-7468, D36-7289, D22-7177, Zh9-7553, Zh9-7550, Zh37-7621, V-56-6885 .

1 Introduction

The causative agents of such harmful diseases as wheat loose smut and barley loose smut are basidiomycetes *Ustilago tritici* (Pers.) Jens and *Ustilago nuda* (Jens.) Kell. and Swing, respectively. These diseases belong to a subgroup of typical seminal infections [1-3]. Grasses are infected with chlamydospores during flowering, resulting in the introduction of the fungus into the developing embryo. The following year, when the grain germinates, the mycelium of the pathogen also begins to develop. The course of the infectious process is highly dependent on weather conditions. The most favorable factors for the development of micromycetes r. *Ustilago* is a high relative humidity and a temperature of 18-24°C. An additional condition for the spread of the pathogen during the season is air currents, with which spores are transferred from the affected organs of the host to healthy ones. In diseased plants, complete or partial destruction of the ear is observed, instead of which a spore mass of olive-black color is formed. In addition to such a clear crop shortage, hidden

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losses are added due to a decrease in productivity parameters in plants without visible symptoms of damage [4-7].

To prevent the development of the described diseases on grain crops, various methods are used: seed dressing, compliance with agrotechnical recommendations, timely variety change and testing of crops, etc. [8]. However, despite all the protective measures taken, the damage from loose smut is observed in all regions of the cultivation of barley and wheat. To reduce crop losses, it is necessary to constantly search for sources of resistance to the disease and create resistant varieties. Why is the annual assessment of the resistance of samples to the defeat of *U. tritici* and *U. nuda* relevant [9].

The aim of the research was to assess the resistance of samples of wheat and barley from the nurseries of the KrasNIISH to regional populations of loose smut pathogens.

2 Materials and methods

The studies were carried out in 2020-2022, in the conditions of the central part of the Krasnoyarsk forest-steppe in the fields of the pilot production "Minino". The studied objects were varieties and breeding lines of spring soft wheat and spring barley from the nurseries of competitive variety testing (CVT) and the collection nursery of the Krasnoyarsk Research Institute of Agriculture, both local and foreign selection.

An artificial infectious background for loose smut was created using the syringe method. Samples were inoculated in the phase of the beginning of flowering of the studied crops with a suspension of freshly harvested chlamydospores of a mixture of pathogen populations of 0.005% concentration. After ripening, the infected ears were harvested and threshed in the usual way. The next year, to account for infection, inoculated seeds were sown in an infectious nursery in an amount of at least 100-150 grains of each sample (Figure 1).

After the development of visible symptoms of the disease, the damage by the pathogen was recorded. The classification of resistance to loose smut was determined according to the VIR scale [10]:

- 0 - high resistance, no damage.
- I - practical stability, damage does not exceed 5%.
- II - weak susceptibility, damage does not exceed 25%.
- III - medium susceptibility, damage does not exceed 50%.
- IV - strong susceptibility, defeat more than 50%.

Fig. 1. Infectious nursery of spring barley and spring soft wheat for loose smut.

The final characteristic for resistance to loose smut was given to the samples according to the maximum lesion obtained over 3 years of study. Varieties and lines in which the pathogen damage did not exceed 5% were classified as sources of resistance and recommended for inclusion in further stages of the breeding process.

3 Results and Discussion

Analysis of samples of wheat and barley from the infectious nursery for head smut revealed both highly susceptible and highly resistant lines and varieties (Tables 1-3).

Thus, out of 38 accessions of wheat from the VIR collection, 16 showed high resistance; 15 - weak susceptibility; cultivars Stepnaya 53, Lutetia and Mandaryna – practical resistance; Khazine, LT-11, Aktobe 14 – average susceptibility to regional races of the *U. tritici* population. The defeat of loose smut of wheat Niva Priirtyshya was 58.3%, which corresponds to the indicator of a highly susceptible variety (Table 1).

Table 1. Resistance of samples of the collection nursery of spring soft wheat to loose smut.

Sample	Loss of loose smut, % (max)	Characteristic
Niva Priirtyshya	58.3	highly susceptible
Aktobe 14	44.8	moderately susceptible
LT-11	41.7	
Khazine	41.2	
Krasnozerka	19.4	unresponsive
Karabalykskaya 22	18.9	
KWS Bittern	15.4	
Digana	11.8	
Stanga	11.4	
Altaiskaya 75	9.8	
Quintus	9.5	
Altaiskaya 70	9.1	
Svirel	7.9	
Stepnaya 75	7.5	
Luteus	7.3	
Kazakhstanskaya 75	7.2	
Sitara, LT-9	6.3	
Rifor-6	5.0	
Mandaryna	4.1	practically stable
Lutetia, Stepnaya 53	2.1	
Rifor 1, Alexandrite, Arabeska, Partyzan, Jubilee 60, Saratov 76, KWS Buran, Orenburg Jubilee, Maestro, H 16-2, LT-12, Arsey, Anabel, Grechanka, Barakat, LT-8	0.0	highly resistant

In the nursery of the competitive variety testing of spring soft wheat, 13 accessions were isolated, which were not at all affected by the pathogen. The same number of samples showed an average susceptibility, and in 8 the percentage of damage did not exceed 5% (Table 2). Variety Kuraginskaya 2 and line K-734-8 stood out as moderately susceptible, and K-727-8 and KP-8 as highly susceptible.

Almost half of the barley samples from the competitive variety trial nursery were classified as weakly susceptible. Varieties Emelya, Kedr, Sobolek, Agul-2, lines Zh37-7621 and V-56-6885 showed high resistance to pathogen infection, and lines D7-7040, D50-7468, D36-7289, D22-7177, Zh9-7553, Zh9-7550 - practical stability. The remaining 8 accessions of barley were classified as moderately susceptible (Table 3).

A three-year study of damage to specimens by loose smut makes it possible to classify all practically resistant and highly resistant specimens as sources of resistance. However, to include breeding lines in the next stages of the breeding process, it is necessary to study their full range of economically valuable traits.

Table 2. Resistance of samples of the nursery of competitive variety testing of spring soft wheat to loose smut.

Sample	Loss of loose smut, % (max)	Characteristic
KP-8	62.7	highly susceptible
K-727-8	60.0	
K-734-8	35.7	moderately susceptible
Kuraginskaya 2	29.1	
K-696-6	23.9	unresponsive
K-817-11	22.4	
K-712-4	21.7	
K-768-3	19.8	
K-801-1	19.6	
Altaiskaya 75	19.1	
K-665-14	18.1	
K-684-3	14.4	
K-613-2	9.7	
Novosibirsk 15	9.2	
K-835-2	8.3	
Svirel	7.2	
K-790-2	5.3	
K-733-3, K-790-6	3.2	practically stable
KP-6	2.9	
Kanskaya	2.6	
KSI-21	2.4	
Omskaya 36, K-943-1	1.9	
Novosibirsk 31	1.7	
K-727-1, Krasnoyarskaya 12, K-782-2, K-868-1, K-734-10, K-693-2, KSI-10, KP-5, Beyskaya, Uyarochka, K-696-7 , KP-4, Altaiskaya 70	0.0	highly resistant

le 3. Resistance of samples of the nursery of the competitive variety testing of spring barley to loose smut.

Sample	Loss of loose smut, % (max)	Characteristic
B33-6315	42.9	moderately susceptible
B4-6123	41.2	
D7-7057	36.7	
Krasnoyarsky 80	33.3	
Bakhus, D59-7505	32.3	
D55-7455	31.6	
D22-7178	25.2	
Biome	24.5	unresponsive
Buyan	23.2	
D 7-7065	20.3	
Zh 13-7558	19.9	
Abalak	19.1	
Zh 52-7637	17.5	
Acha	16.1	
Zh37-7621	12.5	
D39-7318	12.3	
Olenyok	11.8	
Zh9-7551	10.8	
D5-7022	10.2	
Zh42-7625, Takmak	7.9	
D10-7091	7.7	
D8-7072	7.3	
Krasnoyarsk 91	6.7	
D44-7362	5.8	
D7-7040	4.9	practically stable
D50-7468	4.6	
D36-7289	4.1	
D22-7177	3.8	
Zh9-7553	2.7	
Zh9-7550	1.1	
Emelya, Kedr, Agul 2, Sobolek, Zh37-7621, V-56-6885	0.0	highly resistant

4 Conclusion

In our study, sources of resistance to regional populations of pathogens of barley loose smut and wheat loose smut were identified. These are wheat varieties Rifor 6, Mandaryna, Lutetia, Stepnaya 53, Rifor 1, Aleksandrit, Arabeska, Partyzan, Yubileinaya 60, Saratovskaya 76, KWS Buran, Orenburgskaya Yubileinaya, Maestro, H 16-2, LT-12, Arsey, Anabel, Grechanka , Barakat, LT-8, Krasnoyarskaya 12, Beiskaya, Uyarochka, Altaiskaya 70, Kanskaya, Omskaya 36, Novosibirskaya 31, as well as breeding lines K-733-3, K-790-6, KP-6, KSI-21, K -943-1, K-782-2, K-868-1, K-734-10, K-693-2, KSI-10, KP-5, K-696-7, KP-4. The accessions of Emelya, Kedr, Agul 2, Sobolek, D7-7040, D50-7468, D36-7289, D22-7177, Zh9-7553, Zh9-7550, Zh37-7621, V-56-6885 were classified as sources of barley resistance.

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