

Septoria blight of spring wheat in West Siberia

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Abstract: *Septoria* blight of spring wheat leaves and ears is widespread in West Siberia, causing a decrease in yield by up to 50% or more with the deterioration in grain quality. The immunological assessment of a collection of 23 spring wheat varieties of different origin has shown no samples immune to *Septoria*. A differentiated manifestation of resistance to *Septoria* disease of leaves and ear has been established. Some varieties ('Orenburgskaya 23' and 'Vyatchanka' (Russia) as well as 'Long Chun 7 Hao' (China)) combine reduced susceptibility to *Septoria* disease of the leaves and ear. A study of a collection of varieties from three regions of Siberia in an epiphytotic year reveals the following trend: As compared with that in the Omsk and Kurgan regions, the transmission of the *Septoria* blotch causative agent is the most active with seeds of the Novosibirsk breeding lines.

Key words: *Septoria*; spring wheat; variety.

1. Introduction

For a long time the *Septoria* infection of leaves and ears has been one of the most common and harmful diseases of spring wheat in all areas of its cultivation (Eyal, 1999; Robert et al., 2004). With the wheat infection by *Septoria*, the leaves dry up prematurely, and the grain is formed only due to the stem and ear green parts. The grain is shriveled, with a low grain unit and a low 1000-grain weight. The spring wheat grain production falls by 25–60 %. The germination ability and germination energy of seeds are reduced by 7–12 % (Parker et al., 2004; Robert et al., 2004). The causative agents of the disease are the fungi *Parastagonospora nodorum* (Berk.) Quaedvl. (teleomorph: genus *Leptosphaeria*), syn. *Septoria nodorum* (Berk.), and *Septoria tritici* Desm., syn. *Mycosphaerella graminicola* (Fuckel) J. Schröt. Of the two fungi on wheat, *P. nodorum* has a predominant distribution, differing in faster (8–10 times) germination of pycnosporangia and faster colonization of the host plant tissue compared to *S. tritici* (Eyal, 1999). Also, the plant pathogen *Phaeosphaeria avenaria* f.sp. *triticeae* Shoem. & C.E. Babc., syn. *Septoria avenae* f.sp. *triticea*, is observed on spring wheat in Siberia (Toropova et al., 2018). With the introduction of resource-saving tillage technologies, the frequency of *Septoria* epiphytotics in the West Siberian forest-steppe over the past 10 years has increased by 2.0–2.5 times (Toropova et al., 2018). In the last decade, the transmission of *P. nodorum* with spring and winter wheat seeds has intensified, which creates prerequisites for the early formation of foci of the disease, causing an increase in the multiplicity of fungicide application (Nolan et al., 1999; Simón et al., 2003). In the systems of control of the *Septoria* disease of spring wheat leaves and ears, resistant varieties are an important element; they are designed to slow down the reproduction rate of *Septoria* causative agents and to slow down or stop the epiphytotic process.

2. Materials and methods

The studies were carried out in 2016–2018 in the West Siberian forest-steppe zone. The investigation of *Septoria* leaf and

ear blight was conducted using a collection of spring wheat varieties from the Institute of Cytology and Genetics of the Siberian Branch of the Russian Academy of Sciences. We used a standard international scale to detect *Septoria* blight and spot. The area under each variety (variety sample) ranged from 3 to 10 m² in triplicate. In the northern forest-steppe of the Novosibirsk region, the year 2016 was dry, while 2017 and 2018 were wet, which significantly affected the intensity of the natural infection background.

3. Results and discussion

The monitoring of *Septoria* blight in 59 spring wheat cenoses in the Novosibirsk, Tomsk, Kemerovo, Kurgan, and Tyumen regions and the Altai Territory established a ubiquitous distribution of *Septoria* diseases in spring wheat varieties. The development of the disease was from 5 to 35 %, and the prevalence reached 90 %. The factors contributing to the development of *Septoria* were susceptible varieties; abundant precipitation during the critical period (spike formation–flowering); high, close to 100 %, air humidity; the presence of infected plant debris in the field; and grass weeds (Nolan et al., 1999). The first *Septoria* foci on the lower leaves of susceptible spring wheat varieties were observed in 2016 and 2017, in third decade of June, and in 2018, due to late sowing, in the first two decades of July. First, *P. nodorum* appeared (June–early July), and then, *S. tritici* (end of July–August). *Septoria* epiphytotics of moderate and significant intensity occurred when precipitation was from 76 to 111 mm and the air temperature was an average of 16.7 °C. The causative agents of the disease were *P. nodorum*, *S. tritici*, and *S. avenae* f.sp. *triticea*, and the species ratio varied with region, spring wheat variety, and plant organs. The obvious predominance of *P. nodorum* was revealed in the Novosibirsk region. In the Tyumen region, with the predominance of *P. nodorum*, the second position was taken by *S. avenae* f.sp. *triticea*, not *S. tritici*, as in the Novosibirsk region. In Altai, the predominance of *P. nodorum* was less significant, 15.3 % lower than in the Novosibirsk region. Also, *S. tritici* was encountered at

all points of reference, but the frequency of its occurrence was 2 times higher than that in the Novosibirsk region. *S. avenae* f.sp. *triticea* was found in Altai 11.3 times more often than in the Novosibirsk region.

Additionally, differences were observed in the species composition of the causative agents of *Septoria* leaf blight in a collection of spring wheat varieties from the Novosibirsk district of the Novosibirsk region. The main causative agent of *Septoria* leaf and ear blight on all the wheat varieties was *P. nodorum*, which in two varieties made up 100 % of the pathogenic complex. Its average proportion on the leaves of the varieties studied was significant, 88.9 %. The second position in the distribution on the leaves was taken by *S. tritici*, 10.4 %, which reached a maximum of 20 % on the variety ‘Altaiskaya 105’. *S. avenae* f.sp. *triticea* was detected only in two varieties, ‘Altaiskaya Stepnaya’ and ‘Novosibirskaya 15’.

An immunological evaluation of spring wheat varieties showed no plant forms immune to the causative agents of *Septoria* disease. A plant pathological analysis of a collection of 23 spring wheat varieties in 2017 and 2018 showed that, at the beginning of the filling stage, ears of susceptible varieties had already been affected by *Septoria*. All the studied varieties of Novosibirsk selection, in which the spike was affected more than the leaves, were classified as the most susceptible. This creates a prerequisite for the transmission of *P. nodorum* with seeds and the early onset of the *Septoria* epiphytotic (Toropova et al., 2018). Eleven of 23 varieties (47.8 %) at the start of grain formation did not show spike damage. The best phytosanitary condition of all the considered wheat organs during the discussed phase was demonstrated by the varieties ‘Orenburgskaya 23’ and ‘Tyumenochka’, which showed an insignificant flag leaf loss with completely healthy spikes. The remaining varieties were in a satisfactory phytosanitary condition: complete dying-off of the subflag leaves, moderate (below the threshold) damage to the flag leaves, and healthy or sporadically affected spikes.

At the milky ripeness stage, the prevalence of *Septoria* reached 100 % in all the varieties. Relative resistance to *Septoria* leaf blight was shown by the varieties ‘Novosibirskaya 31’, ‘Sibirskaya 17’, and ‘Obskaya 2’ with a strong development of *Septoria* spike spot. The domestic varieties ‘Tyumenochka’ and ‘Zauralochka’, as well as the NILs ‘Thatcher Lr2c’ (Canada), ‘UI Pettit’ (United States), ‘Kaiyr’ and ‘Dostyk’ (Kazakhstan), and ‘KWS Akvilon’ (Germany) showed relative resistance to *Septoria* blight. Reduced susceptibility was shown by the varieties ‘Orenburgskaya 23’ and ‘Vyatchanka’

as well as ‘Long Chun 7 Hao’ (China). They suffered moderate (threshold level) damage of both the leaves and the spike.

4. Conclusions

Monitoring has revealed significant differences in the presence of *Septoria* pathogens in the regions. In the Novosibirsk region, the predominance of *P. nodorum* is observed. In the Tyumen region, the predominance of *P. nodorum* is not always the case, because at some geographical points *S. tritici* and *S. avenae* f.sp. *triticea* show a higher prevalence in the pathogenic complex of the *Septoria* disease of spring wheat. In Altai, *P. nodorum* predominates at all survey points, but to a smaller extent than in the Novosibirsk region, and coexists with widespread *S. tritici*. The average contribution of *S. avenae* f.sp. *triticea* to the pathogenic complex of *Septoria* leaf blight in Altai is similar to that in the Tyumen region. The immunological assessment of the collection of spring wheat varieties has shown no forms completely immune to *Septoria*. A differentiated manifestation of resistance to *Septoria* leaf and ear disease has been established: Some varieties show resistance to the *Septoria* leaf blight with a strong ear spot incidence, while others, by contrast, are resistant to *Septoria* ear spot with strong damage to the leaf apparatus. Reduced susceptibility has been shown by the varieties ‘Orenburgskaya 23’ and ‘Vyatchanka’ as well as ‘Long Chun 7 Hao’ (China), which combined both positive qualities.

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Conflict of interest. The authors declare no conflict of interest.