



RESEARCH COMMUNICATION

Pathogenic complexity of septoria spot disease of wheat in northern Kazakhstan

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ABSTRACT

Northern Kazakhstan is the main zone of spring wheat cultivation where, 85 % of the cultivated area is located. There is not a single variety resistant to Septoria spot among the varieties approved for use. The frequency of epiphytioses of wheat diseases in the northern part of Kazakhstan is four cases every ten years. During the years of epiphytotic development of brown rust and Septoria spot with the dominance of a particular disease, the yield of spring wheat is reduced by 25 % or more. Knowledge of the species composition of pathogens of Septoria spot allows a more focused approach to the study and creation of varieties of wheat resistant to this disease. The aim of the research is to study the species of Septoria spot pathogens in wheat in Northern Kazakhstan. In 2018–2019, the pathogenic complex of the causative agents of wheat Septoria spot was studied. The collection of leaves affected by Septoria spot was carried out on spring wheat varieties in the steppe, forest-steppe zones of Northern Kazakhstan. The species composition of Septoria pathogens was determined from microscopic preparations from the collected samples; which were represented by three types of septorial fungi: *Septoria tritici*, *Stagonospora nodorum*, *Stagonospora avenae*. In the steppe and forest-steppe zones of Northern Kazakhstan, the dominant species was *S. tritici* followed by *S. nodorum*.

Introduction

Annually, on average, about 13.0 million tons of grain are produced in Kazakhstan (1). The average grain yield is 1.1 tons per hectare. There is a large number of harmful fungal diseases of wheat, and Septoria spot is currently the dominant one. *Septoria tritici* and *Stagonospora nodorum* cause significant crop loss and severely reduce grain quality (2, 3). Epiphytioses of various diseases had been observed on the wheat crops four times in the last ten years. Annual yield losses amount to 10–15 % in cases of moderate development of the disease and up to 40 % during epiphytioses (4-6). Grain yield losses occur mainly as a result of a decrease in ear grain content and grain weight in diseased plants (7-10). The study of the species diversity of pathogens of *Septoria* allows identifying their most common types in the region.

The aim of the research was to study the species composition of the pathogens of wheat Septoria spot in Northern Kazakhstan.

Materials and Methods

The study of the species composition of the populations of Septoria spot pathogens in a specific area began with examinations of spring common wheat crops, the names of which are given in Table 1. These varieties were sown with SZS-2.1 stubble seeder in the optimal time from 20–25 May in 2018-2019. To obtain a reliable picture of the spread of the disease, we examined the steppe zone of the Akkayin, Esil districts, as well as the forest-steppe zone of the Mamlyut and Kyzylzhar districts of Northern Kazakhstan (Fig. 1).

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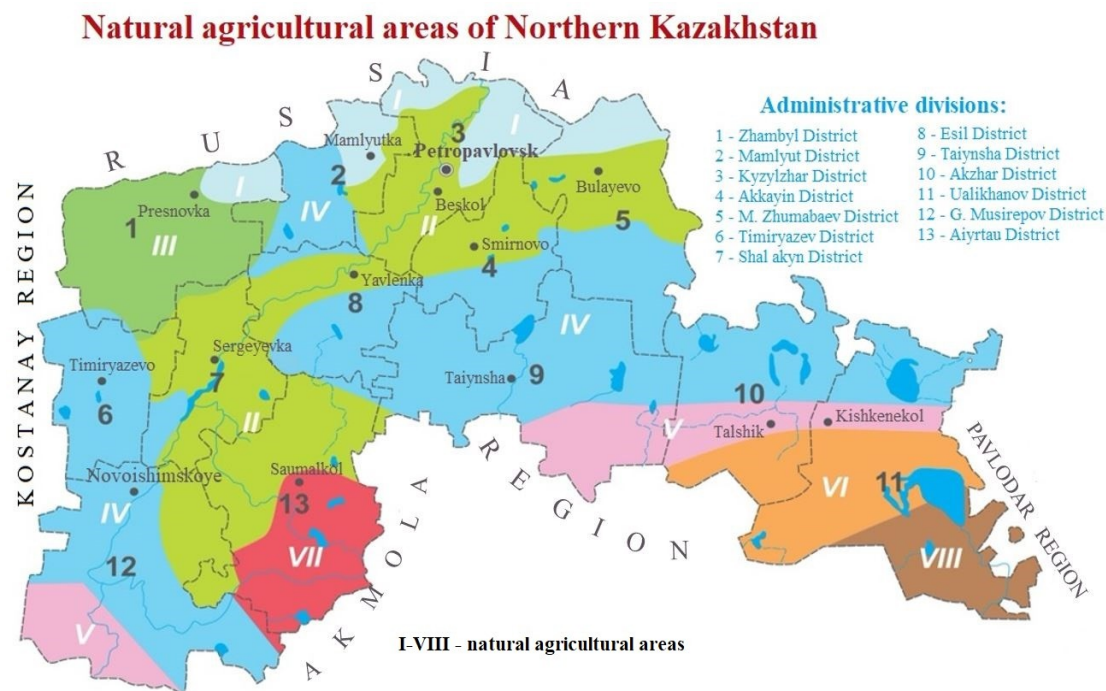


Fig.1. Map of the studied areas of the Northern Kazakhstan.

The accounting for *Septoria* infection was determined according to the international James' scale (11). The collected material was put into bags, properly labelled indicating the place, date of collection, phase of plant development, variety name, the date and method of sowing, the degree of damage to the plants, which was determined as the average percentage of the affected leaf surface. The bags were later stored in the refrigerator at a temperature of +5-8 °C (12).

To determine the species composition of *Septoria* spot pathogens, microscopic preparations were made from the collected samples. Pieces of the affected tissue were placed on a glass slide in a drop of water for several minutes, and the preparation was examined under a microscope (Leica DFS 320) at 20-40x magnification. The species of the fungus were identified using field guides based on the shape and size of pycnospores (13).

Results

Weather conditions in 2018, namely rainfall in the end of June and throughout the month of July, heavy rains in August contributed to the development and spread of *Septoria* spot. The degree of damage during the phase of milky-wax ripeness reached 40–60 %. In 2019, the meteorological conditions of the spring wheat vegetation period were characterized as arid. Precipitation in June, July and August totalled 82 mm, which was by 54.3 mm lower than the average long-term norm. The spread of the disease reached 100 %, and the development was weak (up to 14 %).

In 2018, the spread of *Septoria* spot on wheat crops was monitored in the forest-steppe zone of the Mamlyutsky, Kyzylzhar districts and in the steppe zone of Akkayin, Esil districts of Northern Kazakhstan.

Based on mycological analysis, in the steppe zone of Northern Kazakhstan, in spring wheat varieties, *S. nodorum*, *S. tritici* and *S. avenae* f. sp. *triticea* were determined (Fig. 2-5). By frequency of occurrence, *S. tritici* prevailed everywhere, with the exception of the “Atameken-Agro-Korneevka” LLP farm in the Esil district. *S. avenae* f. sp. *triticea* (96.7 %) prevailed at this farm, with *S. nodorum* (43.3 %) being the second most frequent species and *S. tritici* (6.7 %) being the third. In other farms, the average incidence rate of *S. tritici* was 64,7 %. The rates for species *S. nodorum* and *S. avenae* f. sp. *triticea* were lower; the average incidence of *S. nodorum* was 30.7 % and the average incidence of *S. avenae* f. sp. *triticea* was 25.3 % (Table 1).

Mycological study in the forest-steppe zone showed that *Septoria tritici* dominated in the spring wheat varieties. Its incidence reached up to 100 % at the “Gadzhiev” farm household in the Mamlyut district. The average incidence for this species was 75.0 %. The average incidence of *S. nodorum* in wheat varieties was 11.5 %. *S. avenae* f. sp. *triticea* had an average incidence of 0.8 % and was recorded only at the “Gadzhiev” farm household in the Mamlyutsky district.

According to the results of the mycological analysis in 2018, it was found that *Septoria tritici* (69.9 %) was predominant in two zones, *S. nodorum* (21.1 %) was second, and the lowest average incidence was observed for *S. avenae* f. sp. *triticea* (13.1 %).

According to the results of the mycological analysis in 2019 in the steppe zone, *S. tritici* prevailed in spring wheat varieties. In several cases, for example, in the Astana variety, *S. nodorum* prevailed. The average incidence of *S. tritici* in the Akkayin and Esil districts was 25.3 %. *S. nodorum* and *S. avenae* f.



Fig. 2. Wheat leaves affected by Septoria spot.

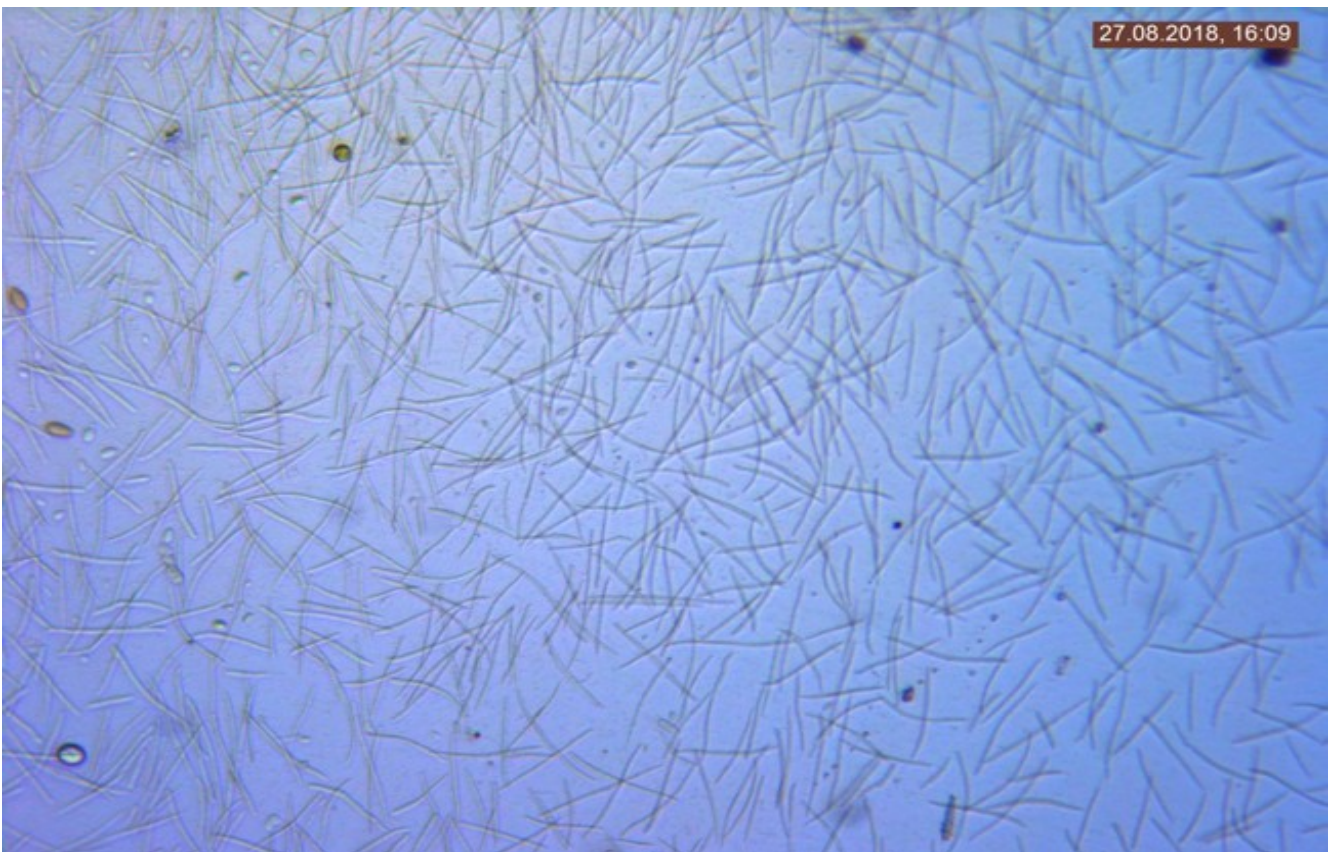


Fig. 3. Spores of *S. tritici* on Shortandy 95 improved variety.



Fig. 4. Spores of *S. nodorum* on Omsk 35 variety.

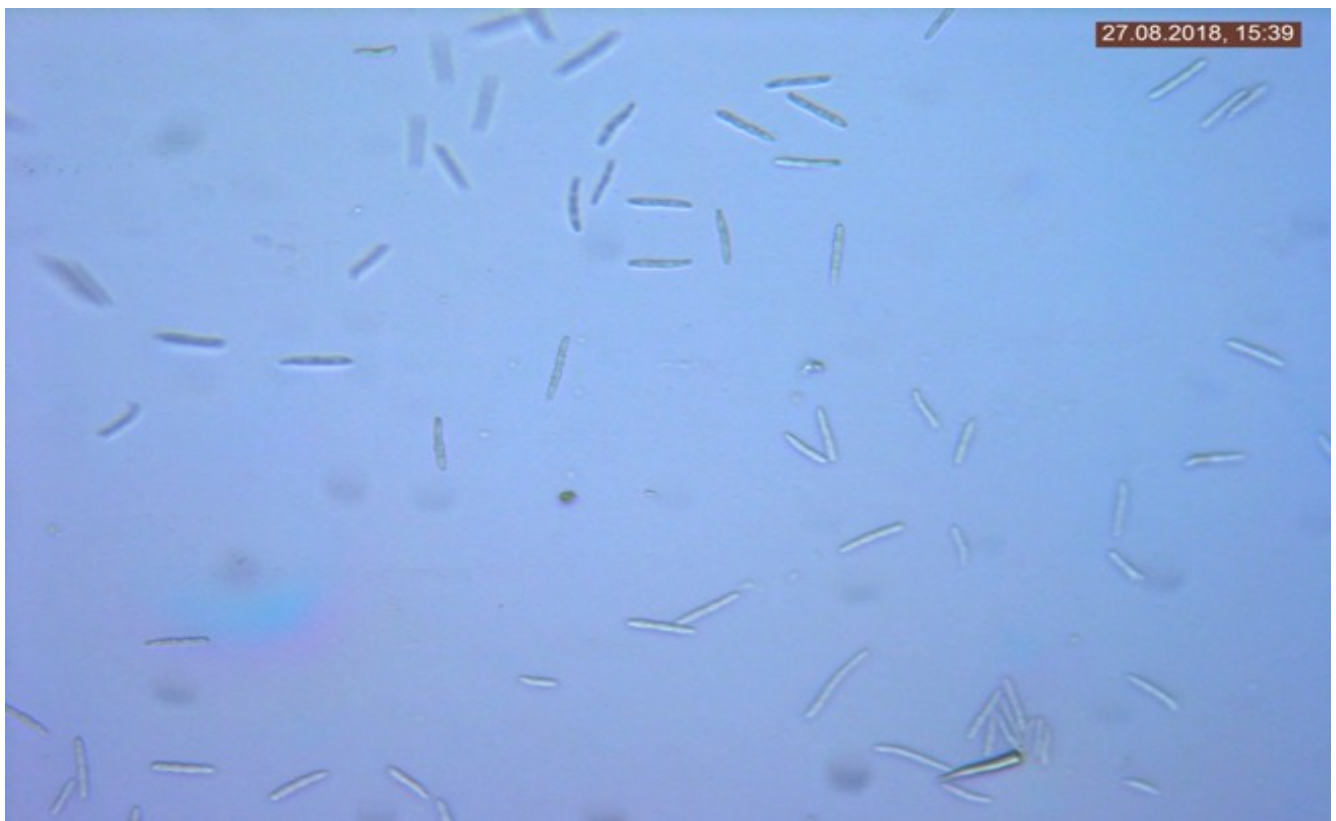


Fig. 5. Spores of *S. avenae f.sp. triticea* on Shortandy 95 improved variety.

Table 1. The incidence of *Septoria* sp. in wheat in the steppe and forest-steppe zones of Northern Kazakhstan (2018)

Variety	District	Farm name	<i>Septoria</i> sp., %		
			<i>S. tritici</i>	<i>S. nodorum</i>	<i>S. avenae</i> f.sp. <i>triticea</i>
Steppe zone					
Omsk 35	Akkayin	“North Kazakhstan SOS” LLP	63.3 ±2.2	66.7 ±3.5	10.0 ±1.1
Tawelsizdik, 20	Akkayin	“North Kazakhstan SOS” LLP	86.7 ±3.0	10.0 ±0.9	-
Shortandy 95 improved	Akkayin	“North Kazakhstan SOS” LLP	76.7 ±4.2	13.3 ±1.0	-
Astana	Akkayin	“Fiat” LLP	90.0 ±9.5	20.0 ±2.5	20.0 ±2.8
Shortandy 95 improved	Esil	“Atameken-Agro-Korneevka” LLP	6.7 ±0.8	43.3 ±5.1	96.7 ±9.3
Average			64.7 ±3.9	30.7 ±2.6	25.3 ±2.7
Forest-steppe zone					
Omsk 28	Mamlyut	“Gadzhiev” farm household	100.0 ±9.1	10.0 ±1.5	3.3 ±0.5
Boevchanka	Mamlyut	“Amanzhelev” farm household	80.0 ±10.1	13.3 ±2.0	-
Boevchanka	Mamlyut	“Tazhiev” LLP	46.7 ±4.1	10.1 ±1.8	-
Novosibirsk 31	Kyzylzhar	“Zenchenko” farm household	73.3 ±8.8	12.4 ±1.9	-
Average			75.0 ±8.0	11.5 ±1.8	0.8 ±0.1

Table 2. The incidence of *Septoria* sp. in wheat in the steppe and forest-steppe zones of Northern Kazakhstan (2019)

Variety	District	Farm name	<i>Septoria</i> sp., %		
			<i>S. tritici</i>	<i>S. nodorum</i>	<i>S. avenae</i> f.sp. <i>triticea</i>
Steppe zone					
Shortandy 95 improved	Akkayin	“North Kazakhstan SOS” LLP	20.0 ±3.1	3.3 ±0.7	23.3 ±2.5
Tawelsizdik 20	Akkayin	“North Kazakhstan SOS” LLP	10.0 ±2.1	-	-
Omsk 35	Akkayin	“North Kazakhstan SOS” LLP	23.0 ±3.1	-	20.0 ±2.8
Astana	Akkayin	“Fiat” LLP	-	53.3 ±4.5	36.7 ±5.1
Shortandy 95	Esil	“Atameken-Agro- Korneevka” LLP	73.3 ±7.8	30.1 ±2.7	-
Average			25.3 ±8.1	17.3 ±2.0	16.0 ±2.1
Forest-steppe zone					
Omsk 28	Mamlyut	“Gadzhiev” farm household	40.0 ±5.5	-	-
Boevchanka	Mamlyut	“Amanzhelev” farm household	-	80.0 ±7.1	43.3 ±3.8
Boevchanka	Mamlyut	“Tazhiev” LLP	6.7 ±1.1	43.3 ±5.1	6.7 ±0.5
Novosibirsk 31	Kyzylzhar	“Zenchenko” farm household	86.7 ±9.2	13.3 ±1.5	-
Average			33.4 ±4.0	34.2 ±3.4	12.5 ±1.1

sp. *triticea* in had the same level of incidence; 17.3 % and 16.0 % respectively.

A mycological study of the affected leaves collected from 4 wheat varieties was carried out in the forest-steppe zone. *S. tritici* prevailed in two samples and *S. nodorum* prevailed in two samples. The average incidence values were as follows: 33.4 % for *S. tritici*; 12.5 % for *S. avenae* f. sp. *triticea* and 34.2 % for *S. nodorum*.

According to the results of the 2019 surveys, it was found that *S. tritici* dominated in two zones, its average incidence was 29.4 % in spring wheat varieties, *S. avenae* f. sp. *triticea* incidence was 14.3 %, and the proportion of *S. nodorum* was 25.8 % (Table 2).

Conclusion

The species composition of pathogens populations of wheat *Septoria* spot in Northern Kazakhstan in 2018–2019 was comprised of three species of *Septoria* fungi: *S. tritici*, *S. nodorum* and *S. avenae* f. sp. *triticea*. Soft spring wheat was mainly affected by the *S. tritici*. During the two-year study of species

diversity of *Septoria* spot pathogens, *S. tritici* was predominant followed by *S. nodorum* and *S. avenae* f. sp. *triticea*.

Authors' contributions

All authors contributed to conduct the study and prepare the manuscript. The final version of the manuscript has been approved by all authors.

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Conflict of interests

The authors declare no competing interests.

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