Effects of Fungicides and Cultivar Genotypes on Populations of *Septoria* spp. on Spring Wheat in Minnesota

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ABSTRACT

Haugen, L. G., Wilcoxson, R. D., and Baumer, J. S. 1985. Effects of fungicides and cultivar genotypes on populations of *Septoria* spp. on spring wheat in Minnesota. Plant Disease 69:162-163.

Interactions between *Septoria* spp., spring wheat (*Triticum aestivum*) cultivars, and fungicides were studied at three locations in Minnesota in 1979 and 1980. Populations of *Septoria* spp. were estimated from numbers of pycnidiospores produced on primary tillers. The predominant species was *S. nodorum* followed by *S. avenae* f. sp. *triticea*; *S. tritici* was not found. Fungicide applications greatly reduced populations of both species across all cultivars and locations. Cultivar effects were generally small and varied with the year and *Septoria* spp. involved. Location effects were not significant.

Additional key words: fenapanil, mancozeb, thiabendazole

In Minnesota, spring wheat (*Triticum aestivum* L.) is commonly infected with *Septoria nodorum* (Berk.) Berk and *S. avenae* Frank f. sp. *triticea* Johnson but rarely with *S. tritici* Rob. ex Desm. (2). Frequently, lesions caused by these pathogens coalesce, making it impossible to study the occurrence of individual pathogens by symptomatology or to study the effects of different cultivars or fungicide treatments on these pathogens. Shearer and Wilcoxson (4) reported that *S. nodorum* was the most important *Septoria* sp. on spring wheat, but their observations were confined to two cultivars at one location. This study evaluated the populations of *Septoria* spp. on spring wheats sprayed with fungicides at several locations in Minnesota.

MATERIALS AND METHODS

Plots were located at University of Minnesota experiment stations at Crookston, Morris, and Rosemount in 1979 and 1980. These areas differ in temperature, rainfall, soil types, and crop production. In 1980, plots at Crookston were abandoned because of drought.

Semidwarf hard red spring wheat (*Triticum aestivum* L.) cultivars Era, Olaf, and Kitt were grown at each location. All have been grown commercially in Minnesota and were considered moderately susceptible to both *S. nodorum* and *S. avenae* f. sp. *triticea*. Plots were at least 3 × 7.6 m and seed was planted with a standard grain drill. Plots were managed for maximum production according to local practices.

In 1979, mancozeb (Dithane M-45), at the rate of 2.24 kg a.i./ha, was applied one to four times at 7-day intervals, beginning at growth stage 10 on the James scale (1). In 1980, mancozeb was applied at 2.24 kg a.i./ha and fenapanil (Sisthane 2EC) and thiabendazole (Mertect 340F) were applied at 0.6 L a.i./ha. Each fungicide was applied twice, beginning at growth stage 10 (1) and again 7 days later. Unsprayed controls were included in both years.

Each year, Triton CS-7 was used as a spreader-sticker at the rate of 200 ml/ha with each fungicide. All fungicides were applied with a ground sprayer at 26–30 kg/cm^2 in 468 L/ha of water.

Experiments were arranged in a split-plot, complete-block design with cultivars as main plots and fungicides as subplots. There were three replicates in 1979 and four in 1980.

Quantities of *Septoria* spp. in the plants were measured using a modification of the procedure of Shearer and Wilcoxson (4). When plants were at growth stage 10 (1) and at 7-day intervals thereafter until maturity, 10 primary tillers were taken at random from each plot and stored dry in paper bags for several months. The tillers were soaked for 4 hr in 400 ml of water containing 0.4 ml of Tween 20 to release pycnidiospores from pycnidia in the leaves. Five drops of 1% (w/v) cotton blue dye in 1 ml of lactophenol were added to the water in which the leaves were soaked to stain the spores and to prevent germination and production of additional spores. A 40-ml aliquot of spore suspension was removed from each sample and centrifuged for 10 min at 5,000 rpm, then 25 ml of the supernatant fluid was removed with a syringe, leaving a pellet of spores. These spores were suspended in the remaining supernatant fluid by vigorous shaking.

Spores of *Septoria* spp. in each sample were counted with a hemacytometer, using four subsamples of each sample from each cultivar and fungicide studied. The size, shape, and septation of the pycnidiospores were used to differentiate the *Septoria* spp. present (4).

The data presented include the total number of pycnidiospores present in primary tillers of plants during the 3-wk period before flag leaves were completely senescent, when plants were between growth stages 10.5 and 11.2 (1). Analysis of variance was used to help interpret the effects of cultivars and fungicide treatments on the populations of the *Septoria* spp. Differences were tested for significance with the studentized Newman-Kuels sequential Q test (5).

RESULTS AND DISCUSSION

1979 Experiment. Because populations of both fungi were similar at the three locations, data were pooled across locations. Fungicide treatments significantly reduced the numbers of pycnidiospores of *S. nodorum*; cultivars did not differ significantly (Table 1). Both the cultivars and the fungicide treatments influenced the size of the populations of *S. avenae* f. sp. *triticea*.

The mean number of pycnidiospores of both *Septoria* spp. was reduced when plants were sprayed with mancozeb. Increasing the number of applications of the fungicide from one to four did not significantly influence sporulation (Table 1), however, though there was a trend for fewer spores to be produced as the number of applications increased. Sporulation of *S. nodorum* was about 10 times that of *S. avenae* f. sp. *triticea* (Table 1).

1980 Experiment. Because populations did not vary with locations, data were pooled across locations. The number of pycnidiospores of *S. nodorum* varied significantly with cultivars and fungicide treatments, and the interaction of the two was significant (Table 2). Treatments did not influence sporulation of *S. avenae* f.

Paper 13,859, Scientific Journal Series, Minnesota Agricultural Experiment Station, St. Paul 55108.

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Accepted for publication 13 August 1984.

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Table 1. Cumulative mean number of pycnidiospores of *Septoria* spp. on primary tillers of three spring wheat cultivars sprayed with mancozeb in 1979

Treatment	No. of applications	No. pycnidiospores ($\times 10^{-4}$) on cultivars[a]			
		Era	Olaf	Kitt	Mean
S. nodorum					
Control	0	1.64	2.12	1.60	1.79 x
Mancozeb	1	1.42	1.27	0.97	1.22 xy
	2	1.84	1.88	0.92	1.22 xy
	3	1.09	0.97	0.91	0.99 y
	4	0.82	1.09	1.29	1.07 y
Mean	...	1.16 x	1.46 x	1.14 x	...
S. avenae f. sp. *triticea*					
Control	0	0.143	0.211	0.129	0.161 x
Mancozeb	1	0.118	0.133	0.102	0.118 y
	2	0.069	0.136	0.076	0.093 y
	3	0.069	0.112	0.074	0.085 y
	4	0.080	0.113	0.078	0.090 y
Mean	...	0.096 y	0.141 x	0.092 y	...

[a] Pycnidiospores on 10 primary tillers from each of three replicates per cultivar at Crookston, Rosemount, and Morris, MN. Means within a row or column of a *Septoria* sp. followed by different letters are significantly different ($P \leq 0.05$) according to studentized Q test (5).

Table 2. Cumulative mean number of pycnidiospores of *Septoria* spp. on primary tillers of three spring wheat cultivars sprayed with fungicides in 1980

Treatment	No. of applications	No. pycnidiospores ($\times 10^{-5}$) on cultivars[a]			
		Era	Olaf	Kitt	Mean
S. nodorum					
Control	0	4.01	6.15	3.19	4.45 x
Mancozeb	1	3.33	3.58	1.96	2.95 y
	2	2.68	2.39	1.96	2.34 z
Thiabendazole	2	2.03	2.00	1.79	1.94 z
Fenapanil	2	2.83	3.00	2.26	2.70 yz
Mean	...	2.98 y	3.42 x	2.23 z	...
S. avenae f. sp. *triticea*					
Control	0	1.63	2.26	1.38	1.75 x
Mancozeb	1	1.13	1.45	1.26	1.28 x
	2	1.46	1.70	0.89	1.35 x
Thiabendazole	2	1.06	1.14	1.89	1.36 x
Fenapanil	2	1.33	1.65	1.19	1.39 x
Mean	...	1.32 x	1.64 x	1.32 x	...

[a] Pycnidiospores on 10 primary tillers from each of four replicates of Era, Olaf, and Kitt at Rosemount and Morris, MN. Means within a row or column of a *Septoria* sp. followed by different letters are significantly different ($P \leq 0.05$) according to studentized Q test (5).

sp. *triticea*.

All fungicide treatments reduced sporulation of *S. nodorum* below that of the untreated check (Table 2). A single application of mancozeb reduced sporulation but not as much as two applications of mancozeb, thiabendazole, or fenapanil. Sporulation also varied significantly with the cultivars tested, but the differences were not great. *S. nodorum* produced more spores on Olaf than on Era or Kitt. The interaction between cultivars and fungicide treatments was statistically significant and appeared to be due to a greater relative reduction in sporulation by *S. nodorum* in Olaf sprayed with mancozeb.

S. avenae f. sp. *triticea* sporulated more abundantly in 1980 than in 1979, but the number of spores produced was not significantly affected by cultivars or fungicides although the trends were similar to those noted above for *S. nodorum*. As in 1979, sporulation of *S. nodorum* exceeded that of *S. avenae* f. sp. *triticea* (Table 2).

S. nodorum is probably the most important of the *Septoria* spp. on semidwarf spring wheats in Minnesota. *S. avenae* f. sp. *triticea* was second most common. *S. tritici* was not seen. Efforts to breed for resistance should probably be directed against *S. nodorum*.

Pycnidiospores of *Septoria* spp. were not found in our experiments until the spikes of the plants were out of the leaf sheath, about a week after sampling began. This agrees with observations of Shearer and Wilcoxson (3,4) who also reported that *S. nodorum* and *S. avenae* f. sp. *triticea* were usually most common at about the heading stage and later.

The semidwarf wheats observed did not differ greatly in their resistance to the two *Septoria* spp., even though small differences were noted in the sporulation of the fungi on them.

Fungicides reduced the numbers of spores of each of the *Septoria* spp. in the plants but sporulation was not eliminated even when mancozeb was applied four times or when systemic fungicides were applied twice.

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