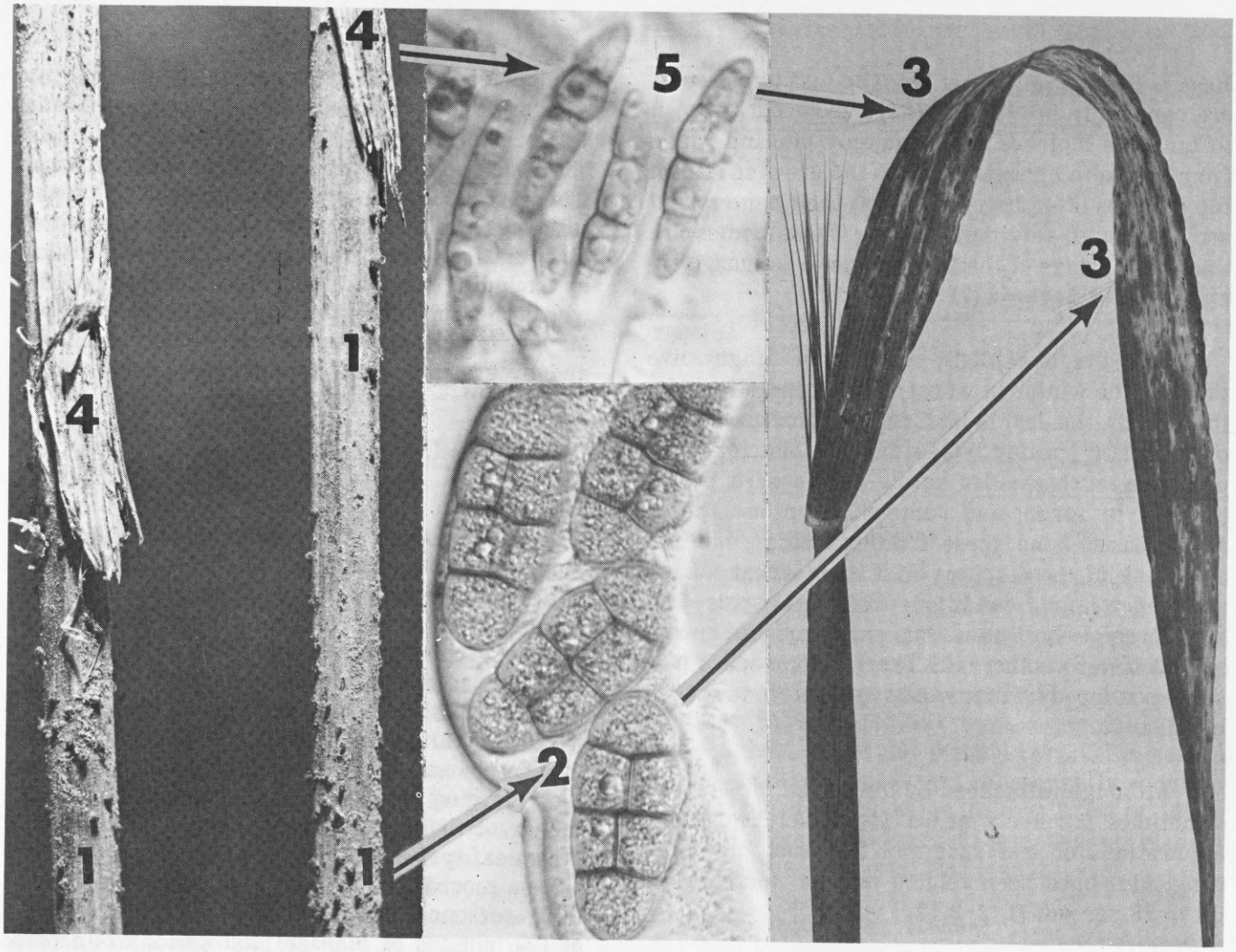

Fig. 1. Pin head size fruiting bodies (1) of the wheat leaf blight fungus on wheat stubble produce spores (2) that cause leaf spots on wheat (3). Barely visible pepper grain size fruiting bodies (4) of the wheat blotch fungus on wheat stubble produce spores (5) that cause leaf spots on wheat.

WHEAT LEAF BLIGHT and BLOTCH --- LOSSES and CONTROL

R. M. Hosford, Jr.

Two leaf spotting fungi commonly have been found to cause slight to severe damage to the foliage of spring, winter and durum wheat varieties grown in North Dakota (5, 6, 7, 8, 9, 10, 11). One, **Pyrenophora trichostoma,** causes a disease called leaf blight, tan spot or yellow leaf blotch. The other, **Leptosphaeria avenaria** f. sp. **triticea,** causes a disease called blotch or septoria leaf spot.

Both diseases appear as brown spots that spread on susceptible wheat varieties and eventually kill entire leaves. Usually, these spreading spots

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have a distinct yellow border. The leaf blight spots are commonly brown and range from dark brown to tan. The blotches are commonly tan and range from brown to light tan. Late in the growing season the blotches often become grey at their centers and are filled with tiny dark bodies. These bodies are the asexual stage of the **Leptosphaeria** fungus, commonly called **Septoria** (7).

Both the leaf blight and blotch fungus live through the winter in wheat stubble and straw. On this debris the leaf blight fungus produces dark, pinhead size fruiting bodies and the blotch fungus produces much smaller barely visible dark bodies (Fig. 1). In spring and summer, countless spores are released from these fruiting bodies into the air. Many of these spores land upon wheat foliage and under humid conditions cause leaf spots. The spots become most numerous and damaging during extended wet weather (10). The development of new spots is stopped by dry, windy weather and reduced by foliar fungicides.

Although influenced by uncharted factors that sometimes adversely affect yield increase, aerial applications of leaf spot and leaf rust inhibiting fungicides have been related to yield increases of up to 28 percent (1, 2, 3,12).

In 1970, a study to quantitatively chart factors influencing leaf spot severities and wheat loss was conducted at the North Dakota Agricultural Branch Experiment Stations. Severe leaf spotting was related directly to wet weather, proximity of wheat stubble beneath the growing wheat, and to poor resistance to leaf blight and blotch in wheat varieties. Leaf spotting and wheat losses were reduced by excluding wheat stubble from beneath growing wheat, by repeated spraying of the foliage with Maneb type (Manzate 200) protective fungicide, and by growing a leaf blight and blotch resistant variety.

Methods

Four to seven wheat varieties were randomly planted three to nine times in each of four blocks. A different treatment was applied to each block. The treatments were: (1) thin scattering of infested wheat stubble beneath emerging wheat, (2) no stubble placed beneath the emerging wheat (bare ground), (3) stubble placed beneath the emerging wheat and fungicide applied to the foliage of the growing wheat, and (4) no stubble placed beneath the emerging wheat and fungicide applied to the foliage of the growing wheat. As the wheat plants grew, leaf spot severity was measured by the rating system recorded in Table 1. Foliage was sprayed as time, personnel and weather permitted at the rate of two pounds of Manzate 200 and six ounces of Triton B 1956 per acre. The spray equipment used

Table 1. Ratings for disease severity caused by Pyrenophora trichostoma and Leptosphaeria avenaria f. sp. triticea.

Reaction	Numerical rating*	Lesion			
		Type	Size/mm	No./Leaf	% foliage damaged
Immune	1	No lesions			
Resistant	2	Light to dark brown usually with yellow halo	1 - 2	0.2 - 1	Under 1
Moderately resistant	3	Light to dark brown usually with yellow halo	2 - 3	2 - 5	2 - 5
Moderately susceptible	4	Light brown with yellow halo	3 - 6	6 - 15	10 - 20
Susceptible	5	Light brown with yellow halo and growing together	Greater than 6	Over 10	30 - 75
Very susceptible	6	Light brown and grown together	Greater than 6	Over 10	76 - 100

*Disease severity between two numerical ratings was recorded in fractions.

was that available at each station. The desired procedure was to spray once every seven to 10 days and following heavy rains from emergence of the wheat to mid-dough. Each plot was a drill strip approximately 6x20 feet. Yield data were taken from 75 square feet of each drill strip plot. For statistical analysis the experiment was treated as a split-block design.

RESULTS

Minot Experiment Station

Fungicide was applied with a rotary mist sprayer on June 9, 12, 15, 20; July 15, 25, 30, and August 14. Only trace amounts of leaf spotting (ratings 1-3) developed as the wheat grew into the five - six leaf stage. As the season progressed rain and dew increased. By early mid-dough, leaf spotting had become severe in stubble plots (treatment 1) of some wheat varieties, less severe in no-stubble plots (treatment 2) and moderate to slight in sprayed plots (treatments 3 and 4) (Table 2). Reductions in yields (Tables 2 and 3) were directly related to disease severity (Table 2). The durum variety, Wells, displayed a high degree of resistance to leaf spotting and related yield loss (Tables 2 and 3). Spraying of foliage and absence of infested wheat stubble reduced both leaf spotting and yield loss in disease susceptible varieties. Leaf-spot related yield losses in Waldron and Chris hard red spring wheats and Hercules durum were of definite economic importance (Table 3).

Table 2. Yield related to severity of "leaf blight" and "blotch" of wheat at early dough at Minot, North Dakota 1970.[a]

Wheat varieties	Treatment			
	Stubble	No stubble	Stubble & sprayed	No stubble sprayed
Waldron	28.6 (4.7)	28.6 (4.2)	38.9 (3.5)	39.7 (3.2)
Chris	31.7 (4.5)	36.9 (3.5)	38.6 (3.2)	41.1 (3.1)
Hercules	47.5 (3.9)	50.7 (3.7)	50.6 (2.7)	52.4 (2.3)
Wells	43.7 (3.6)	44.8 (3.5)	52.0 (1.7)	47.5 (1.8)

LSD.05 between treatments for yields equals 2.8
LSD.05 between varieties for yields equals 4.1
LSD.05 between treatments for disease ratings equals 0.4
LSD.05 between varieties for disease ratings equals 0.7
a/ Each yield figure (bu/A) and disease severity rating (in parentheses, see Table 1 for description) is an average of three plots.

Table 3. Yield losses related to "leaf blight" and "blotch" of wheat at Minot, North Dakota 1970.[a]

Variety	Average yield in no stubble, spray protected plots	Average yield in stubble, no spray plots	Yield loss, difference between 1 & 2
Waldron	39.7	28.6	11.1**
Chris	41.1	31.7	9.4**
Hercules	52.4	47.5	4.9*
Wells	47.5	43.7	3.8

**Significant at the 1 percent level of the Duncan Range Test.
*Significant at the 5 percent level of the Duncan Range Test.
a/ Each yield figure (bu/A) is an average of three plots.

Fargo Experiment Station

Seven varieties were randomly replicated three times per treatment. Fungicide was applied with a John Bean Sprayer at 200 pounds per square inch every seven days from emergence to mid-dough. During early spring rains, the leaves of emerging seedlings were moderately spotted (ratings 1 to 3). The weather turned dry for the rest of the season and leaves which developed subsequently acquired only a trace of leaf spotting (ratings 1 to 2.5). There were no severe leaf spot disease and no distinct yield differences among treatments.

Dickinson Experiment Station

Fungicide was applied every 10 days after emergence until the early dough stage of wheat development. During the early part of the season only a trace of leaf spotting occurred. By the early dough stage, moderate disease was occurring in all seven varieties in the unsprayed plots (average disease rating 3.2) and only a trace of leaf spotting (average disease rating 1.5) was occurring in the sprayed plots. Under these conditions of moderate disease severity the fungicide controlled the leaf spotting extremely well. Heavy rains and subsequent flooding of the plots ruined the yield part of the experiment.

Williston Experiment Station

Fungicide was applied at 40 pounds per square inch on June 6, 14, 22, 25, and 28 and August 3. At the five - six leaf stage (7/2/70) only trace to light leaf spotting (rating 1-3) occurred in the plots. By early dough leaf spot damage was moderate (average rating 3.0) in most sprayed plots and severe (average rating 4.8) in most unsprayed plots. Yields were not distinctly different among treatments. Due perhaps to insufficient moisture, yields were uniformly low (12.5 - 24.0 bu./A.).

Other Stations

The irregular pattern of leaf spotting and yield loss suggested that fungicide application techniques needed improvement.

Discussion and Summary

The results of the 1970 study at the Minot Experiment Station indicate that the diseases leaf blight and blotch can cause losses of economic importance in commercial wheat varieties in North Dakota. Results support earlier findings (1, 2, 3, 12) that foliar fungicides can reduce losses. Results indicate that grain farmers can reduce disease severeity and related yield decline by removing infested wheat stubble and growing wheat varieties which are resistant to these diseases.

Each of these control measures (protective fungicides, removal of stubble and selection of resistant varieties) requires further study. Repeated applications of protective fungicide controlled severe leaf spotting and related yield decline at the Minot Station. At the Dickinson Station, where leaf spotting was moderate in unsprayed plots, the fungicide practically eliminated leaf spotting in sprayed plots. At the Williston Station, the fungicide controlled leaf spotting, but this did not result in a distinct yield increase. Perhaps water stress in the soil at Williston inhibited yield increase in fungicide protected plots.

Results from the stations indicate that fungicide can control severity of leaf spotting and related yield decline but that uncharted factors may be involved. The study is being repeated in 1971. In this study, numerous applications of fungicide were applied in an attempt to determine the maximum yield loss from leaf spot diseases. In continuing work, the number of fungicide applications is being reduced and the time of application will be stressed in studies of the economics of controlling leaf spotting with fungicides.

The fungi causing the leaf spots come from weathered wheat stubble (7, 10). To reduce this source of infection, wheat residue should be eliminated before planting. However, plowing under the residue will expose the bare land to wind erosion. This problem is reduced by stubble mulching, but stubble mulching leaves wheat residue on the soil surface. Tillage practices that place a thin layer of soil over wheat stubble are being investigated. A compromise procedure which provides for complete removal of residue by deep plowing, but still controls wind erosion, is planting sunflower rows in fallow land (4). In addition, sunflower stubble aids in trapping snow on fallow land (4). Flax has also been used for these purposes. Permanent strips of wheat grasses can be used to reduce wind erosion. However, wheat grasses are attacked by the leaf blight fungus and may serve as another source of wheat infection. Oats or flax which are not attacked by these leaf spotting fungi might be incorporated into a crop rotation.

A range of resistance to the two leaf spot diseases exists in the wheat population. ND 487, a hard red spring wheat selection developed by Dr. R. C. Frohberg at the North Dakota Experiment Station, is resistant to blotch but not to leaf blight. A wheat from India, C 306, and a wheat from Pakistan, C 518, are very susceptible to blotch (7). Resistance to leaf blight is related to the length of time moisture from dew or rain is on the leaves (10). Wells durum requires 18 to 24 hours with moisture and the leaf blight fungus on the leaves for severe development of leaf blight. Chris and Hercules require 12 to 18 hours. Waldron and ND 487 require six to 12 hours, and North Dakota spring wheat breeding line 495 requires under six hours. North Dakota 495 is very susceptible to leaf blight. Wells durum appears to be resistant to most attacks by both leaf spot fungi. The spring wheat breeder and the durum breeder are incorporating detected sources of resistance into breeding lines. A total of 1,170 wheat selections from the World Wheat Collection are being screened for leaf spot disease resistance.

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