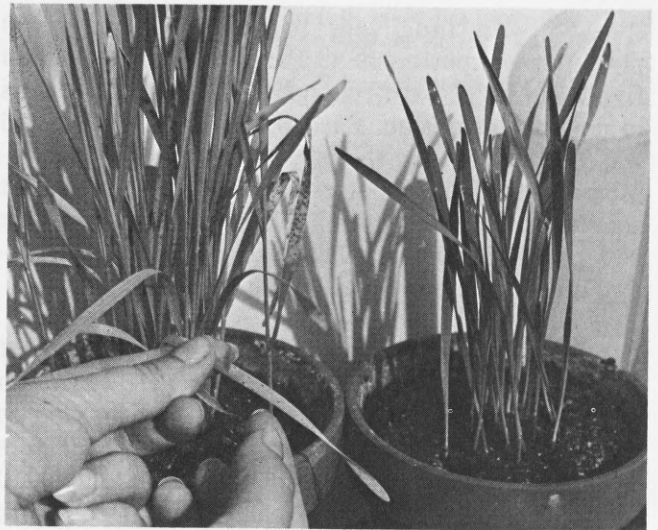


Host-pathogen reaction types on single gene lines ranging from susceptible (above) to resistant (below) are used to determine the virulence of each leaf rust isolate.



Single pustule isolates of *P. recondita* are established by transferring urediospores from a single uredia (left) to little club wheat (right).

# The Virulence and Potential Destructiveness of Wheat Leaf Rust in North Dakota

Glen D. Statler

Foliar diseases are among the most important cereal diseases in North Dakota. Each year these diseases reduce the production potential of our wheat crop (4). Wheat leaf rust incited by ***Puccinia recondita*** is one of the most destructive foliar diseases in North Dakota. Resistance of our commercial varieties has not been permanent because of the ability of the leaf rust fungus to change by mutation or hybridization (9) and attack formerly resistant varieties. These new strains of the fungus increase at an alarming rate if they parasitize a variety grown on large wheat acreages (1).

Studies on pathogenic specialization have been important in the development of rust resistant commercial wheat varieties (3). Data obtained by assaying the pathogenic potential of parasite populations can be directly applied in the release of rust resistant commercial varieties. Virulence changes in the natural leaf rust population have been studied with

single gene lines in Canada (5, 6, 7) and in North Dakota (8). A knowledge of race frequencies, virulence on common varieties and virulence associations on single gene lines is essential for the release of wheat varieties resistant to prevalent leaf rust populations.

## Materials and Methods

Leaf rust nurseries were grown at six locations in North Dakota to determine the resistance of numerous wheat varieties and experimental lines grown under different environmental conditions. Rust severity and host pathogen reaction types were recorded for hard red spring, durum and winter wheats grown in these nurseries.

Leaf rust cultures were collected from hard red spring, durum, and winter wheats in 1971 throughout North Dakota. Single pustule isolates of these cultures were used to identify the Unified Numeration (U.N.) races of leaf rust based on resistance or susceptibility of lines with host genes **Lr1, Lr2, Lr2D and Lr3** (2).

The potential destructiveness of wheat leaf rust was assessed by comparing yields of plots

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*The author wishes to express appreciation for planting and caring for branch station plots to Dr. J. R. Erickson, D. J. Grant, E. W. French, B. K. Hoag, R. E. Nowatzki, H. M. Olson and T. J. Conlon.*

sprayed with fungicides to yields of unsprayed plots. One experiment at Fargo in 1971 included five varieties of hard red spring and durum wheats in a split plot design. Each plot was 5x16 feet and was replicated four times. Maneb + zinc ion complex at two pounds per acre and Triton B-1956 at six ounces per acre were applied to wheat plants at 200 psi. Fungicide applications were made at 10-day intervals from the seedling stage.

In a similar test, one application of the leaf rust specific experimental fungicide RH-124 (Rohm and Haas 4-n-Butyl-1, 2, 4-triazole) was applied to wheat seedlings in the three-leaf stage at the rate of 0.4 lbs. active per acre. The trial included 10 varieties of hard red spring and durum wheats in a rod row split plot design replicated three times. A separate treatment consisted of treating seed of the 10 varieties at the rate of one ounce active RH-124 per 100 pounds of seed. This trial was also de-

signed as a rod row split plot experiment replicated three times. The plots were artificially inoculated with leaf rust at heading.

### Results and Discussion

The development of wheat leaf rust was relatively slow throughout the summer of 1971. This was largely due to the planting of vast acreages to rust resistant wheat varieties such as Waldron. These varieties reduced the amount of inoculum as well as rust severity. Consequently, the disease did not severely damage the North Dakota wheat crop in 1971 except for fields planted to susceptible varieties (e.g., Manitou) which were heavily rusted late in the season.

The per cent leaf rust severity and reaction types of hard red spring and durum wheat grown throughout the state are rated in Table 1. Rust ratings are not shown for Williston due to hail prior to rust evaluations. The per cent severity was much

Table 1. Per cent severity and reaction types of *Puccinia recondita* on adult plants of spring and durum wheat at five North Dakota locations.

Variety	Carrington	Fargo	Langdon	Minot	Dickinson
Thatcher	50S <sup>1</sup>	60S	50S	40S	5S
Manitou	60S-10MR <sup>2</sup>	50S-10MR	50S-10MR	20S-5MR	tMS-tMR
Empire	50S	60S	40S-5MR	50S	tS
Inia 66	50S	40S	50S	40S-10MR	tS
Selkirk	40MS	40S-10MR	25S-10MR	10S-5MR	tMR
Neepawa	30MS-10MR	40S	20S-5MR	10S-tMR	tMS
Justin	30S	30S	10S	5-10S	tS
Wamduska	30S	5-10S	10S-5MR	10S	tS
Fletcher	20S-5MR	10MS-5MR	40S-5MR	5-10S	tS
Fortuna	50S	5-10MS	30S	10S	tS-tMR
Chris	10MR-5S	10MS	15S	5S	tS
World Seeds 1812	15MS	tMS	15MS	5S	tR-tS
Barton	5S	10S	10MR-10MS	t-5S	tS
Polk	5MS	5MS	10MS	tMS-tMR	tMR
Era	tMR-tMS	tMS-tMR	10MR-5MS	2MS	tMS
Bounty 208	tMS-tMR	tMR	15S-15MR	10MS	tS
World Seeds 1809	tMS	tMS	tS-5MR	tMS	0
Red River 68	tR	tMR	5MS-10R	tMS	0
Bonaniza	tMS	0	5MS-5MR	tMS	0
Waldron	tR	0	0,tMR	0	0
Exchange	0	tR	0	0	0
Transfer	0	0	0	0	0
Lr1	5MS-5MR	15S	10MS-10MR	t-5MS	0
Lr2	tMS	20S	t-5S	tR	0
Lr2D	5S	10MS	5S	10S-5R	tMS
Lr3	60S	70S	50S	60S	tS
Leeds	0	tMS-tMR	tMS-tMR	tR	0
Wells	0,tMS	tMS-tMR	tMS	tMS-tMR	0
Hercules	0,tMS	t-5MS	t-5MS	tMR	0
Wascana	tMS	tMS-tMR	t-5MS	tMS	tMS
Golden Ball	0	tMR	tMS-tMR	tMR	0

<sup>1</sup>Per cent severity precedes reaction type, S equals susceptible; R equals resistant; MR equals moderately resistant; MS equals moderately susceptible; t equals trace; 0 equals none; numerals equals per cent.

<sup>2</sup>A dash (—) indicates a range in severity or reaction on the same plants.

<sup>3</sup>A comma (,) indicates a separation of plants into two or more reaction types.

lower at Dickinson than the other branch stations, but ratings were made at approximately the half-berry stage and more rust may have developed prior to maturity.

Leaf rust was severe at most locations on Thatcher, Manitou, Inia 66, Empire and Selkirk. Moderate to heavy amounts were found on Neepawa, Fortuna, Fletcher, Justin and Wamduska. Chris was more severely rusted than in 1970. Varieties such as Waldron, Red River 68, Bonanza, World Seeds 1809, Exchange and Transfer were resistant at all locations. Only traces of leaf rust developed on durum in 1971 except for a late planted nursery at Fargo in which Hercules was rated 20MS-20MR, Leeds 5MR-5MS and Wells t-5MR.

The leaf rust severity and reaction types of several lines and varieties of winter wheat grown at Casselton are shown in Table 2. Most of the winter wheat varieties tested were heavily infected. Centurk, rated 10MS, had less rust than the other varieties. The isogenic line Lr9 from Transfer was very resistant, and may be an important source of rust resistance for winter wheat.

**Table 2. Leaf rust severity and reaction types of winter wheat varieties and isogenic lines grown at Casselton, North Dakota in 1971.**

Winter wheat variety	Per cent severity and reaction type	Isogenic line	Per cent severity and reaction type
Froid	70S <sup>1</sup>	Lr1	60S
Minter	80S	Lr2	50S
Hume	60S-10MR <sup>2</sup>	Lr2b	15MS-15MR
Lancer	70S	Lr2c	70S
Winoka	80S	Lr2d	70S
Cheyenne	80S	Lr3	70S
Trapper	80S	Lr3	80S
Scout 66	70S	Lr9	5MR
Karkoff	60S	Lr11	70S
Centurk	10MS		

<sup>1</sup>Per cent severity precedes reaction type, S equals susceptible; R equals resistant; MR equals moderately resistant; MS equals moderately susceptible.

<sup>2</sup>A dash (—) indicates a range in severity or reaction on the same plants.

Eleven different U.N. races of leaf rust were identified from the 124 isolates collected in 1971 (Table 3). U.N. races 2, 3, 5 and 13 were the most prevalent ones identified in 1971. In contrast, race 2 alone accounted for 66.1 percent of the isolates

**Table 3. Frequency of Puccinia recondita races identified by the U.N. system in North Dakota in 1970 and 1971.**

Race	Number Cultures Identified			
	1970		1971	
	Frequency	% total	Frequency	% total
1	2	1.1	0	0.0
2	119	66.1	35	28.2
3	44	24.4	30	24.2
5	2	1.1	15	12.1
6	0	0.0	9	7.3
7	3	1.7	8	6.5
9	0	0.0	1	0.8
10	1	0.6	0	0.0
12	0	0.0	2	1.6
13	0	0.0	14	11.3
17	2	1.1	6	4.8
22	0	0.0	1	0.8
25	7	3.9	3	2.4
TOTAL	180		124	

tested in 1970; in 1971 there were fewer cultures of race 2 and more cultures of 5, 6, 7 and 13. This increased frequency of leaf rust races with a wider range of virulence indicate shifts in the natural population. These changes are related to the large acreages of resistant varieties planted and may pose a potential threat of increased virulence in the natural leaf rust population.

The mean yields of the susceptible varieties were increased considerably by chemically controlling leaf rust with maneb + zinc ion complex (Table 4). The mean yield of Thatcher which had an average rating of 58S in the dough stage was increased by 11.89 bu/A or 35.4 per cent. The mean yield of Manitou with an average rating of 34S was increased by 5.83 bu/A or 13.6 per cent. The mean yields of Thatcher and Manitou were significantly greater (.01 level) than the unsprayed plots. The mean yields of sprayed plots of Waldron and Hercules were significantly higher than the controls. Maneb + zinc ion complex also controls other foliar diseases which may have been responsible for these increased yields (R. M. Hosford, personal communication). The increase in yields derived from spraying Justin was not significant. This variety was not as severely rusted in this test as normally expected.

Yields of the susceptible varieties were increased considerably by controlling leaf rust with RH-124 (Table 5). The mean yields were increased by 29.9 per cent for Thatcher, 17.6 per cent for Manitou, and 15.9 per cent for Selkirk. These differences were significantly greater (.01 level) than the unsprayed controls. However, the increased yield of the leaf rust resistant variety Waldron just reached the .01 level of significance with a 6.25 per cent increase. Waldron is more susceptible to

**Table 4. Mean yields in bushels per acre and average leaf rust ratings of five wheat varieties sprayed with 2 lbs/A of maneb + zinc ion complex compared to unsprayed plots.<sup>1</sup>**

	Average yield/bu/A			Leaf rust ratings			
	Sprayed	Unsprayed	Yield advantage	Sprayed Dough	Milk	Unsprayed Dough	
Thatcher	45.49**	33.60	11.89	0	27S		58S
Manitou	48.65**	42.82	5.83	0-2S <sup>2</sup>	8S		34S
Waldron	48.66*	45.78	2.88	0	0		0
Justin	49.07	47.34	1.73	0			2-5S
Hercules	50.66*	47.58	3.08	0	tMS		tMS

<sup>1</sup>Mean yields of four replications.

<sup>2</sup>A dash indicates a range in rust reaction.

\*Significant at the .05 level.

\*\*Significant at the .01 level.

other foliar diseases, but RH-124 is not effective against diseases other than leaf rust. The mean yield of the North Dakota experimental durum was also significantly greater than the control. This variety had a trace of leaf rust at the milk stage and an average of 8MS-7MR at the dough stage.

Wheat leaf rust was not controlled by RH-124 seed treatment at the rate of application used in this trial. Furthermore, the mean yields of the leaf rust susceptible varieties were not increased by the seed treatment.

It is evident from these and many other spray trials that wheat leaf rust is a devastating foliar disease capable of reducing potential wheat yields of our commonly-grown commercial varieties. It is also evident from the shifts in virulence patterns that this pathogen has the ability to change and attack formerly resistant varieties. This ability poses an ever-present potential threat to our commonly used genes for leaf rust resistance in our commercial wheat varieties.

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**Table 5. Mean yields in bushels per acre and leaf rust severity and reaction types of 10 wheat varieties sprayed with 0.4 lb. active RH-124 per acre compared to untreated checks.<sup>1</sup>**

Varieties	Average yield bu/A			Leaf rust rating			
	Sprayed	Unsprayed	Yield Advantage	Milk	Sprayed Dough	Milk	Unsprayed Dough
Thatcher	61.76**	47.53	14.23	4S	4S	60S	67S
Manitou	64.50**	54.83	9.67	0	tMS	28S <sup>2</sup> 13MR	43S-7MR
Selkirk	57.26**	49.40	7.86	0	1MS	20MR- 12MS	27MS-13MR
Waldron	57.30**	53.93	3.37	0	0	0	0
Justin	47.06	45.00	2.06	0	tMS	18MS- 7MR	20MS-5MR
Chris	41.86	42.70	.84	0	tMS	8MS	12MS
HRS Exp 1	52.00	50.90	1.10	0	0	tMS	3MS
Red River 68	62.77	60.63	2.14	0	0	tMS	tMR
Leeds	67.50	67.07	0.47	0	tMR	tMS	4MS
Durum Exp 1	61.37*	58.37	3.00	0	0	tMS	8MS-7MR

<sup>1</sup>Average of three replications.

<sup>2</sup>A dash indicates a range in rust severity.

\*Significant at the .05 level.

\*\*Significant at the .01 level.