

Wheat Leaf Rust in North Dakota During 1982-1984

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ABSTRACT

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Rust nurseries were established at five North Dakota locations to evaluate resistance of wheat (*Triticum aestivum* and *T. turgidum*) cultivars to the natural *Puccinia recondita* f. sp. *tritici* population. The commercially grown hard red spring wheat cultivars Marshall, Len, Alex, Coteau, Walera, Solar, and Stoa are resistant to *P. recondita* and provide excellent protection against the natural population. Many spring wheat cultivars grown in North Dakota have susceptible reactions with low severities. Severities have increased on Butte, Olaf, and Waldron between 1982 and 1984. Most durum wheat cultivars have low coefficient of infection values and are probably not damaged by leaf rust. Most winter wheat cultivars grown in North Dakota are susceptible to *P. recondita* and can be damaged by rust. Virulence of the natural population was evaluated on near-isogenic lines. Annual shifts in the natural population were recorded. Lines with leaf rust-resistant genes *Lr3ka*, *Lr9*, *Lr11*, *Lr16*, *Lr17*, *Lr19*, *Lr21*, *Lr24*, *Lr25*, and *Lr30* were resistant to the greatest percentage of field collections of *P. recondita*.

Leaf rust incited by *Puccinia recondita* Rob. ex Desm. f. sp. *tritici* is one of the most important diseases of wheat worldwide. *P. recondita* is a potential threat in the upper Mississippi Valley whenever susceptible cultivars are grown. Yield losses on susceptible cultivars have been well documented (2,8). The disease is also a potential threat because *P. recondita* has vast pathogenic variability, allowing it to genetically shift and parasitize previously resistant cultivars. These changes, coupled with an increase of the new virulent form in the natural rust population, have caused epidemics resulting in widespread losses (2). These losses have forced growers to plant different cultivars or to apply foliar fungicides in attempts to manage the disease. Smith (6) reported that most of the changes in wheat cultivars in North Dakota have resulted from shifts in the natural populations of *P. graminis* Pers. f. sp. *tritici* Ericks. & E. Henn. and *P. recondita*.

MATERIALS AND METHODS

Rust nurseries were planted each of 3 yr at five locations within North Dakota to evaluate the resistance of hard red spring (*Triticum aestivum* L.) and durum (*T. turgidum* L.) wheat cultivars to the natural *P. recondita* population. Fields were surveyed to determine rust severity on commercially grown cultivars.

Adult wheat plants in the nursery were

evaluated for leaf rust severity and reaction at the milk stage. Severity was estimated according to the modified Cobb scale (4). Host reaction was determined by a modified method of Mains and Jackson (3). The coefficient of infection (CI) was calculated by multiplying the severity by the numerical value of the resistant or susceptible rust reactions ($R = 0.2$, $MR = 0.4$, $MS = 0.8$, and $S = 1.0$) times 100. Data from five locations in all years were combined to obtain the average CI value.

Collections of *P. recondita* were obtained from hard red spring, durum, and hard red winter wheats grown throughout North Dakota during the summers of 1982-1984. Urediniospores of each collection were suspended in a nonphytotoxic oil and sprayed on the first leaf of monogenic lines listed in Table 1. Inoculated plants were maintained at 100% relative humidity at 20 C for 18-20 hr, then placed on greenhouse benches at 21-25 C. Infection types (IT) were recorded 10-12 days after inoculation. The recorded ITs were used to classify collections, thus ITs 0, 1, and 2 indicated avirulent collections and ITs 3 and 4 indicated virulent collections.

RESULTS AND DISCUSSION

The leading hard red spring wheat cultivars by acreage in North Dakota in 1984 were Marshall, Len, Alex, Butte, Olaf, Coteau, Waldron, and Oslo (1) (Table 2).

Marshall, Len, Alex, Coteau, Oslo, Walera, Solar, and the recent North Dakota release, Stoa, were resistant (CI values usually <5) and provided the best protection against the naturally occurring races of *P. recondita* (Table 2). In fact,

most hard red spring wheat cultivars grown in North Dakota have low CI values for leaf rust. Exceptions are Butte, Waldron, and Olaf, on which rust increased during 1982-1984; however, our fungicide spray trials indicate that the amount of rust on these cultivars is causing little damage (9). Fields of Marshall were reported rusted near Park River, ND, in 1984. Our observations indicated, however, that pure lots of Marshall were resistant and had only a few segregating (susceptible) plants. The fields of Marshall reported rusted were probably segregation or admixture.

The leading durum wheat cultivars by acreage in North Dakota in 1984 were Vic, Ward, Rugby, and Crosby (1) (Table 2). The CI values for durum cultivars ranged from 1.2 to 5.6. We reported previously that *P. recondita* developed more slowly on durum cultivars than on susceptible hard red spring wheat cultivars and yields were not reduced (7). Thus, leaf rust is probably not reducing yields of the durum cultivars currently grown in North Dakota. Most durum cultivars display MS-MR reactions, however, and higher severities could result in yield loss.

Most hard red winter wheat cultivars

Table 1. Percentage of *Puccinia recondita* f. sp. *tritici* isolates collected in North Dakota virulent on wheat seedlings containing single genes for resistance to leaf rust^a

Monogenic line or cultivar ^b	1982	1983	1984
<i>Lr1</i>	50.0	62.5	75.4
<i>Lr2a</i>	72.0	66.0	81.0
<i>Lr2d</i>	72.0
<i>Lr3</i>	98.0	100.0	100.0
<i>Lr3ka</i>	34.0	5.8	0.0
<i>Lr9</i>	5.0	0.0	0.0
<i>Lr10</i>	100.0	98.2	98.1
<i>Lr11</i>	36.0	13.4	1.8
<i>Lr16</i>	0.0	0.0	3.7
<i>Lr17</i>	5.0	7.8	1.8
<i>Lr19</i>	0.0	0.0	0.0
<i>Lr21</i>	24.0	13.4	1.8
<i>Lr23</i>	82.0	73.0	88.4
<i>Lr24</i> (Agent)	3.4	3.9	0.0
<i>Lr25</i> (Transec)	1.7	1.9	0.0
<i>Lr30</i> (T)	20.0	21.1	1.8
<i>Lr31</i>	...	28.8	13.2
D6733 ^c	13.0	7.7	0.0

^a Values based on about 50 collections each year.

^b Monogenic lines in Thatcher background.

^c Experimental *Triticum turgidum*.

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Table 2. Average coefficient of infection of *Puccinia recondita* on adult wheat cultivars at five North Dakota locations^a

Cultivars	North Dakota hectares, 1984 ^b (%)	Average coefficient of infection ^c		
		1982	1983	1984
Hard red spring wheat				
Marshall	21.5	2.2	4.4	1.7
Len	20.6	1.1	3.0	1.1
Alex	10.0	1.0	4.9	1.4
Butte	8.4	7.6	11.4	17.2
Olaf	8.0	2.5	6.6	9.8
Coteau	6.8	0.8	1.3	2.1
Waldron	6.7	5.4	6.2	15.4
Oslo	5.4	5.7	4.4	4.8
Walera	3.0	1.8	3.2	2.0
Solar	2.0	1.6	1.9	4.2
Pioneer 2369	1.1	7.4	4.4	7.3
Stoa	...	1.1	1.9	2.0
Thatcher	...	72.0	58.0	66.0
Durum				
Vic	50.4	2.0	1.8	3.1
Ward	18.3	2.6	2.6	1.4
Rugby	13.3	2.0	2.8	1.6
Crosby	5.7	2.0	1.8	2.3
Cando	3.9	2.0	4.0	2.8
Rolette	2.0	5.6	2.0	3.3
Lloyd	1.8	1.2	2.2	3.3
Winter wheat^d				
Roughrider	78.0	80.0	50.0	80.0
Norstar	18.0	70.0	40.0	60.0
Winalta	<1.0	70.0
Winoka	<1.0	60.0	40.0	40.0
Agassiz	<1.0	...	40.0	60.0

^aLocations include Oakes, Carrington, Minot, Langdon, and Fargo.

^bAbout 2.2 million hectares of hard red spring wheat, 1.1 million hectares of durum, and 0.28 million hectares of hard red winter wheat were planted in 1984.

^cCoefficient of infection is based on the following values for resistant or susceptible reaction types multiplied by percentage of severity: R = 0.2, MR = 0.4, MS = 0.8, S = 1.0.

^dPlanted only at Casselton or Fargo, ND.

grown in North Dakota were susceptible to leaf rust (Table 2). Some winter wheat cultivars are resistant and are currently used in the North Dakota State University breeding program but do not possess winterhardiness necessary for North Dakota. We received several reports of heavy rust on winter wheats grown in eastern North Dakota during the 3-yr period. A fungicide spray program is needed for any susceptible cultivar grown in eastern North Dakota, since leaf rust develops most years on susceptible cultivars.

Changes in virulence of the natural leaf rust population were observed (Table 1). We recorded increases in isolates virulent on *Lr1* and *Lr2a* during 1982–1984. This is probably due to an increase in acreage of cultivars containing *Lr1* and *Lr2a* in North Dakota (10). Most isolates continued to be virulent on *Lr3* and *Lr10*, and many, on *Lr23*. The number of cultures virulent on *Lr3ka*, *Lr11*, *Lr21*, and *Lr30* decreased during the 3-yr period.

Monogenic lines possessing *Lr3ka*,

Lr9, *Lr11*, *Lr16*, *Lr17*, *Lr19*, *Lr21*, *Lr24*, *Lr25*, and *Lr30* were resistant to a high percentage of field collections of *P. recondita* (Table 1). These monogenic lines probably provided the best protection against leaf rust, but many intermediate ITs (IT 2) were recorded for *Lr3ka*, *Lr11*, *Lr16*, and *Lr21*.

The *P. recondita* population in North Dakota is similar to that reported in Manitoba (5), and the same resistance genes are usually affected. We did have a higher percentage of cultures virulent on *Lr1* and *Lr2a* than reported in Manitoba. This may be due to more widespread use of cultivars containing *Lr1* or *Lr2a* by North Dakota farmers (10).

We reported previously that many cultivars grown in North Dakota have seedling genes *Lr1*, *Lr2*, and *Lr10* (10). These genes do not provide adequate protection against the natural *P. recondita* population.

Fortunately, most cultivars grown in North Dakota probably possess genes that condition adult plant resistance in addition to genes for resistance in the

Table 3. Number of hard red spring wheat fields surveyed in North Dakota^a

Year	Leaf rust severity (%)					
	0	5	10	20	30	40
1982	17	12	7	3	0	3
1983	15	9	1	5	0	2
1984	18	6	5	1	0	1

^aAnthesis to dough stage of development.

seedling stage.

Observations of growers' fields indicated that most hard red spring wheat cultivars grown in North Dakota were resistant to *P. recondita* (Table 3); however, in six of the 105 fields surveyed, leaf rust severity was about 40% and these fields may have suffered some yield loss. Only one hard red spring wheat field with severity as high as 30% was observed during our 1979–1981 survey (8).

We have demonstrated yield losses as great as 30% for susceptible cultivars with severe leaf rust (9). Therefore, the value of resistance in the presently grown wheat cultivars is probably worth several million dollars each year to North Dakota wheat growers. Data from rust nurseries determine the cultivars that provide best protection against the natural population of *P. recondita*. Virulence ratings of the near-isogenic lines determine which genes are most useful in breeding for leaf rust resistance.

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