

Races of *Puccinia hordei* in the United States from 1979 Through 1982

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ABSTRACT

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Barley leaf rust was moderately severe in the Upper Midwest in 1979, nearly absent in 1980, severe in late-planted barley fields in 1981, and light in 1982. Isolates of *Puccinia hordei* from 93 field collections from 16 states and Mexico were studied and 6 races identified. Race 8 was present in 98% of the collections. Race 4 was the second most common but was found only in 1979 and 1980. Races 13, 19, 40, and 42 were found only in trace amounts. The cultivars Abyssinian (Pa 9), Aim (Pa 3), Cebada Capa (Pa 7), and Quinn (Pa 2 and Pa 5) were resistant to all six races.

Barley leaf rust, caused by *Puccinia hordei* Oth., is occasionally widespread in commercial fields of Minnesota and North Dakota because the barley cultivars grown are susceptible to the prevalent races. For development of resistant cultivars, it is important to know the virulence patterns of the natural population of the pathogen. The last extensive surveys, however, for races of *P. hordei* in the continental United States were between 1956 and 1964 by Moseman

and Roane (4) and Moseman and Greeley (3). This study was undertaken to identify the current races of *P. hordei* in relation to potential sources of host resistance available.

MATERIALS AND METHODS

Barley leaves infected with *P. hordei* were collected from commercial fields or from nurseries. The pathogen was cultured on seedlings of barley (*Hordeum vulgare* L.) cultivars Manker or Larker; uredospores from a single uredium were used to inoculate a differential set of 7-day-old barley seedlings consisting of nine cultivars used to differentiate races (2). Four supplemental cultivars, Abyssinian, Aim, Cebada Capa, and Peruvian, were also tested because they possess resistance genes not available in the differential set and might be used to develop resistant cultivars (5,6). Plants

were inoculated with a suspension of uredospores in a lightweight mineral oil, kept in the dew chamber at 20 ± 2 C for 16 hr, and then placed in a greenhouse at 22 ± 4 C with supplemental fluorescent lighting (11,000 lux) for 12 hr daily. Infection types were recorded after 14 days; types 0, 1, and 2 were taken to indicate host resistance. Races were described using the key provided by Levine and Cherewick (2).

RESULTS AND DISCUSSION

1979. Favorable environmental conditions led to moderately severe epidemics of barley leaf rust in Minnesota and in both North and South Dakota. *P. hordei* overwintered in southern Texas and leaf rust was widespread there in late April. Barley was planted late in the Upper Midwest. Terminal rust severities were at least 30%, but losses were considered light in some fields where barley matured late. Only races 4 and 8 were found, with race 8 predominant (Table 1).

1980. Insufficient production of inoculum in southern Texas led to a near absence of barley leaf rust in Minnesota and adjacent states; however, the disease occurred in the mid-Atlantic coastal states, where the pathogen probably overwintered. Race 8 again was predominant and race 4 was more widespread than in 1979 (Table 1). Race 40 was found in only one collection from Virginia.

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1981. Early occurrence of the disease together with very favorable environmental conditions for rust development led to the most severe epidemic in many years in Minnesota and North Dakota. Barley leaf rust was common in southern Texas. In Minnesota, it occurred earlier than usual, appearing in mid-June. Terminal leaf rust severities of 80% occurred and yield losses were common in late-planted

fields. Race 8 was predominant; race 4 was not found but traces of races 13, 19, 40, and 42 were found (Table 1).

1982. Barley leaf rust was severe in some fields in South Dakota and western Minnesota, but elsewhere, it was generally light but widespread. Barley leaf rust was moderately severe in Texas and provided inoculum for states located further north. Race 8 again predominated.

Table 1. Summary of the races of *Puccinia hordei* identified by year and origin for 1979 through 1982

Year and source of collection	Number of		Percentage of isolates of each race ^a					
	Collections	Isolates	4	8	13	19	40	42
1979								
California	1	2	...	100	...	...	...	...
Minnesota	10	20	10	90	...	...	...	...
North Dakota	3	6	33	66	...	...	...	...
South Dakota	5	9	...	100	...	...	...	...
Texas	3	5	...	100	...	...	...	...
1980								
Alabama	1	1	...	100	...	...	...	...
Delaware	1	2	...	100	...	...	...	...
Florida	1	1	...	100	...	...	...	...
Michigan	1	1	100	...	...	...	...	...
Pennsylvania	1	2	50	50	...	...	...	...
South Dakota	3	6	50	50	...	...	...	...
Texas	6	5	...	100	...	...	...	...
Virginia	6	12	14	71	...	...	14	...
West Virginia	1	1	...	100	...	...	...	...
1981								
Delaware	2	4	...	50	...	...	50	...
Kansas	1	2	...	100	...	...	...	...
Minnesota	13	26	...	100	...	...	...	...
Nebraska	1	2	...	100	...	...	...	...
North Dakota	2	4	...	100	...	...	...	...
Oklahoma	1	2	...	100	...	...	...	...
South Dakota	1	2	...	100	...	...	...	...
Texas	13	26	...	69	12	15	...	4
Virginia	3	6	...	100	...	...	...	...
Washington	1	2	...	...	...	...	...	100
1982								
Iowa	1	1	...	100	...	...	...	...
Minnesota	3	3	...	100	...	...	...	...
North Dakota	1	2	...	100	...	...	...	...
South Dakota	2	2	...	100	...	...	...	...
Texas	3	4	...	75	...	25	...	...
Washington	1	1	...	100	...	...	...	...
Mexico	4	10	...	80	...	20	...	...

^a Race designation according to Levine and Cherewick (2).

Table 2. Infection types produced on seedlings of 13 barley cultivars infected with six races of *Puccinia hordei*

Cultivar ^a	CI no.	Resistance gene ^b	Infection types ^c for race no.					
			4	8	13	19	40	42
Speciale	7536	Pa	;-1 ⁻	4	4	4	1 ⁻	4
Sudan	6489	Pa	;-1 ⁻	4	4	4	1 ⁻	4
Oderbrucker	940	Pa	;-1 ⁻	4	4	4	1 ⁻	4
Reka I	5051	Pa 2 + ^d	1-2 ⁻	;	3-4	1 ⁻	1-2 ⁻	;-1 ⁻
Quinn	1024	Pa 2 & Pa 5	1-2	0-;	2 ⁺	0-;	0-;	0-;
Bolivia	1257	Pa 2 & Pa 6	;-1 ⁻	1	;-1 ⁻	3-4	;	0-1
Gold	1145	Pa 4	1 ⁺	4	4	4	4	1 ⁺ -2
Lechtaler	6488	Pa 4	1 ⁺	4	4	4	4	1 ⁺ -2
Egypt 4	6481	Pa 8	4	3-X ⁺	1-2 ⁻	3-X ⁺	X	1-2 ⁻
Abyssinian	1243	Pa 9	;-1 ⁻	;	;-1 ⁻	;	;	;-1 ⁻
Aim	3737	Pa 3	0-;	0-;	0	0	0	0-;
Cebada Capa	6193	Pa 7	;	;	;	;	;	;
Peruvian	935	Pa 2	;-1 ⁻	;	4	4	;-1 ⁻	;-1 ⁻

^a Cultivars Speciale through Egypt 4 were used as standard differentials for race designations.

^b Designation of resistance genes from Parlevliet et al (5) and Roane (6).

^c Infection type designations (0-4 indicates the size of uredia): 0 = no uredia, ; = fleck, X = mesothetic, 4 = large uredia, and - or + = gradation below or above an infection type.

^d + = An additional but unnumbered gene (6).

The infection types on seedlings of 13 barley cultivars infected with the six races of *P. hordei* found in the United States and Mexico from 1979 through 1981 are shown in Table 2. In addition to the nine standard differential cultivars (Speciale through Egypt 4), Abyssinian, Aim, Cebada Capa, and Peruvian were studied because they carry the single resistance genes Pa 9, Pa 3, Pa 7, and Pa 2, respectively. Only Abyssinian (Pa 9), Aim (Pa 3), Cebada Capa (Pa 7), and Quinn (Pa 2 and Pa 5) were resistant to all six races. Only race 19 was virulent on Bolivia (Pa 2 and Pa 6). All other cultivars tested were resistant to some but not all of the races. Infection of Egypt 4 (Pa 8) with races 8, 19, and 40 resulted in a mesothetic reaction.

A comparison of results of this race survey with those done between 1956 and 1964 (2,4) revealed major differences. Three races, 4, 8, and 40, were found in our survey and in the previous (2,4) surveys; races 13, 19, and 42 were found only in our survey in 1981; and races 16, 34, 44, 45, and 53 were found only in the previous surveys. A change in the predominant race also occurred. Race 4 was present in 67% of all collections from 1956 through 1964, but race 8 was predominant in 86% of the collections from 1979 through 1982. Race 8 is virulent on Pa and Pa 4, whereas race 4 is not. No reason for the gain in virulence is known.

The moderately severe leaf rust in 1979 and 1981 indicated the potential for barley leaf rust epidemics in the Upper Midwest. This indicates that resistant cultivars should be developed because those presently grown are fully susceptible to *P. hordei*. Sources of specific resistance are available and sources of the slow rusting type of resistance have been identified (1).

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