

Races of *Puccinia graminis* f. sp. *avenae* in the United States During 1979

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ABSTRACT

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Oat stem rust overwintered in south Texas and produced a large amount of inoculum in 1979. Unfavorable environmental conditions and a lack of virulence for *Pg-2* and *Pg-4* restricted disease development to the north. From 501 uredial collections, 1,372 isolates were obtained. NA-27 made up 94% of the isolates. No virulence was found for *Pg-16* and -a or the "universally" resistant lines Saia, CI 9221, SES Selection No. 52, X-1588-2, Kyto, and CI 9139.

Oat stem rust caused by *Puccinia graminis* (Pers.) f. sp. *avenae* was more prevalent in 1979 than 1978 but less prevalent than in the epidemic year of 1977. Stem rust was first observed on 27 February 1979 in a nursery in south Texas, where vast quantities of inoculum were produced. A rapid increase in disease was anticipated in central and

northern Texas, but below-normal spring rainfall resulted in conditions unfavorable for disease increase.

By mid-June, traces of oat stem rust had been observed from northern Kansas to southern Minnesota. The earliest centers of stem rust infection in Minnesota resulted from inoculum that arrived in late May. These centers were widely scattered, and secondary spread indicated that they were as infrequent as one per county. Although the initial infection was 20 days earlier than normal (4), the low initial prevalence of the disease plus marginal environmental conditions in June offset the potential effect of early disease onset on epidemic development. Thus, moderate losses

occurred in fields initially infected, and light to moderate losses occurred in late-planted fields in the Dakotas and Minnesota.

MATERIALS AND METHODS

Collections from the United States were classified into ecological areas: area 1, the winter oat area of the southern states; area 2, eastern Oklahoma, northern Arkansas, eastern Missouri, Kentucky, Tennessee, and the southern counties of Illinois and Indiana; area 3, the northeastern states from Virginia northward; area 4, North and South Dakota, Nebraska, Kansas through Ohio and northward; and area 5, the western states and panhandle regions of Texas and Oklahoma. Collections from Mexico and Ontario Province of Canada were included for comparison.

Data pertaining to collections from commercial fields and naturally occurring hosts (field) were separated from data pertaining to collections from experimental plantings (nursery) to eliminate bias from unique host resistances or susceptibilities. No data were included from collections obtained

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Table 1. Identified races of *Puccinia graminis* f. sp. *avenae* by area and source of collection, 1979

Area ^a	Collection source	Collections (no.)	Isolates (no.)	North American (NA) physiologic race ^b												
				1	2	3	5	7	16	23	24	26	27	Others		
USA	Field	287	763	...				1			1	1				97
	Nursery	214	609	4	...	1	1	...		3		1				90
	Total	501	1,372	2	...	...	1	...		2	...	...	...			94
1	Field	8	12	17				33								50
	Nursery	110	323	7	1	1	1	...		2		2				86
	Total	118	335	7	1	1	3	...		2		2				84
2	Field	1	2							100						
	Field	1	1					100								
	Nursery	3	8													100
3	Field	1	1					100								
	Nursery	3	8													100
	Total	4	9					11								89
4	Field	276	745					...		1	1			...		98
	Nursery	101	278							5						95
	Total	377	1,023					...		2	1			...		97
5	Field	1	3													100
	Field	5	13										31	15		54
	Nursery	18	54										15	15	5	65
Canada	Field	5	13										18	15	4	63
	Nursery	18	54													
	Total	23	67													
Mexico	Field	10	27					3		19						78
	Nursery	20	51							2						98
	Total	30	78					1		8						91

^a Area 1 = winter oat area of the southern states; area 2 = eastern Oklahoma, northern Arkansas, eastern Missouri, Kentucky, Tennessee, and the southern counties of Illinois and Indiana; area 3 = northeastern states from Virginia northward; area 4 = North and South Dakota, Nebraska, Kansas through Ohio and northward; area 5 = western states and panhandle regions of Texas and Oklahoma.

^b After Martens et al (1). Each entry is a percentage of isolates.

^c ... = less than 0.6%.

Table 2. Virulence in oat stem rust population for the resistance of the single-gene differential cultivars in the 1979 survey

Area ^a	Collections (no.)	Isolates (no.)	Percentage of isolates virulent on <i>Pg</i>									
			-1	-2	-3	-4	-8	-9	-13	-15	-16	-a
USA	501	1,327	97	95	98	94	96	1	...	2	0	0
1	118	335	88	86	91	86	86	2	1	9	0	0
2	1	2	100	0	100	0	100	0	0	0	0	0
3	4	9	89	89	100	89	89	0	0	0	0	0
4	377	1,023	100	98	100	97	99	...	...	...	0	0
5	1	3	100	100	100	100	100	0	0	0	0	0
Canada	23	67	72	100	88	100	9	84	30	96	0	0
Mexico	30	78	99	91	100	91	99	0	0	0	0	0

^a Area 1 = winter oat area of the southern states; area 2 = eastern Oklahoma, northern Arkansas, eastern Missouri, Kentucky, Tennessee, and the southern counties of Illinois and Indiana; area 3 = northeastern states from Virginia northward; area 4 = North and South Dakota, Nebraska, Kansas through Ohio and northward; area 5 = western states and panhandle regions of Texas and Oklahoma.

^b ... = less than 0.6%.

from nurseries or areas adjacent to inoculated nurseries.

A collection consisted of a varying number of stems or leaves bearing stem rust uredia from a field, nursery, or individual plant or cultivar. Uredospores were removed from each collection and used to inoculate seedlings of the susceptible host Marvellous, CI 7027. After 10–14 days, up to four leaves, each bearing or pruned to a single uredium, were saved and the seedlings reincubated to ensure germination of loose uredospores. Infected plants were maintained in the greenhouse 3–4 more days to provide enough uredospores per pustule (up to three per collection) to inoculate a set of differential hosts. Thus, each collection provided 1–3 isolates.

After uredospores were removed from the collection for inoculation to the

susceptible host, a second portion was removed as part of a bulk from each geographic area to inoculate the "universally" resistant series, seven cultivars selected over a period of years as resistant to oat stem rust. Thus, each infection of this series resulted from a uredospore produced in the field or nursery.

After inoculation, plants were placed in a dew chamber at 18 C overnight, followed by 3 hr of fluorescent light (10,000 lux) and temperatures gradually rising to 30 C. Plants were placed in an 18–30 C greenhouse for 10–14 days, and infection was then recorded. Race designations were based on the North American system (1). Rodney backcross lines with *Pg*-1, -2, -3, -4, -8, -9, -13, -15, -16, and -a were used as differential hosts. The "universally" resistant host series

consisted of Saia (CI 7010), CI 9221, SES Selection No. 52 (CI 3034), X-1588-2 (CI 8457), Kyoto (CI 8250), MN 730358, and CI 9139. Gopher (CI 2027) was the susceptible check.

RESULTS AND DISCUSSION

The 1979 stem rust race survey data (Table 1) are presented for the entire United States, the five ecological areas, Ontario, and Mexico. From 501 collections, 1,372 isolates were identified. Most of the collections (61%) were from area 4, the major oat-producing area. Area 3 collections were from Pennsylvania and West Virginia. Most area 1 collections were from winter oat nurseries in south Texas.

The most important race continued to be NA-27 (94% of the isolates). NA-16

was much less prevalent in 1979 than in 1978 (3) and was similar to the epidemic year of 1977, when it was designated race 61 (2). As in previous years, races NA-1, 2, 3, 5, 7, and 24 were found only in Texas.

In the 1979 survey, no isolates were virulent for *Pg*-16 or -a (Table 2). Only 1 and 2% of the isolates from the United States were virulent on *Pg*-9 and -15, respectively, compared with 84 and 96% from Ontario (Table 2). Collections from the United States were avirulent on the "universally" resistant series, except that those virulent on *Pg*-13 were also virulent on MN 730358. Virulence for *Pg*-9 and -13 was detected in south Texas and

in area 4. Approximately 14% of the Texas (area 1) oat stem rust races were avirulent on genes *Pg*-2 and -4. Because most early collections were from south Texas, the effect of this inoculum was reduced by the presence of *Pg*-2 or -4, singly or in combination, in many of the spring oat cultivars.

Uredial collections from wild oats were made in California, Minnesota, and North and South Dakota. Among 206 isolates from 75 collections from wild oats, races NA-27 (96%) and NA-16 (4%) were most common. Race NA-16 made up a smaller percentage of the races identified from wild oats than in previous years.

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