125

RACES OF PUCCINIA GRAMINIS F. SP. TRITICI IN THE U.S.A. DURING 1973

A. P. Roelfs and D. V. McVey

Research Plant Pathologists, Cereal Rust Laboratory; Plant Protection and Quarantine Programs, Animal and Plant Health Inspection Service, and North Central Region, Agricultural Research Service, respectively; U.S. Department of Agriculture, St. Paul, Minnesota 55101.

Cooperative investigations, U.S. Department of Agriculture, and the University of Minnesota. Paper No. 8553, Scientific Journal Series, Minnesota Agricultural Experiment Station.

The authors acknowledge the cooperation of those persons who supplied us with collections during the year and the assistance of Mr. D. Casper, project technician.

ABSTRACT

In 1973, a total of 1,304 isolates of Puccinia graminis f. sp. tritici were identified from 459 collections received from the U.S.A. during the spring and summer of 1973. Twelve lines of wheat with a single gene for stem rust resistance, that is, Sr 5, 6, 7b, 8, 9a, 9b, 9d, 9e, 10, 11, 13, and Tt-1, were used for differentials. The most frequently isolated races were standard race 15-TNM 51% and -TLM 14%; race 151-QFB 13%, -QSH 8%, -QCB 2%; race group 11-32-113-RKQ and -RTQ 2% each; and race 17-HDL 2%. TNM was the most common race in the Great Plains north of Texas. In Texas, race QSH was the most prevalent, and east of the Mississippi River QFB was the most prevalent. No uredial collections were received from the area west of the Rocky Mountains.

Plant Dis. Reptr. 58: 608-611.

Wheat stem rust, Puccinia graminis f. sp. tritici, was first reported in 1973 at Beeville, Texas in late January. By late April and early May, stem rust was severe at Beeville, and traces were found in nurseries in north Texas at Seymour and Iowa Park, throughout Louisiana, in Mississippi at Poplarville, and in a field at Freeport, Florida. Rust probably overwintered at Iowa Park, Beeville, Freeport, and Baton Rouge, Louisiana. Stem rust had spread northward into Kansas by late May; however, cool nights limited epidemic development. Dry weather and resistant varieties prevented rust development in the spring wheat area and resulted in much less stem rust in 1973 than in 1972, even on susceptible varieties.

MATERIALS AND METHODS

Collections were processed by the methods (1) and facilities (3) used previously. The susceptible host list, the identification series, and the "universally resistant" series were modified in 1973 (Table 1). The differentials consisted of the eight single gene lines for stem rust resistance used previously: Set I with Sr 5, 9d, 9e (dlv), and 7b; Set II with Sr 11, 6, 8, and 9a (2, 3). In 1973, Set III with Sr Tt-1, 9b, 13, and 10 was added (Table 1). The CRL code, which has been described previously (2, 3), was expanded (Table 2) and used to designate combinations of virulence. About 150 isolates, representing all CRL races, were further tested to verify the standard race numbers.

The U.S.A. was divided into eight areas of wheat production, as was done previously (1); however, Area 1 was subdivided in 1973. Area 1S is those Texas counties that are entirely south of the 30th parallel. Area 1N is the central portion of Texas. Collections from this area were from nurseries in Brazos, Burleigh, and Bell counties. Area 2 is the soft red winter wheat area, including eastern and north-central Texas, Arkansas, southeastern Missouri, Illinois, lower Michigan, Ohio, western West Virginia, and North Carolina. Area 3 is the hard red winter wheat area south of the Platte River of Nebraska. Area 4 is the Northeastern U.S.A. and Area 5 includes the eastern three-fourths of Minnesota and Iowa, northeastern Missouri, northwestern Illinois, and Wisconsin. Area 6 is the hard red spring and durum region of northeastern Montana, North Dakota, eastern South Dakota, and the western one-fourth of Minnesota. Area 7 is the hard red winter wheat region of the Nebraska Panhandle, Wyoming, Montana, and western South Dakota. Area 8 is the area west of the Rocky Mountains. The Mexican

collections were from the states of Sonora and Nuevo Leon in the spring and from Mexico in mid-October. Seven collections were made during the fall of 1973 in Oklahoma and northern Texas.

RESULTS

The results of the 1973 race survey are shown in Table 3. The data are presented for the eight ecological areas, U.S.A. totals, and for the Mexican and autumn collections. The collections obtained from commercial fields and naturally occurring gramineous hosts are separated from those from uninoculated nurseries and plots. No data are included from collections made near nurseries known to be inoculated.

Race 15-TNM comprised 51% of all the U.S.A. isolates and was the most prevalent race. Race 15-TLM was the second most prevalent and comprised 14% of the isolates. These were the most prevalent races in Area 3, both spring and fall, and Areas 5, 6, and 7. These races were among the most prevalent in Areas 2 and 4; however, they were not found in Area 1S or Mexico. Two other biotypes of race 15 were found in the survey, races -TDM and -TBM.

Races 151-QFB and -QSH comprised 13 and 8% of all isolates, respectively. QFB predominated in Areas 2 and 4, and was the next to the most common race in Area 1N; it occurred in both eastern and western Mexico also. QSH is the most prevalent race in Areas 1S, 1N, and in eastern Mexico. This race occurred in all areas except 7 and 8. Races 151-QKB,

Table 1. Hosts used in the 1973 wheat stem rust survey.

Variety or line	CI no.	Crop
Susceptible hosts		
Baart	1967	wheat
Transfer	13483	wheat
Identification series		
Little Club	4066	wheat
Line E	-	wheat
Hiproly	-	barley
Prolific	26	rye
Marvellous	7027	oats
Set I and Set II[a]		
Set III		
Line C (Sr Tt-1)	-	wheat
Line AA (Sr 9b)	-	wheat
Line S (Sr 13)	-	wheat
Line F (Sr 10)	-	wheat
"Universally resistant" series		
Line W (Sr Tt-2)	-	wheat
Webster	3780	wheat
Leeds	13168	durum
Little Club (check)	4066	wheat
Gamut (Sr 6, 9b, 11, Gt)	W2123	wheat
Waldron	13958	wheat
Rosner	15013	triticale
Prolific	26	rye
Era	13986	wheat
Agent (Sr 10, Ag-2)	13523	wheat
Wheat-Rye-Translocation	14134	wheat
Khapli (Sr 7a, 13, 14)	4013	emmer

[a]Plant Dis. Reptr. 56: 1038-1039.

Table 2. Key to the Cereal Rust Laboratory (CRL) races, 1973.

	SR gene			
Set 1[a] :	5	9d	9e	7b
Set 2 :	11	6	8	9a
Set 3 :	Tt-1	9b	13	10
Code	Host response[b]			
B	R	R	R	R
C	R	R	R	S
D	R	R	S	R
F	R	R	S	S
G	R	S	R	R
H	R	S	R	S
J	R	S	S	R
K	R	S	S	S
L	S	R	R	R
M	S	R	R	S
N	S	R	S	R
P	S	R	S	S
Q	S	S	R	R
R	S	S	R	S
S	S	S	S	R
T	S	S	S	S

[a]Combinations of host responses from Set 1 determines first letter of code, Set 2 the second, and Set 3 the third.

[b]R = host not susceptible; S = host susceptible.

Table 3. Summary of the identified races of Puccinia graminis f. sp. tritici by area and source of collection for 1973.

Area	Source of collection	No. of collections	No. of isolates	Percentage of isolates of each race																						
				TNM	TLM	T*[a]	QFB	QSH	QCB	QKB	QCC	RKQ	RTQ	RPQ	R*[a]	HDL	HNB	HNL	H*[a]	MBC	MCB	GCC	LCL	L*[a]	B*[a]
All U.S.A.	Field	214	568	48	16	*	17	2	4		*	1	2	*	2	*	*	*	*	1		*	2	2	1
	Nursery	245	736	54	12	*	10	*	*		*	3	2	*	1	2	*	*	*	*		*	*	*	*
	Total	459	1304	51	14	*	13	*	2		*	2	2	*	2	2	*	3	*	*		*	1	1	1
1S	Field	5	13				23	23				31	8	15									12	10	16
	Nursery	32	96				10	61				1	3		4	17	3								
	Total	37	109				12	57				4	4	2	4	15	3								
1N	Nursery	17	49	8		2	37	39					10	2									2		
2	Field	21	56	27	12		36	2	7			4	9										2	2	
	Nursery	25	66	33	11		27	3				12	3		8	3									
	Total	46	122	30	11		31	2	3			8	6		4	2							1	1	
3	Field	81	224	66	19		6	2	2			1				1							2	1	
	Nursery	55	144	62	12	1	15	2	1		1	1	1	1	1		1								1
	Total	136	368	65	16	*	10	2	1		*	1	*	*	*	*	*						1	1	*
4	Field	44	116	18	15		46	1	11						1			1		3			1	3	
	Nursery	1	3	33	33							33													
	Total	45	119	18	15		44	1	11			1			1			1		3			1	3	
5	Field	42	102	60	14	1	6	2	1		1		1	1	1		1	2		1			5	1	3
	Nursery	56	216	72	16	*	3	1	*			5						*		*				*	*
	Total	98	318	68	15	1	4	1	1		1	3	*	*	1		*	1		1			1	1	1
6	Field	14	36	67	17		3	6					6												3
	Nursery	59	162	76	19	1		1	2			1													
	Total	73	198	74	19	*	*	2	2			1	1												*
7	Field	2	6	50	33										17										
8	Field	5	15								7				47			7				7			33
Mexico	Nursery[c]	38	114				20	10	4	2		31	29	5											
	Nursery[d]	3	9					100																	
	Field[d]	5	15					53					40								7				
Mexico[e]	Fall	12	36				14	3				39	31	14											
3[f]	Fall	7	18	94	6																				

[a]Other. [b]Less than 0.6%. [c]State of Sonora. [d]State of Nuevo Leon. [e]State of Mexico. [f]Oklahoma and Texas field and nursery.

Table 4. Incidence of virulent isolates of Puccinia graminis f. sp. tritici for the resistance of the single gene differential lines used in the 1973 survey.

Area	Percentage of the isolates virulent on Sr gene											
	5	6	7b	8	9a	9b	9d	9e	10	11	13	Tt-1
1S	82	69	31	99	23	71	100	0	60	68	0	26
1N	100	49	22	96	51	51	98	8	49	59	0	24
2	98	20	61	81	52	18	98	42	49	52	0	61
3	99	4	84	79	16	4	98	81	85	84	0	85
4	99	3	39	66	60	2	92	34	39	36	0	36
5	95	5	90	80	13	5	96	84	88	87	0	90
6	100	4	95	79	4	4	99	93	95	96	0	95
7	100	0	100	50	16	0	100	83	100	50	0	100
8	60	0	53	7	47	0	67	0	100	0	0	0
U.S.A.	97	13	74	80	23	13	97	65	77	76	0	73
Mexico	100	75	57	70	78	76	99	0	21	48	0	49

-QCB, and -QCC were found in trace amounts. QKB was confined to western Mexico; QCB was most common in Areas 2 and 4.

Race group 11-32-113 decreased in prevalence from 1972 (3). RKQ and RTQ each comprised 2% of the total isolates. RKQ was common in Area 1S, and predominated in nurseries in the Mexican states of Sonora in the spring and Mexico in the fall. RTQ and RPQ also occurred in these locations, generally in a lesser amount. In Area 1S, race RSH was also identified. Race 24-RCB and -RBC were also identified, the latter from Area 8.

Race 17, which has been rare since 1965, was common in Area 1S, where HDL and HNB occurred. These two races also were identifed in Area 3, and HDL was found in Area 2. Race 17-HNL was found in Areas 4 and 5.

Race 56-MBC was found in Areas 4 and 5. This is the first finding of race 56 since 1971. Race 155-MCB was found in a single collection from eastern Mexico. Races 33-LCL and -LCB were found in Areas 1N, 2, 3, 4, 5, and 6 in trace amounts, normally associated with cultures from rye or from naturally occurring gramineous hosts and from aecial collections. Race 48-GCC was identified from Area 8. Race group 2-59-102-BBC, -BCC, and -BFC were also isolated in trace amounts from the same type of hosts as race 33.

DISCUSSION

A continued difference exists between races identified in collections from Mexico and Area 1S and those from Area 6, the major spring and durum wheat area. The resistance of the major winter wheat varieties (except Centurk) to the races QSH, RKQ, RTQ, RPQ, RSH, and RHM may provide a barrier against these races.

An evaluation of the effectiveness of the 12 genes for stem rust resistance is shown in Table 4. Only Sr 13 appears to offer resistance to all cultures. Sr 6 and 9b offer considerable resistance, except in south Texas and Mexico where Sr 9e is most effective.

For the U.S.A. the change in incidence of virulence in 1973 from 1972 for the Sr genes is as follows: Sr 5, -2%; Sr 6, -7%; Sr 7b, +1% Sr 8, -10%; Sr 9a, -22%; Sr 9d, 0%; Sr 9e, +11%; and Sr 11, +13%.

The universally resistant varieties were resistant to all cultures of wheat stem rust from both the U.S.A. and Mexico. Thus, some of these varieties (probably Line W, Webster, and Agent) possess single genes that are effective against a wide range of cultures, and others (probably Leeds, Gamut, and Waldron) possess combinations of genes that are effective.

Literature Cited

1. ROELFS, A. P. 1971. Races of Puccinia graminis f. sp. tritici in the USA during 1970. Plant Dis. Reptr. 55: 986-990.
2. ROELFS, A. P., and D. V. McVEY. 1972. Wheat stem rust races in the Yaqui Valley of Mexico during 1972. Plant Dis. Reptr. 56: 1038-1039.
3. ROELFS, A. P., and D. V. McVEY. 1973. Races of Puccinia graminis f. sp. tritici in the USA during 1972. Plant Dis. Reptr. 57: 880-884.

☆ U. S. GOVERNMENT PRINTING OFFICE: 1974--667221/9 REGION NO. 6