Stem rust of wheat, barley, and rye in Canada in 1975[1]

G. J. Green

Wheat stem rust *[Puccinia graminis* f. sp. *tritici*] developed slowly in Canada in 1975 because of unfavorable weather in July. Rain in early August favored rust development in western Canada, and by mid-August stem rust was common on susceptible wheat varieties and wild grasses. Plots of susceptible varieties in Manitoba were severely attacked before harvest. There was less rust than usual in rust nurseries at 32 locations across Canada. There were no economically important changes in the physiologic races. Race C33(15B-1L) contined to predominate and races C25(38), C49(15), and C18(15B-1L) were fairly common. The wheat stem rust population exhibited the high level of variability observed in 1974. About twice as many races as usual were identified. If this level of variability continues, chances for the development of dangerous virulence combinations will increase.

Can. Plant Dis. Surv. 56:15-18. 1976

En 1975, la rouille de la tige du ble *[Puccinia graminis* f. sp. *tritici*] a connu une croissance lente au Canada en raison du mauvais temps qui a sevi au mois de juillet. Au debut d'août, la pluie a favorise le developpernent de la rouille dans l'ouest du Canada et, a la mi-août, le champignon etait tres repandu chez les varietes de ble et les graminées sauvages sensibles. Au Manitoba, certaines parcelles de varietes sensibles ont ete gravement atteintes avant la recolte. La rouille etait moins frequente que d'habitude dans les parcelles d'étude sur la rouille a 32 endroits au Canada. Aucune modification economiquement importante n'a ete observee chez les races physiologiques. La race C33 (15B-1L) a continue de dominer et les races C25(38), C49(15) et C18(15B-1L) etaient assez répandues. La population de rouille de la tige du ble a presente le maximum de variabilite observe en 1974. Environ deux fois plus de races que d'habitude ont ete identifiees. Si ce niveau de variabilite persiste, un accroissement des possibilites de developpement de combinaisons virulentes est a prevoir.

Prevalence and importance in western Canada

Wheat stem rust ***[Puccinia graminis*** Pers. f. sp. ***tritici*** Eriks. and E. Henn.] was widespread in the United States by the end of July but infections were light. It was first observed in western Canada at Morden, Manitoba, on July 11, about 2 weeks later than usual. Hot, dry weather in July delayed rust development but rain in early August increased the rate of spread and by mid-August it was common on susceptible wild barley ***(Hordeum jubatum*** L.) throughout Manitoba and south-eastern Saskatchewan. Plots of susceptible wheat varieties at Morden and Portage la Prairie, Manitoba, were severely attacked before harvest. There was no rust on resistant varieties in farm fields.

Barley fields in the rust area of western Canada showed only traces of stem rust. Most barley varieties are resistant to wehat stem rust but they are susceptible to rye stem rust. An investigation of stem rust infections on wild barley indicated that rye stem rust developed too late in the season to cause damage.

Stem rust of wheat, barley, and rye in the rust nurseries

Uniform rust nurseries consisting of 20 varieties of wheat, three varieties of barley, one variety of rye, and one variety of triticale were planted by cooperators at 32 locations across Canada in 1975. Most of the varieties used in the nurseries were discussed in a previous report (1). In 1975 the new commercial varieties Sinton, Macoun, and Wakooma were added.

Stem rust was less prevalent than usual in the nurseries. Moderate infections of wheat stem rust developed on the susceptible variety Red Bobs at only 4 of the 32 nursery locations (Table 1). Most rust occurred in the traditional rust area of Manitoba and eastern Saskatchewan, and at nearby Thunder Bay in northwestern Ontario. The small amount of stem rust in most nurseries seems to have been caused mainly by unfavorable weather early in the growing season.

The commercial varieties and sources of stem rust resistance planted in the nurseries continued to show high resistance (Table 1). The variety Pitic 62, which was susceptible in earlier years, was also resistant, indicating that races such as C35(32-113) have become less prevalent. The varieties Lee and Mindum are susceptible to the predominant race C33(15B-1L) but they were not severely infected.

Barley and rye were infected at 12 locations (Table 2) indicating that rye stem rust [***P. graminis*** f. sp. ***secalis***] was more widely distributed than wheat stem rust, especially in eastern Canada. The levels of infection in the nurseries suggest that rye stem rust was responsible for much of the infection on barley, although wheat stem rust probably contributed at the locations in western Canada.

Physiologic races

Wheat stem rust was widespread in western Canada in 1975 and 332 isolates were identified. Thirty-five

[1] *Contribution No. 713, Research Station, Agriculture Canada, Winnipeg, Manitoba R3T 2M9*

Table 1. Percent infection of stem rust (*Puccinia graminis f. sp.* tritici) on 20 wheat varieties in uniform rust nurseries at 9 locations* in Canada in 1975

	Common wheat															Durum wheat				
Location	Red Bobs	Lee	Pitic 62	Neepawa	Napayo	Sinton	Kenya Farmer	C.I.8154 X Frocor^2	Glenlea	Norquay	Exchange	Frontana	Thatcher^6 X Transfer	R.L.4255	Agatha	Hercules	Mindum	Wascana	Macoun	Wakooma
Creston, B.C.	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Melfort, Sask.	60	40	0	0	0	0	0	0	0	0	0	10	5	5	tr**	0	5	tr	0	0
Indian Head, Sask.	0	0	0	0	0	0	0	0	0	0	0	0	tr	0	0	0	0	0	0	0
Durban, Man.	5	tr	0	0	0	0	0	0	0	0	0	0	tr	0	0	0	tr	0	0	0
Brandon, Man.	20	tr	tr	0	0	0	0	0	0	0	0	tr	tr	tr	tr	tr	40	0	0	0
Morden, Man.	tr	0	0	0	0	0	0	0	0	0	tr	0	0	tr	0	0	0	0	0	0
Glenlea, Man.	60	1	tr	tr	tr	tr	1	tr	tr	tr	tr	tr	tr	tr	tr	tr	10	tr	tr	tr
Thunder Bay, Ont.	60	10	0	0	0	0	0	0	0	0	0	tr	10	5	5	0	15	0	0	0
Guelph, Ont.	60	tr	0	0	0	0	0	0	0	0	0	tr	5	tr	5	0	tr	0	0	0

* No rust was observed in nurseries at 23 locations: Agassiz, B.C.; Beaverlodge, Lacombe, Edmonton and Lethbridge, Alta.; Scott, Sask.; New Liskeard, Vineland, Sunbury, Appleton, Ottawa, Kemptville and Kapuskasing, Ont.; Macdonald College, Normandin, Lennoxville, Quebec and La Pocati'ere, Que.; Fredericton, N.B.; Kentville and Truro, N.S.; Charlottetown, P.E.I.; St. John's West, Nfld.

** tr = trace

Table 2. Percent infection of stem rust (*Puccinia graminis*) on three varieties of barley, one variety of rye, and one variety of triticale in uniform rust nurseries at 12 locations* in Canada in 1975

	Barley			Rye	Triticale
Location	Montcalm	Conquest	Wpg.-702-M.7118-13	Prolific	Rosner
Creston, B.C.	20	tr	0	tr	0
Melfort, Sask.	tr**	0	0	tr	0
Durban, Man.	0	0	0	10	0
Brandon, Man.	tr	0	5		0
Glenlea, Man.	10	tr	tr	0	tr
Thunder Bay, Ont.	0	0	0	tr	0
Guelph, Ont.	0	0	0	50	0
Sunbury, Ont.	5	0	0	25	0
Appleton, Ont.	0	0	0	10	0
Kemptville, Ont.	tr	0	0	tr	0
Macdonald College, Que.	0	0	0	tr	0
Lennoxville, Que.		tr	0	50	

* No rust was observed in nurseries at 19 locations: Agassiz, B.C.; Beaverlodge, Lacombe, Edmonton and Lethbridge, Alta.; Scott, Sask.; Morden, Man.; New Liskeard, Vineland, Ottawa and Kapuskasing, Ont.; Normandin, Quebec and La Pocatière, Que.; Fredericton, N.B.; Kentville and Truro, N.S.; Charlottetown, P.E.I.; St. John's West, Nfld.

Table 3. Distribution by provinces of physiologic races of *Puccinia* graminis f. sp. tritici on wheat, barley, and grasses, and frequency of isolation of P. graminis f. sp. *secalis* from barley and grasses in 1975

Virulence formula and (race) number	Virulence formula (effective/ineffective host genes)	Number of isolates from: Que.	Ont.	Man.	Sask.	Alta.	B.C.	Total number of isolates	Percent of total isolates
C 4 (23)	5,6,8,9a,9e,11,17,22,Tt1,Tt2/7a,10,15					1		1	0.3
C10 (15B-1)	6,7a,8,22,GB/5,9a,9b,9d,9e,10,11,13,14,15,17,Tt1,Tt2			1	1			2	0.6
C16 (39)	6,7a,8,9e,11,17,22,Tt2/5,9a,10,15						2	2	0.6
C17 (56)	6,8,9a,9b,9d,9e,11,13,17,22,Tt2/5,7a,10,14,15		1					1	0.3
C18 (15B-1L)	6,8,9a,9b,13,15,17,22,Tt2/5,7a,9d,9e,10,11,14,Tt1		2	6	5			13	3.9
C19 (38)	6,7a,9e,10,11,22,Tt2/5,8,9a,15,Tt1				1			1	0.3
C22 (32)	9a,9d,9e,13,22,Tt1,Tt2/5,6,7a,8,9b,10,11,14,15,17			2	1			3	0.9
C23 (38)	9a,9e,11,22,Tt1,Tt2/5,6,7a,8,10,15				1			1	0.3
C25 (38)	9a,9e,22,Tt1,Tt2/5,6,7a,8,10,11,15		2	20	2			24	7.3
C25 (38)	9a,9e,22,Tt1,Tt2/5,6,7a,8,10,11*,15			1				1	0.3
C27 (59)	6,8,9e,11,17,22,Tt1,Tt2/5,7a,9a,10,15						1	1	0.3
C32 (32)	9a,9b,9d,9e,11,13,22,Tt2/5,6,7a,8,10,14,15,17		1		1			2	0.6
C33 (15B-1L)	6,9a,9b,13,15,17,22,Tt2/5,7a,8,9d,9e,10,11*,14,Tt1		2	22	6			30	9.0
C33 (115)	6,9a,9b,15,17,22,Tt2/5,7a,8,9d,9e,10,11,Tt1			1		1		2	0.6
C33 (15B-L)	6,9a,9b,13,15,17,22,Tt2/5,7a,8,9d,9e,10,11,14,Tt1		4	173	33	1		211	63.6
C35 (32-113)	9d,9e,10,11,13,17,22,Tt2/5,6,7a,8,9a,9b,14,15,Tt1				2			2	0.6
C41 (32-113)	9d,9e,10,13,17,22,Tt2/5,6,7a,8,9a,9b,11,14,15,Tt1			1				1	0.3
C42 (15)	6,8,9a,9b,11,13,15,17,22,Tt2/5,7a,9d,9e,10,14,Tt1			1				1	0.3
C49 (15)	6,9a,9b,11,13,15,17,22,Tt2/5,7a,8,9d,9e,10,14,Tt1		1	13	2			16	4.8
C50 (15B-5)	7a,8,22/5,6,9a,9b,9d,9e,10,11,13,14,15,17,Tt1,Tt2			3				3	0.9
C53 (15B-1L)	6,9a,9b,13,15,22,Tt2/5,7a,8,9d,9e,10,11,14,17			1				1	0.3
C57 (32)	9a,9d,9e,22,Tt1,Tt2/5,6,7a,8,9b,10,11,13,14,15,17			1	1			2	0.6
C59 (31)	9d,9e,13,22,Tt1,Tt2/5,6,7a,8,9a,9b,10,11,14,15,17			3	1			4	1.2
C61 (38)	6,7a,9e,10,11,22,Tt2/5,8,9a,15,17,Tt1			1				1	0.3
C63 (32)	7a,9d,9e,10,11,13,17,22,Tt2/5,6,8,9a,9b,14,15,Tt1			3	1			4	1.2
C65 (38)	6,8,9e,11,17,22,Tt1,Tt2/5,7a,9a,10,15				1	1		2	0.6
Total wheat stem rust isolates			13	253	59	4	3	332	100
Rye stem rust isolates		1	6	85	14	11		117	

* Intermediate infection type; see text

isolates were from plots of the susceptible variety Klein Titan grown at Morden and 35 isolates were obtained from the susceptible variety Marquis at each of the locations Morden, Portage, and Brandon, Manitoba. Over 150 of the 253 Manitoba isolates were obtained from susceptible varieties at these three locations. The remaining isolates were from wild barley, and it is evident (Table 3) that wheat stem rust and rye stem rust were about equally prevalent on this host in Manitoba.

Physiologic races were identified by methods already described (1). A wheat line carrying resistance gene *SrTt1* was added to the differential hosts. When effective this gene produced a mesothetic reaction. It is included in the formulas in Table 3 for those races that produced clear infection types.

Twenty-six races were identified including two strains of race C25(38) and three of race C33 (Table 3). The common strain of race C25(38) is virulent on varieties with resistance gene *Sr11* but a new strain that produces an intermediate infection type was found. A strain of race C33(15B-1L) was separated from the common strain by the same intermediate virulence on *Sr11*. A third strain of race C33 was distinguished by its avirulence on the "standard" differential Marquis. Consequently it was not a "standard" race 15 but race 115.

Race C33(15B-1L) continued to predominate as it has since 1970. The three variants mentioned above comprised 73% of the isolates in 1975 (Table 3) and 63% in 1974. Race C25(38) was next in prevalence. It is avirulent on Marquis and Selkirk but is moderately virulent on seedlings of the widely grown varieties Manitou, Neepawa, and Napayo. Race C49(15), third in order of prevalence, resembles race C33(15B-1L) except that it is avirulent on resistance gene *Sr11*. Race C18(15B-1L) decreased from 11.2% of the isolates in 1974 to 3.9% in 1975.

No new races were identified in 1975 and only four of the races found were not present in 1974. The identification of races C10(15B-1), C17(56), and C50(15B-5) is noteworthy. Race C10(15B-1), the original 15B of 1950, was not found from 1964 to 1972 but it has been found in trace amounts each year since 1973. Race C17(56), the most important race in North America before 1950, has been found rarely since 1969. Race C50(15B-5), a widely virulent race that threatened Selkirk when it was widely grown, was found for the first time since 1960.

In 1975 the wheat stem rust population again exhibited the greatly increased variability observed in 1974. The reduced number of isolates in 1975 probably was

Table 4. Percent of total isolates and races avirulent on single identified resistance genes in 1975 and (1974)

Resistance gene	Avirulent isolates (%) 1975 (1974)	Avirulent races (%) 1975 (1974)
Sr 5	0.3 (0.2)	4 (3)
Sr *6*	85.8 (88.7)	58 (72)
Sr 7a	3.9 (4.1)	23 (22)
Sr 8	7.8 (20.7)	35 (44)
Sr 9a	93.1 (91.3)	58 (53)
Sr *9b*	93.6 (85.2)	56 (50)
Sr 9d	6.4 (7.7)	50 (44)
Sr 9e	16.0 (16.3)	65 (63)
Sr10	2.7 (7.5)	19 (31)
Sr11	10.5 (11.3)	52 (34)
Sr13	97.6 (90.2)	81 (75)
Sr14	0 (0.2)	0 (3)
Sr15	82.5 (82.2)	27 (28)
Sr17	90.2 (86.1)	63 (56)
Sr22	100.0	100 (100)
SrTt2	98.5 (99.5)	92 (97)

responsible for the identification of a slightly smaller number of races (26) than in 1974 (32). In earlier years about 12 races were found. The greatly increased number of races in the las? 2 years suggests that factors such as new selection pressures are influencing rust evolution. The increased variability is disturbing from the practical point of view because, if continued, it could result in new and more virulent rust variants that would threaten resistant commercial varieties.

The finding of rust variants that have intermediate virulence on resistance gene ***Sr11*** produced a nomenclatural problem. The genetic basis of the intermediate condition is uncertain and until there is a better understanding of what happened an asterisk placed beside the gene in question (Table 3) is being used to indicate an intermediate interaction.

The percentages of races and isolates avirulent on the identified resistance genes have not changed appreciably in the last year (Table 4). The small increase in virulence on *Sr8* was caused by the increase of race C33. The genes conferring resistance to most isolates and races were ***Sr22, SrTt2*** and ***Sr13***. Although ***Sr6,*** *Sr9a* and *Sr9b* conferred resistance to the predominant races and to most isolates, over 40% of the races were virulent on them.

Thirty-two highly resistant varieties were inoculated with 11 composite collections of urediospores from all isolates identified. Most results resembled those of earlier years with many varieties being resistant (Table 5), but some reactions are noteworthy. The varieties Chris, Mida-McMurachy-Exchange 11-47-26, Frontana-K58-Newthatch 11-50-17, and Sinton showed large pustules, as they have in previous years. However, a few large pustules were observed on Era, Glenlea, and Webster for the first time since composite urediospore collections came into use. Preliminary results with isolates from these large infections indicate they are virulent on seedlings of these varieties.

Table 5. Infection types produced on 32 resistant varieties by 11 composite collections of urediospores from 332 isolates of wheat stem rust collected in 1975

	Lowest	*Highest*
Agatha	0	2
Agent	0	2
Chris	0	; to 3+
C.I.8154 X Frocor[2]	0	; to 2
D.T.411	0	
Era	0	; to 3+
Esp 518/9	0	; to 2
Glenlea	0	; to 3+
Hercules	0	1
Frontana-K58-Newthatch II-50-17	0	4
Kenya Farmer	0	2 to 3+
Macoun	;1	1
Mida-McMurachy-Exchange 11-47-26	0	; to 4
Norquay	0	2
N.D.499	0	; to 2
N.D.506	0	2±
(P X Mq^8)^6 X (Rsc X Etoile de Choisi)	0	2
Romany	0	;1
Rosner triticale	0	
R.L.4308	0	; to 4
R.L.4311	0	; to 2+
R.L. 4320	0	; to 4
R.L.4326	0	2 to 3
R.L. 5405	0	2
Sinton	0	; to 4
St464	0	;1
Tama	0	; to 2
T^6 X (Rsc X Etoile de Choisi)	0	2
Wascana	;1	1+
Wakooma	;1	1+
Webster	0	2 to 3+
WRT240 (Manitou with rye translocation)	0	

Acknowledgments

I thank the staff at Universities and Agriculture Canada Research Stations at the rust nursery locations for planting and caring for the nurseries and for sending rust collections for race identification. Mr. J. H. Campbell was responsible for the technical operation of the survey and for recording rust intensities in the nurseries.

Literature cited

1. Green, G. J. 1975. Stem rust of wheat, barley, and rye in canada in 1974. Can. Plant Dis. Surv. 55:51-57.