Stem rust of wheat, barley and rye in Canada in 1978[1]

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Wheat stem rust occurred sporadically in western Canada in 1978 but generally there was less infection than usual. The most severe infections were observed on susceptible cultivars in experimental plots at Portage and Brandon in south-central Manitoba. Resistant commercial cultivars in farm fields were free from rust. The stem rust that infected Hordeum *jubatum* L. was mainly rye stem rust. The deficiency of wheat stem rust samples for race identification from this important source necessitated intensive sampling in plots of the susceptible cultivar Klein Titan planted at five locations in Manitoba and south-eastern Saskatchewan. Nineteen races were identified. Race C53 (15B-1L) was identified most frequently and it was closely followed by race C33 (15B-1L). Race C25(38), the most widely virulent race identified, was third in order of prevalence. Four new races were found. There were no race changes that affected the resistance of commercial cultivars or lines under test.

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La rouille de la tige du ble s'est manifestee sporadiquement cette année dans l'ouest canadien mais en general on peut dire que l'infection a ete moins grave que d'habitude. Les infestations les plus serieuses ont été observées sur des cultivars sensibles en parcelles d'essais a Portage et a Brandon (centre sud du Manitoba). Dans les plantations commerciales, les cultivars resistants etaient indemnes. La rouille de la tige qui a infect0 Hordeum *jubatum* L. était essentiellement celle du seigle. La pénurie d'echantillons de rouille disponibles aux fins d'identification des races a imposé l'echantillonnage intensif des parcelles du cultivar sensible Klein Titan, installées a 5 endroits du Manitoba et du sud-est de la Saskatchewan. On a ainsi pu identifier 19 races, la C53 (15B-1L) étant la plus fréquente, suivie de près par C33 (15B-1L). La race virulente la plus répandue, C25 (38) venait en troisième place. On a constaté la presence de 4 nouvelles races mais l'évolution du tableau n'était pas suffisante pour alterer la resistance des cultivars commerciaux ou des lignées à l'essai.

Prevalence and importance in western Canada

Wheat stem rust (***Puccinia graminis Pers.*** f. sp. ***tritici*** Eriks. and E. Henn.) was widely distributed in the southern United States early in the 1977-78 growing season. Spore trap results showed that a comparatively large quantity of inoculum was carried into western Canada in June but rust development was sporadic. Infections on susceptible cultivars in experimental plots were less severe than usual, but a plot of the susceptible cultivar Klein Titan at Brandon, Manitoba, was severely damaged (80% infection) by early August and a plot of the same cultivar at Portage was severely infecled (70%) by mid-August. On the other hand, plots of Klein Titan at Morden, Indian Head and Regina had only light infections on August 22. The resistance of the commercial cultivars grown in western Canada continued to protect them and wheat fields in the rust area were free from stem rust.

The pattern of stem rust development was unique in at least one respect. Stem rust was not observed until July 14 on wild barley, ***Hordeum jubatum*** L., at Jordan, Manitoba. Subsequently it was found that this rust was rye stem rust (***P. graminis*** f. sp. ***secalis***). By August ***22*** there was abundant stem rust on wild barley throughout Manitoba and eastern Saskatchewan and by the last week of September it was also abundant in Alberta. A large number of collections were made from wild barley in the three provinces as part of the physiologic race survey but nearly all of them were rye stem rust. Rye stem rust has not damaged commercial crops of rye or barley although it has been prevalent for several years.

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

Rust nurseries consisting of 16 cultivars of wheat, three of barley, one of rye, and one of triticale were grown at 29 locations in Canada in 1978 (Tables 1 and 2). The cultivars included in the nurseries were described in previous reports excepting Coulter, a new cultivar of durum wheat.

Wheat stem rust infections in the rust nurseries were lighter than they have been for many years. Severe infection of the highly susceptible cultivar Red Bobs occurred at only three locations and trace infections occurred at four locations. There was no rust at the other 22 locations (Table 1). The severe infections at the eastern locations of New Liskeard, Ontario, and Normandin, Quebec, could have been initiated by inoculum from barberry.

Rye stem rust was more common in the nurseries than wheat stem rust, occurring in 12 nurseries from Creston, B.C. to Kentville, N.S. The rust on the barley cultivar Montcalm at New Liskeard, Ont. (Table 2) was probably wheat stem rust but infections on Conquest and Wpg M7118-13, that are resistant to wheat stem rust, and Prolific rye, at most other locations suggest that most of the rust on barley was rye stem rust.

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Physiologic specialization

Physiologic races were identified in 1978 using the differential hosts described previously (1, 2).

Following the practice of previous years many stem rust collections were obtained from the universally susceptible wild barley. In earlier years about half of the collections from wild barley contained wheat stem rust, but in 1978 only 28 wheat stem rust isolates were obtained from wild barley in the prairie provinces. There were 296 collections that contained rye stem rust. There were not enough wheat stem rust isolates from wild barley to meet the needs of race survey.

Table 1. Percent infection of stem rust *(Puccinia graminis* f. sp. *tritici)* on 16 wheat cultivars in uniform rust nurseries at 7 locations* in Canada in 1978

	Common Wheat											Durum Wheat				
Location	Red Bobs	Lee	Pitic 62	Neepawa	Napayo	Sinton	Kenya Farmer	Glenlea	Exchange	Frontana	Thatcher[6] x Transfer	Mindum	Wascana	Macoun	Wakooma	Coulter
Indian Head, Sask.	tr**	0	0	0	0	0	0	0	0	0	tr	0	0	0	0	0
Brandon, Man.	80	10	0	0	0	0	5	0	0	tr	5	20	0	0	0	0
Morden, Man.	tr	tr	0	0	0	0	0	0	tr	0	0	0	0	0	0	0
Thunder Bay, Ont.	tr	tr	0	0	0	0	0	0	0	0	0	0	0	0	0	0
New Liskeard, Ont.	70	25	1	5	0	05	0	4	03	5	5	5	0	0	5	0
Normandin, P.Q.	80	10	0	tr	0	0	0	0	5	02	5	15	0	0	0	0
La Pocatiere, P.Q.	tr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* No rust was observed in nurseries at 22 locations: Agassiz and Creston. B.C.: Beaverlodge, Lacombe, Edmonton, and Lethbridge, Alta.; Scott and Melfort, Sask.; Durban, Man.; Kapuskasing, Guelph, Vineland. Sunbury, Appleton, and Ottawa, Ont.: Macdonald College, Lennoxville. and Quebec, P.Q.; Fredericton, N.B.; Kentville and Truro, N.S.; and Charlottetown, P.E.I.

** tr - trace

Table 2. Percent infection of stem rust *(Puccinia graminis)* on 3 cultivars of barley and one cultivar each of rye and triticale in uniform rust nurseries at 12 locations* in Canada in 1978

	Barley			Rye	Triticale
Location	Montcalm	Conquest	Wpg M 7118-13	Prolific	Rosner
Creston, B.C.	0	0	tr	tr	0
Indian Head, Sask.	0	0	0	0	5
Brandon, Man.	tr	0	tr	5	0
Morden, Man.	tr	tr	20	5	0
Thunder Bay, Ont.	tr	0	0	0	0
Guelph, Ont.	0	0	0	10	0
New Liskeard, Ont.	20	0	0	0	0
Appleton, Ont.	10	15	20	60	0
Normandin, P.Q.	10	tr	5	0-70	0
Lennoxville, P.Q.	0	0	0	40	0
La Pocatiere, P.Q.	1	5	10	70	0
Kentville, N.S.	0	0	0	20	0

* No rust was observed in nurseries at 17 locations: Agassiz, B.C.; Beaverlodge, Lacombe, Edmonton, and Lethbridge, Alta.; Scott and Melfort, Sask.; Durban, Man.; Kapuskasing. Vineland. Sunbury, and Ottawa, Ont.; Macdonald College and Quebec, P.Q.; Fredericton, N.B.. Truro. N.S.; and Charlottetown, P.E.I.

Table 3. Distribution by provinces of physiologic races of ***Puccinia graminis*** f. sp. *tritici* on wheat, barley, and grasses and of ***Puccinia graminis*** f. sp. ***secalis*** on barley and grasses in 1978.

Virulence formula and (race number)	Virulence formula";* (effective/ineffective host genes)	Number of isolates from: N.S.	P.Q.	Ont.	Man.	Sask.	Alta.	Total number of isolates	Percent of total isolates
C4 (23)	5,6,7b,8,9a,9b,9d,9e,11, 13,Tt1,Tt2/7a,10,14,15,17						1	1	0 3
C18 (156-1L)	6,8,9a,9b,13,15,17,Tt2/5, 7a,7b,9d,9e,10,11,14,Tt1						1	1	0 3
C25 (38)	7b,9a,9d,9e,Tt1,Tt2/5,6, 7a,8,9b,10,11,13,14,15,17				24	22	1	47	15 5
C33 (15B-1L)	6,9a,9b,13,15,17,Tt2/5,7a, 7b,8,9d,9e,10,11,14,Tt1		5	4	27	39	1	76	25 0
C33 (158-1L)	6,9a,9b,13,15,17,Tt2/5,7a, 7b,8,9d,9e,10,11*,14,Tt1		2	1	1	3		7	2 3
C49 (15)	6,9a,9b,11,13,15,17,Tt2/5, 7a,7b,8,9d,9e,10,14,Tt1				5	6		11	3 6
C53 (158-1L)	6,9a,9b,13,15,Tt2/5,7a,7b, 8,9d,9e,10,11,14,17,Ttl		1	6	73	26	1	107	35 2
C53 (15B-1L)	6,9a,9b,13,15,Tt2/5,7a,7b, 8,9d,9e,10,11*,14,17,Tt1				5	4		9	3 0
C54 (38)	6,7a,7b,9b,9d,9e,10,11, Tt2/5,8,9a,13,14,15,17,Tt1			1	17	1		19	6 3
C56 (38-151)	6,7a,7b,8,9b,9d,9e,10,11, Ttl,Tt2/5,9a,13,14,15,17			4				4	1 3
C57 (32)	9a,9d,9e,Tt1,Tt2/5,6,7a,7b. 8,9b,10,11,13,14,15,17				1			1	0 3
C62 (39)	6,7b,8,9b,9d,9e,11,13,Tt1, Tt2/5,7a,9a,10,14,15,17						1	1	0 3
C63 (32)	7a,9d,9e,10,11,13,17,Tt2/5, 6,7b,8,9a,9b,14,15,Tt1					1		1	0 3
C66 (15)	6,9a,9b,11,13,15,Tt2/5,7a, 7b,8,9d,9e,10,14,17,Tt1					4		4	1 3
C67 (38)	7b,9d,9e,Tt1,Tt2/5,6,7a,8, 9a,9b,10,11,13,14,15,17					2		2	0 7
C74 (115)	6,7b,9a,9b,13,Tt2/5,7a,8, 9d,9e,10,11,14,15,17,Tt1					10		10	3 4
C75 (38)	6,7a,7b,9b,9d,9e,10,11,Tt1, Tt2/5,8,9a,13,14,15,17				1			1	0 3
C76 (11-32)	7a,9a,9b,9d,9e,10,13,17, Tt2/5,6,7b,8,11,14,15,Tt1				1			1	0 3
C77 (48)	5,6,7a,7b,9b,9d,9e,11,13 Ttl,Tt2/8,9a,10,14,15,17						1	1	0 3
Total wheat stem isolates			8	16	155	118	7	304	100
Rye stem rust isolates		2	2	4	166	94	36	304	

* Intermediate infection type.
** All isolates were avirulent on *Sr22*, *Sr24*, *Sr26*, *Sr27*, *Sr29*, and *Sr30*

The sampling problem was partially solved by collecting intensively from plots of the susceptible cultivar Klein Titan planted at Morden (33 isolates), Portage (39 isolates), and Brandon (63 isolates) in Manitoba, and at Indian Head (58 isolates) and Regina (49 isolates) in Saskatchewan. In earlier years it was found that isolates from similar plots were good indicators of the prevalence of the main races but that most of the rare races were isolated from wild barley. There were insufficient isolates from wild barley this year to form a basis for comparison although the rust population again showed broad variability. The smaller number of races identified in 1978 (19 vs 23 to 32 in the previous 4 years) may have resulted from the shortage of collections on wild barley. It is clear that there would not have been a meaningful wheat stem rust physiologic race survey in western Canada in 1978 if the plots of Klein Titan had not been planted. However, five small plots cannot be depended on to provide a reliable sample of the rust population.

Race C53 (15B-1L) became the main race in 1977 and in 1978 it continued to predominate (38% of the isolates) although it was only slightly more prevalent than race C33 (15B-1L) (Table 3). Race C25 (38) was third in prevalence (15.5% of the isolates) as it was in 1977. It continues to be the most widely virulent race identified, but it has not been found in farm fields.

The distribution of the less prevalent races may have been distorted by the sampling procedure. For example,

all isolates of the new race C74 (115) came from the plot of Klein Titan at Indian Head and 13 cultures of race C54 (38) were from Portage. Four new races were identified. Two were isolated from Klein Titan and two were from wild barley. In Manitoba 13 isolates from wild barley were identified as seven races and 142 isolates from Klein Titan were identified as six races. In Saskatchewan 10 isolates from wild barley were identified as five races and 108 isolates from Klein Titan were identified as seven races. Five isolates from wild barley in Alberta were identified as five races. It is clear that the rust on wild barley was more variable than that on Klein Titan.

Four of the seven races identified in Alberta were not found elsewhere. It seems likely that the source of inoculum for Alberta is different than that for Manitoba and Saskatchewan.

The number of isolates of the various races from the five locations where Klein Titan was planted (Table 4) shows that race C53 predominated at Morden and Portage but farther west in Manitoba at Brandon and in Saskatchewan race C33 was more prevalent and race C25 occurred commonly. The less common races occurred sporadically, possibly the result of a non-uniform distribution of a small quantity of primary inoculum.

Table 4. Number of isolates of races identified in stem rust collections from plots of the cultivar Klein Titan at 5 locations.

Location	Race								
	C25	C33	C49	C53	C54	C66	C67	C74	C75
Manitoba									
Morden	0	4	3	25	0	0	0	0	1
Portage	1	1	0	24	13	0	0	0	0
Brandon	21	16	1	25	0	0	0	0	0
Saskatchewan									
Indian Head	14	19	1	12	0	0	2	10	0
Regina	7	17	5	18	0	3	0	0	0

Table 5. Percent of total isolates and races avirulent on single identified resistance genes

Resistance gene	Avirulent isolates % 1978	(1977)	Avirulent races % 1978	(1977)
Sr5	0.6	(0.4)	11.8	(8)
Sr6	82.9	(76.9)	70.6	(76)
Sr7a	8.8	(4.1)	35.3	(24)
Sr7b	28.4	–	52.9	–
Sr8	2.2	(3.6)	23.5	(28)
Sr9a	96.5	(94.8)	58.8	(64)
Sr9b	83.2	(74.8)	76.5	(68)
Sr9b	25.9	(27.4)	64.7	(60)
Sr9e	25.9	(27.4)	64.7	(60)
Sr10	8.5	(3.2)	29.4	(32)
Srl1	14.0	(16.5)	52.9	(52)
Srl3	75.6	(75.9)	64.7	(80)
Sr14	0	(0)	0	(0)
Srl5	70.7	(72.0)	29.4	(36)
Sr17	31.8	(40.0)	29.4	(44)
SrTt1	19.0	(22.9)	47.1	(28)
SrTt2	100	(99.4)	100	(96)

A collection of stem rust on wild barley from Kincaid, Saskatchewan produced infection types 2 to 3+ on highly susceptible Little Club wheat (*T. compactum*). It was avirulent on all of the differentials. In other tests it produced infection types 2 to 3+ on the very susceptible Australian wheat cultivars W2691 and W3498 but it produced only a 0; infection type on the susceptible cultivars Prelude, Red Bobs, Klein Titan, Prelude x Marquis[X], and Pellisier. It was also avirulent on Rosen rye and Rosner triticale, but the barley cultivars Montcalm and Conquest were only moderately resistant. In many ways it resembled the hybrid rust cultures produced by crossing *P. graminis* f. sp. *tritici* and *P. graminis* f. sp. *secalis* (3). Since a race with such a narrow host range would have difficulty surviving in nature its possible origin is of considerable interest. There is no direct evidence indicating how it might have originated but, in view of the large amount of rye stem rust on wild barley in 1978, there is a possibility that it might have originated by somatic hybridization between wheat stem rust and rye stem rust as proposed for the origin of new rust strains in Australia (4).

A group of highly resistant cultivars was inoculated with composite collections of urediospores that included samples from all of the 1978 isolates. The cultivars resistant to all urediospore collections were: C.I. 8154 x Frocor[2], Waldron, Agatha, Norquay, Glenlea, Tama, Esp 518/9, R.L. 5405, ND 499, ND 506, St 464, Coulter, Hercules, Wascana, Wakooma, and Macoun. Cultivars that had susceptible as well as resistant infections were: Mida-McMurachy-Exchange II-47-26, Frontana-K58-Newthatch 11-50-17, Kenya Farmer, R.L. 4314, Chris, Era, Bonny, and Romany. Isolates from large pustules on eight of these cultivars were race C25 (38). These results nearly duplicate those recorded in 1977. It is clear that race C25 (38) is the most threatening of the races identified in recent years but it seems incapable of attacking presently grown commercial cultivars. There were no important changes in the virulence of the rust population on single resistance genes (Table 5).

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