STEM RUST OF WHEAT. BARLEY, AND RYE IN CANADA IN 1971'

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Prevalence and importance in Western Canada

Although air-borne inoculum was present in Western Canada during May and June, wheat stem rust (Puccinia graminis Pers. f. sp. tritici Eriks. and E. Henn.) developed slowly in 1971. It was observed first on July 8 at Winnipeg but was not found again until August 4. During August in southern Manitoba, severe infections developed on the variety Pitic 62 which is grown on a small acreage. By September, susceptible wild barley (Hordeum jubatum L.) was infected throughout Manitoba and eastern Saskatchewan, but there were only traces of stem rust on the widely grown resistant varieties Manitou, Neepawa, and Selkirk.

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

Little wheat stem rust developed in the uniform rust nurseries in 1971. Infections were observed in only 10 of the 33 nurseries as a test of the rust resistance of the varieties grown. However, it is clear that the variety Pitic 62 was susceptible in Manitoba. The common wheat varieties Selkirk, Manitou, and Neepawa and the durum varieties Stewart 63, Hercules, and D. T. 317 were virtually free from infection.

Barley and rye were infected at 14 of the 33 locations. Rye was severely infected at locations in Eastern Canada and British Columbia. Barley was heavily infected only at Creston, B. C. (Table 2).

Physiologic races

Physiologic races were identified by the virulence formula method and by six "standard" differential hosts (Triticum aestivum L. 'Marquis' and 'Reliance'; T. durum Desf. 'Arnautka' and 'Mindum'; T. monococcum L. 'Einkorn'; T. dicoccum Schrank 'Vernal').

Stem rust developed slowly in 1971, but 266 collections were obtained. Of these, 170 were rye stem rust (P. graminis Pers. f. sp.

Table 1. Percentage infection of stem rust (Puccinia graminis f. sp. tritici) on 16 wheat varieties in uniform rust nurseries at locations* in Canada in 1971

	Common wheat												Durum wheat			
Location	Red Bobs	Lee	Pitic 62	Selkirk	Manitou	Neepawa	Kenya Farmer	C.T. 432	Thatcher[6] X Transfer	Exchange	Frontana	R.L. 4255	Mindum	Stewart 63	Hercules	D.T. 317
Creston, B.C.	20	0	0	0	0	0	0	0	0	tr**	0	0	0	0	0	0
Indian Head, Sask.	tr	tr	0	0	0	0	0	0	0	0	0	0	tr	0	0	0
Brandon, Man.	5	tr	40	0	0	0	0	0	0	0	0	0	tr	0	0	0
Morden, Man.	5	0	0	0	0	0	0	0	0	0	0	0	tr	0	0	0
Glenlea, Man.	80	10	30	tr	tr	0	1	0	60	5	50	70	5	0	0	0
Thunder Bay, Ont.	tr	tr	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kapuskasing, Ont.	1	tr	0	0	0	0	0	0	tr	0	0	tr	tr	0	0	0
New Liskeard, Ont..	30	10	tr	0	0	1	tr	0	5	1	tr	1	5	0	0	0
Appleton, Ont.	5	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0
Apple Hill, Ont.	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0

* No rust was observed in nurseries at 23 locations: Agassiz, B.C.; Edmonton, Beaverlodge, Lacombe, and Lethbridge, Alta.; Scott and Melfort, Sask.; Durban, Man.; Kemptville, Guelph, Ottawa, Williamstown, and Vineland, Ont.; La Pocatière, Québec, Macdonald College, Lennoxville, and Normandin, Qué.; Truro and Kentville, N.S.; Fredericton, N.B.; Charlottetown, P.E.I.; and St. John's, Nfld.

** tr = trace

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Table 2. Percentage infection of stem rust (*Puccinia graminis*) on three varieties of barley and one variety of rye in uniform rust nurseries at 14 locations* in Canada in 1971

Location	Barley			Rye
	Montcalm	Parkland	C.I. 10644	Prolific
Agassiz, B.C.	0	0	0	30
Creston, B.C.	60	50	30	70
Brandon, Man.	0	0	0	20
Morden, Man.	0	0	0	tr
Glenlea, Man.	10	0	0	0
Thunder Bay, Ont.	tr	0	0	0
Kapuskasing, Ont.	5	0	tr	0
Kemptville, Ont.	0	0	0	70
Appleton, Ont.	tr	tr	0	70
Apple Hill, Ont.	0	0	0	30
Québec, Qué.	0	0	0	5
Lennoxville, Qué.	0	0	0	70
Kentville, N.S.	0	0	0	30
Charlottetown, P.E.I.	0	0	0	60

* NO rust was observed in nurseries at 19 locations: Edmonton, Beaverlodge, Lacombe and Lethbridge, Alta.; Indian Head, Scott, and Melfort, Sask.; Durban, Man.; New Liskeard, Guelph, Ottawa, Williamstown and Vineland, Ont.; La Pocatière, Macdonald College, and Normandin, Qué.; Truro, N.S.; Fredericton, N.B.; St. John's, Nfld.

secalis Eriks. and E. Henn.) or were mixtures of wheat stem rust and rye stem rust. Rye stem rust has been prevalent since 1968 and the large number of collections in 1971 indicates that its prevalence increased. The reasons for the increase are not clear. The relative scarcity of wheat stem rust may have exaggerated the prevalence of rye stem rust but this factor alone does not appear to explain all of the increase in 1971. There has been no increase in the amount of stem rust on barley in Western Canada, probably because rye stem rust developed late.

The large proportion of rye stem rust reduced the number of wheat stem rust isolates to 135, but it is clear that major changes occurred in the race population of Canada in 1971 (Table 3). Race C18 (15B-1L), which predominated from 1964 to 1970, was found only once. It declined nearly to extinction from over 62% of the isolates in 1970 and was replaced by race C33 (15B-1L) which increased from 16% of the 1970 isolates to over 56% in 1971. The other main race in 1971 was C35 (32-113), which increased from less than 8% in 1970 to over 25% in 1971. Race C33 (15B-1L) does not threaten resistant varieties grown in Western Canada. It is virulent on Marquis-Sr8, and C18 (15B-1L) is avirulent, but Western Canadian varieties do not carry Sr8. Race C35 (32–113) is potentially a more threatening race because it has moderate virulence on seedlings of Thatcher and its important resistant derivatives Manitou and Neepawa. In the field and in adult plant studies in greenhouse, it has not been sufficiently aggressive on Manitou and Neepawa to cause serious concern, but it has increased in prevalence for three consecutive years. TWO Other interesting races, C38 and C41, that first appeared in 1970 were found in 1971. Race C38 (15B-1L) is like C18 (15B-1L), but it is virulent on Norka CSr15), whereas C18 (15B-1L) is avirulent. Like C18 (15B-1L) and C33 (15B-1L), C38 (15B-1L) does not threaten resistant varieties grown in Western Canada. Race C41 (32-113) resembles race C35 (32-113), but it is virulent on Marquis-Srll, whereas, C35 (32–114) is avirulent. Five isolates of race C41 (32–113) were obtained in 1971, and it may be significant that four of them were from farm fields of resistant varieties. Although stem rust was scarce in farm fields in 1971, 20 collections were obtained from wheat fields and cultures were

Table 3. Distribution by provinces of physiologic races of Puccinia graminis f. sp. tritici collected on wheat, barley, and grasses in 1971 and frequency of isolations of P. graminis f. sp. *secalis* from barley and wild grasses

Virulence formula (race) number	Virulence formula (effective/ineffective host genes)	Number of isolates from					Total number of isolates	Percent of total isolates
		Ont.	Man.	Sask.	Alta.	B.C.		
C4 (23)	5, 6, 11/7, 15, 16					1	1	0.7
C4 (48)	5, 6, 11/7, 15, 16					1	1	0.7
C14 (38-39)	6, 7, 10, 11/5		2	2		1	5	3.7
C18 (15B-1L)	6, 8, 9a, 9b, 13, 15/1, 5, 7, 10, 11, 14, 16		1				1	0.7
C27 (23-59)	6, 11/5, 7, 10, 15, 16					2	2	1.5
C27 (33)	6, 11/5, 7, 10, 15, 16		1				1	0.7
C33 (15B-1L)	6, 9a, 9b, 13, 15/1, 5, 7, 8, 10, 11, 14, 16	14	44	16	2		76	56.4
C35 (32-113)	1, 10, 11, 13/5, 6, 7, 8, 9a, 9b, 14, 15, 16	1	21	12			34	25.3
C35 "S" (32-113)	1, 10, 11, 13/5, 6, 7, 8, 9a, 9b, 14, 15, 16		1				1	0.7
C38 (15B-1L)	6, 8, 9a, 9b, 13/1, 5, 7, 10, 11, 14, 15, 16	2	1				3	2.2
C41 (32-113)	1, 10, 13/5, 6, 7, 8, 9a, 9b, 11, 14, 15, 16		5				5	3.7
C44 (15B-1L)	6, 9a, 9b, 13/1, 5, 7, 8, 10, 11, 14, 15, 16		4	1			5	3.7
Total wheat stem rust isolates		17	80	31	2	5	135	100.0
Rye stem rust *P. graminis* f. sp. secalis isolates		3	110	54		3	170	

established from half of them. In addition to the four isolates of race C41 (32–113) six isolates of C33 (15B-1L), seven of C35 (32-113), and one of C35'S' (32-113) were identified from these collections. Race C35'S" (32–113) is a strain of race C35 that attacks Selkirk. Clearly races C35 (32–113) and C41 (32–113) are found more commonly on resistant commercial varieties than other races, but there is no evidence that they are sufficiently aggressive on these varieties to cause important losses. However, they demonstrate that the rust population has evolved strains with increased virulence on the kind of varieties now grown in the rust area of Western Canada. Further evolution in this direction could produce races that are virulent and aggressive on these varieties.

One new race was found in 1971 in Manitoba and Saskatchewan. It resembles the predominant race C33 (15B-1L), but is virulent on Norka (Sr15). It has been called C44 (15B-1L) and its formula appears in Table 3. It was isolated five times (4% of the isolates) and may be sufficiently aggressive to become prevalent. It does not threaten varieties now grown in the rust area.

The disappearance of two old and important races should not be overlooked. Race C17 (56) was not found in Western Canada in 1971 for the first time since 1931. This important and well–adapted race has probably not been eliminated, but clearly its prevalence has been reduced to a very low level. Race C20 (11) was present from 1964 to 1970. It was one of the first races found with some virulence on Manitou, and, although it was not sufficiently aggressive to cause damage, it may have been a progenitor of races such as C35 (32-113) and C41 (32–113) that have increased virulence on Manitou and Neepawa.

The isolates from susceptible wheat varieties and susceptible wild grasses, which are presumed to be nonselective, show about the same distribution as the isolates from all hosts (Table 4). Races C33 (15B-1L) and C35 (32–113) predominate. However, race C35'S' (32–113) was found only on a selective variety and does not appear in Table 4, and only one isolate of race C41 (32–113) was from a nonselective host. These two races appear to have been even scarcer than the data in Table 3 indicate. All isolates of the new race C44 (15B-1L) were collected on nonselective hosts.

There were some sharp changes in the effectiveness of some of the identified resistance genes (Table 5). These changes resulted from the decline of race C18 (15B-1L) and the increase of races C33 (15B-1L) and C35 (32–113). The effectiveness of Sr1 increased and that of Sr6, Sr9a, Sr9b, and Sr15 declined because of the increased prevalence of race C35 (32–113). The effectiveness of Sr8 was reduced to a very low level by the increase of races C33 (15B-1L) and C35 (32–113) and the decline of race

Table 5. Percent of total isolates avirulent on single identified resistance genes and number of avirulent races in 1971

Resistance gene	Avirulent isolates (%) 1971 (1970)	Number of avirulent races
Sr 1	31.2 (13.8)	3
Sr 5	1.6 (1.5)	2
Sr 6	68.8 (90.7)	7
Sr 7a	0.8 (4.0)	1
Sr 8	3.2 (71.1)	2
Sr 9a	65.6 (87.2)	4
Sr 9b	65.6 (87.2)	4
Sr 10	32.0 (11.3)	4
Sr 11	30.4 (14.3)	5
Sr 13	96.8 (97.0)	7
Sr 14	0 (0)	
Sr 15	59.2 (80.3)	2
Sr 16	0 (0)	

Table 4. Distribution by provinces of physiologic races of Puccinia *graminis* f. sp. tritici collected on susceptible varieties of wheat and susceptible wild grasses in 1971

Virulence formula (race) number	Virulence formula (effective/ineffective host genes)	Number of isolates from Ont.	Man.	Sask.	B.C.	Total number of isolates	Percent of total isolates
C4 (23)	5, 6, 11/7, 15, 16				1	1	1.0
C4 (48)	5, 6, 11/7, 15, 16				1	1	1.0
C14 (38–39)	6, 7, 10, 11/5		2	2		4	3.9
C18 (15B-1L)	6, 8, 9a, 9b, 13, 15/1, 5, 7, 10, 11, 14, 16		1			1	1.0
C27 (23–59)	6, 11/5, 7, 10, 15, 16				2	2	1.9
C27 (33)	6, 11/5, 7, 10, 15, 16		1			1	1.0
C33 (15B-1L)	6, 9a, 9b, 13, 15/1, 5, 7, 8, 10, 11, 14, 16	7	39	13		59	57.8
C35 (32–113)	1, 10, 11, 13/5, 6, 7, 8, 9a, 9b, 14, 15, 16		14	12		26	25.5
C38 (15B-1L)	6, 8, 9a, 9b, 13/1, 5, 7, 10, 11, 14, 15, 16	1				1	1.0
C41 (32-113)	1, 10, 13/5, 6, 7, 8, 9a, 9b, 11, 14, 15, 16		1			1	1.0
C44 (15B-1L)	6, 9a, 9b, 13/1, 5, 7, 8, 10, 11, 14, 15, 16		4	1		5	4.9
Total isolates		8	62	28	4	102	100.0

C18 (15B-1L). Sr13 continued to be the most effective gene.

Six composite collections of urediospores from all isolates were used to inoculate seedlings of a group of highly resistant varieties. Varieties resistant to all components of the composite collections are: Frontana-K58-Newthatch II-50-17, St464, C.I. 8155, WRT 240 (Manitou with rye translocation), Agent, Tama, Esp 518/9, Inia 66, Minn. II-54-30, Era, Hercules, D.T. 327, Wascana, and R.L. 5244 (T. monococcum). Varieties that had susceptible pustules are: Mida-McMurachy-Exchange 11-47-26, Chris, Romany, Bonny (one plant), Giza 144, C.T. 296, C.T. 299, C.T. 615, Timgalen, and D.T. 407. Races C33 (15B-1L), C35 (32-113), and C41 (32-113) were isolated most frequently from these varieties. C.T. numbers are varieties from the Western Canadian Spring Wheat Cooperative Test and D.T. numbers are from the Durum Test.

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