STEM RUST OF WHEAT, BARLEY AND RYE IN CANADA IN 1966[1]

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Prevalence and importance in Western Canada

Wheat stem rust (Puccinia graminis Pers. f. sp. tritici Erikss. & Henn.) was first observed much later than usual in Manitoba on July 12. It developed slowly and by the end of the growing season only traces were present on susceptible varieties and wild grasses but the rust was widely distributed throughout Manitoba, Saskatchewan, and southern Alberta. Cultivated varieties suffered little or no damage.

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

Wheat stem rust infections were relatively light in the uniform rust nurseries, occurring only in 16 of the 36 nurseries grown throughout Canada (Table 1). The heaviest infection of susceptible varieties occurred in the southern parts of the Prairie Provinces from Winnipeg in the east to Lethbridge in the west. No rust was observed at more northerly locations such as Lacombe and Edmonton, Alberta, Scott and Melfort, Saskatchewan, and The Pas, Manitoba. In Eastern Canada infections were light and they occurred sporadically. The proximity of barberry bushes to the nurseries may have been an important factor determining the degree of rust infection.

The varieties in the nurseries reacted as expected. The new common wheat variety 'Manitou' had only a trace of rust at 2 locations and the recently released durum wheat variety 'Stewart 63' was free from infection at all locations. 'Selkirk' was lightly infected only at Glenlea and Winnipeg in the Red River Valley. In Western Canada, 'Lee' was more heavily infected than 'Thatcher' in 2 of the 3 nurseries where infections exceeded 1 percent. A similar situation occurred in 1965 when 'Thatcher' appeared to be less susceptible than 'Lee' to race C18 (15B-1L (Can.)) which predominated in both years. Race identifications of isolates from the nursery at Ottawa in Eastern Canada demonstrated that race C9(15B-1L (Can.))was responsible for the heavier rusting of 'Thatcher' there. Apparently this race was introduced into the plots on plants transferred from the greenhouse.

Stem rust was observed on barley and rye in only 10 of the 34 nurseries (Table 2) and infections were generally light. The heaviest infections occurred at Appleton, Ontario, where all varieties of barley as well as the rye showed moderately heavy infections. These infections presumably were caused by rye stem rust, which also attacks barley, including those varieties resistant to wheat stem rust such as 'Parkland'. The barley variety 'C.I. 10644' appears to be less susceptible to rye stem rust than 'Parkland'. 'Montcalm' is susceptible to wheat stem rust which appears to have caused most of the infection on it. The barley at Creston, B. C., probably ripened before rye stem rust could develop on it.

Distribution of physiologic races

In 1966, the isolates of wheat stem rust identified in Canada were classified into 11 virulence formulas that correspond to 13 standard physiologic races (Table 3). The standard physiologic races were identified on the differential host varieties described by Stakman et al(2). The virulence formulas and their numbers (1) were obtained by determining the reactions to each isolate of lines of 'Marquis' wheat carrying single identified genes for resistance. In this report the races are designated by the formula number followed by the standard race number in brackets.

Virulence formulas C1 to C30 have been recorded (1). One new virulence combination was observed in 1966: C31 - 5, 6, 7, 10, 11/.

The relatively small number of races found probably results from the scarcity of stem rust in Canada in 1966. The 163 isolates identified is not much more than half the number usually obtained.

The prevalence of the main races changed in accordance with the trend that began in 1964. Race C18(15B-1L (Can.)) increased from 53% of all isolates in 1965 to 68% in 1966 and race C17(56) decreased from 15% in 1965 to 5.5% in 1966. The other 9 races occurred in small amounts. Races C1(17), C22(34), C25(38) and C31(27) occurred mainly in Ontario and Quebec, race C4(44) in British Columbia, and C9(15B-1L (Can.)) in Manitoba and Saskatchewan. Races C2(17A), C14(23, 38), and C20(11) were found in trace amounts in both Eastern and Western Canada.

These changes had little practical significance. The resistant varieties now grown in Canada are resistant to races C18(15B-1L (Can.)) and C17(56) and to most of the other races. The most interesting races are C22(32) and C25(38) that are moderately virulent on seedlings of some highly resistant varieties including the new common wheat variety 'Manitou', but they have less virulence on adult plants of 'Manitou' (1) and for the present do not appear to seriously threaten that variety.

The tabulation of the isolates from susceptible hosts showed that the over-all survey results were not greatly influenced by the collection of rust from

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Table 1. Percent infection of stem rust of wheat (Puccinia graminis f. sp. tritici) on 14 wheat varieties in uniform rust nurseries at 16[1] locations in Canada in 1966.

Locality	Common wheat										Durum wheat			
				Sh	rk	Manit	Kenya Farm	McMi						
Creston, B. C.	2	tr	0	0	0	0	0	0	0	0	0	0	0	0
Lethbridge, Alta.	50	40	1	1	0	0	0	0	O t r		1	0	0	tr
Indian Head, Sask.	50	10	tr	1	0	0	0	O t r t r			25	0	0	0
Brandon, Man.	20	5	tr	tr	0	0	0	0	1	0	5	0	0	0
Morden, Man.	70	40	5	1	0	0	0	0	0	0	25	0	0	0
Winnipeg, Man.	60	70	20	10	tr	tr	tr	tr	1	5	40	tr	0	0
Glenlea, Man.	70	50	15	15	3	tr	3	3	3	tr	20	tr	0	tr
Fort William, Ont.	1	1	tr	1	0	0	0	0	0	0	5	tr	0	0
Kapuskasing, Ont.	tr	1	tr	0	0	0	0	0	0	0	0	0	0	0
Guelph, Ont.	20	30	tr	tr	0	0	0	0	0	0	0	0	0	0
Appleton, Ont.	tr	5	0	0	0	0	0	0	0	0	0	0	0	0
Ottawa, Ont.	tr	50	30	4	0	0	0	0	1	5 t r	0	0	0	0
Lennoxville, Que.	tr	tr	0	0	0	0	0	0	0	0	0	0	0	0
La Pocatière, Que.	30	20	10	20	0	0	2	20	10	50	20	5	0	0
Normandin, Que.	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Kentville, N. S.	tr	0	0	0	0	0	0	0	0	0	0	0	0	0

[1] No rust was observed in nurseries at 20 other locations: Saanichton and Agassiz, B. C., Edmonton, Beaverlodge and Lacombe, Alta., Scott and Melfort, Sask., The Pas, Man., Williamstown, Douglas, Alfred, Kemptville, Merrickville and St. Catharines, Ont., Macdonald College and L'Assomption, Que., Fredericton, N. B., Charlottetown, P. E. I., Doyles and St. John's, Nfld.

Table 3. Distribution by provinces of physiologic races of Puccinia graminis f. sp. tritici collected on wheat, barley and grasses in 1966.

virulence Formula Number	Physiologic Race Number	Province								Number of Isolates	Percent of Total Isolates
		P.E.I.	N.S.	Que.	Ont.	Man.	Sask.	Alta.	B. C.		
C1	17	0	0	1	5	0	0	0	0	6	3.7
c2	17A	0	0	2	4	3	2	0	0	11	6.7
c4	44	0	0	0	0	0	0	0	2	2	1.2
C9	15B-1L (Can.)	0	0	0	0	1	1	0	0	2	1.2
C14	23*, 38	0	0	1*	1	1	0	1	0	4	2.5
C17	56	0	0	3	2	1	0	3	0	9	5.5
C18	15B-1L (Can.)	0	1	10	15	42	26	16	1	111	68.1
C20	11	1	0	0	0	2	0	1	0	4	2.5
C22	32	0	0	1	4	0	0	1	0	6	3.7
C25	38, 151*	0	0	1	5	0	0	1*	0	7	4.3
C31	27	0	0	0	1	0	0	0	0	1	0.6
Total Isolates		1	1	19	37	50	29	23	3	163	100.00

* Indicates where race was found.

Table 2. Percent infection of stem rust (Puccinia graminis) on three varieties of barley and one variety of rye in uniform rust nurseries at 10[1] locations in Canada in 1966.

Locality	Barley			Rye
	Montcalm	Parkland	C. I. 10644	Prolific
Creston, B. C.	0	0	0	10
Lethbridge, Alta.	tr	0	0	10
Indian Head, Sask.	10	0	0	0
Morden, Man.	15	0	0	0
Guelph, Ont.	5	tr	tr	tr
Kemptville, Ont.	0	0	0	tr
Appleton, Ont.	40	40	10	60
Ottawa, Ont.	40	5	0	tr
Lennoxville, Que.	0	0	0	1
La Pocatière, Que.	0	0	0	tr

[1] No rust was observed in nurseries at 24 other locations: Saanichton and Agassiz, B. C., Edmonton, Beaverlodge and Lacombe, Alta., Scott and Melfort, Sask., Brandon and The Pas, Man., Fort William, Kapuskasing, Williamstown, Douglas, Alfred, Merrickville and St. Catharines, Ont., Macdonald College, L'Assomption and Normandin, Que., Kentville, N.S., Fredericton, N.B., Charlottetown, P.E.I., Doyles and St. John's, Nfld.

resistant and hence selective hosts.

Rye stem rust was more prevalent in relation to wheat stem rust than is usual. Thirty-two collections of stem rust on barley and wild barley from Ontario contained rye stem rust.

The formula system of race nomenclature assists in determining the relative effectiveness of the resistance conferred by the identified genes. Gene Sr6 confers resistance to more races than any other identified gene (Table 4). It is ineffective against only 3 of the uncommon races identified by the formula system. Such a degree of effectiveness from a gene that has been a main defense against stem rust in Western Canada for 12 years is rather surprising. The varieties 'Selkirk' and 'Pembina', that have predominated in the rust area for these 12 years, depend on Sr6 for resistance to race 15B and several other less prevalent races. When 'Selkirk' was released to farmers in 1954, race 15B-3 (Can.) and several strains of race 29 had been found that could attack it and a few later years race 15B-5 (Can.), that can also attack it, was found. These races now occur rarely if at all, Races virulent on Sr6 (C20 (11, 87), C22 (32) and C25 (38)) that have been found in recent years have not yet demonstrated any greater ability to increase than did the earlier Sr6 virulent races. The reasons why races virulent on 'Selkirk' and 'Pembina' failed to become epidemic are not clear. Other varieties carrying Sr6 have been vigorously attacked at certain locations but the races attacking them could not develop on 'Selkirk' or 'Pembina'. The main difference between 'Selkirk' and 'Pembina' and the other varieties is that they carry adult plant resistance from 'H44' which presumably protected them from races virulent on

Table 4. The percentage of total isolates avirulent on single identified resistance genes.

Virulence Formula No.	Resistance Gene							
	Sr5	Sr6	Sr7	Sr8	Sr9a	Sr9b	Sr10	Sr11
C1	3.5	3.5	3.5	0	3.5	3.5	3.5	3.5
c2	5.3	5.3	5.3	0	5.3	5.3	5.3	0
c4	1.8	1.8	0	---*	---	---	---	1.8
c9	0	1.8	1.8	1.8	1.8	1.8	1.8	0
C14	0	3.5	3.5	---	---	---	3.5	3.5
C17	0	7.1	0	7.1	7.1	7.1	0	7.1
C18	0	65.5	0	65.5	65.5	65.5	0	0
c20	0	0	2.7	2.7	0	0	0	2.7
c22	0	0	0	0	3.5	0	0	0
C25	0	0	0	---	---	---	0	0
C31	0.9	0.9	0.9	---	---	---	0.9	0.9
Total	11.5	89.4	17.7	77.1	86.7	83.2	15.0	19.5

* A dash indicates that the reaction is unknown.

varieties such as 'McMurachy' that carry only Sr6. The only conclusion that seems justified with our present knowledge is that the rust was unable to combine virulence on the 'H44' adult plant resistance and Sr6 with sufficient aggressiveness to be epidemic.

Genes Sr8, Sr9a and Sr9b also protected against most of the rust population. They confer a lower level of resistance than Sr6.

Races C22(32) and C25(38) are the most threatening of those identified (Table 4). Only is effective against C22 (32) and although 'Marquis' is resistant to C25(38) none of the identified genes have been shown to be effective against it. These races do not appear to seriously threaten the varieties grown in Western Canada (1), but they indicate the need of a larger group of identified and isolated genes for race differentiation and breeding purposes.

A group of highly resistant varieties was inoculated with bulked urediospores of all isolates. The varieties 'Kenya Farmer', '(R. L. 2768. 1)', 'C. T. 289', 'R. L. 4204', and 'St 464' showed only resistant infections. 'Mida-McMurachy-Exchange II-47-26', 'Frontana-K58-Newthatch 11-50-17', 'Justin', 'N. D. 264', 'Chris' and 'C. T. 261' showed occasional susceptible infections that were caused by races C14(38) and C22(32).

Acknowledgements

I wish to thank the many university and Department of Agriculture personnel who cared for the rust nurseries. Their help makes this project possible. I am grateful also to many others who annually make the rust collections used in the physiologic race survey. Mr. J. H. Campbell carried out the technical work of the program.

literature cited

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