STEM RUST OF WHEAT, RYE AND BARLEY IN CANADA IN *1965*

G. J. Green[1]

Prevalence and importance in Western Canada

Wheat stem rust (Puccinia graminis Pers. f. sp. tritici Erikss. & Henn.) was widely distributed in Western Canada in 1965 and severe infections developed on susceptible varieties in the three Prairie Provinces. It was first found at Morden, Manitoba, on June 17. Development was slow until mid-July, but by the end of July there was abundant infection on susceptible varieties and wild grasses in much of Western Canada. Fields of susceptible varieties were severely infected before harvest, which was later than normal.

Fortunately, the acreage of susceptible varieties was small and the overall loss was small. The resistant varieties 'Selkirk', 'Pembina', 'Ramsey' and 'Stewart 63' that predominate in the main rust area of Manitoba and eastern Saskatchewan were nearly free from stem rust, but fields of the 15B susceptible variety 'Lee' had moderately severe infections. Stem rust infections were light on the variety 'Thatcher' that predominates in central and western Saskatchewan and in Alberta. Susceptible varieties of durum wheat, mostly 'Pelissier' and 'Stewart', sown in southwestern Saskatchewan were severely infected and suffered heavy losses. Some fields were reported to have been destroyed. The severe infections on susceptible varieties indicate that the resistance of the predominant varieties in Weslern Canada again prevented widespread and severe stem rust losses.

The small amount of stem rust on 'Thatcher', the main variety in Western Canada, was unexpected. 'Thatcher' is susceptible to the biotypes of race 15B found in earlier years and race 15B predominated in 1965. It appears that, in the fieldunder the relatively cool conditions that prevailed in 1965, 'Thatcher' is resistant to the biotype of race 15B now prevalent This biotype, C18(15B-1L (Can.)), was first found in 1962 and has quickly increased to predominance. It was mainly responsible for the severe damage to susceptible durum wheat in southwestern Saskatchewan and to susceptible varieties in Manitoba.

Stem rust of wheat in the rust nurseries

Uniform rust nurseries that included the 13 varieties shown in Table 1, were grown at 37 locations across Canada in 1965. The nurseries were planted and cared for by Canada Department of Agriculture and University personnel. A small sheaf was cut from each row of each nursery before the plants matured and sent to Winnipeg where disease ratings were made.

Severe infections developed in nurseries from Alberta to Quebec on the susceptible varieties 'Red Bobs' and 'Marquis'. The severe stem rust epidemic seemed to be confined to central Canada, since most nurseries in British Columbia and all of those located east of Quebec were free from infection.

In most nurseries, the variety 'Lee' was more severely infected than 'Thatcher'. Both varieties were considered susceptible to race 15B, but 'Thatcher' appears to be less susceptible than 'Lee' to the strain of 15B now prevalent. The widely grown variety 'Selkirk' was lightly infected at only a few locations, and the recently released variety 'Manitou' had only traces of rust at a few locations. The new durum wheat variety 'Stewart 63' had only a trace of rust at one location.

Stem rust of barley and rye in the rust nurseries

The barley variety 'Montcalm' is susceptible to both wheat stem rust and rye stem rust (P. graminis Pers. f. sp. secalis Erikss. & Henn.), and it was infected at the same locations as susceptible varieties of wheat (Table 2). The smaller percentages of rust on 'Montcalm' than on wheat is attributable to the earlier maturity of barley. The barley varieties 'Parkland' and 'C.I. 10644' are resistant to wheat stem rust, but susceptible to rye stem rust. They appear to have matured before heavy infections of rye stem rust could develop on them.

Rye stem rust was widely distributed on 'Prolific rye' (Table 2). The heaviest infections were at locations in Eastern Canada where barberry occurs, and at Creston, B. C. The reason for the heavy infection of rye stem rust at Creston is not known. Creston is isolated from the prairie region by mountains, and in past years physiologic race surveys of wheat stem rust have indicated that inoculum is brought into the Creston area from the south. There is no comparable information to indicate the source of inoculum of rye stem rust.

[1] Plant Pathologist, Canada Department of Agriculture Research Station, Winnipeg, Manitoba.

Table 1. Percent infection of stem rust of wheat (Puccinia graminis f. sp. tritici) on 13 wheat varieties in uniform rust nurseries at 29[1] locations in Canada in 1965.

Locality	Common Wheat										Durum Wheat		
											Mindum	Ramsey	Stewart 63
Creston, B. C.	1	tr[2]	0	0	0	0	0	0	0	tr	0	0	0
Edmonton, Alta.	50	20	5	tr	0	0	0	0	5	0	5	0	0
Lacombe, Alta.	5	1	2	tr	0	0	0	0	0	0	tr	0	0
Lethbridge, Alta,	10	tr	0	0	0	0	0	0	0	0	tr	0	0
Scott, Sask.	25	5	35	2	0	tr	tr	0	2	tr	45	tr	0
Melfort, Sask.	80	45	25	20	0	3	25	0	35	10	75	0	tr
Indian Head, Sask.	40	5	2	tr	tr	0	0	0			5	0	
Brandon, Man.	80	20	60	5	0	20	tr	0	10	tr	10	tr	0
The Pas, Man.	50	15	10	5	5	0	0	0	tr	tr	1	0	0
Morden, Man.	70	60	60	5	0	tr	tr	0	20	0	20	tr	0
Winnipeg, Man.	90	90	40	10	tr	tr	1	0	50	10	50	1	0
Glenlea, Man.	80	50	40	10	0	tr	0	0	1	tr	30	0	0
Fort William, Ont.	65	50	40	25	0	0	0	0	4	0	10	0	0
Kapuskasing, Ont.	5	tr	0	0	0	0	0	0	0	0	tr	tr	0
St. Catharines, Ont.		1	0	1	0	0	0	0	1	0	5	1	0
Guelph, Ont.	50	50	15	5	tr	0	10	0	2	tr	45	2	0
Kemptville, Ont.	25	30	0	tr	0	0	0	0, 30*	1	5	10	5	0
Merrickville, Ont.	60	40	5	5	0	tr	tr	0	5	0	7	5	0
Appleton, Ont.	70	100	30	5	0	40	25	tr	35	35	80	30	0
Williamstown, Ont.	tr	tr	0	0	0	0	0	0	0	0	0	0	0
Alfred, Ont.	tr	0	0	0	0	0	0	0	tr	0	0	0	0
Verner, Ont.	80	60	1	5	0	0	0	0	1	tr	10	1	0
Ottawa, Ont.	70	70	50	10	0	5	tr	0	20	10	40	30	0
Macdonald Coll., Que.	40	15	20	tr	0	tr	tr	0	35	tr	40	tr	0
Lennoxville, Que.	0	5	2	0	0	0	tr	0	0	0	8	0	0
La Pocatière, Que.	60	80	20	10	0	5	0	tr	20	10	20	tr	0
L'Assomption, Que.	tr	2	0	0	0	0	0	0	tr	0	tr	0	0
Normandin, Que.	1	1	tr	0	0	0	tr	0	0	tr	5	1	0
Qukbec, Que.	20	5	0	tr	0	tr	0	0	0	tr	10	tr	0

[1] No rust was observed in 8 other nurseries located at Saanichton and Agassiz, B.C., Beaverlodge, Alta., Nappan and Kentville, N. S., Fredericton, N. B., Charlottetown, P. E. I., and Doyles, Nfld.

[2] tr = trace infection

* Segregating

Table 2. Percent infection of stem rust (Puccinia graminis) on three varieties of barley and one variety of rye in uniform rust nurseries at 22[1] locations in Canada in 1965.

Locality	Barley			Rye
	Montcalm	Parkland	C.I. 10644	Prolific
Creston, B. C.	1	tr	1	60
Edmonton, Alta.	10	5	0	1
Lacombe, Alta.	1	0	0	0
Scott, Sask.	tr	0	0	0
Melfort, Sask.	tr	0	0	0
Indian Head, Sask.	tr	0	0	5
Brandon, Man.	10	0	0	5
The Pas, Man.	tr	tr	tr	tr
Morden, Man.	50	tr	tr	tr
Winnipeg, Man.	30	tr	tr	tr
Glenlea, Man.	10	tr	tr	10
Fort William, Ont.	tr	tr	0	tr
Guelph, Ont.	15	tr	0	80
Kemptville, Ont.	50	5	1	20
Merrickville, Ont.	30	tr	0	50
Appleton, Ont.	25	10	5	70
Verner, Ont.	tr	0	0	0
Ottawa, Ont.	20	tr	0	10
Macdonald Coll., Que.	5	0	0	15
Lennoxville, Que.	tr	0	0	0
La Pocatibre, Que.	tr	0	0	5
L'Assomption, Que.	5	5	2	0

[1] No rust was observed in nurseries located at Saanichton and Agassiz, B. C., Beaverlodge and Lethbridge, Alta., Kapuskasing, St. Catharines, Williamstown and Alfred, Ont., Normandin and Qubbec, Que., Nappan and Kentville, N. S., Fredericton, N. B., Charlottetown, P.E.I., and Doyles, Nfld.

Distribution of physiologic races

In 1965, 15 physiologic races were identified on the differential host varieties 'Marquis', 'Reliance', 'Arnautka', 'Mindum', 'Einkorn' and 'Vernal' of the set described by Stakman et al. (3). Lines of 'Marquis' wheat carrying single substituted resistance genes (2) were used to classify cultures into 15 virulence formulas. The 23 virulence combinations described in 1964 (1) and seven new combinations appear in Table 5. In this report, races are designated by the formula number followed by the physiologic race number in parentheses.

The main feature of the physiologic race distribution in Canada in 1965 was a continuation of the trend of increasing prevalence of race C18(15B-1L (Can.)), and of decreasing prevalence of races C17 (56) and C9(15B-1L (Can.)). Race C18(15B-1L (Can.)) increased from 31. 3% of the isolates in 1964 to 53% in 1965 (Table 3), whereas, race C17(56) decreased by 6. 9% to 15% of the isolates, and race C9(15B-1L (Can.)) decreased from 15. 4% to 1.9%. These changes probably had practical importance, because the variety 'Thatcher' that predominates in Saskatchewan and Alberta appears to have some resistance to race C18(15B-1L (Can.)). It was not seriously affected by stem rust in 1965 when susceptible' durum wheat varieties in southwestern Saskatchewan were heavily rusted. In the main rust area of Manitoba and eastern Saskatchewan, where 'Selkirk' and 'Pembina' predominate, the changes had no significance.

There was a sharp increase, mainly in Ontario and Quebec, of races C1(17) and C2(17A), and the new virulence combinations C24(17) and C29(17) were found. There is no obvious reason for the increase of races C1(17) and C2(17A) as they do not threaten

Table 5. Virulence formulas, formula numbers, and physiologic race numbers of cultures identified in 1964 and 1965.

Formula Number	Virulence Formula (Effective/Ineffective Host Genes)	Physiologic Race
C1	5, 6, 7, 9a, 9b, 10, 11/8	17
C2	5, 6, 7, 9a, 9b, 10/8, 11	17A
c 3	5, 6, 9a, 11/7, 8, 9b, 10	29-4 (Can.)
c 4	5, 6, 11/7	**23**
c 5	5, 9a, 9b, 11/6, 7, 8, 10, GB[1]	29-1 (Can.)
C6	5, 9a, 9b, 11, GB/6, 7, 8, 10	29-2 (Can.)
c 7	5, 11, GB/6, 7	48
C8	5, 11/6, 7, GB	48A
c 9	6, 7, 8, 9a, 9b, 10/5, 11	15B-1L (Can.)
C10	6, 7, 8, GB/5, 9a, 9b, 10, 11	15B-1 (Can.)
C11	6, 7, 8/5, 9a, 9b, 10, 11, GB	15B-4 (Can.)
C12	6, 7, 9a, 9b, 10, 11/5, 8	11
C13	6, 7, 10, 11/5, 8, 9a, 9b	32, 113
C14	6, 7, 10, 11/5	14, 38
C15	6, 7, 10/5, 8, 9a, 9b, 11	11, 32, 113
C16	6, 7, 11/5	39
C17	6, 8, 9a, 9b, 11/5, 7, 10	11, 56
C18	6, 8, 9a, 9b/5, 7, 10, 11	15B-1L (Can.)
C19	6, 10, 11/5, 7	10
c20	7, 8, 11/5, 6, 9a, 9b, 10	11, 87
C21	9a, 11/5, 6, 7, 8, 9b, 10	32
c22	9a/5, 6, 7, 8, 9b, 10, 11	32
C23	/5, 6, 7	38
C24	5, 7, 9a, 9b, 10/6, 8, 11	17
C25	/5, 6, 7, 10, 11	38
C26	6, 7, 8, 9b/5, 9a, 10, 11	15B-4 (Can.)
C27	6, 11/5, 7, 10	33, 59
C28	6, 8, 9b, 11/5, 7, 9a, 10	18, 54
C29	5, 6, 7, 9a, 10, 11/8, 9b	17
C30	9a, 9b/5, 6, 7, 8, 10, 11	29

[1] GB indicates the reaction of the variety Golden Ball

Table 3. Distribution by provinces of physiologic races of Puccinia graminis f. sp. tritici collected on wheat, barley and grasses in 1965.

Virulence Formula Number	Physiologic Race Number	Province							Number of Isolates	Percent of Total Isolates
		P. E. I.	Que.	Ont.	Man.	Sask.	Alta.	B. C.		
C1	17	1	4	36	3	2	1	0	47	12.6
C2	17A	0	3	12	1	2	0	0	18	4.8
C9	15B-1L (Can.)	0	0	1	1	4	1	0	7	1.9
C11	15B-4 (Can.)	0	0	0	0	1	0	0	1	0.3
C13	113	0	0	1	0	0	0	0	1	0.3
C17	56	0	1	10	9	20	16	0	56	15.0
C18	15B-1L (Can.)	0	5	30	37	91	35	0	198	53.0
C20	11	0	0	2	3	1	1	0	7	1.9
C20	15-87	0	1	6	1	1	1	0	10	2.7
c22	32	0	0	2	0	0	2	0	4	1.0
C24	17	0	0	3	0	1	0	0	4	1.0
C25	38	0	0	5	3	3	2	0	10	3.5
C27	33	0	0	0	0	0	0	1	1	0.3
C27	59	0	0	0	0	0	0	1	1	0.3
C28	18	0	0	0	0	0	0	2	2	0.5
C28	54	0	0	0	0	0	0	1	1	0.3
C29	17	0	0	1	0	0	0	0	1	0.3
C30	29	0	0	0	0	0	0	1	1	0.3
Total Isolates		1	14	109	58	126	59	6	373	100.0

resistant commercial varieties.

There was very little difference between the distribution of races isolated from all varieties (Table 3), and the distribution of the races isolated from susceptible varieties (Table 4). Evidently the isolates from selective, resistant varieties did not influence the results of the survey in any important way.

In 1965, the recently released variety 'Manitou' was inoculated with all isolates. No isolate produced type 4 infections on 'Manitou', but races C20(11 and 15), C22(32) and C25(38) produced the most susceptible reactions. These races are not new, and they did not increase in prevalence in 1965. Race C25(38) is of interest because, as shown below, it is more virulent on seedlings of certain highly resistant varieties than most other races.

Variety	Infection Type
Kenya Farmer	2
Mayo 54	2 to 3
Mida-McMurachy-Exchange 11-47-26	1 to 3
Crim	0
Chris	; to 3

Table 4. Distribution by provinces of physiologic races of Puccinia graminis f. sp. tritici collected on wild barley and susceptible varieties of wheat and barley in 1965.

Virulence Formula Number	Physiologic Race Number	Province							Number of Isolates	Percent of Total Isolates
		P. E. I.	Que.	Ont.	Man.	Sask.	Alta.	B.C.		
C1	17	1	0	31	2	0	0	0	34	14.1
C2	17A	0	1	9	0	0	0	0	10	4.2
C9	15B- L (Can.)	0	0	1	1	3	0	0	5	2.1
C13	113	0	0	1	0	0	0	0	1	0.4
C17	56	0	0	9	8	17	12	0	46	19.1
C18	15B- L (Can.)	0	4	16	35	46	18	0	119	49.4
C20	11	0	0	2	3	0	1	0	6	2.5
C20	15-87	0	0	3	1	0	0	0	4	1.7
C22	32	0	0	0	0	2	1	0	3	1.2
C24	17	0	0	1	0	1	0	0	2	0.8
C25	38	0	0	1	0	2	1	0	4	1.7
C27	33	0	0	0	0	0	0	1	1	0.4
C27	59	0	0	0	0	0	0	1	1	0.4
C28	18	0	0	0	0	0	0	2	2	0.8
C28	54	0	0	0	0	0	0	1	1	0.4
C29	17	0	0	1	0	0	0	0	1	0.4
C30	29	0	0	0	0	0	0	1	1	0.4
Total Isolates		1	5	75	50	71	33	6	241	100.0

Adult plant tests were carriedout with 'Manitou', and its parent variety 'Thatcher' to determine the significance of the variable results with seedlings. Infection types on adult plants of 'Manitou' ranged from 1 to 3 with two cultures of race C25(38), but on the average the variety was considered to be moderately resistant (Table 6). Two cultures of race C22(32) were slightly more virulent on 'Manitou' than was race C25(38).

The varieties 'Selkirk' and 'Stewart 63' also were inoculated with all isolates. 'Stewart 63' was resistant to all isolates, but races C20(11 and 87) and C22(32) were virulent on seedlings of 'Selkirk'. They are not new races and they have not increased in prevalence.

Isolates obtained from rust collected at Creston, B.C., were distinct from those obtained from other parts of the country. They were identified as the new formulas C27, C28 and C30, and corresponded roughly to races 33 and 59, 18 and 54, and 29 respectively (Table 3).

Table 6. Estimated mean infection types on the upper two sheaths of four adult plants of the wheat varieties 'Manitou' and 'Thatcher' inoculated with seven cultures of stem rust.

Formula No.	Physiologic Race	Culture No.	Infection Type	
			Manitou	Thatcher
C18	15B-1L (Can.)	86-65	Fleck	3-
c2	17A	327-65	0	0
c22	32	306-65	2	2t
c22	32	247-65	2+	2t
C25	38	188-65	2	2t
C25	38	124-65	1+	2t
C17	56	92-65	Fleck	1+

Composite urediospore collections of all isolates in groups of about 20 were used to inoculate 20 highly resistant varieties that included 'Kenya Farmer', 'Mayo 54', 'Mida - McMurachy - Exchange II-47-26', 'Frontana-K58-Newthatch 11-50-17', 'Crim', 'Justin', 'ND 264', 'Chris', 'C.T. 261', 'St 4641, and C.I. 8155'. A few large pustules developed on the varieties 'Mayo 54', 'Mida-McMurachy-Exchange II-47-26', 'Frontana-K58-Newthatch II-50-17', and 'Chris'. Single pustule isolates from these varieties were identified as race C25(38).

Literature cited

1. Green, G. J. 1965. Stem rust of wheat, rye and barley in Canada in 1964. Can. Plant Dis. Survey 45: 23-29.
2. Green, G.J., D.R. Knott, I.A. Watson, and A. T. Pugsley. 1960. Seedling reactions to stem rust of lines of Marquis wheat with substituted genes for rust resistance. Can. J. Plant Sci. 40: 524-538.
3. Stakman, E.C., D.M. Stewart, and W.Q. Loegering. 1962. Identification of physiologic races of Puccinia graminis var. tritici. U. S. D. A. Bureau of Entomology and Plant Quarantine Bull. E-617 (Revised).