# Stem rust of wheat, barley, and rye in Canada in 1976[1]

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Stem rust development was slowed by dry weather after mid July, but moderate to severe infections developed by early August in plots of susceptible varieties in southern Manitoba and southeastern Saskatchewan. There was virtually no stern rust in farm fields of resistant varieties. Stem rust was common on susceptible varieties in rust nurseries grown at locations from eastern British Columbia to eastern Ontario. Twenty-three physiologic races were identified in 1976 indicating that the wheat stem rust population continues to be as variable as in the previous 2 years. Race C33 (15B-1L) continued to predominate and two closely related races, C49 (15) and C53 (156-1L), increased in prevalence. There was little change in the virulence of the rust population on identified resistance genes.

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Le temps sec a ralenti le developpement de la rouille de la tige (*Puccinia graminis)* apres la mi-juillet, mais des infections allant de moderees a graves se sont manifestées au debut d'août en parcelles de varietes sensibles dans le sud du Manitoba et le sud-est de la Saskatchewan. La rnaladie était virtuellement absente des champs de ferrne sernes en varietes resistantes. Elle etait cependant répandue en parcelles d'observation de varietes sensibles cultivees a certains endroits echelonnes de l'est de la Colombie-Britannique a l'est de l'Ontario. Vingt-trois races physiologiques ont ete identifiees en 1976, ce qui indique que les populations de rouille de la tige du blé demeurent aussi variables qu'au cours des deux annees precedentes. La race C33 (15B-1L) a continue de dominer, et deux races etroitement apparentees, soit C49 (15) et C53 (156-1L), ont acquis plus d'irnportance. La virulence des populations de rouille a l'égard des genes de resistance identifies n'a pratiquement pas change.

## Prevalence and importance in western Canada

In 1976 wheat stem rust *[Puccinia graminis* Pers. f. sp. *tritici* Eriks. and E. Henn.] was first observed in western Canada on a susceptible variety at Morden, Manitoba, on June 25. It increased quickly during early July but dry conditions later in the month and during August slowed development. Despite the dry weather, stem rust was severe (70-80%) on susceptible *Triticum aestivum* L. cv. Klein Titan at Morden, Manitoba, in early August, moderate (20-40%) at Brandon, Manitoba, and Indian Head, Saskatchewan, and light (10%) at Regina, Saskatchewan. By mid October stem rust was easily found on susceptible wild barley *(Hordeum jubatum* L.) from the Red River Valley of Manitoba to Cardston, Alberta.

Stem rust resistant wheat varieties recommended for the rust area of western Canada continued to show excellent resistance in 1976 and were not damaged. The recommended varieties of six-row barley are resistant to wheat stem rust and only traces of rust were observed on susceptible two-row barley.

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

Uniform rust nurseries consisting of 20 varieties of wheat, 3 varieties of barley, 1 variety of rye, and 1 variety of triticale were planted by cooperators at 32 locations across Canada in 1976. The varieties included in the nurseries (Tables 1 and 2) have been described previously (1).

Wheat stem rust occurred on susceptible varieties in 17 nurseries from British Columbia to eastern Ontario. The heaviest infections occurred in Manitoba and at Thunder Bay, Ontario (Table 1). The incidence of stem rust in 1976 was much higher than in 1975, returning to the level of earlier years when rust was common.

The widely grown common wheat varieties Neepawa, Napayo, and Sinton were highly resistant at all locations as were the durum wheat varieties Hercules, Wascana, Macoun, and Wakooma. The moderate amount of rust on Kenya Farmer at Thunder Bay was unexpected. Kenya Farmer has been resistant since it was first grown in the nurseries in 1954 and the infection at Thunder Bay this year was probably caused by favorable weather for rust development and moderately avirulent races.

Stem rust occurred on barley and rye at 14 locations (Table 2). Although rye stem rust attacks barley varieties resistant to wheat stem rust, heavy infection of rye was not associated with heavy infection of barley, except at Creston, B.C. Presumably the barley ripened before rust could develop. Much of the rust on barley at Manitoba locations seems to have been wheat stem rust.

## Physiologic specialization

Physiologic races were identified by the methods used previously (1) with the addition of the varieties Agent with *Sr24* and Eagle with *Sr26*. Six hundred and two isolates of wheat stem rust were identified. This is a much larger number than usual and it was made

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Table 1. Percent infection of stem rust *(Puccinia graminis* f. sp. *tritici)* on *20* wheat varieties in uniform rust nurseries at 17 locations in Canada in 1976

| | Red Bobs | Lee | Pitic 62 | Neepawa | Napayo | Sinton | Kenya Fa | C.I. 8154 | Glenlea | Norquay | Exchange | Frontana | Thatcher | R.L. 42 | Agatha | Hercules | Mindum | Wascana | Macoun | Wakoom |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Creston, B.C. | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | tr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lacombe, Alta. | tr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Edmonton, Alta. | tr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lethbridge, Alta. | tr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | tr | 0 | 0 | tr | 0 | 0 | 0 | 0 | 0 | 0 |
| Melfort, Sask. | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 |
| Indian Head, Sask. | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | tr | 0 | 0 | tr | 0 | 0 | tr | 0 | 0 | 0 |
| Brandon, Man. | 70 | 50 | tr | tr | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 20 | 10 | 5 | 0 | 25 | tr | 0 | tr |
| Durban, Man. | 60 | 40 | tr | tr | O | t r | 0 | 0 | 0 | 0 | 5 | t r | 50 | 10 | 25 | 0 | 40 | tr | 0 | 0 |
| Morden, Man. | 30 | tr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | tr | 0 | tr | 0 | tr | 0 | 0 | 0 | 0 | 0 |
| Glenlea, Man. | 60 | 30 | tr | 2 | tr | tr | 1 | tr | tr | tr | 10 | tr | 30 | 31 | 10 | tr | 5 | tr | tr | 1 |
| Thunder Bay, Ont. | 90 | 80 | 15 | tr | 0 | 0 | 3 | 5 | 0 | 0 | 0 | 2 | 5 | 0 | 20 | 1 | 30 | 0 | 30 | 0 | 0 | 0 |
| Kapuskasing, Ont. | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Guelph, Ont. | 60 | tr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | tr | 0 | tr | 0 | 0 | 0 | tr | 0 | 0 | 0 |
| Ottawa, Ont. | 10 | tr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | tr | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Appleton, Ont. | 30 | tr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sunbury, Ont. | tr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Vineland, Ont. | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

No rust was observed in nurseries at 15 locations: Agassiz, B.C.; Beaverlodge, Alta.; Scott, Sask.; New Liskeard and Kemptville, Ont.; Macdonald College, Normandin, Lennoxville, Quebec, and La Pocatikre, P.Q.; Truro and Kentville, N.S.; Fredericton, N.B.; Charlottetown, P.E.I.; and St. John's, Nfld.

Table 2. Percent infection of stem rust *(Puccinia graminis)* on three varieties of barley and one variety each of rye and triticale in uniform rust nurseries at 14 locations in Canada in 1976

| | Montcalm | Conquest | Wpg. M7118–13 | Prolific | Rosner |
|---|---|---|---|---|---|
| Creston, B.C. | 50 | tr | 10 | 50 | 0 |
| Lacombe, Alta. | 0 | 0 | 0 | 50 | 0 |
| Lethbridge, Alta. | 0 | 0 | 0 | tr | 0 |
| Brandon, Man. | 15 | 0 | 0 | 5 | 0 |
| Durban, Man. | 5 | 0 | 0 | tr | 0 |
| Glenlea, Man. | 5 | 1 | 1 | tr | 1 |
| Thunder Bay, Ont. | tr | tr | 0 | 0 | 0 |
| Guelph, Ont. | 0 | 0 | 0 | 10 | 0 |
| Ottawa, Ont. | 0 | 0 | 0 | 40 | 0 |
| Appleton, Ont. | 0 | 0 | 0 | 40 | 0 |
| Sunbury, Ont. | tr | 0 | tr | 60 | 0 |
| Macdonald College, P.Q. | 0 | 0 | 0 | 5 | 0 |
| Lennoxville, P.Q. | | | | 60 | |
| Kentville, N.S. | 0 | 0 | 0 | 70 | 0 |

No rust was observed in nurseries at 18 locations: Agassiz, B.C.; Beaverlodge and Edmonton, Alta.: Scott, Melfort and Indian Head, Sask.; Morden, Man.; New Liskeard, Vineland, Kemptville, and Kapuskasing, Ont.; Normandin, Quebec and La Pocatikre, P.Q.; Truro, N.S.; Fredericton, N.B.: Charlottetown, P.E.I.; and St. John's, Nfld.

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 1976

| Virulence formula and (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. | | |
| C17 (56) | 6,8,9a,9b,9d,9e,11,13,17,22,24,26,Tt1,Tt2/5,7a,10,14,15 | 1 | | | | | 1 | 0.2 |
| C18 (15B–1L) | 6,8,9a,9b,13,15,17,22,24,26,Tt2/5,7a,9d,9e,10,11,14,Tt1 | | 11 | 2 | 1 | | 14 | 2.3 |
| C25 (38) | 9a*,9e,22,Tt1,Tt2/5,6,7a,8,10,11,15 | | 1 | | 1 | | 2 | 0.3 |
| C33 (15B–1L) | 6,9a,9b,13,15,17,22,24,26,Tt2/5,7a,8,9d,9e,10,11,14,Tt1 | 6 | 194 | 93 | 29 | | 322 | 53.4 |
| C33 (15B–1L) | 6,9a,9b,13,15,17,22,24,26,Tt2/5,7a,8,9d,9e,10,11*,14,Tt1 | | 23 | 13 | 2 | | 38 | 6.3 |
| C33 (115) | 6,9a,9b,15,17,22,24,26,Tt2/5,7a,8,9d,9e,10,11,Tt1 | | | 9 | | | 9 | 1.5 |
| C35 (32–113) | 9d,9e,10,11,13.17,22,24,26,Tt2/5,6,7a,8,9a,9b,14.15,Tt1 | 1 | 20 | 1 | 2 | | 24 | 3.9 |
| C35 (32–113) | 9d,9e,10,11*,13,17,22,24,26,Tt2/5,6,7a,8,9a,9b,14,15,Tt1 | | 1 | | | | 1 | 0.2 |
| C41 (32–113) | 9d,9e,10,13,17,22,24,26,Tt2/5,6,7a,8,9a,9b,11,14.15,Tt1 | | 1 | | | | 1 | 0.2 |
| C42 (15) | 6,8,9a,9b,11,13,15,17,22,24,26,Tt2/5,7a,9d,9e,10,14,Tt1 | | 1 | | | | 1 | 0.2 |
| C44 (15B–1L) | 6,9a,9b,13,17,22,24,26,Tt2/5,7a,8,9d,9e,10,11,14,15,Tt1 | | | 1 | | | 1 | 0.2 |
| C46 (15B–1L) | 6,8,9a,9b,13,15,22,24,26,Tt2/5,7a,9d,9e,10,11,14,17,Tt1 | | 2 | | | | 2 | 0.3 |
| C49 (15) | 6,9a,9b,11,13,15,17,22,24,26,Tt2/5,7a,8,9d,9e,10,14,Tt1 | | 36 | 20 | 8 | | ***64*** | 10.6 |
| C53 (15B–1L) | 6,9a,9b,13,15,22,24,26,Tt2/5,7a,8,9d,9e,10,11,14,17,Tt1 | 1 | 63 | 27 | 7 | | 98 | 16.3 |
| C53 (15B–1L) | 6,9a,9b,13,15,22,24,26,Tt2/5,7a,8,9d,9e,10,11*,14,17,Tt1 | | 1 | | | | 1 | 0.2 |
| C56 (38) | 6,7a,8,9e,11,Tt1,Tt2/5,9a,15 | | | 1 | | | 1 | 0.2 |
| C59 (31) | 9d,9e,13,22,24,26,Tt1,Tt2/5,6,7a,8,9a,9b,10,11,14,15,17 | | 2 | 1 | | | 3 | 0.5 |
| C65 (39) | 6,8,9e,11,17,Tt1,Tt2/5,7a,9a,10,15 | | | | | 1 | 1 | 0.2 |
| C66 (15) | 6,9a,9b,11,13,15,22,24,26,Tt2/5,7a,8,9d,9e,10,14,17,Tt1 | 1 | 9 | 2 | | | 12 | 1.9 |
| C67 (38) | 9e,Tt1,Tt2/5,6,7a,8,9a,10,11,15.1 7 | | | | 1 | | 1 | 0.2 |
| C68 (33) | 6,8,9a,9e,11,17,Tt1,Tt2/5,7a,10,15 | | | | 1 | 2 | 3 | 0.5 |
| C69 (113) | 6,9e,10,11,Tt2/5,8,9a,15,17,Tt1 | | 1 | | | | 1 | 0.2 |
| C70 (23) | 6,8,9a,9e,11,17,Tt1,Tt2/5,7a,10,15 | | | 1 | | | 1 | ***0.2*** |
| Total wheat stem rust isolates | | 10 | 366 | 171 | 52 | 3 | 602 | 100.0 |
| Rye stem rust isolates | | 2 | 26 | 16 | 52 | | 96 | |

* Intermediate infection type

possible by planting plots of the susceptible variety Klein Titan at Morden and Brandon, Manitoba, and at Indian Head and Regina, Saskatchewan, and making 187 collections from the Manitoba locations and 104 collections from the Saskatchewan locations. The remaining 311 collections were mainly from wild barley in the prairie provinces and from susceptible varieties in experimental plots. More collections were obtained from western Saskatchewan and southern Alberta than in previous years but there were few collections from eastern Canada and British Columbia.

The Canadian rust population continued to show the wide variability observed in 1974 and 1975. Twenty-three races including five new virulence combinations were found. The virulence formulas for the new races, C66 to C70, and formulas for the other races identified (Table 3) include resistance genes ***SrTt1, SrTt2, Sr24,*** and ***Sr26*** that were not included in the previous list of formulas (2).

Although race C33 continued to predominate, as it has since 1970, there were sharp increases in the prevalence of two related races (Table 3). Race C53 which comprised only 0.3% of the 1975 isolates increased to 16.3% in 1976, and race C49 that comprised 4.8% of the 1975 isolates increased to 10.6%. Race C53 is like race C33 except that it is virulent on varieties with resistance gene ***Sr17***. Race C49 also is like race C33 except that it is avirulent on ***Srl1***. The most common of the new races, C66, is like race C49 except that it is virulent on resistance gene ***Sr17***. Race C35 was more common than in 1975 but it was the only strain of the old race 11-32 group found in 1976. This group includes potentially dangerous virulence combinations. There was a sharp decline in the prevalence of race C25 that had shown moderate virulence on Neepawa and Manitou, the main varieties of the rust area. Fourteen other races were found rarely at scattered locations in the prairie provinces and a single isolate of race C17, the **old** race 56, was obtained from Ontario. Although some interesting changes seem to be taking place in the Canadian stem rust population, they do not appear to threaten the resistant varieties now grown in the rust area.

The prevalence of rye stem rust was investigated by inoculating both wheat and rye with 240 collections of rust on barley and wild barley. Ninety-six collections were, or included, rye stem rust, indicating that rye stem rust was prevalent but not nearly as prevalent as wheat

Table 4. Percent of total isolates and races avirulent on single identified resistance genes in 1976 and (1975)

| Resistance gene | Avirulent isolates % 1976 (1975) | Avirulent races % 1976 (1975) |
|---|---|---|
| *Sr5* | 0 ( 0.3) | 0 ( 4) |
| *Sr6* | 94.7 (85.8) | 74 (58) |
| *Sr7a* | 0.2 ( 3.9) | 4 (23) |
| *Sr8* | 4.1 ( 7.8) | 30 (35) |
| *Sr9a* | 94.4 (93.1) | 65 (58) |
| *Sr9b* | 93.4 (93.6) | 52 (56) |
| *Sr9d* | 5.2 ( 6.4) | 26 (50) |
| *Sr9e* | 6.3 (16.0) | 52 (65) |
| *Sr10* | 4.5 ( 2.7) | 17 (19) |
| *Srll* | 18.3 (10.5) | 4%(52) |
| *Sr13* | 98.2 (97.6) | 61 (81) |
| *Sr14* | 0 0 | 0 0 |
| *Sr15* | 93.0 (82.5) | 40 (27) |
| *Sr17* | 79.7 (90.2) | 57 (63) |
| *SrTt1* | 2.3 | 35 |

No data for races C25 (38), C56 (38), C65 (39), C67 (38), C68 (33), C69 (113), and C70 (23) on *Sr9b* and *Sr9d*.

stem rust. The 291 collections from Klein Titan in Manitoba and Saskatchewan were identified as 12 races, and 21 races were identified from collections on wheat, barley, and wild barley. Races C44 and C56 were found only on Klein Titan at Regina, and eight rare races from the prairie provinces were not found on Klein Titan. The four main races (C33, C53, C49, and C33 Srl 1 Int.) that comprised 86.6% of the isolates were found in all four plots of Klein Titan in about the same frequency as for the total survey. Evidently collections from the plots of Klein Titan were good indicators of the prevalence of the main races, but they failed to reveal a number of rare rust strains.

The percentages of isolates and races avirulent on varieties with *Sr* genes (Table 4) has not changed much in recent years. Since 1972 there has been a slight trend to increased virulence on genes *Sr5, Sr7a, Sr8, Sr9d, Sr10,* Sr 11, and Sr 17 and decreased virulence on *Sr6, Sr9a, Sr9b*, and *Sr15*. These trends are mainly due to changes in the prevalence of race C33 and related races. The main differences between 1976 and 1975 were reduced virulence on *Sr6,* Srl*1,* and *Sr15*, and increased virulence on *Sr9e* and *Sr17*. These changes do not affect resistant Canadian wheats or most sources of resistance used in breeding programs. Resistance genes *Sr22, Sr24, Sr26*, and *SrTt2* were effective against all rust isolates.

Essentially the same group of highly resistant varieties used in 1975 (1) were inoculated with composite collections of urediospores from all isolates. Varieties that were resistant to the inoculum were: Agatha, Bonny, C.I. 8154 X Frocor[2], D.T. 411, Era, Esp 518/9, Glenlea, Hercules, Frontana-K58-Newthatch 11-50-17, Macoun, Norquay, N.D. 499, N.D. 506, (P X Mq[8])[6] X (Rsc X Etoile de Choisy), Romany, R.L. 4308, R.L. 5405, St 464, Tama, Waskana, Wakooma, and WRT 240. Varieties that segregated or had a few susceptible infections were: Chris, Kenya Farmer, Mida-McMurachy-Exchange 11-47-26, R.L. 4320, Sinton, and Webster.

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## Literature cited

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