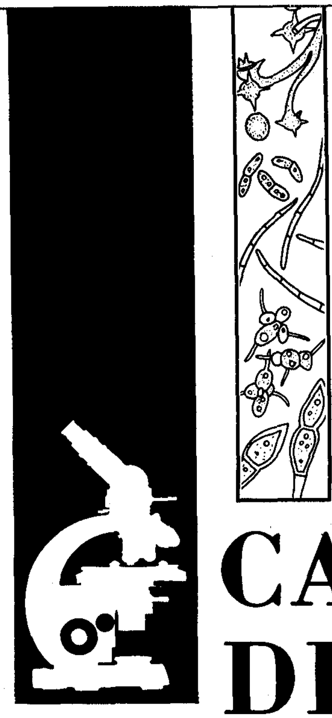
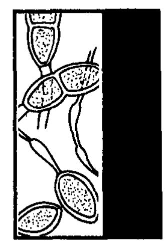
VOL.47, No.1, MARCH, 1967



# CANADIAN PLANT DISEASE SURVEY



EDITOR: D.W. CREELMAN

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RESEARCH BRANCH CANADA DEPARTMENT OF AGRICULTURE

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# CANADIAN PLANT DISEASE SURVEY

RESEARCH BRANCH CANADA DEPARTMENT OF AGRICULTURE



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"The Canadian Plant Disease Survey is a periodical of information and record on the occurrence and severity of plant diseases in Canada. It will also accept other original information such as the development of methods of investigation and control, including the evaluation of new materials. Review papers and compilations of practical value to phytopathologists will be included from time to time. It will not accept results of original research suitable for publication in more formal scientific journals".

# AIR-BORNE RUST INOCULUM OVER WESTERN CANADA IN 1966[1]

G.J. Green [2]

Cereal rust spore traps were operated in Western Canada in 1966 as in previous years. Vaseline-coated microscope slides were exposed to the air currents for 48-hour periods at six locations in Manitoba and Saskatchewan. The numbers of spores caught (Table 1) on the vaseline-coated surface were counted by means of a microscope. The slides exposed at Saskatoon were examined at the Canada Department of Agriculture Research Station there; the other slides were examined at the Winnipeg Research Station.

Few rust spores were carried into Western Canada from the south in May and early June. Small numbers of spores were caught on most slides during the latter half of June, but spore showers were generally light. The numbers of spores caught during the first half of July continued to be small, but after the middle of the month their numbers increased sharply, presumably because of local rust development. The large numbers of leaf rust spores caught at Regina and Saskatoon in August probably resulted mainly from the late development of leaf rust on susceptible Thatcher wheat in the northerly part of Saskatchewan.

The total numbers of spores of both rusts caught on the slides were not as great as in 1965, but are greater than in most recent years (1).

[1] Contribution No. 241 from the Canada Department of Agriculture, Research Station, Winnipeg, Manitoba.

[2] Plant Pathologist.

## Literature cited

1. Green, G.J. 1966. Air-borne rust inoculum over Western Canada in 1965. Can. Plant Dis. Survey 46: 20-21.

Table 1. Numbers of urediospores of stem rust and leaf rust per square inch caught on vaseline-coated slides exposed for 48-hour periods at 3 locations in Manitoba and 3 locations in Saskatchewan in 1966.

| Date | Winnipeg | | Morden | | Brandon | | Indian Head | | Regina | | Saskatoon | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Stem Rust | Leaf Rust | Stem Rust | Leaf Rust | Stem Rust | Leaf Rust | Stem Rust | Leaf Rust | Stem Rust | Leaf Rust | Stem Rust | Leaf Rust |
| May Total | 0 | 0 | 2 | 6 | 0 | 0 | 0 | 0 | 1 | 1 | - | - |
| May 31-June 1 | 0 | 0 | 1 | 4 | - | - | 2 | 11 | 3 | 5 | 0 | 0 |
| 2-3 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6-7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 8-9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | 0 | 0 |
| 10-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 12-13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14-15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 16-17 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 6 |
| 18-19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 |
| 20-21 | 1 | 3 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 6 | 0 | 4 |
| 22-23 | 1 | 5 | 2 | 4 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 1 |
| 24-25 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 8 |
| 26-27 | 0 | 0 | 2 | 2 | 0 | 2 | 0 | 1 | 1 | 4 | 0 | 6 |
| 28-29 | - | - | 0 | 1 | 0 | 2 | 2 | 39 | 2 | 8 | 0 | 0 |
| June Total | 2 | 9 | 6 | 16 | 0 | 7 | 5 | 58 | 6 | 35 | 0 | 25 |

Table 1. (Continued)

| Date | Winnipeg | | Morden | | Brandon | | Indian Head | | Regina | | Saskatoon | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Stem Rust | Leaf Rust | Stem Rust | Leaf Rust | Stem Rust | Leaf Rust | Stem Rust | Leaf Rust | Stem Rust | Leaf Rust | Stem Rust | Leaf Rust |
| June 30 - July 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 5 | 0 | 0 |
| 2-3 | 4 | 5 | 0 | 0 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 30 |
| 4-5 | 0 | 0 | 0 | 1 | 1 | 2 | 1 | 8 | 1 | 9 | 0 | 26 |
| 6-7 | 0 | 1 | 0 | 2 | 1 | 2 | 1 | 6 | 1 | 3 | 0 | 8 |
| 8-9 | 3 | 12 | 1 | 1 | 1 | 4 | 0 | 4 | 4 | 9 | 0 | 52 |
| 10-11 | 1 | 1 | 1 | 3 | 1 | 4 | 5 | 15 | 2 | 9 | 0 | 50 |
| 12-13 | 1 | 4 | 0 | 0 | 1 | 2 | 2 | 11 | 2 | 7 | 0 | 8 |
| 14-15 | 6 | 18 | 10 | 23 | 1 | 6 | 5 | 30 | 8 | 35 | 0 | 6 |
| 16-17 | 4 | 2 | 28 | 32 | 3 | 21 | 49 | 560 | 11 | 128 | 2 | 36 |
| 18-19 | 4 | 16 | 4 | 11 | 5 | 54 | 34 | 336 | 9 | 149 | 4 | 202 |
| 20-21 | 48 | 270 | 10 | 101 | 17 | 90 | 7 | 238 | 16 | 302 | 4 | 2,624 |
| 22-23 | 4 | 25 | 1 | 8 | 1 | 19 | 2 | 36 | 0 | 8 | 16 | 780 |
| 24-25 | 9 | 81 | 2 | 37 | 7 | 20 | 9 | 118 | 5 | 205 | 0 | 972 |
| 26-27 | 4 | 47 | 2 | 36 | 2 | 39 | 26 | 1,992 | 0 | 492 | 0 | 898 |
| 28-29 | 9 | 200 | 49 | 1,253 | 4 | 95 | 46 | 3,203 | 19 | 2,941 | 4 | 1,984 |
| 30-31 | 23 | 156 | 11 | 204 | 4 | 134 | 9 | 893 | 23 | 3,136 | 0 | 3,564 |
| July Total | 120 | 838 | 119 | 1,712 | 50 | 493 | 197 | 7,454 | 102 | 7,438 | 30 | 11,240 |
| Aug. 1-2 | 0 | 37 | 39 | 2,125 | 5 | 190 | 23 | 2,802 | 9 | 2,349 | 4 | 376 |
| 3-4 | 74 | 432 | 9 | 571 | 2 | 313 | - | - | 4 | 1,246 | 4 | 6,512 |
| 5-6 | 39 | 236 | 16 | 135 | 2 | 46 | 2 | 406 | 5 | 925 | 0 | 568 |
| 7-8 | 47 | 712 | 11 | 118 | 5 | 37 | 5 | 181 | 2 | 814 | 0 | 212 |
| 9-10 | 116 | 364 | 16 | 79 | 2 | 51 | 16 | 1,871 | - | - | 8 | 756 |
| 11-12 | 53 | 199 | 97 | 591 | 23 | 410 | 12 | 1,584 | - | - | 24 | 9,408 |
| 13-14 | 79 | 522 | 81 | 158 | 2 | 92 | 32 | 1,137 | 9 | 197 | 4 | 744 |
| 15-16 | 100 | 742 | 179 | 2,271 | 11 | 339 | 16 | 441 | 46 | 7,081 | 8 | 1,912 |
| 17-18 | 44 | 62 | 109 | 1,202 | 74 | 1,161 | 16 | 127 | 206 | 5,950 | 24 | 1,716 |
| 19-20 | 160 | 149 | 97 | 1,225 | 21 | 188 | 0 | 0 | 9 | 568 | 28 | 590 |
| 21-22 | 1,347 | 1,320 | 183 | 1,245 | 18 | 67 | 2 | 11 | 0 | 285 | 46 | 468 |
| 23-24 | 294 | 508 | 209 | 867 | 65 | 323 | 25 | 288 | 42 | 20,649 | 20 | 852 |
| 25-26 | 387 | 216 | - | - | 58 | 211 | 47 | 348 | 116 | 12,390 | 18 | 366 |
| 27-28 | 802 | 781 | 373 | 1,624 | 246 | 752 | 4 | 85 | 18 | 4,702 | 72 | 880 |
| 29-30 | 97 | 162 | 244 | 721 | 132 | 269 | 55 | 353 | 79 | 12,626 | 136 | 944 |
| 31 Sept. 1 | 69 | 67 | 53 | 139 | 21 | 70 | 12 | 193 | 70 | 9,269 | 100 | 420 |
| Aug. Total | 3,708 | 6,509 | 1,716 | 13,071 | 687 | 4,519 | 267 | 9,827 | 615 | 79,051 | 496 | 26,724 |
| TOTAL | 3,830 | 7,356 | 1,843 | 14,805 | 737 | 5,019 | 469 | 17,339 | 724 | 86,525 | 526 | 37,989 |

# LEAF RUST OF WHEAT IN CANADA IN 1966[1]

D.J. Samborski [2]

## Disease development and crop losses in Western Canada

Drought and frost in Kansas and drought in Oklahoma and Texas restricted rust development in those states and greatly reduced the amount of inoculum moving north into Western Canada in the early part of the 1966 growing season. Consequently, 1966 can be regarded as a "light" leaf rust year and it is doubtful whether leaf rust reduced yields in most of Western Canada. A slight yield reduction probably occurred in late fields of susceptible varieties.

By the end of July, leaf rust was widespread in Western Canada but infections were much lighter than are normally found at that time. Heavy infections were observed later on 'Pembina', 'Selkirk', 'Thatcher' and 'Canthatch', but this development was too late to have much effect on yield. As the crop matured, considerable leaf rust was observed on 'Manitou'. However, earlier observations recorded trace to 1% infections on 'Manitou' when 'Selkirk' in adjacent fields had infections of 80 percent. These observations suggest that the resistance of 'Manitou' declines as the crop matures since 'Manitou' is still resistant to all rust races studied in Canada in 1966.

## Leaf rust in the rust nurseries

Severe infections of leaf rust occurred in many nurseries (Table 1). 'Manitou', a newly released variety, showed good resistance at all locations and the rust infections observed on this variety were all of the resistant or moderately resistant type. The durum varieties 'Ramsey', 'Mindum', 'Stewart 63' and 'D. T. 184', and the common wheats 'Thatcher$^6$ × Transfer', 'Exchange' and 'Frontana' were highly resistant at all locations.

## Distribution of physiologic races

Six races of wheat leaf rust were isolated in the 1966 race survey (Table 2). Race 15 constituted 81% of the isolates in Canada while races 58 and 161, which are very similar, comprised 13% of the isolates. Races 5 and 9 were very scarce while race 11 was important only in British Columbia. In Canada, the leaf rust population is largely characterized by virulence on the varieties 'Mediterranean' and 'Democrat', and to a lesser extent, virulence on 'Loros'.

Table 2. Distribution by geographic areas of physiologic races of Puccinia recondita isolated in Canada in 1966.

| | Geographic Area | | | | | | |
|---|---|---|---|---|---|---|---|
| Race | Que. & Ont. | Man. | Sask. | Alta. | B.C. | Total Isolates | % Total Isolates |
| 5 | | 1 | 4 | 1 | | 6 | 1.9 |
| 9 | | | 1 | | | 1 | 0.3 |
| 11 | 2 | | | | 10 | 12 | 3.7 |
| 15 | 10 | 121 | 118 | 6 | 4 | 259 | 80.9 |
| 58 | 13 | | | | | 13 | 4.1 |
| 161 | | 1 | 1 | 19 | 8 | 29 | 9.1 |
| | 25 | 123 | 124 | 26 | 22 | 320 | 100.0 |

Table 3. Distribution by geographic areas of NA65 races of Puccinia recondita isolated in Canada in 1966.

| | Geographic Area | | | | | |
|---|---|---|---|---|---|---|
| Race | Que. & Ont. | Man. | Sask. | Alta. | B.C. | Total Isolates |
| 1 | 3 | | 1 | | 4 | 8 |
| 3 | 9 | 10 | 25 | 7 | 4 | 55 |
| 9 | 4 | 33 | 50 | 3 | 6 | 96 |
| 10 | 8 | 66 | 48 | 2 | | 124 |
| 11 | 1 | 10 | | 12 | 8 | 31 |
| 12 | | 4 | | 2 | | 6 |

Table 4. Percent of isolates of Puccinia recondita studied in Canada in 1966 virulent on each of the NA65 differential wheat varieties.

| Geographic Area | Percent of isolates virulent on: | | | | |
|---|---|---|---|---|---|
| | Dular | Waban | Lee | Sinvalocho | Exchange |
| Que. & Ont. | 0 | 0 | 52.0 | 16.0 | 32.0 |
| Man. | 0 | 0 | 91.9 | 19.5 | 56.9 |
| Sask. | 0 | 0 | 79.0 | 21.6 | 38.7 |
| Alta. | 0 | 0 | 73.8 | 80.8 | 15.4 |
| B. C. | 0 | 0 | 63.4 | 54.5 | 0.0 |

Analysis of the rust population with supplementary differential varieties demonstrates further variability in the rust population (Table 3). However,

[1] Contribution No. 245 from Canada Department of Agriculture, Research Station, Winnipeg, Manitoba.

[2] Plant Pathologist.

Table 1. Percent infection of leaf rust of wheat (Puccinia recondita) in 1966 on 15 wheat varieties in uniform rust nurseries at 23[a] locations in Canada.

| Locality | Lee | Thatcher | Selkirk | Red Bobs | Manitou | Marquis | Kenya Farmer | McMurachy | Ramsey | Mindum | Stewart 63 | D. T. 184 | Thatcher$^6$x Transfer | Exchange | Frontana |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saanichton, B. C. | 15 | 70 | 10 | 70 | 5 | 60 | 10 | 70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Agassiz, B. C. | 2 | 10 | 3 | 10 | 10 | 10 | 1 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Creston, B. C. | 1 | 80 | 5 | 80 | 1 | 60 | 1 | 80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lacombe, Alta. | 0 | 1 | 0 | 5 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lethbridge, Alta. | 40 | 80 | 60 | 90 | 5 | 70 | 20 | 80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Indian Head, Sask. | 70 | 90 | 60 | 90 | 3 | 80 | 70 | 90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Scott, Sask. | 40 | 80 | 40 | 80 | 5 | 70 | 30 | 80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Melfort, Sask. | 20 | 50 | 20 | 60 | 1 | 50 | 10 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brandon, Man. | 40 | 80 | 50 | 80 | 1 | 80 | 30 | 80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| The Pas, Man. | 10 | 40 | 10 | 50 | 2 | 40 | 50 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Morden, Man. | 60 | 90 | 60 | 90 | 3 | 80 | 40 | 90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Winnipeg, Man. | 20 | 60 | 20 | 60 | 1 | 40 | 10 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Glenlea, Man. | 60 | 80 | 50 | 60 | 20 | 80 | 15 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Kapuskasing, Ont. | t | 5 | t | 5 | t | 3 | t | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Kemptville, Ont. | 5 | 40 | 5 | 40 | 1 | 40 | 5 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fort William, Ont. | 40 | 70 | 30 | 80 | 1 | 60 | 20 | 80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Guelph, Ont. | 50 | 80 | 20 | 80 | 5 | 70 | 20 | 80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ottawa, Ont. | 2 | 5 | 2 | 5 | t | 2 | t | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| La Pocatiere, Que. | 1 | 30 | 0 | 30 | 0 | 30 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lennoxville, Que. | 10 | 70 | 20 | 80 | 3 | 60 | 5 | 70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Normandin, Que. | 0 | 1 | 0 | 4 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Kentville, N. S. | t | 1 | t | 5 | 0 | 1 | t | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| St. John's, Nfld. | t | 10 | t | 5 | 0 | 3 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

[a] Leaf rust was not found on nurseries from Beaverlodge, Alta., Williamstown, Douglas, Alfred, Merrickville and St. Catherines, Ont., Macdonald College and L'Assomption, Que., Fredericton, N. B., Charlottetown, P. E. I.

only 'Lee', 'Sinvalocho' and 'Exchange' acted as differentials in 1966 (Table 4). In addition, the resolving power of these supplementary differentials is low since several varieties contain the same gene while others contain genes identical to some in the standard differentials.

An interesting relationship was observed between 'Lee' and 'Sinvalocho' to cultures of race 15. Cultures virulent on 'Sinvalocho' were almost invariably avirulent on 'Lee' while cultures avirulent on 'Sinvalocho' were virulent on 'Lee'. Avirulent cultures of race 15 produce an intermediate reaction (1 $\pm$ - 2 ++) on 'Sinvalocho' and this reaction is quite variable for different cultures.

A group of highly resistant varieties were inoculated with bulked collections of urediospores in order to detect scarce or new virulence types in the rust population. These varieties were 'Agrus', 'Transfer', 'Klein Lucero', 'Aniversario', 'South Africa 43', 'Wanken', 'C. I. 13523', 'Klein Titan', 'Maria Escobar', 'Rio Negro', and 'Agatha'. A few susceptible pustules were observed on 'Klein Titan', 'Maria Escobar' and 'Rio Negro', but this type of virulence is normally present in the leaf rust population.

## Acknowledgements

I am grateful for assistance given by the cooperators for the care of the rust nurseries and the collection of rust specimens. Mr. W. O. Ostapyk performed the technical operations requisite to the identification of the physiologic races.

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

G.J. Green[2]

## 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 (32), 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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[1] Contribution No. 248, Canada Department of Agriculture Research Station, Winnipeg, Manitoba.

[2] Plant Pathologist.

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 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Red Bobs | Marquis | Lee | Thatcher | Selkirk | Manitou | Kenya Farmer | McMurachy | Exchange | Frontana | Mindum | Ramsey | Stewart 63 | D. T. 184 |
| 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 | 0 | tr | 1 | 0 | 0 | tr |
| Indian Head, Sask. | 50 | 10 | tr | 1 | 0 | 0 | 0 | 0 | tr | tr | 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 | 40 | 0 | 0 | 0 | 1 | 5 | tr | 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 Sr9a 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 II-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.

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# STEM RUST OF OATS IN CANADA IN 1966[1]

J.W. Martens[2]

## Disease development and crop losses in Western Canada

Stem rust of oats (Puccinia graminis Pers. f. sp. avenae Erikss. & Henn.) caused little or no yield reduction in Western Canada in 1966. Stem rust was first found in Manitoba on July 28 and its subsequent development was relatively slow. However, some losses occurred in a few late fields that had moderately severe infections by the end of August.

## Uniform rust nurseries

Rust nurseries consisting of ten oat varieties (Table 2) were grown at 36 locations across Canada. The nurseries were planted, cared for and harvested by cooperating University and Canada Department of Agriculture personnel and then sent to Winnipeg for disease rating. No rust was found in nurseries in Alberta and only trace to slight infections were observed in single nurseries in British Columbia and Saskatchewan. Rust infections in Manitoba nurseries were also light, excepting those at Winnipeg and Glenlea which had moderate infections, mainly because they were late. In Eastern Canada only the nurseries at Appleton and Ottawa, Ontario, and La Pocatière, Quebec, carried moderate to heavy infections.

## Physiologic race identification and distribution

Physiologic races were identified by inoculating seedlings of the varieties 'Richland' (gene A), 'Rodney' (gene B), 'Minrus' (gene D), 'Jostrain' (gene E), 'Eagle$^2$ × C.I. 4023' (gene F), and 'C.I. 5844-1' (gene H). The race designations given (Table 1) follow the system of nomenclature now in use in Canada (1, 2).

A supplementary set of differential hosts composed of the varieties 'Rosen's Mutant', 'Saia' and 'C.I. 3034' was also used. In addition, headed plants of all the above varieties, with the exception of 'Saia', were inoculated with representative races from the survey. The seedling rust reactions of 'Rosen's Mutant' were usually similar to those of 'C. I. 5844-1' but slightly more resistant. 'Saia' was resistant to all field isolates excepting a culture of race C6 from Plaissance, Quebec. 'C.I. 3034' seedling reactions were similar to those of 'Minrus'. The adult plant reactions were similar to seedling reactions with the exception of 'C. I. 3034'. This variety was moderately resistant to all races tested, including races C3, C5, C9, C10, and C20.

Table 1. Virulence formulas and numbers for races of oat stem rust identified in Canada from 1963-1966.

| Formula No. | Formula (Effective/Ineffective Host Genes) | Race |
|---|---|---|
| C1 | ABDEF/H | 1 |
| C2 | ABDF/EH | 2 |
| C3 | AF/BDEH | 7A-12A |
| C4 | BDFH/AE | 8 |
| C5 | BH/ADEF | 6F |
| C6 | DF/ABEH | 8A-10A |
| C7 | D/ABEFH | 8AF |
| C8 | EF/ABDH | 4A |
| C9 | F/ABDEH | 6A-13A |
| C10 | H/ABDEF | 6AF |
| C11 | DF/ABE | 8A |
| C12 | DH/ABEF | 8AF |
| C13 | BF/ADEH | 6 |
| C14 | FH/ABDE | 6A |
| C15 | ABF/DEH | 8 |
| C16 | BDF/AEH | 7 |
| C17 | DEF/ABH | 11A |
| C18 | ABFH/DE | 7 |
| C19 | ABDFH/E | 2 |
| C20 | /ABDEFH | 6AFH |
| C21 | DFH/ABE | 8A |
| C22 | DEFH/AB | 11A |

Race C10 has become the predominant race of oat stem rust in Western Canada (Table 3). Since its first appearance in 1963 it has increased to 80% of all isolates collected from Manitoba and Saskatchewan in 1966. Race C20, a polyvirulent race that can attack varieties carrying all of the six identified resistance genes, was found for the first time in Canada. Two isolates of this race were obtained from field collections made in Manitoba and Saskatchewan. A third isolate was obtained from experimental material collected at Ottawa, Ontario. In Ontario and Quebec, 66% of the isolates were race C9 with races C8 and C6 accounting for most of the balance. The race distribution in Eastern Canada has changed relatively little since 1958 when race C9 and closely related races first became predominant.

The separation of isolates according to the susceptibility or resistance of the host from which they were collected does not greatly affect the race distribution pattern for 1966.

The predominant races, C9 and C10, for Eastern and Western Canada, respectively, are capable of attacking all commercial oat varieties. Since there is little or no effective resistance in the Canadian oat population, and since no resistant varieties are immediately available, serious economic

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[1] Contribution No. 246 from the Canada Department of Agriculture Research Station, Winnipeg, Manitoba.

[2] Plant Pathologist.

Table 2. Percent infections of stem rust of oats (Puccinia graminis f. sp. avenae) on 10 varieties of oats in 16[a] uniform rust nurseries in Canada in 1966.

| Locality | Bond | Tri-spernia | Land-hafer | Ceirch du Bach | Saia | Exeter | Clinton | Rodney | Garry | C.I. 4023 |
|---|---|---|---|---|---|---|---|---|---|---|
| Saanichton, B.C. | 1 | tr[b] | 1 | 2 | tr | 0 | 0 | 0 | 0 | 0 |
| Melfort, Sask. | tr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brandon, Man. | tr | 0 | tr | 0 | 0 | 0 | tr | tr | 0 | 0 |
| Glenlea, Man. | 20 | 1 | 1 | 5 | 0 | 5 | 10 | 3 | 1 | 1 |
| Morden, Man. | 1 | tr | tr | tr | 0 | tr | tr | tr | tr | tr |
| Winnipeg, Man. | 40 | 10 | 10 | 5 | tr | 40 | 30 | 20 | 10 | 10 |
| Appleton, Ont. | 70 | 80 | 60 | 60 | 5 | 60 | 70 | 70 | 50 | 10 |
| Ft. William, Ont. | tr | 0 | 0 | tr | 0 | 0 | 0 | 0 | 0 | 0 |
| Guelph, Ont. | 20 | 3 | 1 | 1 | 0 | 3 | 3 | 1 | tr | tr |
| Kemptville, Ont. | 5 | tr | tr | 0 | 0 | 3 | 5 | 10 | 5 | 10 |
| Merrickville, Ont. | 1 | 0 | tr | 0 | 0 | 1 | 5 | 1 | tr | tr |
| Ottawa, Ont. | 30 | tr | 5 | 0 | 0 | 20 | 30 | 20 | 10 | 0 |
| L'Assomption, P.Q. | tr | 0 | 0 | 0 | 0 | tr | tr | 1 | 3 | 0 |
| Lennoxville, P.Q. | 1 | 1 | tr | - | 0 | 1 | 2 | tr | tr | 0 |
| Normandin, P.Q. | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| La Pocatière, P.Q. | 50 | - | - | - | tr | 40 | 50 | 40 | 30 | 5 |

[a] No rust was observed in 20 other nurseries located at Agassiz and Creston, B.C., Edmonton, Beaverlodge, Lacombe, and Lethbridge, Alta., Indian Head and Scott, Sask., The Pas, Man., Alfred, Douglas, Kapuskasing, St. Catherines, Verner, and Williamstown, Ont., Kentville, N.S., Fredericton, N.B., Charlottetown, P.E.I., Doyles and St. John's, Nfld.

[b] tr = trace

Table 3. Distribution by provinces of physiologic races of Puccinia graminis f. sp. avenae 1963-1966.

| Formula No. | Sask. | Man. | Ont. | Que. | N.B. | N.S. | Isolates | % total isolates |
|---|---|---|---|---|---|---|---|---|
| C2 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0.7 |
| C3 | 4 | 6 | 0 | 0 | 0 | 0 | 10 | 7.0 |
| C5 | 2 | 7 | 0 | 0 | 0 | 0 | 9 | 6.4 |
| C6 | 0 | 0 | 0 | 4 | 0 | 0 | 4 | 2.8 |
| C8 | 0 | 0 | 2 | 1 | 0 | 1 | 4 | 2.8 |
| C9 | 0 | 0 | 10 | 6 | 2 | 0 | 18 | 12.8 |
| C10 | 32 | 59 | 0 | 0 | 0 | 0 | 91 | 64.6 |
| C14 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | .7 |
| C19 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | .7 |
| C20 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 1.4 |
| Total | 41 | 73 | 12 | 12 | 2 | 1 | 141 | 99.9 |

losses are possible in the immediate future. However, in Western Canada, epidemics of oat stem rust are not expected to occur as frequently as those of wheat stem rust, partly because the relatively small oat acreage in the central great plains of the United States restricts the production of inoculum. Western Canadian oat growers can keep losses at a minimum by planting early to escape the rust. The continued eradication of barberry in Eastern Canada will reduce the amount of primary inoculum in that region.

## Acknowledgements

The assistance of all the cooperators who submitted rust collections from various parts of Canada is gratefully acknowledged.

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# CROWN RUST OF OATS IN CANADA IN 1966[1]

George Fleischmann [2]

## Disease development and crop losses in Western Canada

In 1966 oat crown rust, Puccinia coronata Cda. f. sp. avenae Erikss., was first found in southern Manitoba on July 18th. By the end of July trace to slight amounts of the disease were general in the Red River Valley of Manitoba, mostly on wild oats. A small gradual increase in crown rust intensity on the oat crop occurred during August. Trace amounts of the pathogen also spread into fields in eastern Saskatchewan. Maximum disease intensity in commercial oat fields ranged from 10 to 25 percent in southern Manitoba at the end of the growing season. Yield losses due to crown rust were negligible in most oat fields in Western Canada in 1966. Slight to moderate losses occurred in late sown fields in which crown rust reached intensities of more than 10 percent while the oats were still at a vulnerable pre-heading stage.

## Disease ratings in the rust nurseries

Ratings of crown rust intensity on 10 oat varieties grown at nurseries across Canada are presented in Table 1. Omitted from this table are those nurseries in which no crown rust was found on any of the 10 oat varieties, as well as a few nurseries in which rust intensity could not be estimated because of the shrivelled or mildewed condition of the leaves.

Except for traces of rust on 'Bond', 'Clinton', and 'Rodney' oats grown at Lacombe, Alberta, no crown rust was recorded from any nursery west of Indian Head, Saskatchewan. The heaviest infections in Western Canada were recorded on varieties grown at Winnipeg and Glenlea in southern Manitoba. In Eastern Canada heavy crown rust infections were once again observed in oat nurseries near dense buckthorn infestations in southeastern Ontario, and from the Guelph region. A slight amount of crown rust was seen on six varieties in the nursery at Lennoxville, Quebec, but none was detected in any other nursery in Quebec and the Maritimes.

## Distribution of physiologic races

The frequency of occurrence and distribution of 49 physiologic races of crown rust identified from 222 isolates is presented in Table 2. In previous years a few biotypes comprised the bulk of isolates in Western Canada but no race isolated in the west in 1966 constituted even 10 percent of the crown rust population. Furthermore, the trend toward virulence on the differential varieties 'Landhafer' and 'Santa Fe' appears to have been reversed; less than one quarter of the western isolates attacked these

Table 1. Percent infection of crown rust on 10 oat varieties at 12 locations across Canada.

| Locality | Bond | Trispernia | Landhafer | Ceirch du Bach | Saia | Exeter | Clinton | Rodney | Garry | C.I. 4023 |
|---|---|---|---|---|---|---|---|---|---|---|
| Lacombe, Alta. | tr* | 0 | 0 | 0 | 0 | 0 | tr | tr | 0 | 0 |
| Indian Head, Sask. | 5 | 0 | 0 | 0 | 0 | tr | tr | 2 | 2 | tr |
| Brandon, Man. | 0 | 0 | 0 | tr | 0 | 15 | 15 | 10 | 5 | tr |
| The Pas, Man. | tr | 0 | 0 | 0 | 0 | 0 | tr | 0 | tr | tr |
| Morden, Man. | 5 | 0 | tr | 0 | 0 | 10 | 10 | 5 | 5 | 2 |
| Winnipeg, Man. ** | 5 | 0 | 1 | 0 | 0 | 10 | 10 | 10 | 10 | 5 |
| Glenlea, Man. *** | 5 | 0 | tr | tr | 0 | 30 | 30 | 25 | 25 | 30 |
| Kemptville, Ont. | 15 | 0 | 0 | 0 | 0 | 10 | 10 | 5 | 5 | 10 |
| Guelph, Ont. | 30 | tr | 0 | 0 | 0 | 60 | 30 | 30 | 40 | 10 |
| Ottawa, Ont. | -- | 0 | 0 | 0 | 0 | 5 | -- | 10 | -- | 5 |
| Merrickville, Ont. | 5 | 0 | tr | 0 | tr | 20 | 30 | 20 | -- | -- |
| Lennoxville, Que. | 2 | 0 | 0 | 0 | 0 | tr | 2 | tr | tr | tr |

* tr - trace infection, less than 1 percent.
** rust ratings taken on Aug. 5, 1966.
*** rust ratings taken on Aug. 22, 1966.

1 Contribution No. 250 from the Canada Department of Agriculture Research Station, Winnipeg, Manitoba.
2 Plant Pathologist.

Table 2. Distribution of physiologic races of crown rust in Canada, 1966.

| Physiologic race | West Number isolates | West % of all isolates | East Number isolates | East % of all isolates | W & E Total isolates |
|---|---|---|---|---|---|
| 201 | 2 | 1.2 | - | - | 2 |
| 202 | 3 | 1.8 | - | - | 3 |
| 203 | 13 | 7.7 | 1 | 1.9 | 14 |
| 209 | 2 | 1.2 | 1 | 1.9 | 3 |
| 210 | 7 | 4.1 | 10 | 18.7 | 17 |
| 211 | 7 | 4.1 | 2 | 3.8 | 9 |
| 212 | 1 | 0.6 | 2 | 3.8 | 3 |
| 213 | 5 | 3.0 | - | - | 5 |
| 216 | 14 | 8.3 | 2 | 3.8 | 16 |
| 226 | 2 | 1.2 | 1 | 1.9 | 3 |
| 228 | 4 | 2.4 | 4 | 7.5 | 8 |
| 230 | 1 | 0.6 | - | - | 1 |
| 231 | 6 | 3.6 | - | - | 6 |
| 237 | 1 | 0.6 | - | - | 1 |
| 240 | - | - | 2 | 3.8 | 2 |
| 241 | 1 | 0.6 | - | - | 1 |
| 258 | 1 | 0.6 | - | - | 1 |
| 259 | 5 | 3.0 | - | - | 5 |
| 264 | 1 | 0.6 | - | - | 1 |
| 265 | 1 | 0.6 | - | - | 1 |
| 274 | 6 | 3.6 | 2 | 3.8 | 8 |
| 276 | 1 | 0.6 | - | - | 1 |
| 279 | 4 | 2.4 | - | - | 4 |
| 281 | 1 | 0.6 | 1 | 1.9 | 2 |
| 283 | 1 | 0.6 | 2 | 3.8 | 3 |
| 284 | 6 | 3.6 | - | - | 6 |
| 290 | 3 | 1.8 | - | - | 3 |
| 293 | 2 | 1.2 | - | - | 2 |
| 294 | 1 | 0.6 | 2 | 3.8 | 3 |
| 295 | 4 | 2.4 | 1 | 1.9 | 5 |
| 297 | 1 | 0.6 | 2 | 3.8 | 3 |
| 299 | 6 | 3.6 | - | - | 6 |
| 320 | 12 | 7.1 | 2 | 3.8 | 14 |
| 324 | - | - | 2 | 3.8 | 2 |
| 326 | 9 | 5.3 | 1 | 1.9 | 10 |
| 327 | 2 | 1.2 | - | - | 2 |
| 330 | - | - | 1 | 1.9 | 1 |
| 332 | 2 | 1.2 | - | - | 2 |
| 337 | 2 | 1.2 | - | - | 2 |
| 338 | 5 | 3.0 | 1 | 1.9 | 6 |
| 339 | 1 | 0.6 | - | - | 1 |
| 341 | 12 | 7.1 | 7 | 13.1 | 19 |
| 342 | 2 | 1.2 | 1 | 1.9 | 3 |
| 362 | 1 | 0.6 | - | - | 1 |
| 392 | 1 | 0.6 | - | - | 1 |
| 421 | 1 | 0.6 | - | - | 1 |
| 422 | 1 | 0.6 | - | - | 1 |
| 423 | 1 | 0.6 | 1 | 1.9 | 2 |
| 427 | 1 | 0.6 | - | - | 1 |
| 428 | - | - | 1 | 1.9 | 1 |
| New races | 3* | 1.8 | 1 | 1.9 | 4 |
| Races-Total | 49 | | 25 | | 54 |
| Isolates-Total | 169 | | 53 | | 222 |

*Each of these 3 biotypes represents a different new race.

Table 3. Virulence of Canadian crown rust biotypes, 1966, on the differential oat varieties.

| | Anthony | Victoria | Appler | Bond | Landhafer | Santa Fe | Ukraine | Trispernia | Bondvic | Saia |
|---|---|---|---|---|---|---|---|---|---|---|
| Western Canada: | | | | | | | | | | |
| from wild oats | 48*(69)** | 36(51) | 46(66) | 54(77) | 19(27) | 18(26) | 51(73) | 3(4) | 3(4) | 5(7) |
| from cultivated oats | 61(62) | 60(61) | 57(58) | 82(83) | 21(21) | 21(21) | 87(88) | 1(1) | 1(1) | 2(2) |
| from all isolates | 109(66) | 96(58) | 103(62) | 136(82) | 40(24) | 39(23) | 138(83) | 4(2) | 4(2) | 7(4) |
| Eastern Canada: | | | | | | | | | | |
| from all isolates | 27(51) | 24(45) | 16(30) | 41(77) | 5( 9) | 5( 9) | 45(85) | 0(0) | 0(0) | 5(9) |
| From all Canadian isolates: | 136(61) | 120(54) | 119(53) | 177(80) | 45(20) | 44(20) | 183(82) | 4(2) | 4(2) | 12(6) |

*Number of virulent isolates. **Percent of virulent isolates in brackets.

two differential varieties in 1966 whereas over half the cultures from the west were virulent on 'Landhafer' and 'Santa Fe' in previous years (1, 2). Perhaps these phenomena both result from the crown rust population developing in the absence of selection pressure from host varieties with effective crown rust resistance.

The virulence of the crown rust cultures isolated in 1966 on the differential oat varieties is presented in Table 3. Only 'Trispernia', 'Bondvic' and 'Saia' appear to have effective crown rust resistance genes against the 1966 physiologic race population. The lower virulence of the isolates from Eastern Canada, relative to those from the west, is also indicated in Table 3. Crown rust cultures from the east were less virulent on all except the most susceptible differential, 'Ukraine'.

Three new races, with previously undescribed virulence combinations on the crown rust differential oat varieties, were isolated in 1966. Their resistance formulae are: race 445 - 1, 2, 3, 4, 7, 8, 9, 10; race 446 - 1, 3, 8, 9, 10; and race 447 - 3, 8, 9, 10.

## Acknowledgements

I am grateful for assistance given by the cooperators in the care of the rust nurseries and in the collection of crown rust specimens in Eastern Canada. Mr. W.L. Timlick performed the technical operations requisite to the identification of the physiologic races.

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# THE SUGAR BEET NEMATODE, HETERODERA SCHACHTII, SCHMIDT, AND OTHER PLANT-PARASITIC NEMATODES ON RHUBARB IN ONTARIO[1]

J.L. Townshend and Th. H.A. Olthof[2]

## Abstract

A survey of rhubarb soils in seven counties in southern Ontario showed the sugar beet nematode, Heterodera schachtii Schmidt, to be present in six: Halton, Oxford, Peel, Simcoe, Wentworth and York. Large populations of root-lesion nematodes, Pratylenchus penetrans (Cobb) Filip. & Stekh., and pin nematodes, Paratylenchus projectus Jenkins, occurred in nearly all counties. Northern root knot nematodes, Meloidogyne hapla Chitwood, occurred in Halton and Peel counties. Of 17 vegetable crops tested, eight were hosts of H. schachtii. Some cysts of the sugar beet nematode were formed on tomato.

## Introduction

In 1964, the sugar beet nematode, Heterodera schachtii Schmidt, was found in a field of table beets at Woodbridge, Ontario. These table beets were grown in rotation with rhubarb which is a host of the nematode (8). Nearly all rhubarb sets used by the fresh winter rhubarb industry in southern Ontario originate from one farm in Oxford County. When this source was found to be infested with the sugar beet nematode, a survey was made of the distribution of H. schachtii and other plant-parasitic nematodes in rhubarb fields in the intensive vegetable growing areas near Hamilton and Toronto.

The vegetable host range of H. schachtii was investigated to confirm earlier studies elsewhere and to detect possible strains of the nematode.

## Materials and methods

In response to a questionnaire, 20 rhubarb growers in the Hamilton-Toronto area collected 75 soil samples during the months of August and September, 1964. Upon arrival in the laboratory, each sample was thoroughly mixed and divided into two 50 g sub-samples. One moist sub-sample was placed on a tissue-lined sieve in a pan of water (11) to extract 2nd stage juveniles of H. schachtii and other migratory nematodes. The second sub-sample was air dried and then washed through a Fenwick can (7) to recover cysts.

To study the host range of the sugar beet nematode, 17 vegetable crops commonly grown in the infested area were either raised in flats and then transplanted to 10.2 cm clay pots or were seeded directly into the pots. All pots were filled with a 1:1 mixture of composted soil and sand. Half the pots were inoculated with 165 cysts of H. schachtii in 25 g of soil. The cyst-infested soil came from a table beet field at Woodbridge and was cropped to table beets in the greenhouse. The remaining pots were not inoculated with the nematode and served as controls.

Each vegetable was grown in both infested and non-infested soil in four replications arranged in a randomized block design. After six weeks of growth, total fresh weights of all plants were determined and the number of cysts on each root grown in infested soil was counted.

## Results

Nine of the 20 farms where rhubarb was grown were found to be infested with H. schachtii (Table 1). The root-lesion nematode, Pratylenchus penetrans, and the pin nematode, Paratylenchus projectus, were found in large numbers on most farms. On two farms, juveniles of the Northern root-knot nematode (Meloidgyne hapla) were present.

Cysts were formed on the roots of eight of the 17 vegetable crops tested in the host range experiment, and these may therefore be considered hosts of H. schachtii. Only a few vegetables suffered significant damage, as based on a comparison of total fresh weight of plants grown in infested and non-infested soil (Table 2).

## Discussion

H. schachtii is now known to occur in at least eight counties in southern Ontario: Halton, Lambton, Middlesex, Oxford, Peel, Simcoe, Wentworth and York. Its presence in Middlesex County was reported in 1921 (3) and in Lambton County from 1939-1942 (1, 2). It is not known whether the nematode has spread to the surveyed area from these two counties during the last two to three decades or

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2 Nematologists.

Table 1. Species and numbers of plant-parasitic nematodes associated with rhubarb on farms in several counties in southern Ontario.

| County | No. of samples | No. of farms | Pratylenchus penetrans | Paratylenchus projectus | Meloidogyne hapla (juveniles) | Heterodera schachtii (juveniles) |
|---|---|---|---|---|---|---|
| Halton | 23 | 6 | 914[1]/12[2]/4[3] | 5101/21/6 | 1600/1/1 | 11,739/13/3 |
| Lincoln | 6 | 1 | 1393/6/1 | 3630/6/1 | 0/0/0 | 0/0/0 |
| Oxford | 13 | 1 | 2375/10/1 | 1691/12/1 | 0/0/0 | 1,390/4/1 |
| Peel | 11 | 4 | 533/9/4 | 8797/11/4 | 440/1/1 | 40/3/1 |
| Simcoe | 2 | 1 | 0/0/0 | 1950/2/1 | 0/0/0 | 20,000/2/1 |
| Wentworth | 6 | 4 | 1390/4/3 | 3845/6/4 | 0/0/0 | 1,400/1/1 |
| York | 14 | 3 | 853/6/3 | 3806/12/3 | 0/0/0 | 6,375/6/2 |

1 Average no. of nematodes/450 g soil.
2 No. of samples containing the nematode.
3 No. of farms infested with each nematode.

Table 2. A comparison of the susceptibility of various vegetables to the sugar-beet nematode.

| Vegetables | Fresh Wt. (g) Control | Fresh Wt. (g) Infested | L. S. D. 0.05 | Percentage reduction in fresh weight | Cysts/Root system |
|---|---|---|---|---|---|
| Sugar Beet var. 'Giant White' | 21 | 2 | 8.5 | 90 | -[1] |
| Table Beet var. 'Detroit Dark Red' | 20 | 7 | 10.1 | 71 | 67 |
| Spinach var. 'Early Hybrid #11' | 14 | 9 | 4.2 | 36 | 38 |
| Turnip var. 'Purple Top White Globe' | 18 | 10 | 5.7 | 46 | 38 |
| Cabbage var. 'Penn State Ballhead' | 42 | 38 | n.s.[2] | -- | 45 |
| Cauliflower var. 'Super Junior' | 25 | 21 | n.s. | -- | 71 |
| Radish var. 'Cherry Belle' | 38 | 38 | n.s. | -- | 5 |
| Tomato var. 'Fireball' | 49 | 47 | n.s. | -- | 5 |
| Bean var. 'Contender' | 20 | 22 | n.s. | -- | 0 |
| Carrot var. 'Scarlet Nantes Strong Top' | 12 | 10 | n.s. | -- | 0 |
| Celery var. 'Utah 52-70' | 7 | 7 | n.s. | -- | 0 |
| Eggplant var. 'Imperial Black Beauty' | 10 | 11 | n.s. | -- | 0 |
| Lettuce var. 'Imperial 456' | 42 | 42 | n.s. | -- | 0 |
| Parsnip var. 'Harris Model' | 8 | 11 | n.s. | -- | 0 |
| Pepper var. 'Vinedale' | 15 | 13 | n.s. | -- | 0 |
| Potato var. 'Irish Cobbler' | 45 | 51 | n.s. | -- | 0 |
| Onion var. 'Southport White Globe' | 7 | 5 | n.s. | -- | 0 |

1 Sugar beet seedlings were too severely stunted for cysts to develop.
2 n.s. - not significant.

whether its infestation results from a separate introduction from abroad.

Most samples contained large numbers of root-lesion nematodes (Pratylenchus penetrans) and pin-nematodes (Paratylenchus projectus). The presence of such large populations of root-lesion nematodes forms a threat to vegetable growing as certain crops, such as celery (10), suffer severely from them. Less is known about the importance of pin-nematodes. The presence of the Northern root-knot nematode (Meloidogyne hapla) may be serious if susceptible crops, such as carrots, are grown.

The host range study generally confirmed findings elsewhere (4, 8, 12). Tomato was found to be a host as a few cysts developed on its roots. In California, Golden and Shafer (6) and Steele (9) reported tomato to be a host of H. schachtii; however, Wheatley and McFarlane (12) did not find any cysts on tomato plants. In Ontario, Mulvey (8) reported that H. schachtii, recovered from sugar beet in Lambton County, did not produce cysts on tomato. These differences in response of tomato to the sugar beet nematode may be due either to the existence of strains or bio-types of H. schachtii or to differences in susceptibility of the tomato varieties involved (5).

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# FUSICOCCUM CANKER OF HIGHBUSH BLUEBERRY IN NOVA SCOTIA[1]

C. L. Lockhart[2] and D. L. Craig[3]

## Abstract

A survey of highbush blueberry plantings showed that 'Jersey' was the variety most susceptible to fusicoccum canker closely followed by 'Earliblue', 'Johnson' and 'Bluecrop'. 'Coville', 'Berkeley', 'Pioneer' and 'Blueray' were moderately susceptible. 'Burlington' and 'Stanley' were slightly more tolerant and 'Rancocas' and 'Concord' were resistant. Fall inoculations of field grown plants with Fusicoccum putrefaciens were successful but summer inoculations failed. Erad at the rate of one pint per 100 gal. applied before growth commenced in the spring and after growth had ceased in the fall provided the best chemical control of fusicoccum canker.

## Introduction

Stem canker (Fusicoccum putrefaciens Shear stat. perf. Godronia cassandrae Pk. f. vaccinii Groves) is causing some concern to growers desiring to increase highbush blueberry plantings in Nova Scotia. This disease is present in many of the highbush blueberry production areas of the north-temperate zone including British Columbia, Michigan, Maine, Massachusetts, England and Finland (1). It was first reported in Nova Scotia in 1948 (2) and is recognized as a factor in limiting production in this area.

The susceptibility of the newer varieties to fusicoccum canker when grown in Nova Scotia, the time of year when field infection occurs and the results obtained from fungicide trials are reported in this paper.

## Materials and methods

### Canker susceptibility rating

The rate of fusicoccum canker infection was determined from four widely separated highbush blueberry plantings in the Annapolis Valley. These plantings differed to some degree in number and age of plants, soil type and method of culture.

Canker determinations were made on July 29. August 11, September 6 and 9, 1966. The numbers of plants examined, their ages and the amount of infection were recorded on each date.

### Inoculation tests

'Pioneer' plants growing in the field were inoculated in triplicate on October 2, 1957, and on May 2, July 30 and August 28 in 1958 by making an incision in the bark with a scapel and inserting, under the bark, spores from an agar culture. The incisions were wrapped with moistened cotton held in place with cellulose tape. Three days after inoculation the cotton was removed. Controls consisted of incisions without inoculum.

### Fungicide trials

Four plots, each containing approximately equal numbers of 'Coville', 'Berkeley' and 'Bluecrop' plants, were treated as follows:

Plot 1. All stems with cankered areas painted with Murphy canker paint[4] (2% organic mercury) on September 29, 1964, and an overall spray of Elgetol at the rate of 2 qt./100 gal. was applied on May 5, 1966.

Plot 2. An overall spray of Erad[5] at the rate of 5 pints/100 gal. was applied on September 25 and October 13 in 1964 and on May 7, 1965, and an overall spray of thiram[6] at the rate of 4 lb./100 gal. plus Rhoplex AC-33[7] at the rate of 7 gal./100 gal. was applied on May 5, 1966.

Plot 3. An overall spray of Erad at the rate of 1 pint/100 gal. was applied on September 25 and October 13, 1964; May 7, 1965 and May 5, 1966. Fall applications were made just prior to leaf fall and spring applications prior to the commencement of growth.

Plot 4. Controls.

In addition Erad at 1 pint/100 gal. was applied, on September 25, October 13, 1964; May 7, 1965,

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4 The Murphy Chemical Company Ltd., Wheathampstead, St. Albans, Hertfordshire

5 Erad (phenyl mercury acetate 10%) Green Cross Insecticides, Montreal, Quebec

6 Thiram (Thylate 65 W) tetramethylthiuram disulphide 65%

7 Semi-permanent sticker. Rhom & Haas Company of Canada Ltd., 2 Manse Road, West Hill, Ontario.

and May 5, 1966 to two rows of blueberries containing two or more plants of the varieties 'Jersey', 'Burlington', 'Rancocas', 'Stanley', 'Pioneer', 'Johnson', and 'Concord'.

Plots were scored for the amount of infection in 1964 and for dying stems, number of cankers per plant and number of cankers per stem in 1966. The number of old stubs infected with Godronia cassandrae Pk. f. vaccinii Groves (the perfect stage) were also recorded.

Cankers were collected from all plots on May 10, 1965 and held in a moist chamber. Spores were placed in a drop of water on a slide to determine viability.

Cankers were collected from all plots on September 27, 1965 and isolations were made on potato dextrose agar media from the edge of cankers to determine if F. putrefaciens was still active.

## Results

### Canker susceptibility rating

Data (Table 1) taken from four commercial plantings showed that 'Jersey' was the most susceptible variety followed closely by 'Earliblue', 'Johnson' and 'Bluecrop'. 'Coville', 'Berkeley', 'Pioneer' and 'Blueray' were moderately susceptible. 'Burlington' and 'Stanley' were slightly more tolerant and 'Rancocas' and 'Concord' were resistant.

Dead plants, infected with F. putrefaciens, in a 4-year-old planting of 'Earliblue' suggested that the canker is capable of killing this variety.

### Inoculation tests

Fusicoccum infection was evident 6 days after wound inoculations were made on October 2, 1957 (Table 2). By April 24, 1958, the cankers were from $\frac{3}{4}$ to $2\frac{1}{4}$ in. long and producing pycnidia and conidia. Early May inoculations caused a slight infection around the inoculation site. This was followed by cankering in late August. No infection occured in July when the plants were growing vigorously. The successful inoculations of August 28 and October 2 coincided with the slowing down or cessation of active growth.

### Fungicide trials

Erad at the rate of one pint/100 gal. applied in 1964, 1965 and 1966 gave the best control of fusicoccum canker (Table 3). Erad at the rate of 5 pints /100 gal. in 1964 and 1965 followed by thiram in 1966 was somewhat less effective (Table 3). Murphy canker paint applied in 1964 followed by Elgetol in 1966 substantially reduced cankers on 'Berkeley' and 'Coville' but was less effective on the more susceptible variety 'Bluecrop' (Table 3).

A single application of Murphy paint in September 1964 inhibited sporulation for 12 months but isolations of F. putrefaciens could be obtained from the edges of most cankers 4 to 12 months after being sprayed or painted. A number of young cankered branches were killed due to the phytotoxicity of the paint.

Actively growing 'Jersey' plants sprayed with Erad at the rate of one pint/100 gal. were severely injured. Treated plants had black necrotic spots on the foliage, dead shoot tips and in some instances shoots blackened and killed back 12 to 15 inches. In contrast, non-dormant 'Berkeley', 'Coville' and 'Bluecrop' plants were uninjured at the 5-pint rate.

Table 1. The susceptibility of highbush blueberry varieties to fusicoccum canker in 1966

| Variety | No. of plants | Age of plants (years) | % infected | Average |
|---|---|---|---|---|
| Jersey | 296 | 6 | 71 | |
| | 11 | 16 | 82 | |
| | 9 | 18 | 78 | 77 |
| Earliblue | 24 | 4 | 71 | 71 |
| Johnson | 7 | 18 | 71 | 71 |
| Bluecrop | 17 | 5 | 65 | |
| | 9 | 11 | 78 | |
| | 22 | 12 | 58 | 67 |
| Coville | 15 | 12 | 60 | 60 |
| Berkeley | 22 | 5 | 50 | |
| | 35 | 12 | 50 | 50 |
| Pioneer | 2 | 18 | 50 | 50 |
| Blueray | 15 | 5 | 47 | 47 |
| Burlington | 257 | 6 | 37 | |
| | 10 | 16 | 50 | |
| | 35 | 18 | 42 | 43 |
| Stanley | 10 | 18 | 30 | 30 |
| Rancocas | 12 | 16 | 0 | |
| | 2 | 18 | 0 | 0 |
| Concord | 2 | 18 | 0 | 0 |

Table 2. Infection of highbush blueberry, variety 'Pioneer', with F. putrefaciens

| Date inoculated | Canker produced |
|---|---|
| October 2, 1957 | + |
| May 2, 1958 | +* |
| July 30, 1958 | - |
| August 28, 1958 | + |

*Slight activity occurred around incision after inoculation but canker size did not increase until late August.

Table 3. Effectiveness of fungicides for control of fusicoccum canker in the highbush blueberry

| Treatment | Varieties | Number of plants | Number of stems | Per cent plants infected 1964 | Per cent plants infected 1966 | Average number of Fusicoccum Cankers per plant 1966 | Average number of Fusicoccum Cankers per stem 1966 | Number of stubs infected with Godronia 1966 | Infected dying stems in August, 1966 |
|---|---|---|---|---|---|---|---|---|---|
| Murphy canker paint in 1964 Elgetol, 2qt./100 gal. in 1966 | Berkeley | 15 | 76 | 40 | 13.3 | 0.07 | 0.01 | 0 | 1 |
| | Coville | 15 | 120 | 50 | 26.6 | 0.26 | 0.02 | 3 | 0 |
| | Bluecrop | 7 | 111 | 57 | 71.3 | 1.85 | 0.06 | 0 | 1 |
| Erad, 5 pt./100 gal. in 1964 and 65 Thiram 4-100 + Rhoplex AC, 7-100 in 1966 | Berkeley | 14 | 110 | 33 | 35.7 | 0.21 | 0.03 | 7 | 2 |
| | Coville | 15 | 148 | 47 | 46.6 | 0.33 | 0.03 | 7 | 0 |
| | Bluecrop | 7 | 95 | 85 | 42.8 | 1.42 | 0.08 | 4 | 0 |
| Erad, 1 pt./100 gal. in 1964, 1965, 1966 | Berkeley | 14 | 111 | 57 | 28.0 | 0.42 | 0.04 | 5 | 1 |
| | Coville | 14 | 161 | 50 | 50.0 | 0.57 | 0.04 | 10 | 2 |
| | Bluecrop | 6 | 73 | 57 | 50.0 | 0.33 | 0.01 | 2 | 0 |
| Control | Berkeley | 15 | 123 | 50 | 60.0 | 0.87 | 0.06 | 21 | 5 |
| | Coville | 15 | 143 | 33 | 60.0 | 1.46 | 0.08 | 18 | 1 |
| | Bluecrop | 9 | 110 | 57 | 77.7 | 1.88 | 0.10 | 7 | 1 |

Fusicoccum cankers placed in a moist chamber three days after receiving Erad at the rate of 5 pints /100 gal. produced no viable conidia within a 16-day period. Twenty per cent of the conidia from cankers which received the one-pint rate were viable following 11 days in a moist chamber. Conidia from the surface of cankers treated with Murphy paint remained non-viable for 12 months.

## Discussion

The results of this study clearly indicate that highbush blueberry growers in Nova Scotia should avoid planting canker-susceptible varieties such as 'Jersey' and 'Earliblue'. 'Rancocas', 'Stanley', 'Concord' and 'Burlington' are more resistant to the disease but unfortunately they lack certain desirable horticultural traits such as fruit size. The moderately resistant and horticulturally superior varieties 'Blueray' and 'Berkeley' are better suited to this area.

We have found that infection occurs mainly in the late summer and fall. McKeen (4) also reported fall infection in British Columbia while Zuckerman (6) reported spring infection in Massachusetts. Attempts to inoculate actively growing plants in the greenhouse were unsuccessful (3).

The control of canker is attributed to applications of Erad at the one-pint rate which inhibited conidial development on the surface of cankers when the plants were in a susceptible stage. Preliminary screening tests indicated Erad that at the $\frac{1}{2}$-pint rate was ineffective (unpublished results). Nelson (5) has also obtained control of fusicoccum canker on the highbush blueberry in Michigan with fall applications of organic mercury. Creelman (3) and Zuckerman (6) reported no control of fusicoccum canker with spring and summer fungicide applications.

Our data suggests that, in view of the prevalance of fusicoccum canker in Nova Scotia, commercial highbush blueberry growers would be well advised to spray with Erad at the rate of 1 pint/100 gal. before growth commenced in the spring and again in the fall when growth has ceased. Growers setting out new plantings should consider planting 'Blueray' and 'Berkeley' because they are moderately resistant to the canker and horticulturally superior to other varieties.

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# INCIDENCE OF LEAF SCORCH OF STRAWBERRY IN AND NEAR THE NIAGARA PENINSULA FROM 1961 TO 1963

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Commercial strawberry plantations and varietal testing plots in and near the Niagara Peninsula were surveyed for leaf scorch (Diplocarpon earliana (Ell. & Ev.) Wolf) during the years 1961 to 1963.

Disease incidence was evaluated by examining plants at various places in each varietal plot for the frequency of scorch lesions, their relative size and sporulation. The observations acquired from 1961 to 1963 are summarized in Table 1 while those from the varietal testing plots at the Horticultural Experiment Station, Simcoe, Ontario taken in August 1963 are presented in Table 2.

In these surveys the varieties 'Louise', 'Pocahontas', 'Earlidawn', 'Jerseybelle', 'Guardsman', 'Frontenac', 'Robinson' and 'Redglow' were very susceptible whereas 'Catskill', 'Redcoat' and 'Premier' ('Howard 17') were relatively free from scorch. 'Surecrop' and 'Sparkle' were variable, being free from scorch in some years and in some areas and showing a heavy incidence in others. On susceptible varieties, although lesions of varied size occurred throughout the season they became larger and blotchy in late summer and fall.

There is an obvious regional variation in leaf scorch resistance among strawberry varieties. Thus, 'Surecrop' and 'Robinson', which have been reported among the most resistant and as exhibiting low scorch incidence in Indiana (3), were very susceptible at times in Ontario. This suggests pathogenic races in the pathogen. Leaf scorch lesions of different size, from pinpoint to blotchy, have been ascribed to differences in host varieties (2), or to differences among isolates of D. earliana (1). Only blotchy lesions were reported in a recent disease survey in Nova Scotia (4). In our observations the incidence of blotchy lesions increased towards the end of summer and in fall in Ontario and this suggests also a seasonal influence.

Table 2. Field incidence of strawberry leaf scorch disease in varietal testing plots at Simcoe, Ontario, in their first fruiting season. August 8, 1963.

| Row no. | Strawberry variety blocks I | II | III |
|---|---|---|---|
| 1 | Fletcher | Fulton$^{+}$ | Redcoat |
| 2 | Fulton$^{+}$ | Redcoat | Jerseybelle$^{++++}$ |
| 3 | Erie$^{+}$ | Erie$^{+}$ | Fulton$^{++}$ |
| 4 | Robinson$^{++++}$ | Guardsman | Robinson$^{++++}$ |
| 5 | Jerseybelle$^{++++}$ | Robinson$^{++}$ | Sparkle$^{++}$ |
| 6 | Guardsman$^{+}$ | Fletcher$^{+}$ | Robinson$^{++++}$ |
| 7 | Redcoat | Erie$^{++}$ | Redcoat |
| 8 | Fulton$^{+}$ | Frontenac$^{+++}$ | Jerseybelle$^{++++}$ |
| 9 | Fletcher | Fulton$^{++}$ | Guardsman$^{++}$ |
| 10 | Erie$^{+}$ | Jerseybelle$^{++++}$ | Fulton$^{++}$ |
| 11 | Sparkle$^{+}$ | Sparkle$^{++}$ | Frontenac$^{++++}$ |
| 12 | Frontenac$^{++++}$ | Redcoat | Fletcher$^{++}$ |
| 13 | Robinson$^{++++}$ | Guardsman$^{+}$ | Erie$^{++}$ * |
| 1 | Catskill | Grenadier | Redcoat |
| 2 | Redcoat | Pocahontas$^{++++}$ | Surecrop |
| 3 | Catskill | Grenadier | Surecrop |
| 4 | Grenadier | Earlidawn$^{++++}$ | Redcoat |
| 5 | Surecrop$^{=}$ | Catskill$^{=}$ | Premier |
| 6 | Premier$^{+}$ | Cavalier$^{+}$ | Pocahontas$^{++++}$ |
| 7 | Pocahontas$^{++++}$ | Pocahontas$^{++++}$ | Midway$^{+}$ |
| 8 | Redcoat | Premier | Grenadier |
| 9 | Midway$^{+}$ | Surecrop | Earlidawn$^{+}$ |

* Line separates 2 different areas of testing plots.

Disease index: order of increasing severity + to ++++; = denotes very few plants infected in the row.

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Table 1. Summary of leaf scorch disease incidence of strawberry varieties in and near Niagara Peninsula during the years 1961 to 1963.

| Variety | Location and field reaction |
|---|---|
| Premier (Howard 17) | Mostly free from leaf scorch. In the fall of 1962 in one plantation at Jordan, most of the plants were infected and bore sporulating lesions. |
| Catskill and Redcoat | Mostly free from leaf scorch. Whenever found, the lesions were confined to the older leaves, restricted in size and with few acervuli. |
| Surecrop, Jerseybelle, Robinson and Fulton | Plants at the end of summer in 1962 in the year of planting and in the summer and fall of 1963 in the year of fruiting were severely infected at Vineland. Lesions were blotchy, 5-10 mm diam. and were sporulating heavily. |
| Redglow | Plants during the summer and fall of 1961 to 1963 at Vineland had severe leaf scorch with heavily sporulating lesions on the leaves. |
| Pocahontas | Leaf scorch was found at many locations in Clarkson-Niagara area during summer and fall of 1961-1963. Lesions found in May-June were narrow and elongated while those in the fall were blotchy. |
| Dixieland | Moderate leaf scorch was seen on this variety in and around Vineland from 1961 to 1963 throughout the growing season. Individual lesions were narrow and elongated. |
| Louise | Moderate to severe infection was seen at Whitby and Dixie, during 1961 and 1962. Lesions became blotchy in late summer and fall and were sporulating heavily. |
| Sparkle | Severe infection seen only in one plantation in Jordan in 1961. Since then 'Sparkle' has been free from scorch at many locations. |
| Guardsman | Heavily fruiting, blotchy lesions were found in severely affected plants at Oshawa in late summer and fall in 1961, and at Vineland from 1961 to 1963. |
| Earlidawn | Leaf scorch was found quite commonly at many locations, in the Clarkson-Niagara area and east and west of Toronto from 1961 to 1963. Moderate sized lesions were found in summer and in the fall they were blotchy and fruiting heavily. |

# SOME RECORDS OF PLANT-PARASITIC NEMATODES ENCOUNTERED IN CANADA IN 1966[1]

Robert Sewell[2]

## Root-knot nematodes

The northern root-knot nematode, Meloidogyne hapla Chitwood, 1949, was intercepted on rose roots from Holland, from several parts of the United States, Texas, California and Tennessee, and from Belgium and France, also on hydrangea and privet from Huntsville, Alabama, on Spiraea sp. from Louisiana, on Spiraea sp., Forsythia sp., Lonicera sp. Viburnum sp., lilac, honeysuckle, Deutzia sp., and Kolkwitzia sp. from Tennessee, strawberries from Delaware, Lycopersicum sp. from Georgia, on fern root from Portugal, on tomato root from Quebec, and on carrot from Nova Scotia. Meloidogyne hapla, and possibly the southern root-knot nematode, M. incognita (Kofoid and White, 1919) Chitwood, 1949, were found on privet from Tennessee. M. incognita was found on interceptions of golden willow, Viburnum sp., and Weigela sp. from Tennessee, on hydrangea from Alabama, and on Lycopersicum sp. from Georgia. M. incognita, and possibly M. arenaria (Neal, 1889) Chitwood, 1949, were found on bush honeysuckle from McMinnville, Tennessee; Meloidogyne spp. (possbily M. incognita and M. arenaria) were reported on Ficus carica and hydrangea from Alabama, on Lycopersicum sp. from Georgia, and on Spiraea sp., bush honeysuckle, Weigela sp., and Buddleja spp. from Tennessee.

The cotton root-knot nematode, Meloidogyne incognita acrita Chitwood and Oteifa, 1952, was reported on privet from McMinnville, Tennessee. M. javanica (Treub, 1885) Chitwood, 1949 was found in one shipment of Lycopersicum sp. from Tifton, Georgia. Meloidogyne sp. (possibly M. hapla) was found on Ligustrum amurense from McMinnville, Tennessee. Meloidogyne arenaria thamesi Chitwood, in Chitwood, Specht and Havis, 1952 was found on Rosa sp. from Holland.

## Cyst-forming nematodes

The oat cyst nematode, Heterodera avenae Wollenweber, 1924, was intercepted in soil taken from Rosa sp. and from Chrysanthemum sp. from Holland, Acer platanoides from Belgium, Cyclamen sp. from England, and herbaceous plants from Romania.

The grass cyst nematode, Heterodera punctata Thorne, 1928, was found in soil associated with herbaceous plants, from Prunus sp., Malus sp., and Begonia sp. from Belgium, also on hyacinth from Germany, and on Prunus sp. from Angers, France. It was recorded on flower bulbs from England and on Juglans sp. from Poland, and in soil taken off cars from several points in Europe.

The golden nematode, Heterodera rostochiensis Wollenweber, 1923, was found during a cyst survey in Sidney and Victoria, British Columbia, and also in nursery soil from a car from Newfoundland. It was also discovered on Dahlia sp. and in soil from passenger's baggage from Holland, on shamrock from Ireland, on several ornamentals from Scotland, Zibrina sp. from England, on potato and hyacinth from Germany, and on greenhouse plants from Italy.

The clover cyst nematode, Heterodera trifolii Goffart, 1932, was intercepted on a shipment of gloxinia from Holland. It was also discovered and identified in soil associated with Mimosa sp., woody plants, Pelargonium sp., Aspidistra sp., and several rootstock cuttings from Italy, on Begonia sp. from Belgium, in soil from a car, and on Prunus sp. from France, on Amaryllis sp., herbaceous plants, and in soil from passenger's baggage from Portugal, on Zibrina sp., Cyclamen sp., and Primulaceae from England, on currant, Juglans sp., and Dahlia sp. from Poland, and on hyacinth from Germany. It was also found in material collected in a cyst survey of the following areas in Canada: St. John's, Newfoundland; Montreal, Quebec; Kentville, Nova Scotia; Toronto, London, and Windsor, Ontario; Sidney, British Columbia.

The cabbage cyst nematode, Heterodera cruciferae Franklin, 1945, was reported on greenhouse plants from Portugal, hydrangea from Italy, and in soil from cuttings from Belgium. The sugar-beet nematode, Heterodera schachtii Schmidt, 1871 was reported on lily from Holland, and on Protea sp. from South Africa.

Cysts identified only as Heterodera spp. were recorded as follows: associated with herbaceous plants from Bermuda and Portugal; on greenhouse plants from the United States and Germany; on Prunus sp. and Malus sp., and in soil off a car from France; on Lilium tigrinum from Japan; on Oleander sp., rosemary, Pelargonium sp., Aspidistra sp., Begonia sp., and on several woody plants from Italy; on Rosa sp. from Holland; on Dahlia sp. from Poland; from a cyst survey in the areas of Montreal, Quebec, and Windsor, Ontario.

## Root-lesion nematodes

Pratylenchus crenatus Loof, 1960 was found in soil from around Douglas fir from Duncan, British Columbia, Ampelopsis veitchii from Holland, Acer platanoides from Belgium, Pratylenchus penetrans (Cobb, 1919) Filipjev and Schuurmans-Stekhoven,

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1941 on roots of Malus sp. from England and New Jersey, U. S. A., and on mint plants from Germany. Pratylenchus pratensis (de Man, 1880) Filipjev, 1936 was intercepted on Cactus sp. from Hungary.

## Spiral nematodes

Helicotylenchus erythrinae (Zimmermann, 1904) Golden, 1956 was found on root of heather from Europe. H. pseudorobustus (Steiner, 1914) Golden, 1956 and Helicotylenchus sp. were found on root of Gleditsia sp. from Illinois, H. canadensis Waseem, 1961 in soil around the roots of African violet from New Brunswick, and H. platyurus Perry, 1959 and H. digonicus Perry, 1959 in soil taken from around the root of juniper, Rockcliffe Park, Ontario.

Rotylenchus buxophilus Golden, 1956 was found in soil around the roots of boxwood from British Columbia. R. pumilus (Perry, 1959) Sher, 1961 was found in soil associated with celery from Germany. R. goodeyi Loof and Oostenbrink, 1958 was found in Ampelopsis veitchii from Holland. R. fallorobustus Sher, 1965 was intercepted in soil associated with celery from Germany. Rotylenchus spp. were intercepted on house plants from Hungary.

Scutellonema brachyurum (Steiner, 1938) Andrássy, 1958 was found on an interception of shrubs from Denmark.

## Pin nematodes

Paratylenchus projectus Jenkins, 1956 was found in soil from the roots of Douglas fir from British Columbia and Fraxinus sp. from Princeton, New Jersey. Hoplolaimus galeatus (Cobb, 1913) Sher, 1961 was intercepted on two shipments of Tilia cordata, Fraxinus sp. and Prunus sp. from Princeton, New Jersey, and also on Tilia cordata from Holland.

## Stunt nematodes

Tylenchorhynchus sp. was discovered in soil from a spruce nursery, Lake Simcoe, Ontario. T. claytoni Steiner, 1937 was in soil about the roots of azalea from East Meadow, New York. T. macrurus (T. Goodey, 1932) Filipjev, 1936 was found on Malus sp. from England. T. brevidens Allen, 1955 was intercepted on several house plants from the Ukraine, U. S. S. R.

Criconemoides lobatum Raski, 1952 was found on roots of sweet alyssum from Ottawa, Ontario, and on mint from Germany. Criconemoides sp. was found on spruce nursery stock from Lake Simcoe, Ontario.

## Other tylenchids

Aglenchus sp. (Andrássy, 1954) Meyl, 1961 was found on azalea from New York, and also on spruce nursery stock from Lake Simcoe, Ontario. Tylenchus sp. was identified on Ampelopsis veitchii from Holland, house plants from Hungary, Gleditsia sp. from Illinois, U. S. A., and also on house and garden plants from the Ukraine. Ditylenchus dipsaci (Kühn, 1857) Filipjev, 1936 was found in onion bulbs from Holland. D. destructor Thorne, 1945, the potato-rot nematode, was found in potatoes from Prince Edward Island. Further studies will be carried out on this particular species by Dr. L. Y. Wu, Nematology Section, Entomology Research Institute, Canada Department of Agriculture, Ottawa, to determine existing variations. Ditylenchus sp. was found in iris bulbs from Washington. Psilenchus hilarulus de Man, 1921 was found in association with African violet from Fredericton, New Brunswick.

## Aphelenchids

Aphelenchus avenae Bastian, 1865 was found in soil supporting African violet from Fredericton, New Brunswick, and in sweet alyssum from Ottawa, Ontario. Aphelenchus sp. was found in soil supporting a stand of alfalfa, Central Experimental Farm, Ottawa, Ontario. Aphelenchoides sp. was recorded on azalea from New York, Cactus sp. from Hungary, heather from the United Kingdom, and in soil taken from the roots of alfalfa, Central Experimental Farm, Ottawa, Ontario.

## Dorylaimids

Some Dorylaimus spp. were recorded from soil supporting nursery stock of spruce from Lake Simcoe, Ontario. Xiphimena americanum Cobb, 1913 was recorded during a cyst survey in Saanichton, British Columbia, on Malus sp. from England, from Princeton, New Jersey, and from Illinois, on Prunus sp. from Princeton, New Jersey, on Tilia cordata from Holland, Gleditsia sp. from Illinois, and on several shrubs from Denmark. Xiphinema diversicaudatum (Micoletzky, 1927) Thorne, 1939 was found around the root of Rosa sp. from the United States.

# PREVALENCE OF DISEASES OF FORAGE CROPS IN QUEBEC

*Claude Aube*[1]


## Abstract

A 2-year survey of forage plant diseases showed the presence of several diseases in Quebec. Common leaf spot of alfalfa caused by Pseudopeziza medicaginis (Biv. - Bern. ex Fr.) Fckl. f. sp. medicaginis - lupulinae Schmied. and target spot of red clover caused by Stemphylium sarcinaeforme (Cav.) Wilts. are widespread and destructive. Fusarium spp. caused severe damage to alsike clover. Other foliage diseases were of minor importance. Many foliage diseases were observed on forage plants but epidemiological studies would be necessary before concluding whether or not they are of economic importance. As far as the root rots are concerned, the problem is very complex and many fungi have been isolated from the diseased roots.


## Introduction

Forage plants are particularly important in the province of Quebec. In 1961, hay (grass and legumes) occupied 67% of the crop area and was worth $97,307,000 or 55.8% of the total value of field crops. Improved pastures, not included in the above figures, occupied over 2,000,000 acres (1). Since alfalfa, red and alsike clovers, and timothy are dominant in the hay crop, their agricultural importance is very evident. Because of this situation and the fact that no systematic surveys of forage crop diseases had ever been carried out, if one excepts surveys for Verticillium wilt (2), it was deemed essential that data be collected on the severity and distribution of such diseases before undertaking any scientific research.

In 1965, a 2-year survey was initiated to investigate the occurrence of diseases on forage legumes and grasses grown in Quebec. This paper reports on the results of the survey.

## Materials and methods

Forage plants are grown throughout the Province of Quebec. Surveys were then made in 357 fields in 38 counties in June before the first hay crop was removed and again later in the season to check the aftermath and new seedlings before they went into the winter. Fields of different ages were selected at random for inspection. Plants of each species growing in the fields were examined while walking through the fields following an X-pattern. All information that could possibly help to explain the occurrence of any particular foliage, stem, or root disease was collected.

It is impossible to give definite figures on the losses attributable to any one of the various forage crop diseases. It is evident, however, that the combined losses aggregate thousands of dollars annually. The type of injury varies greatly. All parts of the plants, leaves, stems, crowns, and roots, are attacked and sometimes destroyed. Fungi, bacteria and viruses all cause damage. Some of the pathogens infect only specific organs of the plant, such as leaves and roots. Others attack several or all the parts of a plant. Forage plants may also suffer from mineral deficiencies and be damaged mechanically. The results of the surveys are presented below.

## Diseases of alfalfa

Common leaf spot (Pseudopeziza medicaginis (Biv. - Bern. ex Fr.) Fckl. f. sp. medicaginis - lupulinae Schmied.) was the most prevalent of the foliar and stem diseases of alfalfa. It occurred each year and although plants were not killed by the disease, defoliation occurred mainly in late-cut stands.

Spring black stem (Ascochyta imperfecta Pk.) occurred commonly in all regions of the province. Damage was more severe in fields where two or more cuts were made.

Root rots (various fungi) were the most important diseases. Damage was more severe in old stands. Injury to alfalfa roots was quite severe in 1965; this might have been due to the lack of snow cover in the previous winter. The damage to roots, crowns, inner parts, outer parts and feeder rootlets by the different fungi isolated will be reported later.

Non-parasitic diseases: Mineral deficiencies occurred occasionally in poorly fertilized soils and they do not seem to be very important. Old alfalfa stands are often plagued with quack grass; when roots were dug up, these were often found to be pierced by quack grass rhizomes (Figure 1). The plants did not seem to be damaged, but the hole made through the roots may be a good infection court for root parasites. The portion of the root pierced by the quack grass rhizome seemed, however, to be always well suberized.

## Diseases of clovers

Target spot (Stemphylium sarcinaeforme (Cav.) Wilts.) was observed on red clover in all the fields visited. In 1965, the disease was severe whereas,

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Table 1. Diseases of forage crops in Quebec, 1965-1966.

| Forage crop and disease | Disease[1)] importance | Distribution[2)] |
|---|---|---|
| ALFALFA (Medicago sativa L.) | | |
| Bacterial wilt (Corynebacterium insidiosum (McCull.) Jens.) | 3 | 3 |
| Common leaf spot (Pseudopeziza medicaginis (Lib.) Sacc.) | 1 | 1 |
| Yellow leaf blotch (Leptotrochila medicaginis (Fckl.) Schüepp) | 3 | 3 |
| Spring black stem (Ascochyta imperfecta Pk.) | 1 | 1 |
| Downy mildew (Peronospora trifoliorum de Bary) | 3 | 3 |
| Summer black stem and leaf spot (Cercospora zebrina Pass.) | 3 | 3 |
| Leptosphaerulina leaf spot (Leptosphaerulina briosiana (Poll.) Graham and Lutrell) | 3 | 3 |
| Stemphylium leaf spot (Stemphylium botryosum Wallr.) | 3 | 2 |
| Stagonospora leaf spot (Stagonospora meliloti (Lasch) Petr.) | 3 | 3 |
| Root rots (various fungi) | 1 | 1 |
| Viruses (unidentified) | 3 | 2 |
| Potassium deficiency | 3 | 3 |
| Phosphorus deficiency | 3 | 3 |
| Boron deficiency | 3 | 3 |
| Root damage by quack grass (See Figure 1) | 3 | 2 |
| RED CLOVER (Trifolium pratense L.) | | |
| Target spot (Stemphylium sarcinaeforme (Cav.) Wilts.) | 1 | 1 |
| Sooty blotch (Cymadothea trifolii (Pers. ex Fr.) Wolf) | 3 | 3 |
| Common leaf spot (Pseudopeziza trifolii (Biv. - Bern.) Fckl. f. sp. trifolii-pratensis Schüepp) | 1 | 2 |
| Powdery mildew (Erysiphe polygoni DC. ex Mérat) | 1 | 2 |
| Black stem (Phoma trifolii E.M. Johnson and Valleau) | 2 | 2 |
| Rust (Uromyces fallens Kern) | 3 | 3 |
| Crown rot (Sclerotinia trifoliorum Erikss.) | 3 | 3 |
| Root rot (various fungi) | 1 | 1 |
| Black patch (unidentified organism) | 3 | 3 |
| Phyllody (clover phyllody virus) | 3 | 3 |
| Viruses (unidentified) | 2 | 2 |
| Potassium deficiency | 3 | 3 |
| Phosphorus deficiency | 3 | 3 |
| ALSIKE CLOVER (Trifolium hybridum L.) | | |
| Sooty blotch (Cymadothea trifolii (Pers. ex Fr.) Wolf) | 1 | 1 |
| Powdery mildew (Erysiphe polygoni (DC. ex Mérat) | 2 | 3 |
| Root rot (Fusarium spp.) | 1 | 2 |
| LADINO CLOVER (Trifolium repens L.) | | |
| Summer black stem and leaf spot (Cercospora zebrina Pass.) | 3 | 3 |
| Powdery mildew (Erysiphe polygoni (DC. ex Mérat) | 3 | 3 |
| Sooty blotch (Cymadothea trifolii (Pers. ex Fr.) Wolf) | 3 | 3 |
| Phyllody (clover phyllody virus) | 2 | 2 |
| Virus (unidentified) | 3 | 3 |
| Magnesium deficiency | 3 | 3 |
| BIRDSFOOT TREFOIL (Lotus corniculatus L.) | | |
| Stemphylium leaf spot (Stemphylium loti Graham) | 3 | 3 |
| BROME GRASS (Bromus inermis Leyss.) | | |
| Leaf blotch (Drechslera bromi (Died.) Shoem.) | 3 | 3 |
| ORCHARD GRASS (Dactylis glomerata L.) | | |
| Powdery mildew (Erysiphe graminis DC.) | 3 | 3 |
| TIMOTHY (Phleum pratense L.) | | |
| Brown stripe (Passolara graminis (Fckl.) Höhn) | 3 | 3 |

1) 1 = major importance; 2 = minor importance; 3 = rare importance.
2) 1 = observed in most fields; 2 = observed in less than half of fields; 3 = observed 1 or 2 times.

Figure 1. Alfalfa root pierced by quack grass rhizome.

in 1966, the severity ranged from slight to moderate. Target spot seems to be the most important disease of red clover.

Common leaf spot (Pseudopeziza trifolii (Biv. - Bern. ex Fr.) f. sp. trifolii-pratensis Schüepp) was quite common on red clover. As reported by Willis (4) in Prince Edward Island, the disease was more prevalent and severe late in the summer.

Powdery mildew (Erysiphe polygoni DC. ex. Merat) was observed on red, alsike and ladino clover but it was more prevalent and severe on red clover. The disease was found late in the summer in 1965 and earlier in 1966. All the red clover fields visited on l'Ile d'Orléans in 1965 were badly infected with the disease.

Sooty blotch (Cymadothea trifolii) (Pers. ex Fr.) Wolf) was found on red, alsike and ladino clovers. However, it was more prevalent and severe on alsike. The disease was more common in 1965 than in 1966.

Root Rot (Various fungi) occurred on alsike and red clover. Red clover roots were more severely damaged than those of alsike. In 1965, damage was severe on red clover whereas it was present in moderate to severe amounts in 1966.

Roots of alsike clover, as reported by Aubé (3), were severely damaged by Fusarium avenaceum (Fr.) Sacc., Fusarium culmorum (W. G. Sm.) Sacc. and Fusarium oxysporum Schlecht. in 1965 and the disease was found in specific regions, mainly in the Lower St. Lawrence and in the Lake St. John area. In 1966, the disease was found in the same areas but the damage was less important.

Virus diseases (clover phyllody and other virus diseases) were not very important on clovers. The clover phyllody virus was found in one field of red clover in 1966, and was not found at all in 1965. On ladino clover, the phyllody virus was more prevalent in 1966 than in 1965, however, only a few fields were found to have the disease. These results are quite surprising since, according to agronomists, the clover phyllody virus was commonly found in the years before. This may mean that clover plants attacked by the clover phyllody virus have been weakened so much that they could not stand the severe winter of 1964-1965.

Mineral deficiencies were found occasionally on red as well as on ladino clover but were not important.

## Diseases of birdsfoot trefoil

Stemphylium leaf spot (Stemphylium loti Graham) was found in only one field in 1965 and did not cause any appreciable damage to the plants.

## Diseases of grasses

Very few diseases were found only occasionally and caused little damage on cultivated grasses.

## Conclusions

No clear estimate can be given of the damage caused by stem and leaf diseases of forage crops in Quebec. All that could be determined was that some diseases were more commonly found and were relatively more important than others. To evaluate precisely the damage caused would necessitate epidemiological studies which would take into account the area of the disease on the plant vigor. Such a study would be particularly valuable with common leaf spot of alfalfa and target spot of red clover. Nevertheless, neither disease may be a problem when one considers that it is normal for most of farmers to cut this forage early. However, this problem arises with the second crop which is invariably attacked by these diseases. Root rots, on the other hand, would make a most interesting field of research. They are a real problem since the microorganisms causing them attack plants of all ages and are present in all types of soils.

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# CONTROL OF RHIZOCTONIA STEM CANKER IN POTATO

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## Abstract

Two isomers of the oxathiin systemic fungicides were evaluated for control of rhizoctonia on potato in field tests. Chemicals were applied as 10 percent dust on seed pieces and as 5 percent granules in the furrow. The best control was obtained with F461, the sulfone isomer. The most effective method of application was as a dust on seed pieces.

## Introduction

The fungus, Rhizoctonia solani Kühn, infects the young germinating shoots of potato, frequently girdling them and causing delayed emergence and "skips". The resulting poor stands are of considerable concern to the growers. The pathogen also attacks roots, rhizomes and tubers and probably causes greater losses than generally realized.

Although many fungicides have been evaluated and several proposed for the control of stem canker on potato, no chemical has attained widespread acceptance. The oxathiin fungicides, which are systemic in plants and toxic to R. solani (1, 2), offer promise of control. Consequently, we evaluated these new fungicides in field plot tests.

## Materials and methods

Two isomers of the oxathiins were evaluated: D735, 2, 3 dihydro-5-carboxanilido-6-methyl 1, 4 oxathiin; and F461, 2, 3 dihydro-5-carboxanilido-6-methyl 1, 4 oxathiin 4, 4-dioxide. Each compound was tested as a 10 percent dust applied to the seed pieces at the rate of 1 lb. per 100 lb. of potatoes. The actual amount of compound used for eighteen seed pieces planted in 15-foot rows was 2.3 g. As the rows were three feet apart this could be equivalent to about 4.7 lb. actual chemical per acre. Each compound was also used as a 5 percent granular compound applied in the furrow at planting at the rate of 20 lb. actual chemical per acre, or 187 g of the granules (9.4 actual) per 15 foot row.

Three isolates of R. solani obtained from potatoes, were grown individually on autoclaved wheat, the inoculum then dried, ground and applied to the furrows immediately before planting the seed pieces. Each of the isolates, designated R-90, R-6, and R-112, was placed in a separate row in each plot. Seed pieces of the potato, variety 'Cherokee', were planted by hand May 30 in the open furrow and immediately covered by means of a rake. Seed pieces for the rows inoculated with R-90 were planted twice as close as the others to permit the removal of alternate plants for the rating of stem cankers.

The disease was rated when plants were about 4 inches in height on a scale of 0-4 with 0 representing no cankers present and 4 where the shoot was killed. Each shoot from a plant was scored and the mean canker index for each row calculated. The alternate plants from the row inoculated with the R-90 isolate and all of the plants from the row inoculated with the R-112 isolate were dug and the disease rated.

The plots were harvested October 13, graded to Canada #1 standards and a 20-tuber sample from each plot washed and rated for black scurf, the sclerotial bodies of R. solani on potato tubers.

## Results

Table 1 shows the canker index and the number of shoots per seed piece. Isolate R-112 was much more pathogenic than R-90 and caused moderate to severe cankers on untreated check plants. Treatment of seed pieces with the 10 percent dust formulation of the chemicals, particularly F461, caused a significant reduction in the canker index. Shoots arising from seed pieces treated with F461 were virtually all free of cankers. The chemicals, applied as 5 percent active granules in the soil, did not give effective control of disease.

Treatment of the seed pieces with the chemicals, particularly F461, caused a marked increase in the number of shoots arising from each seed piece. The chemicals applied as soil granules did not cause an increase in the number of shoots. The vigor of individual shoots, as indicated by thickness of the stem, was decreased with the stimulation in the number of shoots per seed piece.

Some phytotoxicity was apparent during the early part of the growing season where F461 was applied as granules in the soil. Plants in these plots were slightly stunted and the leaves were smaller than normal.

No significant differences were observed in either yield or amount of scurf on harvested tubers with any of the treatments.

## Discussion

While F461 is less fungitoxic than D735 (1), it is more effective, possibly because D735 might be adsorbed or decomposed in the soil.

The method of application of the fungicides is very important. Seed treatment proved to be super-

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Table 1. Effect of oxathiin fungicides on stem canker and number of shoots per potato seed piece.

| Treatment | Stem Canker[a] Index | | Shoots per seed piece | |
|---|---|---|---|---|
| | R-90 | R-112 | R-90 | R-112 |
| | (Fungal isolate) | | | |
| Check | 0.8 | 2.2 | 3.3 | 3.9 |
| D735 Seed Dust | 0.7 | 0.8 | 5.0 | 5.2 |
| F461 Seed Dust | 0.2 | 0.4 | 6.6 | 6.6 |
| D735 Soil Granules | 1.4 | 1.2 | 3.7 | 3.6 |
| F461 Soil Granules | 0.7 | 0.8 | 3.8 | 3.8 |
| L.S.D. 19:1 | 0.2 | 0.9 | 0.5 | 0.9 |

[a] Stem cankers were rated on a scale of 0 to 4 with 0 = no disease, 1 = mild cankers, 2 = moderate cankers, 3 = severe cankers, and 4 = shoot killed.

ior to granular application in furrows. Even though about 4 times the amount of active chemical was applied per acre by granular application to soil than by seed treatment, the best disease control with both materials resulted from the latter method. Furthermore, the higher concentration applied as granules caused some phytotoxicity. Apparently, the seed treatment permits rapid contact with the emerging roots and shoots and results in a rapid uptake of the chemical at the stage when infection is occurring.

The increase in the number of shoots per seed piece is probably due to an inhibition of apical dominance of the initial buds. We doubt whether this physiological effect is causally related to the reduction in the canker index. The oxathiins are known to be fungitoxic to *R. solani*.

The harvested plots did not exhibit severe disease resulting in a reduction in yield. Hence, we cannot measure the attributes of the treatments in terms of yield.

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