Crown rust of oats in Canada in 1977

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Oat crown rust (*Puccinia coronata* f. sp. *avenae)* did not cause significant crop losses in western Canada in 1977. In Ontario crown rust was widespread, but there was a wide range in the severity of infection. Infections ranged from trace in some farm fields to very severe in others. The severity of infection was closely associatedwith the proximity to the oat field of European buckthorn *(Rhamnus cathartica* L.). Nearly all crown rust infections in Ontario appeared to originate locally from infected buckthorn. The occurrence of standard races of crown rust across Canada was determined. In eastern Canada race 210 predominated, while in western Canada races 326 and 295 predominated. Virulence combinations in the crown rust population were also determined used a set of 12 oat lines carrying single substituted genes (Pc) for crown rust resistance. The 242 isolates from eastern Canada and 190 isolates from western Canada comprised 38 and 31 virulence combinations, respectively. In eastern Canada virulence on genes Pc 35 and Pc 56 predominated, and in western Canada on genes Pc 40 and Pc 35. There has been little change from previous years in the level of virulence on the currently most resistant commercial oat cultivar Hudson, and no virulence was found on the gene combinations Pc 38-39 and Pc 55-56.

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La rouille couronnee de l'avoine *(Puccinia coronata* f. sp. *avenae)* n'a pas entraîné d'importantes pertes de rendement dans l'ouest du Canada en 1977. En Ontario, la maladie a ete tres répandue bien que son degre de virulence ait varie grandement allant de traces imperceptibles dans certains champs a de graves infestations dans d'autres. Le degre d'infection était etroitement lie a la presence voisiné de nerprun cathartique *(Rhamnus cathartica* L.). Presque tous les cas de rouille couronnee trouves en Ontario semblent avoir pour origine des nerpruns atteints. L'auteur a determine la frequence des races courantes de rouille couronnee au Canada. Dans l'Est c'est la race 210 qui a prédominé tandis que dans l'Ouest, ce sont les races 326 et 295. Les combinaisons de virulence presentes au sein des populations de rouille ont aussi été etablies a l'aide d'un ensemble de 12 lignees d'avoine portant des genes simples substitués (Pc) pour la resistance a la rouille couronnee. Les 242 isolats trouves dans l'est du Canada et les 190 isolats de l'Ouest comportaient respectivement 38 et 31 combinaisons de virulence. Dans l'est du pays, la virulence envers les genes Pc 35 et Pc 56 a predomine et dans l'Ouest, elle s'est surtout portee sur les gènes Pc 40 et Pc 35. Le degre de virulence sur Hudson, le cultivar commercial actuellement le plus resistant a tres peu change par rapport aux annees precedentes et on n'a pas trouve de signe de virulence sur les combinaisons de genes Pc 38-39 et Pc 55-56.

Occurrence in western Canada

Oat crown rust caused by ***Puccinia coronata*** Cda. f. sp. ***avenae*** Eriks. did not cause significant damage to oat crops across western Canada in 1977. The first infections were observed by mid July, and conditions were favorable for rust development throughout most of the growing season. However, the air-borne influx of crown rust inoculum in 1977 was insufficient to generate an extensive epidemic.

Occurence in Ontario

A survey of the cereal growing areas of Ontario in late July of 1977 showed variable Occurrence of crown rust. Infections ranged from trace amounts in some fields to near destruction of the oat crop in others. In some fields most of the oat plants were killed, and nearly all of the rust was in the telial stage. In Ottawa-Carleton, Lanark, Dundas, Grenville, and Frontenac counties infection was generally light to moderate, with occasional severe infections occurring where European buckthorn *(Rhamnus cathartica* L.) was found nearby. In the southern portions of Hastings, Northumberland-Durham, Ontario, and in York and Peel counties, infection was generally moderate to heavy. In some fields there was severe damage due to crown rust, despite generally dry conditions over much of this region. The heaviest infections were found near Nestleton Station, where buckthorn occurred extensively in woodlots and in hedgerows alongside farm fields. In Waterloo, Perth, Oxford, Middlesex, and Lambton counties, infection ranged from trace to moderately heavy. The trace infections occurred in relatively isolated fields where no buckthorn was found in the immediate vicinity. Moderate to moderately heavy infections occurred more generally in regions where there was a greater concentration of oat or barley-oat crops. In Peterborough county all fields examined were oat-barley mixtures, and the fields were quite isolated. Some fields had only traces of crown rust, while in others the oat component of the crop was destroyed by crown rust. The severe infections were associated with the proximity of buckthorn. A single large buckthorn shrub was sufficient to generate a moderately-severe infection in an adjacent field.

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Table 1. Distribution of standard physiologic races of *Puccinia coronata* in Canada in 1977

Standard physiologic race	Eastern Canada		Western Canada	
	No. of isolates	% of isolates	No. of isolates	% of isolates
203	7	2.9	1	0.5
210	74	30.5	0	0.0
211	9	3.7	0	0.0
216	5	2.1	0	0.0
217	0	0.0	1	0.5
224	0	0.0	1	0.5
226	4	1.6	0	0.0
227	5	2.1	0	0.0
228	11	4.5	0	0.0
230	6	2.5	0	0.0
231	3	1.2	0	0.0
232	1	0.4	0	0.0
240	0	0.0	1	0.5
241	1	0.4	0	0.0
259	16	6.6	0	0.0
264	0	0.0	26	14.2
274	6	2.5	0	0.0
276	0	0.0	9	4.9
279	1	0.4	0	0.0
281	0	0.0	1	0.5
283	7	2.9	0	0.0
284	8	3.3	4	2.2
294	4	1.6	0	0.0
295	0	0.0	41	22.4
299	3	1.2	0	0.0
320	11	4.5	5	2.7
324	1	0.4	0	0.0
325	0	0.0	3	1.6
326	3	1.2	67	36.6
327	0	0.0	1	0.5
330	8	3.3	1	0.5
333	0	0.0	7	3.8
335	2	0.6	0	0.0
338	1	0.4	0	0.0
341	18	7.4	0	0.0
342	0	0.0	1	0.5
345	0	0.0	2	1.0
371	1	0.4	0	0.0
384	0	0.0	1	0.5
388	0	0.0	1	0.5
391	1	0.4	0	0.0
403	3	1.2	0	0.0
410	0	0.0	3	1.6
415	2	0.8	0	0.0
416	2	0.8	0	0.0
423	1	0.4	0	0.0
424	1	0.4	0	0.0
425	1	0.4	0	0.0
427	1	0.4	0	0.0
495	2	0.8	0	0.0
496	1	0.4	0	0.0
498	0	0.0	1	0.5
499	2	0.8	0	0.0
[a]1,3,4,5,6,8,9	2	0.8	0	0.0
[a]2,3,4,5,8,9,10	1	0.4	0	0.0
[a]2,3,5,6,8,10	0	0.0	2	1.0
[a]2,5,6,8,9	1	0.4	0	
[a]4,8,9,10	0	0.0	1	0.5
[a]8,10	0	0.0	1	0.5
TOTAL	243		183	

[a]Resistant standard differential varieties: 1 = Anthony, 2 = Victoria, 3 = Appler, 4 = Bond, 5 = Landhafer, 6 = Santa Fe, 8 = Trispernia, 9 = Bondvic. 10 = Saia

Table 2. Virulence combinations of *Puccinia coronata* on backcross lines of *Avena* sativa cv. Pendek containing single (Pc) genes for crown rust resistance

Virulence formula effective/ineffective Pc genes	Eastern Canada		Western Canada	
	No. of isolates	% of isolates	No. of isolates	% of isolates
35,38,39,40,45,46,47,48,50,54,55,56	48	19.8	34	17.9
38,39,40,45,46,47,48,50,54,55,56/35	41	16.9	12	6.3
35,38,39,45,46,47,48,50,54,55,56/40	7	2.9	71	37.4
35,38,39,40,46,47,48,50,54,55,56/45	12	5.0	1	0.5
35,38,39,40,45,47,48,50,54,55,56/46	1	0.4	7	3.7
35,38,39,40,45,46,47,50,54,55,56/48	1	0.4	0	0.0
35,38,39,40,45,46,47,48,54,55,56/50	11	4.5	5	2.6
35,38,39,40,45,46,47,48,50,55,56/54	1	0.4	2	1.0
35,38,39,40,45,46,47,48,50,54,55/56	22	9.1	3	1.6
38,39,45,46,47,48,50,54,55,56/35,40	3	1.2	8	4.2
38,39,40,46,47,48,50,54,55,56/35,45	5	2.1	0	0.0
38,39,40,45,46,47,48,54,55,56/35,50	6	2.5	3	1.6
38,39,40,45,46,47,48,50,54,55/35,56	24	9.9	1	0.5
35,39,40,45,46,47,48,50,54,55/38,56	0	0.0	1	0.5
35,38,39,46,47,48,50,54,55,56/40,45	8	3.3	0	0.0
35,38,39,45,47,48,50,54,55,56/40,46	0	0.0	6	3.1
35,38,39,45,46,47,48,54,55,56/40,50	2	0.8	5	2.6
35,38,39,45,46,47,48,50,55,56/40,54	0	0.0	5	2.6
35,38,39,45,46,47,48,50,54,55/40,56	3	1.2	1	0.5
35,38,39,40,47,48,50,54,55,56/45,46	1	0.4	0	0.0
35,38,39,40,46,47,48,54,55,56/45,50	2	0.8	0	0.0
35,38,39,40,46,47,48,50,54,55/45,56	6	2.5	0	0.0
35,38,39,40,45,47,50,54,55,56/46,48	0	0.0	1	0.5
35,38,39,40,45,47,48,54,55,56/46,50	0	0.0	2	1.0
35,38,39,40,45,47,48,50,55,56/46,54	1	0.4	0	0.0
35,38,39,40,45,46,47,48,55,56/50,54	0	0.0	4	2.1
35,38,39,40,45,46,47,48,54,55/50,56	6	2.5	0	0.0
35,38,39,40,45,46,47,48,50,55/54,56	1	0.4	0	0.0
39,45,46,47,48,50,54,55,56/35,38,40	0	0.0	1	0.5
39,40,45,46,47,48,50,54,55/35,38,56	1	0.4	0	0.0
38,39,46,47,48,50,54,55,56/35,40,45	1	0.4	0	0.0
38,39,45,47,48,50,54,55,56/35,40,46	1	0.4	3	1.6
38,39,45,46,47,48,54,55,56/35,40,50	1	0.4	1	0.5
38,39,45,46,47,48,50,55,56/35,40,54	1	0.4	4	2.1
38,39,45,46,47,48,50,54,55/35,40,56	3	1.2	1	0.5
38,39,40,46,47,48,50,55,56/35,45,54	1	0.4	0	0.0
38,39,40,46,47,48,50,54,55/35,45,56	6	2.5	0	0.0
38,39,40,45,47,48,50,54,55/35,46,56	1	0.4	0	0.0
38,39,40,45,46,47,48,54,55/35,50,56	6	2.5	0	0.0
38,39,40,45,46,47,48,50,55/35,54,56	1	0.4	0	0.0
35,38,39,47,48,50,54,55,56/40,45,46	2	0.8	0	0.0
35,38,39,45,47,48,54,55,56/40,46,50	0	0.0	1	0.5
35,38,39,45,47,48,50,55,56/40,46,54	0	0.0	1	0.5
35,38,39,45,46,47,48,54,55/40,50,56	2	0.8	0	0.0
35,38,39,40,47,48,50,55,56/45,46,54	0	0.0	1	0.5
35,38,39,40,46,47,48,54,55/45,50,56	1	0.4	0	0.0
38,39,45,47,48,54,55,56/35,40,46,50	0	0.0	1	0.5
38,39,45,47,48,50,54,55/35,40,46,56	0	0.0	1	0.5
38,39,45,46,47,48,54,55/35,40,50,56	0	0.0	2	1.0
38,39,40,45,47,48,54,55/35,46,50,56	0	0.0	1	0.5
38,39,47,48,50,54,55/35,40,45,46,56	1	0.4	0	0.0
38,39,47,48,54,55/35,40,45,46,50,56	1	0.4	0	0.0
TOTAL	242		190	

The distribution of crown rust in Ontario indicates that in 1977 buckthorn was responsible for most of the crown rust infection of oats. The very light infections that occurred in the absence of buckthorn suggests that there was little influx of inoculum from elsewhere. It is apparent that many growers are not aware of the association between crown rust on Oats and buckthorn. It is most important that they be informed in those areas

Table 3. Distribution of virulence of isolates of ***Puccinia coronata*** in 1977 on the standard differential varieties, on backcross lines carrying single crown rust resistance (Pc) genes, and on Hudson. The trap nursery consisted of selected oat lines grown near Winnipeg, Manitoba

	Eastern Canada		Western Canada		Trap Nursery	
Variety or resistance gene	No. of virulent isolates	% of isolates	No. of virulent isolates	% of isolates	No. of virulent isolates	% of isolates
Anthony	78	32.1	176	96.2	76	98.7
Victoria	93	38.3	114	62.3	52	67.5
Appler	93	38.3	166	90.7	69	89.6
Bond	168	69.1	180	98.4	76	98.7
Landhafer	25	10.3	163	89.1	69	89.6
Santa Fe	14	5.8	163	89.1	69	89.6
Ukraine	240	98.8	175	95.6	74	96.1
Trispernia	0	0	44	24.0	17	22.1
Bondvic	0	0	49	26.8	17	22.1
Saia	22	9.0	14	17.6	8	10.4
Pc 35	104	43.0	40	21.0	30	35.3
Pc 38	1	0.4	2	1.1	0	0.0
Pc 39	0	0.0	0	0.0	0	0.0
Pc 40	36	14.9	114	60.0	33	38.8
Pc 45	47	19.4	2	1.1	2	2.4
Pc 46	8	3.3	28	4.7	24	28.2
Pc 47	0	0.0	0	0.0	0	0.0
Pc 48	1	0.4	1	0.5	0	0.0
Pc 50	38	15.7	25	13.2	13	15.3
Pc 54	6	2.5	17	8.9	12	14.1
Pc 55	0	0.0	0	0.0	0	0.0
Pc 56	85	35.0	11	5.8	15	17.6
Hudson	37	15.3	21	11.1		

where oats may be grown. Growers must either avoid planting oats near buckthorn or eradicate buckthorn from their farms. Buckthorn has become very widespread in Ontario, and complete eradication is not feasible. However, in Ontario severe crown rust infections were limited to fields in close proximity to buckthorn, thus removal of buckthorn from individual farm fields would be sufficient to greatly reduce damage.

Physiologic specialization

Isolates of crown rust from eastern Canada ,were obtained from uniform nurseries grown at McDonald College and Lennoxville in Quebec and Guelph, Ottawa, Appleton, and Sunbury, Ontario, and from farm fields in southern and eastern Ontario. In western Canada the isolates were obtained from field surveys in Manitoba and eastern Saskatchewan. Isolates were also obtained from a trap nursery consisting of selected oat lines, grown near Winnipeg, Manitoba.

In 1977 all crown rust collections were identified using the standard international differential varieties (3) and a series of backcross lines of ***Avena sativa*** L. cv. Pendek containing single genes (Pc) for crown rust resistance, derived from ***A. sterilis*** L.

From eastern Canada 243 isolates, comprising 40 races, were identified using the standard differential varieties (Table 1). There were no major changes in the main races since the previous assessment in 1975 (1). Race 210 has remained the predominating race, comprising 30.5% of the isolates. Race 341, which was not found in the previous survey (1), occurred fairly frequently at 7.4% of the isolates.

In western Canada 183 isolates comprised 25 races (Table 1). This represents relatively more races (race/isolate ratio of 0.13) as compared to the race/isolate ratio of 0.085 in 1975 (1). Since 1975 race 326 has become the predominating race, although this is probably due to a decrease in race 295, which predominated previously. Race 295 decreased from 35.5% of isolates in 1975 to 22.4% in 1977. Race 264 increased from 4.3% in 1975 to 14.2% in 1977. Races 264, 295, and 326 are quite closely related in their virulence on the standard differential varieties. Races 295 and 326 are differentiated by the variety Victoria, and the virulences of both races on this cultivar are variable, indicating considerable heterozygosity tor virulence at the locus involved. Race 264 is separated from race 326 by the additional virulence of 264 on Trispernia and

Bondvic, but the reaction of these cultivars to races 295, 326, and 264 appears to involve a single locus, and the reaction is variable. The increase in virulence on Victoria, Trispernia, and Bondvic (Table 3) is reflected in the increase in prevalence of races 264 and 326. The relative frequency of virulence on the standard differential varieties of isolates obtained from the trap nursery was similar to that of isolates from the field survey (Table 3) in western Canada.

In addition to the races described in the international register of crown rust races (3) and more recent descriptions (Dr. M.D. Simons, personal communication), six new races of crown rust were found (Table 1).

Using the single Pc-gene lines of Pendek, 242 isolates comprising 38 virulence combinations were identified in eastern Canada, and 190 isolates comprising 31 virulence combinations in western Canada (Table 2). Compared to, 1976 (2), there was a decrease in the number isolates avirulent on the twelve Pc-gene lines, with the largest decrease in eastern Canada. There was increased virulence on gene Pc 35 in eastern Canada, but decreased virulence on Pc 35 in western Canada. Virulence on gene Pc 40 increased across Canada, with the largest increase occurring in western Canada. There were also substantial increases in virulence on genes Pc 45, Pc 50, and Pc 56 in eastern Canada. There were no new combinations of virulence on the Pc-gene carrying lines which would be of concern to the rust resistance breeding program. At present combinations of genes Pc 38-39 and Pc 55-56 are of most interest to the breeding program at Winnipeg, and these gene combinations have remained highly effective.

The most crown rust resistant cultivar presently being grown in Canada is Hudson. Based on the number of isolates identified using the standard differentials, 15.3% and 11.1%, respectively, of isolates from eastern and western Canada were virulent on Hudson. This represents a decrease from 28% in 1975 (1) in eastern Canada and little change from 10% in 1975 in western Canada.

The distribution of standard races and virulence combinations in eastern and western Canada indicates that these regions are epidemiologically isolated from each other. In western Canada the crown rust inoculum originates from over-wintering rust in the southern United States, and arrives as showers of urediospores blown if from infected oats south of the United States-Canada boundary. The distribution in Canada indicates that these spore showers do not reach the areas surveyed in Ontario. In Ontario the primary crown rust inoculum appears to be largely derived from infected buckthorn, and this inoculum remains confined to the oat growing regions of Ontario. There is insufficient data from other regions of eastern Canada to evaluate the epidemiology of crown rust.

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