Stem rust of oats in Canada in 1976[1]

J.W. Martens and R.I.H. McKenzie

Stem rust [*Puccinia graminis* f. sp. *avenae*] was first found on oats *(Avena sativa)* in Manitoba in mid July. Light infections developed throughout Manitoba and a large part of Saskatchewan, but dry weather arrested disease development and there were no crop losses except in small areas of central and eastern Manitoba and northeastern Saskatchewan. Races C10 and C23 continued to predominate in western Canada while race C9 predominated in eastern Canada. Virulence on resistance conferred by gene Pg 13 was again found in both areas of the country. Several new races were also isolated.

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On a commence a observer la presence de rouille de la tige *(Puccinia graminis* f. sp. *avenae)* chez l'avoine *(Avena sativa)* au Manitoba, a la mi-juillet. De faibles infections se sont produites dans cette province et dans une grande partie de la Saskatchewan, mais le temps sec a stoppe l'évolution de la maladie, laquelle ne s'est traduite par aucune perte de recolte, a l'exception de regions restreintes du centre et de l'est du Manitoba et du nord-est de la Saskatchewan. Les races C10 et C23 ont continue de dominer dans l'ouest du Canada, alors que la race C9 était la plus répandue dans l'est. Elles se sont montrees virulentes a l'égard du gene de resistance Pg 13 dans les deux regions du pays. On a eyalement isolé plusieurs nouvelles races du champignon.

Prevalence and crop losses in western Canada

Stem rust of oats *(Avena sativa* L.) caused by *Puccinia graminis* Pers. f. sp. *avenae* Eriks and E. Henn.. was first observed in southern Manitoba in mid July. By mid August light infections occurred throughout Manitoba and in Saskatchewan as far west as Swift Current and north to Prince Albert, but disease development was arrested by a hot dry summer. The rust caused no crop losses except in small areas in central and eastern Manitoba and in northeastern Saskatchewan where a few fields developed moderate levels of infection and sustained some losses.

Uniform rust nurseries

Rust nurseries comprising the oat cultivars Fraser, Hudson, Rodney, and the lines C.I. 3034, C.I. 4023, C.I. 9139, R.L. 2924, R.L. 2925, R.L. 2926, and R.L. 3062 were grown at 30 locations across Canada. Trace to moderate infections of stem rust were observed at Kentville, N.S., Lennoxville and Macdonald College, Quebec; Appleton, Kemptville, Ottawa, and Thunder Bay, Ontario; and Brandon, Durban, and Morden, Manitoba. Heavy infections were observed at Sunbury, Ontario. No rust infections were observed on nurseries grown at St. John's West, Newfoundland; Charlottetown, Prince Edward Island; Truro, Nova Scotia, Fredericton, New Brunswick, La Pocatière, Normandin, and Quebec, Quebec; Guelph, New Liskeard and Vineland, Ontario; Indian Head, Melfort, and Scott, Saskatchewan; Beaverlodge, Edmonton, Lacombe, and Lethbridge, Alberta: and Agassiz and Creston, British Columbia.

Physiologic specialization

Rust isolates obtained from wild oats (A. *fatua* L.), commercial oat fields, and the uniform rust nurseries were established on the susceptible cultivar Victory and virulence combinations were determined by the infection types produced on seedlings of "Rodney O'' single-gene backcross lines as indicated in Table 1. The oat line Rodney O^2 X C.I. 9139 *(Pg X)*, an undetermined genotype thought to have *Pg 12* plus one or more other resistance genes, was also used as a supplementary differential. All 218 field cultures were avirulent on the *Pg X* differential. Races C10 (U.S. 31) and C23 (U.S. 61) continued to predominate in western Canada and comprised 57% and 39% of all field isolates, respectively (Table 1). This is similar to the most recently published results in the United States (3). Several uncommon races were identified and a new virulence combination, C32, was isolated from wild oats near Woodside, Manitoba. Race C31 (U.S. 77), with virulence on *Pg 13* resistance, was first found in Manitoba in a trap nursery in 1975 and was isolated from two field collections in 1976. This race has previously been reported in the United States (3). A separation of cultivars by origin (Table 1, B and C) demonstrates the bias introduced by collections from commercial cultivars with some stem rust resistance. Results from susceptible host cultures indicate that race C23 is in fact the dominant race in western Canada.

In eastern Canada, race C9 (U.S. 87) and the closely related C30 (U.S. 87) with virulence on *Pg 13* resistance, continued to predominate. The frequency of virulence on lines with single genes for resistance (Table 2) has not changed significantly from the previous year except for increased (from 8% to 20%) virulence on *Pg 13* resistance in eastern Canada. With the exception of

[1] *Contribution No. 781, Research Station, Agriculture Canada, Winnipeg. Manitoba R3T 2M9*

Table 1. Virulence combinations of oat stem rust field isolates on backcross lines with single–gene resistance to stem rust in Canada in 1976

Designation	Avirulence/virulence formula	No. of isolates from: Ont. & Que.	Man.	Sask. & Alta.	Total isolates	Percentage of total isolates
A. Combined isolates from all hosts						
C9	8/1,2,3,4,9	9			9	4
C10	9/1,2,3,4,8	4	80	33	117	53.7
C18	2,4,8,9,/1,3		2	1	3	1.4
C23	2,4,9,13/1,3,8	3	41	37	81	37.2
C26	1,2,3,4,8,9,13/		1		1	0.5
C30	8/1,2,3,4,9,13	4			4	1.8
C31	1,2,4,8/3,9,13		2		2	0.9
C32	2,3,4,9,13/1,8		1		1	0.5
Total					218	
B. Isolates from cultivars with some stem rust resistance						
C9		6			6	6
C10		4	44	22	70	69
C18			1		1	1
C23			12	8	20	20
C30		4			4	4
Total					101	
C. Isolates from wild oats and cultivars with no stem rust resistance						
C9		3			3	2.6
C10			36	11	47	40.2
C18			1	1	2	1.7
C23		3	29	29	61	52.1
C26			1		1	0.9
C31			2		2	1.7
C32			1		1	0.9
Total					117	

Table 2. Frequency of virulence in the oat stem rust population on various types of resistance in eastern and western Canada in 1974

Source of isolates	Percentage of isolates virulent on cultivars with the following genes for resistance: *Pg 1*	*Pg 2*	Pg3	*Pg 4*	Pg8	*Pg 9*	*Pg 73*	*Pg (X)* (C.I. 9139)	Total no. isolates	Mean virulence capability*
East	100	85	100	85	35	65	20	0	20	4.9
West	98.5	57.1	99.0	57.1	97.0	1.0	1.0	0	198	4.1

* **Mean virulence capability =** No. **of isolates virulent on** ***Pg 1+ ... Pg 13***/total **no. of isolates.**

races C9 and **C30,** none of the races so far identified presents a threat to the cultivar Hudson which combines resistance conferred by genes *Pg* 2, *Pg* 4, and *Pg* 9.

In an effort to detect the evolution of new virulence combinations in the rust population, a natural-infection trap nursery consisting of breeding material and various other genotypes has been planted at Glenlea, Manitoba, for the past 3 years. The isolates obtained (Table 3) from this material, usually by culturing small "resistant" type pustules, have been interesting both from the standpoint of detecting new virulence combinations and in terms of the races identified, relative to those isolated from "field" cultures. Even though many of the field cultures

Table 3. Virulence combinations of 1974, 1975, and 1976 oat stem rust trap nursery isolates on backcross lines with single–gene resistance to stem rust

Designation	Avirulence/virulence formula	1974		1975		1976	
		No. of isolates	% total	No. of isolates	% total	No. of isolates	% total
C1	1,2,3,4,8/9	35	23.3	18	10.1	2	1.0
c2	1,2,4,8/3,9			6	3.4	5	2.4
C8	3,8/1,2,4,9					1	0.5
C9	8/1,2,3,4,9					4	1.9
C10	911.2.3.4.8	90	60.0	99	55.6	101	48.8
C19	1,2,4,8,9/3			1	0.6	5	2.4
C23	2,4,9,13/1,3,8	18	12.0	47	26.4	79	38.2
C24	1,2,8/3,4,9,13	7	4.7	3	1.7	1	0.5
C26	1,2,3,4,8,9,13/					3	1.4
C30	8/1,2,3,4,9,13					2	1.0
C31	1,2,4,8/3,9,13			4	2.2	4	1.9
Total		150		178		207	

are obtained from wild oats (no resistance) or cultivars that have no known stem rust resistance, the full range of variability present in nature is not being detected with the field collections. In 1974 only two virulence combinations were isolated from 125 Manitoba field collections (1) vs. four from the naturally-infected trap nursery at Glenlea (Table 3). In 1975 nine virulence combinations were isolated from 160 Manitoba field cultures (2) vs. seven for the trap nursery, but the latter produced four isolates of a race (C31, U.S. 77) virulent on Pg 13 resistance and not previously found in Canada. This race was reported from Texas, Florida, and South Carolina in 1975 (3). However, the widely virulent race C14 was not found in the trap nursery but was isolated six times from field collections in 1975. In 1976 field collections produced six virulence combinations (Table 1) vs. 12 from the trap nursery.

Variability in oat stem rust appears to be increasing and changes being observed are not readily explained in terms of host population changes on the continent.

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Literature cited

1. Martens, **J.W.** 1975. Stem rust of oats in Canada in 1974. Can. Plant Dis. Surv. 55:61-62.
2. Martens, J.W., and R.I.H. McKenzie. 1976. Stem rust of oats in Canada in 1975. Can. Plant Dis. Surv. 56:23-24.
3. Roelfs, A.P., and P.G. Rothman. 1976. Races of *Puccinia graminis* f. sp. *avenae* in the U.S.A. during 1975. Plant Dis. Rep. 60:703-706.