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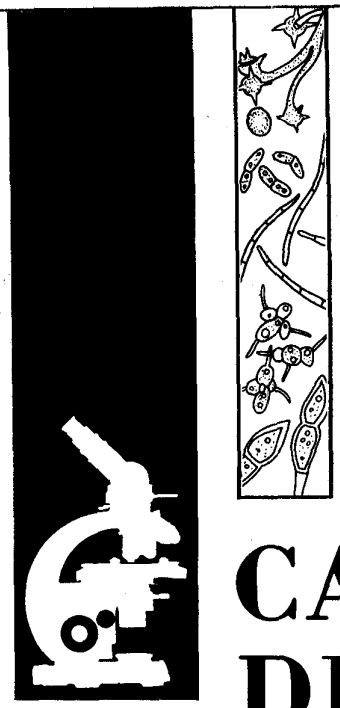

CANADIAN PLANT DISEASE SURVEY

EDITOR W.L. SEAMAN

RESEARCH BRANCH CANADA DEPARTMENT OF AGRICULTURE

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CONTENTS

"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."

CROWN AND ROOT ROT OF BIRDSFOOT TREFOIL IN ALBERTA

B. Berkenkamp, L. Folkins, and Joan Meeres

Abstract

A rot affecting only the internal tissues of the crown and tap root of birdsfoot trefoil (Lotus corniculatus) was found in second year and older stands. Associated fungi were isolated and tested for pathogenicity on seedlings. A single causal organism could not be specified, nor was the incidence of the disease affected by the application of fertilizer.

Introduction

Birdsfoot trefoil (Lotus corniculatus L.), a recent introduction to Alberta, shows promise as a perennial pasture legume in the higher rainfall areas of central Alberta. However, older experimental stands have been observed to become thin due to dying of plants. Examination of plants revealed discolored and dead centers of the crown, sometimes extending down the tap root. Other forage legumes in this and other areas have shown similar symptoms (4, 6, 7, 8, 9). Symptoms of crown and root rot were distinctly different from winter crown rot (5) or crown bud rot (3) in being usually internal and in not attacking buds in the spring. The center of the crown of affected plants was dark brown and the discoloration extended varying distances down the tap root (Figure 1). Observations in the field did not reveal any foliage symptoms, such as the chlorosis resulting from infection by Plenodomus meliloti Dearn & Sanford (1). In the spring, plants with rotted crowns and dead plants were found but plants that survived the winter appeared to grow as well as those without internal discoloration. An examination of fungi associated with the crown and root of affected plants was undertaken in 1969.

Materials and methods

In the fall of 1968, second year trefoil plants grown in a fertilizer test were examined for root rot by splitting the roots. Isolations were made from living trefoil plants dug from the field, washed with tap water and dissected. Samples were removed with a flamed scalpel and forceps from the margin of the discolored area from roots of plants showing internal symptoms and were plated on potato-dextrose agar (PDA) directly or after the surface was sterilized with sodium hypochlorite solution (commercial Javex diluted to 10%). Isolations were made without surface sterilization in the fall of 1969 and 1970, and the spring of 1970.

Figure 1. Symptoms of crown and root rot of birdsfoot trefoil; internal discoloration in a 4 year-old-plant in the spring.

Selected fungi and bacteria commonly isolated from the diseased roots were tested for pathogenicity using a water suspension of colonies produced on PDA. The inoculum from each petri plate culture was mixed with sterilized sand and placed in four 300 ml plastic cups with sufficient distilled water to saturate the sand. Fifty surface sterilized seeds of birdsfoot trefoil cv. Leo were placed on the sand in each cup and covered with a 1-cm layer of dry sterile sand, and the cups covered with petri dishes.

[1] Research Station, Canada Department of Agriculture, Lacombe, Alberta.

Four replicates for each inoculum were incubated in a greenhouse for 13 days. The seedlings were then removed, counted, and examined for lesions with a dissecting microscope.

Fifty seeds from eight sources were also examined for seed-borne pathogens by plating directly, or after surface sterilizing by wetting samples with 70% ethanol and then treating with sodium hypochlorite solution. The seed samples were plated on both PDA and water agar.

Results and discussion

Of the 535 roots examined from the 1968 fertilizer test 340 roots (63%) showed disease symptoms. No differences in severity of symptoms were found among fertilizer treatments. Organisms isolated from 36 surface sterilized samples from these diseased roots showed no differences from those isolated from unsterilized samples removed aseptically from the same roots. Isolations made from diseased roots in the fall of 1969 and 1970 and the spring of 1970 were from unsterilized samples.

Frequency of isolation of fungi from 219 diseased trefoil roots is shown in Table 1. Similar numbers of the various fungi were found at each sampling date except for Gliocladium sp., wfich was rarely found in the spring sample. Rhizoctonia sp., commonly reported in association with legume root rots, was not found nor was Mycoleptodiscus terrestris (Gerd.) Ost., a common pathogen of trefoil and other legume roots in the southern United States (7).

Isolates were tested for pathogenicity to seedlings and the results are shown in Table 2. Two fusaria differing in pigmentation in culture were labelled (pink) and (orange).

Table 1. Bacteria and fungi isolated from roots of birdsfoot trefoil affected by crown and root rot

Isolate	No. of isolates
Bacteria	79
Gliocladium sp.	56
Stemphylium loti	22
Fusarium sp.	15
Phoma sp.	6
Rhizopus sp.	3
Alternaria sp.	2
Papulaspora sp.	2
Penicillium sp.	2
Pyrenochaeta sp.	1
Unidentified fungi	46
Total	234

Two isolates of bacteria were also tested, a yellow colony and a white colony. Stemphylium sp., a common foliar pathogen, was pathogenic on seedlings. Fusarium (pink) caused the greatest reduction in emergence. In Ontario Fusarium solani (Mart.) App. & Wr. has been reported from diseased basal parts of birdsfoot trefoil (2). Pyrenochaeta sp. was a weak pathogen on birdsfoot trefoil seedlings. In Manitoba Pyrenochaeta terrestris (Hansen) Gorenz, Walker & Larson has been associated with crown and root rot of alfalfa (6).

Table 2. Effect of bacteria and fungi isolated from birdsfoot trefoil roots on emergence and seedling injury

Isolate	% reduction in emergence	% surviving seedlings lesioned	Total % injured plants
Fusarium (pink)	100	0	100
Stemphylium loti	27	67	94
Fusarium (orange)	51	15	66
Papulaspora	34	13	47
Bacteria (yellow)	20	11	31
Gliocladium	14	8	22
Pyrenochaeta	4	2	6
Bacteria (white)	0	5	5

The testing of seedlings gives only an indication of the possible pathogenicity of various isolates on mature plants, but the difficulties involved in producing axenic mature plants precluded such tests. The isolates were not tested in combinations which may occur in the field. Also the disease may be compounded by winter injury since no root rot was observed in first year plantings.

In the test for seed-borne root pathogens, common contaminants such as Alternaria sp. and Penicillium sp., were found. Only one seed in 800 yielded a suspected root pathogen, Papulaspora sp. Apparently the more pathogenic isolates from roots are not commonly seed-borne.

The study indicated that birdsfoot trefoil, in common with other forage legumes, was affected by a crown and root degeneration which caused reductions in stand and longevity. Several fungi found in association with the disease were shown to be pathogenic on seedlings. Mature plants were not inoculated due to the questionable validity of field inoculations, and to difficulties in producing mature axenic plants. The cause of the disease could not be attributed to a single pathogen or to the influences of climate or cultural practice.

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INCIDENCE OF GREEN PETAL DISEASE IN SOME STRAWBERRY CULTIVARS AND SELECTIONS IN PRINCE EDWARD ISLAND, 1970-71 [1]

L.S. Thompson and J.A. Cutcliffe [2]

Abstract

A total of 23 strawberry cultivars and selections, exposed to natural infection in replicated variety trials at Charlottetown, Prince Edward Island, were rated in 1970 and 1971 for the presence of green petal disease. The cultivars Gorella, Veestar, and Vibrant, the Kentville selections K60-98 and K64-462, and the Ottawa selection 55-01-01 exhibited the lowest incidence of geen petal infection.

Introduction

Green petal disease of strawberries was apparently observed for the first time in Prince Edward Island in 1961. The disease was particularly severe in some fields from 1961 to 1967 (3, 4), but it has since occurred only sporadically in commercial strawberry plantings. In 1971 green petal could be found in almost all strawberry fields in Prince Edward Island, but the level of infection was usually low. A survey of first crop plantings conducted in 1971 indicated averages of 1.8, 2.7, and 7.5% infected plants in the cultivars Cavalier, Redcoat, and Sparkle, respectively. Second and third crop plantings usually had fewer infected plants than first year crops.

In the Maritime Provinces higher levels of infection have been observed in Sparkle than in Redcoat or Cavalier (1, 2, 4). These three cultivars have been the most extensively grown in recent years in Prince Edward Island, but Sparkle is rapidly losing favor because of small berry size, susceptibility to green petal, and its poor hulling characteristic.

In 1966, Willis and Thompson (4) noted that the lowest levels of green petal infection in replicated strawberry variety trials at Charlottetown occurred in the cultivars Fletcher and Siletz and in the Kentville selection K-59-8. In a field test at Oxford, Nova Scotia, Gourley et al. (2) reported that the cultivars Redcoat and Elista, and the Kentville selection K-63-280 showed less infection with green petal than the other 10 cultivars and selections exposed to natural infection.

Materials and methods

Strawberry plants in replicated variety evaluation trials at the Research Station, Charlottetown, were rated in 1970 and 1971 for the presence of green petal disease. Plants for both trial plots were raised in a screenhouse at the CDA Research Station Kentville, Nova Scotia, then set out in variety evaluation plots at Charlottetown in 1969 and 1970. Cultivars and selections were arranged in randomized blocks of 10 plants per plot with plants 2 feet apart in rows 4.5 feet apart. Plots were allowed to form matted rows. DDT plus malathion dusts were applied to all plots every 10 days during the first growing season, and the following year DDT alone was applied once for weevil control. Yield data were recorded as the fruit matured. Fruit was considered unmarketable when it was malformed, damaged by rot, or mechanically damaged.

In 1970, disease incidence was evaluated by visually rating each plot on a 0 to 9 basis. A rating of 0 indicated freedom from green petal while a rating of 9 represented 100% infection. In 1971, the total number of plants in each plot was counted, and the number of plants showing symptoms of green petal was recorded as a percentage. Disease ratings were made at harvest time in July each year.

Results and discussion

The mean ratings or percentages of green petal for each of the 23 cultivars and selections are given in Table 1. A considerable range of green petal infection was apparent among cultivars and selections in both years. Gorella, Veestar, Vibrant, K60-98, K64-462, and Ottawa 55-01-01 exhibited the lowest incidence of green petal infection. Red Chief, which exhibited the highest number of infected plants in 1971, was uniformly infected throughout each plot, while adjacent plots of other cultivars and selections generally had much lower infection

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[1] Contribution No. 246, Research Station, Canada Department of Agriculture, Charlottetown, Prince Edward Island.

[2] Entomologist and Horticulturist.

Table 1. Green petal infection and fruit yield in strawberry cultivar and selection trials, Charlottetown, Prince Edward Island

Cultivar	1970 Trial		1971 Trial		
	Green petal index*	Yield marketable fruit lb/20-ft plot	No. plants per 20-ft plot	% plants infected†	Yield marketable fruit lb/20-ft plot
Acadia	1.7	35.0			
Cheam			348	3.1	24.6
Gorella	0.5	32.3			
Guardian			311	6.8	24.8
K60-98	0.5	37.5			
K64-401	1.3	20.9	481	2.3	33.3
K64-405	5.0	22.3	308	6.0	28.9
K64-436	3.3	41.1	344	4.0	34.3
K64-462	0.5	48.6	343	0.8	34.5
K65-253			300	5.6	26.5
K65-436			176	12.6	13.1
Midway	2.8	27.1	288	6.1	26.1
Ott. 55-01-01	1.0	39.4	549	1.9	39.8
Ott. 55-02-04	1.0	20.2	349	2.9	23.3
Raritan	2.8	21.8	258	3.4	33.8
Red Chief			393	20.2	23.2
Red Coat	1.3	24.2	347	2.9	30.3
Senga Sengana	1.3	41.9			
Sparkle	3.2	22.3			
Surecrop	2.7	27.3	243	8.0	25.2
Veestar	0.3	31.2	513	0.3	39.8
Vesper	2.5	39.2			
Vibrant	0	33.7	508	1.4	36.0

* Mean green petal indices 0 = none, 1 = trace, up to 9 = 100% infection; based on observations of from 3 to 6 replications.

† Mean percent of total plants per plot showing green petal symptoms; based on counts of 4 replications.

ratings. This suggests that Red Chief is a highly susceptible cultivar and discounts border effects. Other cultivars and selections exhibiting high incidence of infection were Surecrop, Sparkle, K65-405, K64-436, and K65-436.

These findings indicate that certain strawberry cultivars have some resistance or tolerance to the green petal disease-causing organism, or that there is a leafhopper vector preference for one variety over another. The breeding of resistant or tolerant cultivars offers the greatest potential as a practical control of the green petal disease. In view of this, some of the cultivars showing resistance to green petal in these and other trials should be incorporated in vector-cultivar transmission studies under controlled conditions to help elucidate these findings. Meanwhile, in areas where green petal is a problem, commercial strawberry plantings should be of cultivars which have good horticultural characteristics and which have been shown to exhibit low levels of green petal infection under natural field conditions.

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AIR–BORNE RUST INOCULUM OVER WESTERN CANADA IN 1971[1]

G.J. Green[2]

The amount of air-borne rust inoculum in Western Canada in 1971 was assessed by exposing vaseline coated microscope slides for 48-hour periods at six locations in Manitoba and Saskatchewan. The slides were placed in spore traps which held the vaseline coated surface at 45% from the vertical. Care was taken to prevent contamination during preparation of the slides at Winnipeg. Except for Saskatoon, the slides were mailed to and from each location protected by a wooden frame and carefully wrapped in paper. After exposure, the number of urediospores caught was determined by microscopic examination of the slides at Winnipeg. Slides exposed at Saskatoon were prepared and examined by the staff of the Canada Department of Agriculture Research Station, Saskatoon, Saskatchewan.

Spores were observed on slides exposed at all locations except Saskatoon during May (Table 1). The numbers counted, although small, were larger and more consistent than is usual in May. The early appearance of urediospores probably had little influence on rust development because crops would not have emerged until the end of May and growth of susceptible wild grasses had only commenced. The relatively large number of stem rust spores caught in May as compared with leaf rust, suggests that that origin of these spores was different that that of the spores caught in June when leaf rust predominated. During June more spores were caught in Saskatchewan than in Manitoba, but in July the number of spores increased more rapidly in Manitoba. Later in the season the numbers of urediospores over the two provinces were similar. The total number of stem rust spores counted was considerably less than in 1970 and less than the average number caught in the previous 10 years (Table 2). Nevertheless, there was sufficient inoculum to initiate appreciable rust development on susceptible varieties and wild grasses. The total number of leaf rust spores counted was less than in 1970 but about the average for the previous 10 years. It agrees with the field observation of widespread leaf rust development on wheat and, in southern Manitoba, of crown rust on oats.

Table 1. Number of urediospores of stem rust and leaf rust per square inch observed on vaseline-coated slides exposed for 48-hour periods at three locations in Manitoba and three locations in Saskatchewan in 1971

	Winnipeg		Morden		Brandon		Indian Head		Regina		Saskatoon	
Date	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 19-20	9	0	0	0	0	0	0	0			0	0
21-22	0	0	0	0	0	0	0	0	3	2	0	0
23-24	0	0	0	0	0	0	0	0	0	0	0	0
25-26	1	0	0	0	5	2	1	1	0	0	0	0
27-28	0	0	1	1	0	0	0	0	2	2	0	0
29-30	2	0	0	0	0	0	0	1	1	1	0	0
31- 1	0	1	0	0	1	1	0	1	1	0	0	0
May Total	12	1	1	1	6	3	1	3	7	5	0	0
June 2- 3	1	0	0	0	1	0	0	1	1	0	0	0
4- 5	0	0	0	1	1	1	1	2	0	0	0	11
6- 7	0	0	0	2	0	1	0	0	0	0	0	0
8- 9	0	1	0	0	0	1	0	2	0	2	0	2
10-11	0	0	0	1	0	2	0	0	0	0	0	0
12-13	0	0	0	0	0	0	0	1	0	1	0	0
14-15	0	0	0	1	0	1	0	1	1	1	0	0
16-17	0	1	0	1	0	1	0	4	2	2	0	2
18-19	1	4	1	1	0	0	0	1	0	0	0	0
20-21	0	1	0	1	0	0	1	5	0	4	0	7
22-23	0	2	0	1	0	0	1	5	1	2	0	10
24-25	0	0	0	0	0	1	1	2	0	1	0	15
26-27	0	0	0	0	0	0	0	2	1	2	0	28
28-29	0	0	0	1	0	0	0	1	0	1	0	4
30- 1	0	0	0	1	0	1	1	15	0	0	0	17
June Total	2	9	1	11	2	9	5	42	6	16	0	96

[1] Contribution No. 508, Research Station, Canada Department of Agriculture Winnipeg, Manitoba R3T 2M9.

[2] Plant Pathologist.

Table 1 (Cont'd.)

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
July 2- 3	9	56	0	0	0	1	1	6	5	16	0	41
4- 5	0	2	0	0	1	4	3	0	0	1	0	19
6- 7	0	6	0	2	1	9	1	5	0	1	0	11
8- 9	0	8	0	2	1	6	0	4	2	13	0	8
10-11	0	10	0	1	1	7	0	2	2	8	0	4
12-13	2	5	0	15	0	5	0	8	0	2	0	12
14-15	2	4	0	12	0	6	0	17	0	4	0	31
16-17			5	112	0	5	0	8	14	33	0	27
18-19	0	2	2	5	0	7	0	0			0	54
20-21	5	40	13	45	3	7	0	0	0	0	0	60
22-23	9	33	5	98	0	1	0	2	0	2	0	3
24-25			4	28	13	120	1	8	0	0	0	45
26-27	1	14	3	59	1	22	0	12	0	6	0	54
28-29	1	18			1	12	0	4	1	7	0	52
30-31	3	72	36	445	5	79	4	68	3	76	0	90
July Total	32	270	68	824	27	291	10	144	27	169	0	511
Aug. 1- 2	26	284	0	2	6	91	9	139	1	164	24	185
3- 4	39	510	54	1,389	6	389	2	249	44	1,328	33	291
5- 6	370	3,485	70	1,429			22	920	15	1,085	15	101
7- 8	229	2,100			25	335	2	201	4	260	0	98
9-10	44	816	33	1,580	11	890	26	312	6	100	0	73
11-12	23	2,445	22	1,510	4	155	19	116	4	155	16	236
13-14	2	34	35	1,350	3	252	11	670	13	350	60	415
15-16	158	1,510	1	68	63	2,200	23	755			9	568
17-18	11	104	6	147	4	392	2	350	15	1,370	5	233
19-20	2	12	9	76	11	284	2	26	35	1,540	3	109
21-22	618	1,740	2	23			167	2,281	84	5,030	44	825
23-24	444	765	61	4,060	109	3,040	21	342	18	246	1	14
25-26	18	21	188	855	6	218	19	93	30	87	25	211
27-28	64	86	82	422	11	378	27	106	91	2,290	17	288
29-30	525	709			69	1,005	65	113	63	1,121	36	105
31- 1	102	66	13	134	33	99	88	261	122	580	16	104
Aug. Total	2,675	14,687	576	13,045	361	9,728	505	6,934	545	15,706	304	3,856
TOTAL	2,721	14,967	646	13,881	396	10,031	521	7,123	585	15,896	304	4,463

Table 2. Total numbers* of urediospores caught in spore traps at six locations in Western Canada from 1961 to 1971

Year	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
1961	88	153	109	212	24	80	27	71	37	101	8	246
1962	782	1,563	2,236	6,282	1,640	2,972	789	1,874	3,000	4,840	198	2,498
1963	2,544	13,685	2,477	26,612	1,722	15,210	1,597	39,785	2,008	69,681	5,571	80,657
1964	12,872	15,041	18,578	14,780	16,439	12,797	3,798	6,918	8,632	42,129	132	531
1965	4,943	9,811	5,362	25,978	2,698	16,091	10,559	66,730	31,635	227,576	1,927	77,502
1966	3,830	7,356	1,843	14,805	737	5,019	469	17,339	724	86,525	526	37,989
1967	2,498	8,997	918	6,974	72	1,107	34	454	70	473	117	344
1968	234	7,623	381	8,393	46	1,480	45	728	317	1,145	10	493
1969	661	5,667	649	9,624	243	5,792	70	877	245	6,972	55	944
1970	5,975	18,969	7,023	27,844	3,393	13,826	1,623	8,373	1,806	20,524	248	6,288
Average 1961-70	3,443	8,886	3,958	14,150	2,701	7,437	1,901	14,314	4,847	45,996	879	20,794
1971	2,721	14,967	646	13,881	396	10,031	521	7,123	585	15,896	304	4,463

* Expressed as spores per square inch of slide except for Saskatoon from 1961 to 1964, where numbers are spores per slide.

LEAF RUST OF WHEAT IN CANADA IN 1971[1]

D.J. Samborski [2]

Disease development and crop losses in Western Canada

Leaf rust was first found in Manitoba on June 21, which is a little later than usual. Inoculum was scarce in June and early July and infections were light. In early August, leaf rust was widespread and infections on 'Manitou' and 'Neepawa' ranged from 20% to 70%. Field observations indicated yield reductions of up to 10% in individual fields, but the average loss from rust was probably less than 5% of the potential yield.

Leaf rust in the rust nurseries

Ratings of leaf rust intensity on 16 wheat varieties grown at nurseries across Canada are shown in Table 1. Leaf rust was widely distributed in Canada, but infections were generally light.

Physiologic specialization

In 1971, field collections of leaf rust were established on 'Little Club' wheat in the greenhouse and one single-pustule isolate was taken from each collection. Most of the collections in Manitoba and Saskatchewan were obtained from commercial fields of 'Manitou' or 'Neepawa'. These varieties do not possess any seedling genes for leaf rust resistance. Collections from other areas were largely obtained from susceptible varieties in the uniform rust nurseries.

In 1971, as in 1970, eight single-gene backcross lines were used to study physiologic specialization in leaf rust. The distribution of virulence on the individual single-gene lines (Table 2) is very similar to the distribution in 1970 except for a decreased number of isolates virulent on Lr10. The replacement of 'Selkirk' by 'Manitou' as the most widely grown variety in Manitoba and Saskatchewan has been accompanied by a decreased number of isolates virulent on Selkirk, which possesses gene Lr10.

Table 1. Percentage infection by *Puccinia recondita* on 16 wheat varieties in uniform rust nurseries at 19 locations in Canada in 1971

Location	Lee	Pitic 62	Selkirk	Red Bobs	Manitou	Neepawa	Kenya Farmer	CT 432	Hercules	Mindum	Stewart 63	DT 317	Exchange	Frontana	^{6}TC X Transfer	R.L. 4255
Agassiz, B.C.	0	0	3	50	5	5	tr*	0	0	0	0	0	0	0	0	0
Creston, B.C.	tr	5	25	90	tr	0	15	tr	10	0	0	0	0	0	0	0
Indian Head, Sask.	tr	5	tr	30	10	5	20	10	0	0	0	0	0	0	0	0
Melfort, Sask.	0	0	tr	15	tr	tr	tr	tr	0	0	0	0	0	0	0	0
Brandon, Man.	25	25	15	65	40	40	25	25	tr	0	0	tr	0	tr	0	0
Morden, Man.	5	15	15	50	20	20	20	25	10	0	0	0	0	0	0	0
Glenlea, Man.	5	2	3	20	10	5	1	5	tr	0	0	0	tr	tr	0	0
Kapuskasing, Ont.	0	0	5	5	tr	tr	0	5	0	0	0	0	0	0	0	0
Thunder Bay, Ont.	10	tr	5	15	20	20	5	5	tr	tr	0	tr	0	0	0	0
Guelph, Ont.	10	10	0	40	tr	0	tr	tr	10	0	0	10	0	0	0	0
Ottawa, Ont.	0	0	0	25	tr	0	tr	tr	tr	0	0	0	0	0	0	0
Appleton, Ont.	0	tr	0	10	tr	0	0	5	0	0	0	0	0	0	0	0
Apple Hill, Ont.	0	20	tr	30	tr	tr	tr	0	tr	0	0	10	0	0	0	0
Vineland, Ont.	tr	10	0	50	0	0	tr	0	0	0	0	tr	0	0	0	0
Québec, Qué.	0	0	tr	20	0	0	0	0	0	0	0	tr	0	0	0	0
Macdonald College, Qué.	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0
Lennoxville, Qué.	5	15	25	70	20	20	0	0	10	0	0	0	0	0	0	0
Normandin, Qué.	tr	0	tr	5	0	0	tr	0	tr	0	0	tr	0	0	0	0
Fredericton, N.B.	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0

*tr = trace

[1] Contribution No. 515, Research Station, Canada Department of Agriculture, Winnipeg, Manitoba R3T 2M9.

[2] Plant Pathologist.

Table 2. Virulence of isolates of *Puccinia recondita* on backcross lines containing single genes for resistance to leaf rust in Canada in 1971

Resistance genes	No. of isolates from:							Total no. of virulent isolates	% total isolates
	Maritimes	Qué.	Ont.	Man.	Sask.	Alta.	B.C.		
Lr 1	2	0	1	2	0	0	1	6	2.7
Lr 2A	2	0	1	1	0	0	1	5	2.2
Lr 2D	8	5	14	2	0	7	8	44	19.5
Lr 3	7	6	20	128	36	8	7	212	94.2
Lr 10	8	3	10	25	5	8	8	67	29.8
Lr 16	0	0	0	7	2	0	0	9	4.0
Lr 17	1	0	0	0	0	7	8	16	7.1
Lr 18	6	7	15	21	3	0	0	52	23.1

Table 3. Virulence combinations of *Puccinia recondita* isolates on backcross lines containing single genes for resistance to leaf rust in Canada in 1971

Avirulence/virulence formula	No. of isolates from:							Total no. of isolates
	Maritimes	Qué.	Ont.	Man.	Sask.	Alta.	B.C.	
1, 2A, 2D, 10, 16, 17, 18/3	1	3	8	84	28	0	0	124
1, 2A, 3, 10, 16, 17, 18/2D	0	0	1	0	0	0	0	1
1, 2A, 2D, 16, 17, 18/3, 10	0	0	2	15	3	1	0	21
1, 2A, 2D, 10, 16, 17/3, 18	0	1	1	18	3	0	0	23
1, 2A, 3, 10, 16, 17/2D, 18	0	2	4	0	0	0	0	6
2A, 2D, 16, 17, 18/1, 3, 10	0	0	0	1	0	0	0	1
1, 2A, 2D, 17, 18/3, 10, 16	0	0	0	6	2	0	0	8
1, 2A, 2D, 16, 17/3, 10, 18	0	1	1	1	0	0	0	3
1, 2A, 16, 17, 18/2D, 3, 10	0	0	0	1	0	0	0	1
1, 2A, 10, 16, 17/2D, 3, 18	0	1	1	0	0	0	0	2
1, 2A, 3, 16, 17/2D, 10, 18	0	2	1	0	0	0	0	3
1, 2A, 2D, 17/3, 10, 16, 18	0	0	0	1	0	0	0	1
3, 16, 17, 18/1, 2A, 2D, 10	1	0	0	0	0	0	0	1
1, 2A, 16, 18/2D, 3, 10, 17	0	0	0	0	0	7	7	14
1, 2A, 16, 17/2D, 3, 10, 18	6	0	6	0	0	0	0	12
10, 16, 17/1, 2A, 2D, 3, 18	0	0	1	1	0	0	0	2
3, 16, 18/1, 2A, 2D, 10, 17	1	0	0	0	0	0	1	2

Seventeen virulence combination were obtained in 1971 (Table 3). The majority of isolates were virulent only on gene Lr3. This pattern of virulence corresponds to the old standard race 15 which has predominated in Western Canada for many years.

The present wheat varieties grown in Manitoba and Saskatchewan do not possess any seedling genes for resistance to leaf rust. 'Manitou' and 'Neepawa' have gene Lr13 that conditions resistance in adult plants. In 1971, adult plants of 'Manitou' were inoculated in the greenhouse with 78 isolates of leaf rust from Manitoba and Saskatchewan. 'Manitou' was resistant to 12 isolates, moderately susceptible to 15 isolates, and susceptible to 51 isolates. In the last few years, there has been a steadily increasing number of isolates virulent on Lr13, paralleling the decreasing number of isolates virulent on Lr10.

Composite collections of leaf rust were used to inoculate the highly resistant varieties Agatha, Transfer, Aniversario,

Wanken, El Gaucho, Terenzio, Preska, Timpaw, Agent, Einkorn, and Tobari. A composite from Saskatchewan produced a susceptible-type pustule on El Gaucho. This proved to virulent on El Gaucho and avirulent on Aniversario, indicating that resistance in these varieties is conditioned by different genes. In 1970, several isolates from Nova Scotia were virulent on both El Gaucho and Aniversario (1).

Acknowledgments

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STEM RUST OF WHEAT, BARLEY, AND RYE IN CANADA IN 1971[1]

G.J. Green[2]

Prevalence and importance in Western Canada

Although air-borne inoculum was present in Western Canada during May and June, wheat stem rust (*Puccinia graminis* Pers. f. sp. *tritici* Eriks. and E. Henn.) developed slowly in 1971. It was observed first on July 8 at Winnipeg but was not found again until August 4. During August in southern Manitoba, severe infections developed on the variety Pitic 62 which is grown on a small acreage. By September, susceptible wild barley (*Hordeum jubatum* L.) was infected throughout Manitoba and eastern Saskatchewan, but there were only traces of stem rust on the widely grown resistant varieties Manitou, Neepawa, and Selkirk.

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

Little wheat stem rust developed in the uniform rust nurseries in 1971. Infections were observed in only 10 of the 33 nurseries as a test of the rust resistance of the varieties grown. However, it is clear that the variety Pitic 62 was susceptible in Manitoba. The common wheat varieties Selkirk, Manitou, and Neepawa and the durum varieties Stewart 63, Hercules, and D. T. 317 were virtually free from infection.

Barley and rye were infected at 14 of the 33 locations. Rye was severely infected at locations in Eastern Canada and British Columbia. Barley was heavily infected only at Creston, B. C. (Table 2).

Physiologic races

Physiologic races were identified by the virulence formula method and by six "standard" differential hosts (*Triticum aestivum* L. 'Marquis' and 'Reliance'; *T. durum* Desf. 'Arnautka' and 'Mindum'; *T. monococcum* L. 'Einkorn'; *T. dicoccum* Schrank 'Vernal').

Stem rust developed slowly in 1971, but 266 collections were obtained. Of these, 170 were rye stem rust (*P. graminis* Pers. f. sp.

Table 1. Percentage infection of stem rust (*Puccinia graminis* f. sp. *tritici*) on 16 wheat varieties in uniform rust nurseries at locations* in Canada in 1971

	Common wheat												Durum wheat			
Location	Red Bobs	Lee	Pitic 62	Selkirk	Manitou	Neepawa	Kenya Farmer	C.T. 432	Thatcher[6] X Transfer	Exchange	Frontana	R.L. 4255	Mindum	Stewart 63	Hercules	D.T. 317
Creston, B.C.	20	0	0	0	0	0	0	0	0	tr**	0	0	0	0	0	0
Indian Head, Sask.	tr	tr	0	0	0	0	0	0	0	0	0	0	tr	0	0	0
Brandon, Man.	5	tr	40	0	0	0	0	0	0	0	0	0	tr	0	0	0
Morden, Man.	5	0	0	0	0	0	0	0	0	0	0	0	tr	0	0	0
Glenlea, Man.	80	10	30	tr	tr	0	1	0	60	5	50	70	50	0	0	0
Thunder Bay, Ont.	tr	tr	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kapuskasing, Ont.	1	tr	0	0	0	0	0	0	tr	0	0	tr	tr	0	0	0
New Liskeard, Ont.	30	10	tr	0	0	1	tr	0	5	1	tr	1	5	0	0	0
Appleton, Ont.	5	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0
Apple Hill, Ont.	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0

* No rust was observed in nurseries at 23 locations: Agassiz, B.C.; Edmonton, Beaverlodge, Lacombe, and Lethbridge, Alta.; Scott and Melfort, Sask.; Durban, Man.; Kemptville, Guelph, Ottawa, Williamstown, and Vineland, Ont.; La Pocatière, Québec, Macdonald College, Lennoxville, and Normandin, Qué.; Truro and Kentville, N.S.; Fredericton, N.B.; Charlottetown, P.E.I.; and St. John's, Nfld.

** tr = trace

[1] Contribution No. 513, Research Station, Canada Department of Agriculture, Winnipeg, Manitoba R3T 2M9.

[2] Plant Pathologist.

Table 2. Percentage infection of stem rust (*Puccinia graminis*) on three varieties of barley and one variety of rye in uniform rust nurseries at 14 locations* in Canada in 1971

Location	Barley			Rye
	Montcalm	Parkland	C.I. 10644	Prolific
Agassiz, B.C.	0	0	0	30
Creston, B.C.	60	50	30	70
Brandon, Man.	0	0	0	20
Morden, Man.	0	0	0	tr
Glenlea, Man.	10	0	0	0
Thunder Bay, Ont.	tr	0	0	0
Kapuskasing, Ont.	5	0	tr	0
Kemptville, Ont.	0	0	0	70
Appleton, Ont.	tr	tr	0	70
Apple Hill, Ont.	0	0	0	30
Québec, Qué.	0	0	0	5
Lennoxville, Qué.	0	0	0	70
Kentville, N.S.	0	0	0	30
Charlottetown, P.E.I.	0	0	0	60

* No rust was observed in nurseries at 19 locations: Edmonton, Beaverlodge, Lacombe and Lethbridge, Alta.; Indian Head, Scott, and Melfort, Sask.; Durban, Man.; New Liskeard, Guelph, Ottawa, Williamstown and Vineland, Ont.; La Pocatière, Macdonald College, and Normandin, Qué.; Truro, N.S.; Fredericton, N.B.; St. John's, Nfld.

secalis Eriks. and E. Henn.) or were mixtures of wheat stem rust and rye stem rust. Rye stem rust has been prevalent since 1968 and the large number of collections in 1971 indicates that its prevalence increased. The reasons for the increase are not clear. The relative scarcity of wheat stem rust may have exaggerated the prevalence of rye stem rust but this factor alone does not appear to explain all of the increase in 1971. There has been no increase in the amount of stem rust on barley in Western Canada, probably because rye stem rust developed late.

The large proportion of rye stem rust reduced the number of wheat stem rust isolates to 135, but it is clear that major changes occurred in the race population of Canada in 1971 (Table 3). Race C18 (15B-1L), which predominated from 1964 to 1970, was found only once. It declined nearly to extinction from over 62% of the isolates in 1970 and was replaced by race C33 (15B-1L) which increased from 16% of the 1970 isolates to over 56% in 1971. The other main race in 1971 was C35 (32-113), which increased from less than 8% in 1970 to over 25% in 1971. Race C33 (15B-1L) does not threaten resistant varieties grown in Western Canada. It is virulent on Marquis-Sr8, and C18 (15B-1L) is avirulent, but Western Canadian varieties do not carry Sr8. Race C35 (32-113) is potentially a more threatening race because it has moderate virulence on seedlings of Thatcher and its important resistant derivatives Manitou and Neepawa. In the field and in adult plant studies in greenhouse, it has not been sufficiently aggressive on Manitou and Neepawa to cause serious concern, but it has increased in prevalence for three consecutive years. Two other interesting races, C38 and C41, that first appeared in 1970 were found in 1971. Race C38 (15B-1L) is like C18 (15B-1L), but it is virulent on Norka CSr15), whereas C18 (15B-1L) is avirulent. Like C18 (15B-1L) and C33 (15B-1L), C38 (15B-1L) does not threaten resistant varieties grown in Western Canada. Race C41 (32-113) resembles race C35 (32-113), but it is virulent on Marquis-Srll, whereas, C35 (32-114) is avirulent. Five isolates of race C41 (32-113) were obtained in 1971, and it may be significant that four of them were from farm fields of resistant varieties. Although stem rust was scarce in farm fields in 1971, 28 collections were obtained from wheat fields and cultures were

Table 3. Distribution by provinces of physiologic races of *Puccinia graminis* f. sp. *tritici* collected on wheat, barley, and grasses in 1971 and frequency of isolations of *P. graminis* f. sp. *secalis* from barley and wild grasses

Virulence formula (race) number	Virulence formula (effective/ineffective host genes)	Number of isolates from					Total number of isolates	Percent of total isolates
		Ont.	Man.	Sask.	Alta.	B.C.		
C4 (23)	5, 6, 11/7, 15, 16					1	1	0.7
C4 (48)	5, 6, 11/7, 15, 16					1	1	0.7
C14 (38-39)	6, 7, 10, 11/5		2	2		1	5	3.7
C18 (15B-1L)	6, 8, 9a, 9b, 13, 15/1, 5, 7, 10, 11, 14, 16		1				1	0.7
C27 (23-59)	6, 11/5, 7, 10, 15, 16					2	2	1.5
C27 (33)	6, 11/5, 7, 10, 15, 16		1				1	0.7
C33 (15B-1L)	6, 9a, 9b, 13, 15/1, 5, 7, 8, 10, 11, 14, 16	14	44	16	2		76	56.4
C35 (32-113)	1, 10, 11, 13/5, 6, 7, 8, 9a, 9b, 14, 15, 16	1	21	12			34	25.3
C35 "S" (32-113)	1, 10, 11, 13/5, 6, 7, 8, 9a, 9b, 14, 15, 16		1				1	0.7
C38 (15B-1L)	6, 8, 9a, 9b, 13/1, 5, 7, 10, 11, 14, 15, 16	2	1				3	2.2
C41 (32-113)	1, 10, 13/5, 6, 7, 8, 9a, 9b, 11, 14, 15, 16		5				5	3.7
C44 (15B-1L)	6, 9a, 9b, 13/1, 5, 7, 8, 10, 11, 14, 15, 16		4	1			5	3.7
Total wheat stem rust isolates		17	80	31	2	5	135	100.0
Rye stem rust *P. graminis* f. sp. *secalis* isolates		3	110	54		3	170	

established from half of them. In addition to the four isolates of race C41 (32-113) six isolates of C33 (15B-1L), seven of C35 (32-113), and one of C35'S' (32-113) were identified from these collections. Race C35'S" (32-113) is a strain of race C35 that attacks Selkirk. Clearly races C35 (32-113) and C41 (32-113) are found more commonly on resistant commercial varieties than other races, but there is no evidence that they are sufficiently aggressive on these varieties to cause important losses. However, they demonstrate that the rust population has evolved strains with increased virulence on the kind of varieties now grown in the rust area of Western Canada. Further evolution in this direction could produce races that are virulent and aggressive on these varieties.

One new race was found in 1971 in Manitoba and Saskatchewan. It resembles the predominant race C33 (15B-1L), but is virulent on Norka (Sr15). It has been called C44 (15B-1L) and its formula appears in Table 3. It was isolated five times (4% of the isolates) and may be sufficiently aggressive to become prevalent. It does not threaten varieties now grown in the rust area.

The disappearance of two old and important races should not be overlooked. Race C17 (56) was not found in Western Canada in 1971 for the first time since 1931. This important and well-adapted race has probably not been eliminated, but clearly its prevalence has been reduced to a very low level. Race C20 (11) was present from 1964 to 1970. It was one of the first races found with some virulence on Manitou, and, although it was not sufficiently aggressive to cause damage, it may have been a progenitor of races such as C35 (32-113) and C41 (32-113) that have increased virulence on Manitou and Neepawa.

The isolates from susceptible wheat varieties and susceptible wild grasses, which are presumed to be nonselective, show about the same distribution as the isolates from all hosts (Table 4). Races C33 (15B-1L) and C35 (32-113) predominate. However, race C35'S' (32-113) was found only on a selective variety and does not appear in Table 4, and only one isolate of race C41 (32-113) was from a nonselective host. These two races appear to have been even scarcer than the data in Table 3 indicate. All isolates of the new race C44 (15B-1L) were collected on nonselective hosts.

There were some sharp changes in the effectiveness of some of the identified resistance genes (Table 5). These changes resulted from the decline of race C18 (15B-1L) and the increase of races C33 (15B-1L) and C35 (32-113). The effectiveness of Sr1 increased and that of Sr6, Sr9a, Sr9b, and Sr15 declined because of the increased prevalence of race C35 (32-113). The effectiveness of Sr8 was reduced to a very low level by the increase of races C33 (15B-1L) and C35 (32-113) and the decline of race

Table 5. Percent of total isolates avirulent on single identified resistance genes and number of avirulent races in 1971

Resistance gene	Avirulent isolates (%) 1971 (1970)	Number of avirulent races
Sr 1	31.2 (13.8)	3
Sr 5	1.6 (1.5)	2
Sr 6	68.8 (90.7)	7
Sr 7a	0.8 (4.0)	1
Sr 8	3.2 (71.1)	2
Sr 9a	65.6 (87.2)	4
Sr 9b	65.6 (87.2)	4
Sr 10	32.0 (11.3)	4
Sr 11	30.4 (14.3)	5
Sr 13	96.8 (97.0)	7
Sr 14	0 (0)	
Sr 15	59.2 (80.3)	2
Sr 16	0 (0)	

Table 4. Distribution by provinces of physiologic races of *Puccinia graminis* f. sp. *tritici* collected on susceptible varieties of wheat and susceptible wild grasses in 1971

Virulence formula (race) number	Virulence formula (effective/ineffective host genes)	Number of isolates from Ont.	Man.	Sask.	B.C.	Total number of isolates	Percent of total isolates
C4 (23)	5, 6, 11/7, 15, 16				1	1	1.0
C4 (48)	5, 6, 11/7, 15, 16				1	1	1.0
C14 (38-39)	6, 7, 10, 11/5		2	2		4	3.9
C18 (15B-1L)	6, 8, 9a, 9b, 13, 15/1, 5, 7, 10, 11, 14, 16		1			1	1.0
C27 (23-59)	6, 11/5, 7, 10, 15, 16				2	2	1.9
C27 (33)	6, 11/5, 7, 10, 15, 16		1			1	1.0
C33 (15B-1L)	6, 9a, 9b, 13, 15/1, 5, 7, 8, 10, 11, 14, 16	7	39	13		59	57.8
C35 (32-113)	1, 10, 11, 13/5, 6, 7, 8, 9a, 9b, 14, 15, 16		14	12		26	25.5
C38 (15B-1L)	6, 8, 9a, 9b, 13/1, 5, 7, 10, 11, 14, 15, 16	1				1	1.0
C41 (32-113)	1, 10, 13/5, 6, 7, 8, 9a, 9b, 11, 14, 15, 16		1			1	1.0
C44 (15B-1L)	6, 9a, 9b, 13/1, 5, 7, 8, 10, 11, 14, 15, 16		4	1		5	4.9
Total isolates		8	62	28	4	102	100.0

C18 (15B-1L). Sr13 continued to be the most effective gene.

Six composite collections of urediospores from all isolates were used to inoculate seedlings of a group of highly resistant varieties. Varieties resistant to all components of the composite collections are: Frontana-K58-Newthatch II-50-17, St464, C.I. 8155, WRT 240 (Manitou with rye translocation), Agent, Tama, Esp 518/9, Inia 66, Minn. II-54-30, Era, Hercules, D.T. 327, Wascana, and R.L. 5244 (T. monococcum). Varieties that had susceptible pustules are: Mida-McMurachy-Exchange II-47-26, Chris, Romany, Bonny (one plant), Giza 144, C.T. 296, C.T. 299, C.T. 615, Timgalen, and D.T. 407. Races C33 (15B-1L), C35 (32-113), and C41 (32-113) were isolated most frequently from these varieties. C.T. numbers are varieties from the Western Canadian Spring Wheat Cooperative Test and D.T. numbers are from the Durum Test.

Acknowledgments

The contribution of those workers across Canada who cared for rust nurseries and forwarded rust collections for identification make this project possible. Mr. J. H. Campbell did the technical work.

CROWN RUST OF OATS IN CANADA IN 1971[1]

George Fleischmann[2]

Disease development and crop losses in Eastern Canada

Oat crown rust caused by Puccinia coronata Cda. f. sp. avenae Eriks. was first found near Pilot Mound, Manitoba on July 21. Disease development was very slow during the remainder of the growing season, and crop losses were confined to a few late sown fields. This was in striking contrast to the previous two seasons (1,2) during which crown rust increased rapidly and caused serious losses in the oat crop, particularly in the Red River area of Manitoba. By the end of August 1971, a light infection of crown rust was present throughout the oat growing regions of southern Manitoba, but damage to the crop was negligible.

Uniform rust nurseries

Ratings of crown rust intensity on 12 oat varieties grown in nurseries across Canada are presented in Table 1. Omitted from this table are nurseries grown at locations where no crown rust was detectable on any of the varieties, as well as nurseries from which rust intensity could not be estimated because of the shrivelled condition of the leaves.

As in previous years, the lines containing crown rust resistance genes Pc38 (R.L. 2924) and Pc39 (R.L. 2925) were not attacked by crown rust at any of the locations, and appear to afford effective protection against this disease. 'Saia' oats provided an equally high level of resistance, but because of its diploid chromosome complement its resistance is more difficult to incorporate in commercial hexaploid oat varieties.

Identification and distribution of physiologic races

The frequency of occurrence and distribution of 18 physiologic races of crown rust identified from 192 Canadian isolates is presented in Table 2. Although 15 different physiologic races were identified in the west, two of these, 295 and 326, comprised nearly 81% of all the isolates. These races attack almost all of the standard differential crown rust varieties. In contrast to the large population of race 264 found in Western Canada last year (1), only 5 isolates of this race were identified in the west in 1971. It appears to have been replaced by race 295, which increased from 9% of the rust population last year (1) to more than 43% this year.

In Eastern Canada 10 physiologic races were identified from 33 isolates. The picture in the east remained much the same as last year with respect to physiologic races in the crown rust population.

Virulence on the differential varieties

The percentage of crown rust isolates virulent on each differential variety from 1966 to 1971 is presented in Table 3. In Western Canada the decrease in supervirulent race 264 is reflected in the reduction in virulence on the varieties Victoria, Trispernia, and Bondvic. This reflects the first reduction in virulence on Trispernia and Bondvic since races of the pathogen began attacking them in 1966. The virulence situation in the east remains basically unchanged from previous years.

Table 1. Percentage infection of crown rust on 12 oat varieties at 10 localities in Canada in 1971

Location	Bond	Trispernia	Landhafer	CI 4023	Saia	Rodney ABDH	CI 3034	Rodney	Harmon	RL 2924	RL 2925	RL 2926
Brandon, Man.	70	0	45	65	0	65	40	70	65	0	0	65
Morden, Man.	65	0	25	50	0	65	20	65	50	0	0	15
Kemptville, Ont.	5	0	0	0	0	0	0	5	5	0	0	5
Thunder Bay, Ont.	20	0	0	5	0	0	0	10	5	0	0	5
Guelph, Ont.	15	5	0	5	0	10	5	20	10	0	0	5
Ottawa, Ont.	tr*	0	0	tr	0	0	0	tr	tr	0	0	0
Appleton, Ont.	5	0	0	tr	0	0	0	tr	tr	0	0	0
La Pocatière, Qué.	tr	0	0	tr	0	tr	tr	tr	tr	0	0	tr
Macdonald College, Qué.	10	0	0	0	0	0	tr	5	5	0	0	0
Lennoxville, Qué.	5	0	0	5	0	tr	tr	tr	5	0	0	tr

* tr = trace infection, less than 1%.

[1] Contribution No. 516, Research Station, Canada Department of Agriculture, Winnipeg, Manitoba R3T 2M9.

[2] Plant Pathologist.

Table 2. Distribution of physiologic races of crown rust in Canada in 1971

Physiologic race	West		East		W & E Totals	
	No. of isolates	% of all isolates	No. of isolates	% of all isolates	No. of isolates	% of all isolates
203	11	6.9	5	15.0	16	8.3
205	1	0.6	0	0.0	1	0.5
210	1	0.6	4	12.0	5	2.6
216	4	2.5	2	6.0	6	3.1
227	1	0.6	0	0.0	1	0.5
228	0	0.0	3	9.0	3	3.1
259	1	0.6	1	3.0	2	1.0
264	5	3.1	1	3.0	6	3.1
268	1	0.6	0	0.0	1	0.5
276	2	1.3	0	0.0	2	1.0
295	69	43.5	7	21.0	76	39.5
320	0	0.0	1	3.0	1	0.5
326	59	37.2	4	12.0	63	32.7
333	1	0.6	0	0.0	1	0.5
341	0	0.0	5	15.0	5	2.6
345	1	0.6	0	0.0	1	0.5
368	1	0.6	0	0.0	1	0.5
427	1	0.6	0	0.0	1	0.5
Total races	15		10		18	
Total isolates	159		33		192	
Race:Isolate ratio	1:11		1:3			

Table 3. Percentage of Canadian crown rust isolates virulent on differential host varieties, 1966 to 1971

Location and year	Anthony	Victoria	Appler	Bond	Landhafer	Santa Fe	Ukraine	Trispernia	Bondvic	Saia
Western Canada										
1971	99	45	99	97	87	87	99	4	5	3
1970	96	86	97	99	93	92	75	55	55	2
1969	92	62	93	94	82	82	87	30	30	5
1968	90	48	90	95	82	81	95	10	10	3
1967	72	59	72	89	68	68	80	24	31	13
1966	66	58	62	82	24	23	83	2	2	4
Eastern Canada										
1971	63	42	60	87	36	36	100	3	3	0
1970	82	66	84	92	42	42	84	18	18	0
1969	50	44	50	93	21	24	97	7	7	10
1968	79	40	83	87	8	9	96	2	2	7
1967	47	54	50	86	10	11	95	2	1	13
1966	51	45	30	77	9	9	85	0	0	9

Acknowledgments

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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STEM RUST OF OATS IN CANADA IN 1971[1]

J.W. Martens and P.K. Anema

Prevalence and crop losses in Western Canada

Stem rust of oats caused by Puccinia graminis Pers. f. sp. avenae Eriks. & E. Henn. was first found in southern Manitoba in late July. The disease developed slowly and caused little or no crop loss except in a few late fields. Although light infections of stem rust were found throughout Manitoba and in eastern Saskatchewan, weather conditions permitting early planting in the Red River Valley, and adverse epidemiological conditions during the growing season combined to prevent the serious losses sustained in 1970 (2).

Uniform rust nurseries

Oat stem rust infections were light in rust nurseries grown at 32 locations across Canada (Table 1). Rust was observed in only 6 of the nurseries, and infections of more than 5% occurred only at Lennoxville, Quebec, and Glenlea, Manitoba. Virulence on the recently discovered stem rust resistance gene, pg 13, was not found in any of the nurseries.

Identification and distribution of physiologic races

Physiologic races were identified by the methods used in previous years (1). In addition to the varieties with the genes listed in Table 2, a supplementary set consisting of 'Kyto' (pg 12), 'Saia', and 'R.L. 2926' (pg 13) was used. All 224 isolates were avirulent on Kyto and Saia; only one culture from Manitoba, an apparently new race, C24, combining virulence on Pg 3, 4, 9, and 13 attacked 'R.L. 2926'. Physiologic race C10 continued to predominate (74% of all isolates) in Western Canada (Table 2). Race C23, a race avirulent on all commercial varieties, increased from 11% in 1970 to 25% in 1971, while race C20, avirulent only on pg 13, decreased from 17% in 1970 to 2% in 1971. Races C3 and C5, once dominant, have almost disappeared. In Eastern Canada, race C9 continued to predominate but races C8 and C10 were also common. Segregating the rust isolates by origin (from hosts with stem rust resistance vs. those without) had no effect on race distribution, except with C23 which was isolated only from wild oats. The evolution of race C24 presents no immediate problems to the development of resistant varieties since sources of resistance effective against it have been used in conjunction with genes Pg 9 and 13, conferring resistance to races C10 and C20.

The virulence range of the rust population has been maintained at a very high level (Table 3). Only genes pg 8 and 13 in Eastern Canada and pg 9 and 13 in Western Canada confer effective resistance to the predominant races in the respective areas. Since Pg 2 and Pg 4 are the only types of resistance present in commercial oat varieties, the crop remains vulnerable to serious losses in 1972.

Table 1. Percentage infection by *Puccinia graminis* f. sp. *avenae* on 12 oat cultivars in uniform rust nurseries* at 6 locations in Canada in 1971

Location	Bond	Trispernia	Landhafer	C.I. 4023	Saia	Rodney ABDH	C.I. 3034	Rodney	Harmon	R.L. 2924	R.L. 2925	R.L. 2926
Lennoxville, Qué.	5	tr**	tr	0	0	25	0	tr	0	25	tr	0
New Liskeard, Ont.	5	0	0	tr	0	0	0	tr	tr	0	5	0
Thunder Bay, Ont.	tr	0	0	0	0	0	0	tr	0	0	0	0
Apple Hill, Ont.	tr	0	0	0	0	0	0	tr	0	0	0	0
Guelph, Ont.	3	tr	0	0	0	3	0	1	tr	0	0	0
Glenlea, Man.	25	0	0	0	0	tr	0	5	tr	0	tr	0

* No rust was observed in 26 other nurseries located at St. John's West, Nfld.; Charlottetown, P.E.I.; Fredericton, N.B.; Kentville and Truro, N.S.; Macdonald College, Normandin, Québec, and La Pocatière, Qué.; Appleton, Kapuskasing, Kemptville, Ottawa, Vineland, and Williamstown, Ont.; Brandon, Durban, and Morden, Man.; Indian Head, Melfort, and Scott, Sask.; Beaverlodge, Edmonton, and Lethbridge, Alta.; and Agassiz and Creston, B.C.

** tr = trace infection

[1] Contribution No. 514, Research Station, Canada Department of Agriculture, Winnipeg, Manitoba R3T 2M9.

Table 2. Distribution of physiologic races of oat stem rust in Canada in 1971

Race formula no.	Virulence formula (effective/ineffective *Pg* host genes)	No. of isolates from				Total isolates	Percentage of total isolates
		Qué.	Ont.	Man.	Sask.		
C3	2, 8/1, 3, 4, 9		1			1	0.4
C5	4, 9/1, 2, 3, 8			1		1	0.4
C6	1, 8/2, 3, 4, 9		1			1	0.4
C8	3, 8/1, 2, 4, 9	2	3			5	2.2
C9	8/1, 2, 3, 4, 9	4	8			12	5.3
C10	9/1, 2, 3, 4, 8	1	3	120	23	147	65.6
C14	8, 9/1, 2, 3, 4	1	1			2	0.9
C20	/1, 2, 3, 4, 8, 9			4		4	1.8
C23	2, 4, 9/1, 3, 8		1	33	16	50	22.3
C24	1, 2, 8/3, 4, 9			1		1	0.4
Total		8	18	159	39	224	

Table 3. Frequency of virulence in the oat stem rust population on various types of resistance in Canada in 1971

Geographic area	Percentage of isolates virulent on cultivars with the following genes for resistance:							Total no. isolates	Mean* virulence capability
	Pg-1	*Pg-2*	*Pg-3*	*Pg-4*	*pg-8*	*pg-9*	*pg-13*		
Eastern Canada	96.1	92.3	80.7	96.1	19.2	73.0	0.0	26	4.57
Western Canada	99.5	74.8	100.0	74.8	99.5	2.5	0.5	198	4.51

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

Acknowledgments

The assistance of cooperators who cared for the rust nurseries and submitted rust collections from various parts of Canada is gratefully acknowledged.

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CEREAL DISEASES IN THE MARITIME PROVINCES, 1971[1]

H.W. Johnston and L.S. Thompson [2]

The 1971 cereal growing season could be characterized as only moderately successful, primarily as a result of heavy rains during mid-May. These rains delayed seeding dates by 2 to 3 weeks and necessitated seeding to be continued until mid-June.

Grain aphid infestations, largely of the bird-cherry oat aphid Rhopalosiphum padi (L.), appeared in mid-June and their presence resulted in heavy losses from barley yellow dwarf (BYD) in barley, oats, and wheat in all three provinces. Some oat fields seeded in mid-June in Prince Edward Island and the Annapolis Valley of Nova Scotia were virtually destroyed, with losses approaching 100%. Plants in the majority of fields seeded in late May and early June displayed visible symptoms of BYD, but to a much lesser degree of severity, and the disease was restricted primarily to the boundaries of the fields. No visible BYD symptoms were detected during a mid July disease survey of early-seeded barley fields in eastern Nova Scotia, where some seeding took place in late April and early May.

In disease loss trials at Charlottetown, plots of 'Herta' barley seeded on May 11 yielded an average of 32 bushels per acre, whereas those seeded on June 15 yielded an average of 15 bushels per acre. Plants in the earlier seeded plots did not exhibit BYD symptoms, while those in some areas of the June-seeded plots were infected with BYD and in these areas yields were as low as 8 bushels per acre. This reduction in yield between seeding dates cannot be attributed solely to virus infections since other leaf diseases were also more severe in the late seeded plots, and other abiotic factors may have contributed to lower yields.

Diseases incited by fungal pathogens were of normal intensity in 1971. Powdery mildew of wheat incited by Erysiphe graminis DC ex Merat f.sp. tritici Marchal has decreased in severity since most wheat growers discontinued seeding the mildew susceptible cultivar Selkirk in favor of the moderately resistant Opal. However, in areas where wheat has been under cultivation for a number of years, take-all incited by Ophiobolus graminis Sacc. has become a much more common disease. Traces of take-all could be found in all wheat growing areas but significant losses were recorded in only two areas - near Shediac, New Brunswick in fields of spring wheat and in the Annapolis Valley of Nova Scotia on Yorkstar winter wheat.

Southern leaf blight of corn incited by Helminthosporium maydis Nisikado & Miyake was found in a small acreage of grain corn in western P. E. I. This was the first noted occurrence of the disease in the Maritimes.

Observations made during the 1971 season indicated that date of seeding is one of the major factors determining the success of Maritime cereal production in the Maritimes.

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[1] Contribution No. 249, Research Station, Canada Department of Agriculture, Charlottetown, Prince Edward Island.

[2] Plant Pathologist and Entomologist.

COOPERATIVE SEED TREATMENT TRIALS – 1971[1]

H.A.H. Wallace[2]

Abstract

Forty-eight seed treatment chemicals were tested for their efficacy in controlling bunt of wheat (Tilletia foetida), covered smut of oats (Ustilago kolleri), seedling blight of barley (Cochliobolus sativus), and seed rot of flax caused by a complex of seed- and soil-borne microorganisms. The results show that there are formulations in the dust, wettable powder, suspension, or liquid forms of seed treatments that could be used as substitutes for mercury, hexachlorobenzene, and pentachloronitrobenzene.

Introduction

In 1971 forty-eight seed treatment chemicals were tested for their efficacy in controlling common bunt of wheat caused by Tilletia foetida (Wallr.) Liro, covered smut of oats caused by Ustilago kolleri Wille, covered smut of barley caused by U. hordei (Pers.) Lagerh., seedling blight of barley caused by Cochliobolus sativus (Ito and Kurib.) Drechsl. ex Dastur, and seed rots of flax caused by a complex of soil- and seed-borne microorganisms.

Materials and methods

Uninfected seed of Red Bobs wheat (Triticum aestivum L.), naturally smutted seed of Vanguard oats (Avena sativa L.), and naturally smutted seed of Herta barley (Hordeum distichon L.) were used. One gram of dry spores of the appropriate smut fungus was added to 200 g of the cereal seed in a quart jar and shaken well to distribute the spores over the seed. Another sample of Herta barley, 100% naturally infected with C. sativus, was used for the seedling blight tests. Noralta flax (Linum usitatissimum L.) was used for the seed rot test.

The seed treatment materials were tested in two series. Except that the two series of materials were randomized separately the experimental procedures were identical. The source, product name, and chemical name, where available, of the treatment materials are listed in Tables 1 and 2. Res-Q and Panogen 15B (Series A) and Agrox NM (Series B) were included as standards. Each chemical was applied to 100 g of seed, or to 200 g of seed if the rate (Tables 3 and 4) was less than 1 oz per bushel, by shaking the seed in a glass jar until the seed was uniformly covered. The seed was removed from the jar after not more than 3 days, and samples of 200 seeds in paper envelopes were stored in polyethylene bags at 15 C for not more than 2 weeks before seeding.

Tests with both series of materials were carried out at Brandon and Morden, Manitoba. Each treatment, replicated four times at each station, consisted of 200 seeds planted in a row 12 ft long. All rows were planted 9 inches apart and treatments were arranged in a randomized block design. Emergence data on barley infected with C. sativus and on flax were recorded 6-8 weeks after seeding. Disease ratings of the emerged barley plants were made at the same time by examining 100 plants from each row. The plants were rated on a 0-5 scale and the disease rating percentage was established according to the following:

$$\text{Disease rating \%} = \frac{\text{avg of numerical ratings of individual plants} \times 100}{5}$$

The percentage of smutted heads, based on counts of 200 heads per row, was recorded after the crop had headed (when infection appeared to be heavy, assessments were based on 100 heads). The results are given as means of eight replicates, four from each planting site.

Results and discussion

Smut infection of untreated seed varied from 25% to 32% for wheat, and from 11% to 15% for oats (Tables 3 and 4). No barley smut developed and hence no barley smut data are recorded in the tables. Some chemicals gave very good control of the smut diseases of wheat and oats and appear to be satisfactory substitutes for mercury, e.g. BEB33, BEB14, BEB15, Vitaflo DB, Manzate D,

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[1] Contribution No. 510, Research Station, Canada Department of Agriculture, Winnipeg, Manitoba R3T 2M9.

[2] Plant Pathologist.

Table 1. Seed treatment materials used in the cooperative test (Series A)

Treatment no.	Source*	Product name	Chemical name
1		Untreated check	
2-3	Niagara	"BEB"	identity not available
4-6	Niagara	Liquid Polyram	zinc activated polyethylene thiuram disulfide (30%)
7-12	Niagara	"BEB"	identity not available
13	Ciba-Geigy	G20-072	identity not available
14	Ciba-Geigy	GS-22-182	identity not available
15-17	Ciba-Geigy	Amdal	identity not available
18	Ciba-Geigy	CGF 2480	identity not available
19	Ciba-Geigy	Maneb suspension	maneb (25%)
20-22	Ciba-Geigy	"SWF-"	identity not available
23-25	Uniroyal	Vitaflo MF-71	Vitavax + thiram
26-28	Uniroyal	V.E.L.	identity not available
29-31	Uniroyal	Vitaflo DB	Vitavax (40%) + thiram (40%)
32-38	Nor-Am	"SN-"	identity not available
39-44	Merck	"S-"	identity not available
45-46	Gustafson	Merck 77	identity not available
47-49	Murphy	MC 833	N-(dimethyldithiocarbamoylmethyl) morpholine
50-52	Chemagro	B 1843	trans-1,2-bis(n-propylsulfonyl) ethylene (50%)
53-56	Canicon	Nicon PQ	methyl dodecyl benzl trimethyl ammonium chloride (20%) + methyl dodecyl xylenebis (trimethyl ammonium chloride) (5%) + 2,2-methylenebis (3,4,6-trichloro-phenol (4.5%) + 2 chloro -4- phenyl phenol (25%) + 5 chloro salicylanilide (0.5%)
57	Du Pont	Arasan 75	thiram (75%)
58	Ciba-Geigy	Res-Q	hexachlorobenzene (20%) + captan (20%) + maneb (15%)
59	Nor-Am	Panogen 15B	methylmercuric dicyandiamide (3.7 oz/gal)
60		Untreated check	

* Niagara Chemicals, Burlington, Ontario; Ciba-Geigy Canada Ltd., Montréal, Québec; Uniroyal Ltd., Elmira, Ontario; Nor-Am Agricultural Products, Inc., Woodstock, Illinois; Merck & Co., Inc., Rahway, New Jersey; Gustafson Manufacturing Inc., Hopkins, Minnesota; Murphy Chemical Ltd., Wheathampsted, St. Albans, Hertfordshire, England; Chemagro Corporation, Kansas City, Missouri; Canicon Chemicals Ltd., Downsview, Ontario; E.I. Du Pont de Nemours & Co., Inc., Wilmington, Delaware.

the Tersan and Arasan mixture, L205, and all TF-formulations. The barley seed used for the seedling blight test had a low weight per bushel which seems to account for the low emergence (30% to 54% in the untreated checks). Seed treatment did little to reduce seedling blight of barley. Emergence of the untreated flax ranged from 50% to 56%, but in general the flax emergence was not increased by seed treatment, again showing that flax does not respond to seed treatment when soil moisture is plentiful or when the seed coat has no fractures.

Acknowledgments

I wish to thank the representatives of the chemical industry for their cooperation and the staffs of the Morden and Brandon Research Stations for their assistance in organizing plot tests.

Table 2. Seed treatment materials used in the cooperative test (Series B)

Treatment no.	Source*	Product name	Chemical name
61		Untreated check	
62	Du Pont	Manzate D	maneb (80%)
63†	Du Pont	Tersan 1991 + Arasan 75	benomyl (50%) thiram (75%)
64	Olin	SD-205	pentachloronitrobenzene (20%) + 5 ethoxy-3-trichloromethyl-1, 2,4-thiadiazole (5%)
65	Olin	L-205	quintozene (pentachloronitrobenzene) (23.2%) + 5 ethoxy-3-trichloromethyl-1, 2,4-thiadiazole (5.8%)
66-70	Chipman	"TF-"	identity not available
71	Chipman	Agrox NM	maneb (37.5%) + hexachlorobenzene (10%)
72-77	Chipman	"TF-"	identity not available
78-79	Buckman	Cosan (TCMTB)	2-(thiocyanomethylthio) benzothiazole (30%)
80-81	Rohm & Haas	RHC 338	mancozeb (25%)
82-83	Rohm & Haas	Dithane M45	zinc coordinated mancozeb
84	Olin	Terra-Coat 24Q	quintozene (pentachloronitrobenzene) (24%)
85	BASF	3191-F	2,5-dimethyl-3-furylanilide
86	BASF	3260-F	identity not available
87		Untreated check	

* E.I. Du Pont de Nemours & Co., Inc., Wilmington, Delaware; Olin Agricultural Division, Little Rock, Arkansas; Chipman Chemicals Ltd., Hamilton, Ontario; Buckman Laboratories, Inc., Memphis, Tennessee; Rohm & Haas Co. of Canada Ltd., West Hill, Ontario; BASF Canada Ltd., Montréal, Québec.

† In treatment 63 the seed was treated twice, once with each fungicide at the rates indicated in Table 4.

Table 3. Results of cooperative seed treatment trials (Series A)*

Treatment no.	Product name	Formulation**	Dosage (oz/bu) (ml/bu)	Smutted heads (%) Wheat	Smutted heads (%) Oats	Barley seedling blight Emergence (%)	Barley seedling blight Disease rating (%)	Flax Dosage (oz/bu) (ml/bu)	Flax Emergence (%)
1	Untreated check			25.24	13.68	53.1	21.5		56.2
2	BEB 33	L	4.00 oz	1.40	0.37	52.4	22.5	4.00 oz	41.4
3	BEB 33		5.00	0.00	0.11	56.7	23.8	5.00	61.1
4	Polyram 30%	SU	1.50	0.26	8.91	53.0	22.8	1.50	51.6
5	Polyram 30%		2.00	0.50	6.84	40.9	22.4	2.00	54.8
6	Polyram 30%		3.00	0.00	2.22	55.7	20.1	3.00	60.0
7	BEB 14	D	1.50	0.04	0.00	52.1	24.6	1.50	51.2
8	BEB 14		3.00	0.80	0.00	49.8	18.4	3.00	50.9
9	BEB 14		4.00	0.00	0.00	52.6	22.2	4.00	50.1
10	BEB 15	D	1.00	0.22	0.04	54.9	21.4	1.00	49.9
11	BEB 15		2.00	0.06	0.00	54.6	23.4	2.00	56.4
12	BEB 15		3.00	0.00	0.05	46.1	23.4	3.00	53.1
13	G20-072	WP	2.00	10.30	0.76	53.1	22.4	2.00	52.8
14	GS 22-182	SL	2.00	1.15	0.40	56.2	21.7	2.00	61.2
15	Amdal 2000	L	1.00	4.07	4.38	53.9	22.6	1.00	59.1
16	Amdal 2001	L	1.00	0.28	0.00	56.5	22.0	1.00	57.9
17	Amdal 2003	L	1.00	0.36	0.00	40.9	23.5	1.00	58.2

Table 3 (Cont'd.)

Treatment no.	Product name	Formulation**	Dosage (oz/bu) (ml/bu)	Smutted heads (%) Wheat	Smutted heads (%) Oats	Barley seedling blight Emergence (%)	Barley seedling blight Disease rating (%)	Flax Dosage (oz/bu) (ml/bu)	Flax Emergence (%)
18	CGF 2480	L	4.00	7.67	8.02	39.9	23.3	4.00	56.3
19	Maneb susp.	SU	3.00	0.50	0.52	53.1	20.8	3.00	52.2
20	SWF 2330	SL	1.00	0.09				4.00	52.2
			2.00		2.77	53.2	21.4		
21	SWF 2470	SL	1.25	0.04				5.00	51.6
			2.50		1.83	46.9	25.5		
22	SWF 2350	D	1.00	1.59				4.00	59.8
			2.00		0.42	58.4	20.5		
23	Vitaflo MF 71	SU	2.50	0.66	0.22	47.1	20.3	3.00	56.9
24	Vitaflo MF 71		2.66	0.93	0.00	44.5	20.7	3.50	50.1
25	Vitaflo MF 71		3.00	1.16	0.13	52.4	24.6	4.00	51.3
26	V.E.L.	SU	2.50	0.33	0.00	48.1	25.5	3.00	43.3
27	V.E.L.		2.66	1.30	0.00	51.0	20.0	3.50	53.6
28	V.E.L.		3.00	0.94	0.00	49.4	22.8	4.00	54.9
29	Vitaflo DB	D	1.50	0.26	0.00	46.8	25.2	2.50	61.2
30	Vitaflo DB		2.00	0.34	0.00	41.9	23.4	3.00	53.4
31	Vitaflo DB		2.50	0.69	0.00	44.7	26.1	3.50	58.1
32	SN 42851	WP	0.50	4.96	0.04	40.0	21.4	1.00	54.6
33	SN 42851		1.00	2.37	0.00	43.3	20.3	2.00	51.8
34	SN 43396	WP	0.50	25.63	0.20	50.4	22.2	1.00	40.6
35	SN 43396		1.00	14.95	0.06	42.7	24.8	2.00	45.2
36	SN 11139	WP	1.00	11.34	10.59	39.4	16.9	1.00	42.0
37	SN 11139		2.00	7.32	10.03	35.7	21.4	2.00	44.8
38	SN 11139		4.00	2.92	7.69	29.2	18.7	4.00	38.1
39	S-8	L	15 ml	10.00	0.24	45.4	21.5	15 ml	45.4
40	S-8		30 ml	3.77	0.00	51.1	20.5	30 ml	48.9
41	S-8		60 ml	2.08	0.00	39.9	18.9	60 ml	40.9
42	S-9	L	15 ml	3.39	0.17	37.8	16.6	15 ml	49.4
43	S-9		30 ml	1.83	0.00	48.4	19.2	30 ml	44.2
44	S-9		60 ml	0.95	0.00	44.1	20.7	60 ml	44.0
45	S-77	L	2.00 oz	3.78	0.00	40.0	21.7	2.00 oz	45.8
46	S-77		4.00	0.46	0.04	35.9	20.8	4.00	38.1
47	MC 833 (25% WP)	WP	3.00	6.53	0.00	37.5	21.6	3.00	46.4
48	MC 833 (25% WP)		6.00	1.81	0.05	36.1	23.0	6.00	45.7
49	MC 833 (75%)	D	1.00	14.31	4.57	35.1	17.5	2.00	50.3
50	B1843 (50% WP)	WP	0.50	8.78	0.44	37.9	18.8	0.50	55.6
51	B1843 (50% WP)		1.00	3.71	0.48	45.5	19.2	1.00	48.6
52	B1843 (50% WP)		2.00	1.48	0.34	43.3	23.4	2.00	55.6
53	Nicon PQ (400 ppm)	L	15 ml	23.89	13.37	32.7	17.6	15 ml	54.6
54	Nicon PQ (400 ppm)		75 ml	16.85	14.62	32.2	19.7	75 ml	58.6
55	Nicon PQ (400 ppm)		150 ml	20.11	15.65	26.4	19.5	150 ml	50.1
56	Nicon PQ (400 ppm)		750 ml	20.25	12.88	31.1	18.7	750 ml	48.2
57	Arasan 75	WP	1.30 oz	1.40	0.55	38.9	24.1	2.00 oz	55.0
58	Res-Q	D	1.00	0.00	1.80	36.2	21.1	2.00	61.1
59	Panogen 15B	L	0.75	0.00	0.00	37.2	23.9	1.50	67.4
60	Untreated check			32.01	10.93	54.0	20.2		54.9

* Means of tests at Brandon and Morden.

** Formulation code: L = liquid; SU = suspension; D = dust; SL = slurry; WP = wettable powder.

Table 4. Results of cooperative seed treatment trials (Series B)*

Treatment no.	Product name	Formulation**	Dosage (oz/bu) (ml/bu)	Smutted heads (%) Wheat	Smutted heads (%) Oats	Barley seedling blight Emergence (%)	Barley seedling blight Disease rating (%)	Flax Dosage (oz/bu) (ml/bu)	Flax Emergence (%)
61	Untreated check			28.69	15.17	51.5	14.0		49.8
62	Manzate D	D	2.00	0.05	0.00	41.6	9.9	4.00	57.6
63	Tersan 1991 and	WP	3.30	0.00	0.04	42.2	16.3		
	Arasan 75	D	1.30						
64	SD-205	D	2.00	0.36	3.45	52.7	14.2	2.0	47.7
65	L-205	L	2.00	0.00	0.81	53.0	12.8	2.0	49.8
66	TF-3087	WP	2.00	0.31	0.90	51.8	10.6	2.0	53.7
67	TF-3088	WP	1.00	0.27				2.0	51.4
68	TF-3088		2.00	0.04	0.40	54.4	9.7		
69	TF-3089	WP	1.00	0.11				2.0	54.9
			2.00		0.00	44.4	11.6		
70	TF-3120	WP	1.00	0.00				2.0	55.2
			2.00		0.00	41.6	10.1		
71	Agrox NM	WP	1.00	0.00				2.0	52.6
			2.00		0.50	43.9	10.7		
72	TF-3088	SL(a)	1.00	0.23				2.0	52.6
			2.00		0.63	36.6	12.3		
73	TF-3088	SL(b)	1.00	0.62				2.0	55.7
			2.00		0.00	38.3	11.0		
74	TF-3089	SL(a)	1.00	0.04				2.0	52.7
			2.00		0.04	41.7	11.0		
75	TF-3089	SL(b)	1.00	0.34				2.0	48.7
			2.00		0.00	38.3	10.4		
76	TF-3091	D	2.00	5.13					
77	TF-3090	D	2.00	0.00	0.04	39.9	10.0	2.0	60.1
78	Cosan (TCMTB)	L	0.75	1.08	0.04	37.9	14.8	0.75	48.4
79	Cosan (TCMTB)		1.00	1.36				1.50	48.1
			1.50		0.00	36.0	14.1		
80	RHC 338	SL	1.00	1.52	7.81	36.0	13.5	1.00	52.9
81	RHC 338	SL	2.00	0.85	5.73	34.1	12.0	2.00	44.4
82	Dithane M45	D	1.00	0.00	1.15	35.6	10.8	1.00	59.7
83	Dithane M45		2.00	0.03	0.04	39.2	11.1	2.00	51.7
84	LT2	L	2.00	0.22	0.83	28.7	13.9	2.00	49.4
85	3191-F	D	1.00	0.07				2.00	51.7
			2.00		0.00	33.1	11.4		
86	3260-F	D	1.00	0.25				2.00	53.4
			2.00		0.05	32.8	11.9		
87	Untreated check			26.00	11.21	30.9	11.5		55.9

* Means of tests at Brandon and Morden.

** Formulation code: D = dust; WP = wettable powder; SL = slurry; L = liquid; (a) = water slurry; (b) = glycol slurry.

SNOW MOLD OF TURFGRASS IN SASKATCHEWAN IN 1971[1]

J. Drew Smith[2]

Abstract

Approximately 1200 domestic lawns at seven locations in Saskatchewan were surveyed for snow mold in early spring 1971. At Moose Jaw, Prince Albert, and Rosetown the percentage of lawns without disease was highest and the severity lowest. Swift Current had a higher incidence of snow mold and it was more severe there than anywhere else. Fusarium nivale was the pathogen commonly isolated at Saskatoon, and it was found on golf green turf at Prince Albert, Regina, and Moose Jaw. The low-temperature basidiomycete was not common. Sclerotinia borealis caused severe snow mold damage on Agrostis turf on golf courses at Prince Albert, Saskatoon, and Swift Current and on Festuca rubra turf on a bowling green at Saskatoon. F. nivale and S. borealis are new records for turf grasses in Saskatchewan. An unidentified fungus with hyphal clamp connections and brown or black microsclerotia was found closely associated with some snow mold cases at Saskatoon. Another unidentified fungus with Typhula-like, orange-colored sclerotia was closely related to snow mold damage on a putting green at Regina. In tests at Saskatoon, several fungicides showed promise in controlling snow mold.

Disease survey

In late April and early May 1971 surveys were made of snow mold on approximately 1200 domestic front lawns in several centers in Saskatchewan (Table 1). An estimate was made of the percentage area affected by snow mold on lawns in the course of transects of the cities and towns. It was found possible to speed up the surveys by using portable radio equipment to report disease estimates to a recorder in an automobile.

The percentage of lawns without disease was highest at Moose Jaw, Prince Albert, and Rosetown and the severity was lowest at those locations. Swift Current had a higher incidence of snow mold and it was more severe there than anywhere else. Snow mold was slightly less severe at Saskatoon in 1971 than in 1969 (8).

Fungal pathogens isolated

Isolations were made from lawns at Saskatoon as soon as disease patches were uncovered at snow melt (from 9 April).

Table 1. Incidence of snow mold on lawns in Saskatchewan, 1971

City or town	Date of survey	Number of lawns surveyed	Percentage of lawns in each rating category*				
			None	Slight	Mod.	Mod.-severe	Very severe
Maple Creek	4 May	84	15.6	30.9	30.9	20.2	2.4
Moose Jaw	4 May	94	30.9	37.2	21.3	10.6	0.0
Prince Albert	13 May	125	31.2	33.6	22.4	12.0	0.8
Regina	5 May	212	9.4	41.0	29.2	19.8	0.6
Rosetown	3 May	63	34.9	39.7	14.3	9.5	1.6
Saskatoon	27-28 April	556	15.8	25.2	28.4	27.0	3.6
Swift Current	4 May	57	8.8	33.3	17.5	29.8	10.5

* Rating scale: Slight = 0-10% of lawn area affected; Mod. = 11-25%; Mod.-severe = 26-50%; Very severe = 51-100%.

Fusarium nivale (Fr.) Ces. was common (5) but the low-temperature basidiomycete (LTB) (2, 3, 8) was not found. F. nivale and the LTB were isolated from Poa annua L. in golf greens at Moose Jaw and F. nivale from the same grass species on golf greens at Prince

[1] Contribution No. 459, Research Station, Canada Department of Agriculture, Saskatoon, Saskatchewan.

[2] Plant Pathologist.

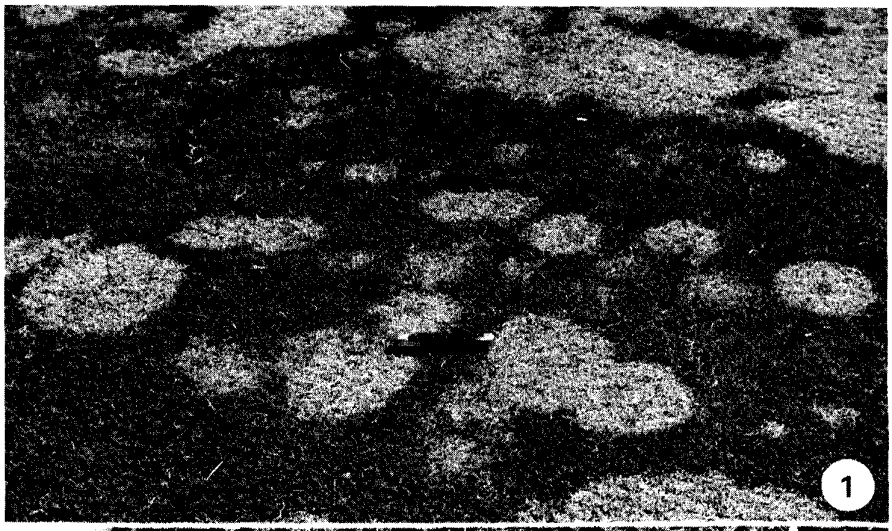

Figure 1. Snow mold on *Agrostis* turf, caused by *Sclerotinia borealis*.

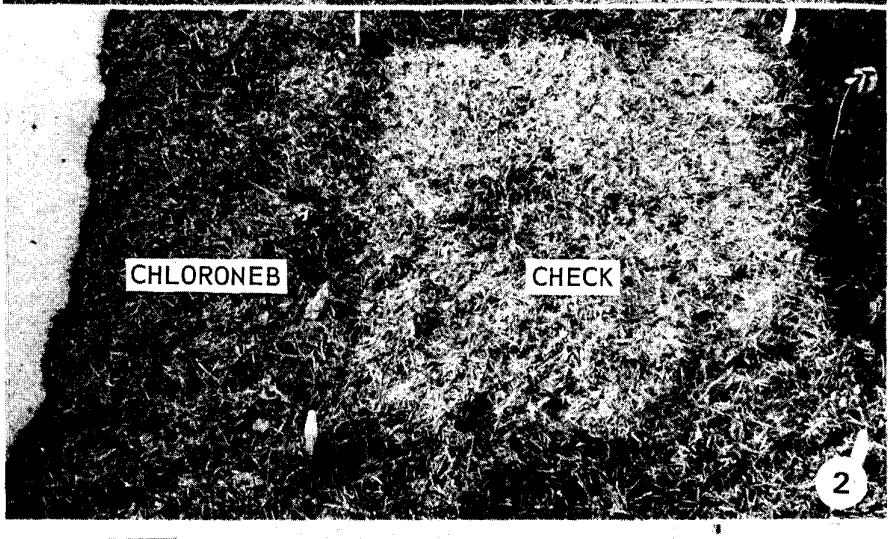

Figure 2. Fusarium snow mold on untreated check plot in domestic lawn.

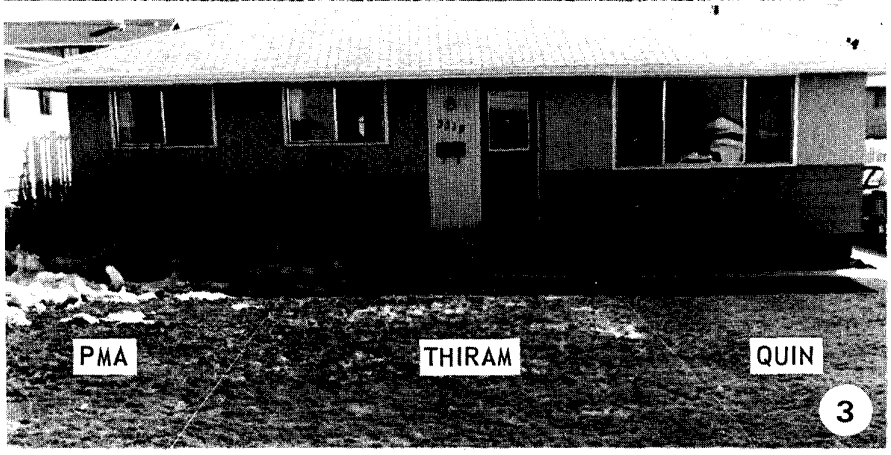

Figure 3. Effective control of snow mold with phenyl mercuric acetate and quintozene; ineffective control with thiram.

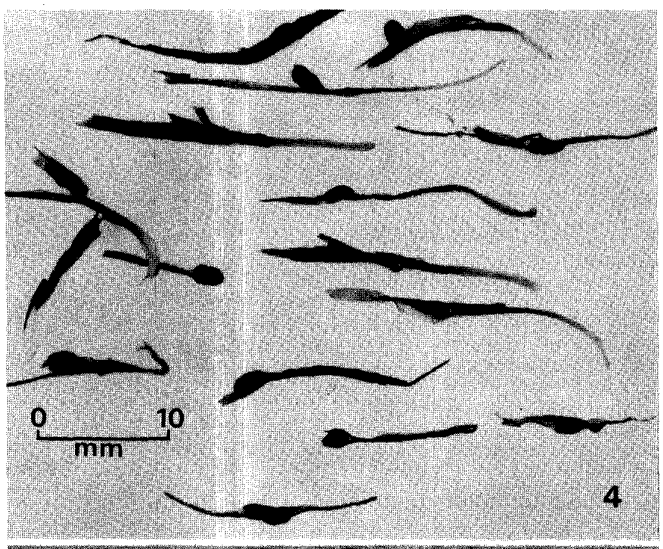

Figure 4. Sclerotia of *Sclerotinia borealis* on *Agrostis* leaves.

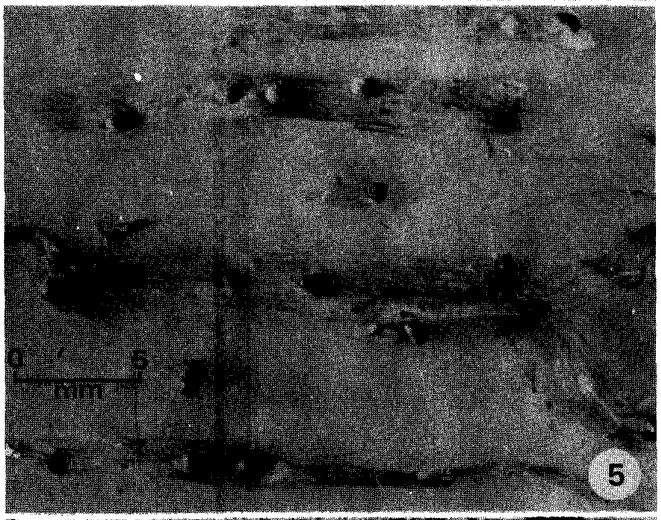

Figure 5. *Typhula*–like sclerotia of an unidentified fungus on leaves of *Poa annua*.

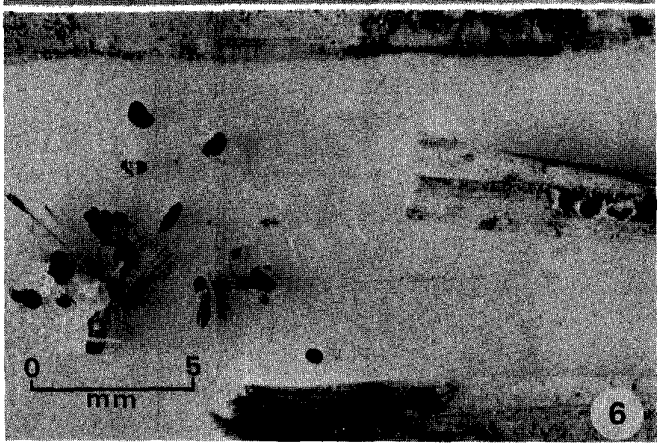

Figure 6. Microsclerotia of an unnamed fungus from leaves of *Poa pratensis*.

Table 2. Fungicides used in snow mold tests

Active ingredient	Product name	% active ingredient	Formulation*	Source†
Chloroneb (WP)	Tersan SP	65	WP	Du Pont
Chloroneb (granular)	Demosan	7.5	Granular	Du Pont
Benomyl	Benlate	50	WP	Du Pont
Thiram	Tersan 75	75	WP	Du Pont
Quintozene	Terraclor	75	WP	Olin
** see footnote	Vitavax	75	WP	Uniroyal
Phenylmercuric acetate	PMAS	10	Solution	Cleary

* WP = wettable powder.

† Du Pont of Canada Ltd., Toronto, Ont.; Olin Corp., Little Rock, Arkansas; Uniroyal (1966) Ltd., Elmira, Ont.; W.A. Cleary Corp. (Canada) Ltd., Belleville, Ont.

** 5,6 dihydro-2 methyl-1, 4 oxathiin-3-carboxanilide.

Albert and Regina. F. nivale was the common snow mold pathogen of bluegrass (Poa pratensis L.) and fescue (Festuca rubra L.) lawns in Saskatoon. The F. nivale records are new ones for the province.

Sclerotinia borealis Bub. & Vleug. was the cause of severe snow mold damage to Agrostis turf on golf greens at Prince Albert, Saskatoon, and Swift Current (Figs. 1, 4) and to a bowling green turf of Festuca rubra L. at Saskatoon. S. borealis is also a new record for the province (3, 9).

An unidentified fungus associated with disease symptoms like those caused by the LTB was often associated with snow mold patches on domestic lawns and golf fairways and occurred on a bowling green at Saskatoon. Like the LTB it had hyphal clamp connections, but unlike the latter fungus it produced microsclerotia on disease patches and in culture (2). In nature the sclerotia were often formed on leaf and twig fragments in the turf (Fig. 6). Attempts to germinate the sclerotia have so far been unsuccessful. A fungus with small, flattened, light-orange colored, Typhula-like sclerotia was found in patches of snow mold on Poa annua on a golf course putting green at Regina (Fig. 5). The sclerotia did not germinate. They did not fit the description for Typhula idahoensis Remsberg or T. incarnata Lasch ex. Fr., which have been reported as the cause of snow mold of turf grasses in Alberta (6, 9). Cladosporium herbarum Fr. was consistently isolated from the gray mycelial mats or crusts found on turf immediately after snow melt at Saskatoon. This fungus did not apparently cause disease (1). The crusts dried up leaving normal-looking turf below.

Control of snow mold with fungicides

Inorganic mercury fungicides (mixtures of mercurous and mercuric chlorides) have been recognized for many years as the most reliable preventatives for snow mold diseases

Table 3. Control of snow mold on domestic lawns with fungicides

Fungicide	Dosage of active ingredient (oz/1000 ft^2)	Number of plots	Average % area affected by snow mold		
			Treated	Untreated	Reduction
Quintozene	6.3	4	7.5	27.5	20.0
Chloroneb (WP)	6.0	8	11.3	30.3	19.0
Phenylmercuric acetate	0.2	13	4.5	21.2	16.7
Vitavax	3.0	3	1.6	16.6	15.0
Benomyl	1.5	8	3.2	11.6	8.4
Thiram	6.0	6	26.0	27.5	1.5
Chloroneb (granular)	3.0	4	2.5	2.5	0.0

in Canada and elsewhere (4, 7). Previous large plot tests on domestic lawns in Saskatoon (unpublished) have shown the effectiveness of these materials against snow mold caused mainly by the LTB fungus. Fungicides containing methyl mercury dicyandiamide or phenyl-mercuric acetate have also been found effective against this pathogen. In an attempt to find less toxic materials, further tests were started in late October and early November, 1970. Since specially developed turf plot facilities were not available at that time, the cooperation of domestic lawn owners was obtained. This precluded the conventional types of randomized plot layouts. Instead, from two to five plots of approximately 500 sq ft, each with a different fungicide treatment, were established at each location. An unsprayed check plot of 6 sq ft was provided within each fungicide plot by covering the grass with a piece of plywood while spraying (Fig. 2). Fungicides (Table 2) were applied with a tractor-mounted sprayer and lance at 60 psi in 5 gal of water per 1000 sq ft except for chloroneb granular which was broadcast. The percentage area of turf affected by patches of snow mold was estimated following snow melt in 1971 (Table 3).

All the fungicides in the domestic lawn tests except the granular formulation of chloroneb gave some control of snow mold. The efficacy of quintozene, chloroneb wettable powder, and Vitavax was similar to that of phenylmercuric acetate which was used as a standard of comparison. Thiram appeared to be an inefficient fungicide (Fig. 3). The predominant pathogen in these tests was F. nivale, but on some sites the microsclerotial fungus was found.

In another test on the Saskatoon campus of the University of Saskatchewan, the same fungicides (Table 2), except for chloroneb granular, were applied to duplicate plots of Kentucky bluegrass turf. Check plots without fungicide and treated plots were 250 sq ft in size. At snow melt the average percentage area affected by snow mold patches was: untreated check, 38; phenylmercuric acetate, 5; benomyl, 8; Vitavax, 10; thiram, 20; quintozene, 20; and chloroneb, wettable powder 25. The predominant pathogen was the microsclerotial fungus.

These test results suggest that effectiveness of the different fungicides in snow mold control depends on which pathogen is dominant. The surveys point to the need for more taxonomic studies on fungi which cause snow mold. Tests with a wider range of materials and under conditions where the cause of disease is known seem necessary. Such conditions may be achieved by the use of turf areas inoculated with the appropriate pathogen.

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SCREENING OF POTATO FUNGICIDES IN 1971[1]

L.C. Callbeck[2]

Introduction

Weather conditions were frequently favorable for the development and spread of the potato late blight fungus Phytophthora infestans (Mont.) de Bary in Prince Edward Island during the July - September period of 1971. It was possible, therefore, to study the relative efficacies of nine selected fungicides under quite constant disease pressure.

Materials and methods

In the following list of the fungicides screened in 1971, the description of each is arranged in order of trade name, quaranteed active ingredient, source, and dosage rate in terms of formulated product.

1. AC 84,467. Confidential chemical composition. American Cyanamid Company, Princeton, New Jersey, U.S.A. 2.0 lb/acre.

2. Bravo W-75. 75% tetrachloroisophthalonitrile. Diamond Shamrock Corporation, Cleveland, Ohio, U.S.A. 1.25 lb/acre.

3. Bravo 6-F. 6.0 lb/U.S. gal tetrachloroisophthalonitrile. Diamond Shamrock Corporation, Cleveland, Ohio, U.S.A. 1.25 U.S. pints/acre.

4. Difolatan 4.8 F. 4.8 lb/Imp. gal N-(1,1,2,2,-tetrachloroethylsulfenyl)-cis Δ -cyclohexene-1, 2-dicarboximide. Chevron Chemical (Canada) Limited, Oakville, Ontario, 1.0 Imp. qt/acre.

5. Dithane M-45 80W. 80% zinc coordinated maneb. Rohm and Haas Company of Canada Limited, West Hill, Ontario. 1.5 lb/acre.

6. Duter 50W. 50% fentin hydroxide. Philips-Duphar, Amsterdam, Holland. 10.0 oz/acre.

7. Manzate 200 80W. 80% zinc coordinated maneb. E. I. du Pont de Nemours & Co. (Inc.), Willmington, Delaware, U.S.A. 1.5 lb/acre.

8. OCC 188-15. Copper ammonium carbonate, 6% Cu. Occidental Chemical Company, Houston, Texas, U.S.A. 0.5 Imp. gal/acre.

9. Polyram 80W. 80% zinc activated polyethylene thiuram disulfide. Niagara Brand Chemicals, Burlington, Ontario. 1.5 lb/acre.

Plots of the Green Mountain variety were planted on June 7. Each plot was 4 rows wide by 50 ft long, and 50 seed pieces were planted in each row. Single rows of the same variety were planted as borders and as buffers between plots. The treatments were randomized and replicated in four ranges.

All rows were sprayed at appropriate times with the insecticide endosulfan.

The fungicides were applied by a tractor-sprayer unit, the 4-row boom of which carried four nozzles per potato row, two being above the plants and two on drop pipes. The applications were made on July 14, 22, 29, August 6, 17, 23, 30, and September 7.

Late blight disease was introduced by lightly sprinkling plants in the border and buffer rows with a water suspension of spores of race 1, 2, 3, 4, 5, 6, 7, 8, on July 20. A few lesions were observed in these rows on July 26 and in the evening of that day a second spore dissemination was made. No further inoculations were necessary, the disease developing at a satisfactory rate and spreading out from the infected rows. By August 20 the unsprayed check plots showed 20% infection of the leaflets. The sprayed plots showed zero to trace infections.

Defoliation readings were taken at regular intervals and the mean readings, expressed as percentages, are contained in Table 1.

Top killer (diquat) was applied on September 15 and the tubers were harvested, graded, and examined for late blight rot on September 24. These data are given in Table 2.

Results and discussion

Under the conditions of the test, fungicides AC 84,467 and OCC 188-15 failed to control the disease, their plots averaging 85% and 92% defoliation respectively on September 13, the last date of inspection. DuTer permitted a defoliation of 36%. This tin-containing fungicide was phytotoxic, as evidenced by a brown spotting of the leaves. It was also observed that all plots sprayed with this fungicide showed leaflet burn and some loss of leaflets after the passage of Hurricane Beth on the night of August 15-16. Other plots did not show these conditions.

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[1] Contribution No. 247, Research Station, Canada Department of Agriculture, Charlottetown, Prince Edward Island.

[2] Plant Pathologist.

Table 1. Percentage defoliation

Treatment	Aug. 27	Sept. 1	Sept. 8	Sept. 13
AC 84,467	7	25	67	85
Bravo W-75	Tr.*	2	10	16
Bravo 6-F	Tr.*	1	8	13
Difolatan 4.8F	Tr.*	3	10	19
Dithane M-45	Tr.*	1	8	14
DuTer	2	7	25	36
Manzate 200	Tr.*	2	7	14
OCC 185-15	4	24	75	92
Polyram	Tr.*	3	11	18
Check	54	100	100	100

* Tr. = trace.

Table 2. Effects of treatments on yield and rot

Treatment	Total (bu/acre)	Small* (bu/acre)	Rot (bu/acre)	No. 1 (bu/acre)	Rot (%)
AC 84,467	384.7	112.6	2.6	269.5	0.7
Bravo W-75	466.6	81.0	0.2	385.4	Trace
Bravo 6-F	454.1	85.6	0.2	368.3	Trace
Difolatan 4.8F	465.9	87.5	0.0	378.4	0.0
Dithane M-45	460.0	80.3	0.9	378.8	0.2
DuTer	421.3	90.4	0.2	330.7	Trace
Manzate 200	465.3	80.3	0.9	384.1	0.2
OCC 185-15	386.5	81.4	2.4	302.7	0.6
Polyram	465.3	81.6	1.1	382.6	0.2
Check	283.6	93.9	19.6	170.1	6.9
LSD 0.05	33.7			43.6	
LSD 0.01	45.6			59.0	

* Diameter less than 2¼ inches.

PLANT PARASITIC NEMATODES FROM CANADA AND ABROAD, 1970

Robert Sewell[1]

During 1970 soil samples, plants, and other material were submitted to the Nematology Section, Entomology Research Institute, for extraction and identification of nematodes. Samples were submitted by members of the Plant Protection Division, Canada Department of Agriculture, mostly of material intercepted at airports and ports, and by agricultural agencies, scientists, local farmers, greenhouse operators, and florists from across Canada.

CYST-FORMING NEMATODES (Genus Heterodera)

Heterodera trifolii Goffart, 1932 (Oostenbrink, 1949) was found during a potato cyst survey carried out in the areas of Montreal, Que.; Toronto, London, and Windsor, Ont.; Charlottetown, P.E.I.; and St. John, N.B.; it was also detected on lady's thumb from St. Catharines, Ont.; and garden pea from Saanichton, B. C. H. cacti Filipjev and Schuurmans Stekhoven, 1941 was detected in a nursery survey carried out in the Windsor, Ont., area. H. rostochiensis Wollenweber, 1923 was found in soil from potatoes sent from Newfoundland.

ROOT-KNOT NEMATODES (Genus Meloidogyne)

The northern root-knot nematode, Meloidogyne incognita acrita Chitwood and Oteifa, 1952 was found on plants from a greenhouse in Harrow, Ont., and on intercepted Lycopersicon sp. from Georgia, U.S.A. Meloidogyne arenaria (Neal, 1889) Chitwood, 1949 was found on Weigela sp. and Forsythia sp. from U.S.A. M. javanica (Treub, 1885) Chitwood, 1949 was discovered on olives from Egypt. Meloidogyne hapla Chitwood, 1949 was intercepted on pink weigela from Tennessee, on Rosa sp. from Belgium, France, and Holland, on red clover root, and on field pea from Prince Edward Island.

PIN NEMATODE (Genus Paratylenchus)

Paratylenchus projectus Jenkins, 1956 was removed from soil around oats from the Central Experimental Farm, Ottawa, from rosemary from France, and from alfalfa from Edmonton, Alberta.

STUNT NEMATODES (Genus Tylenchorhynchus)

T. dubius (Butschli, 1873) Filipjev, 1936 was discovered in soil from Charlottetown, P.E.I., and in soil from Holland. T. brevidens Allen, 1955 was found in soil from corn fields at Vineland, Ont. T. claytoni Steiner, 1937 was found on Azalea sp. intercepted from California and on nursery stock from Vancouver, B. C. T. maximus Allen, 1955 was found in soil from Prince Edward Island.

ROOT-LESION NEMATODE (Genus Pratylenchus)

Pratylenchus minyus was found in soil from a corn field at Vineland, Ont. P. coffeae (Zimmermann, 1898) Filipjev and Schuurmans Stekhoven, 1941 was found in soil samples taken from a citrus grove in Winter Haven, Florida. P. penetrans (Cobb, 1917) Filipjev and Schuurmans Stekhoven, 1941 was taken from a corn field at Vineland, Ont., and P. crenatus Loof, 1960 from soil samples submitted from Charlottetown, P.E.I. P. thornei Sher and Allen, 1953 was intercepted on Rosa sp. from Oregon, U.S.A. Pratylenchus sp., close to P. pseudopratensis Seinhorst, 1968, was intercepted on rosemary from France.

SPIRAL NEMATODES (Genera Helicotylenchus and Rotylenchus)

Helicotylenchus digonicus Perry, 1959 was taken from samples from a corn field at Vineland Ont., and was also intercepted from France on rosemary. Hoplolaimus galeatus (Cobb, 1938) Sher, 1963 was intercepted in soil around conifers from Maine, U.S.A. Rotylenchus fallorobustus Sher, 1965 was discovered in soil from Charlottetown, P.E.I. Rotylenchus robustus (de Man, 1876) Filipjev, 1936 was intercepted on Thuja nigra from Connecticut, U.S.A., in soil from around conifers from Maine and around spruce, and on a passenger's baggage from Germany.

RING NEMATODES (Genus Criconemoides)

Criconemoides xenoplax Raski, 1952 was identified from soil from around roots of conifers from Maine. C. curvatum Raski, 1952 was found in soil in which oats was grown on the Central Experimental Farm, Ottawa, Ont., and on rosemary from France.

DORYLAIMIDS

Xiphinema americanum Cobb, 1913 was recorded on Rosa sp. from the U.S.A., on potato from Prince Edward Island, and field pea from Windsor, Ont.

MISCELLANEOUS

Anguina agrostis (Steinbuch, 1799) Filipjev, 1936 was recorded on bentgrass from New Zealand.

[1] Nematology Section, Entomology Research Institute, Canada Department of Agriculture, Ottawa.