Canadian Plant Disease Survey

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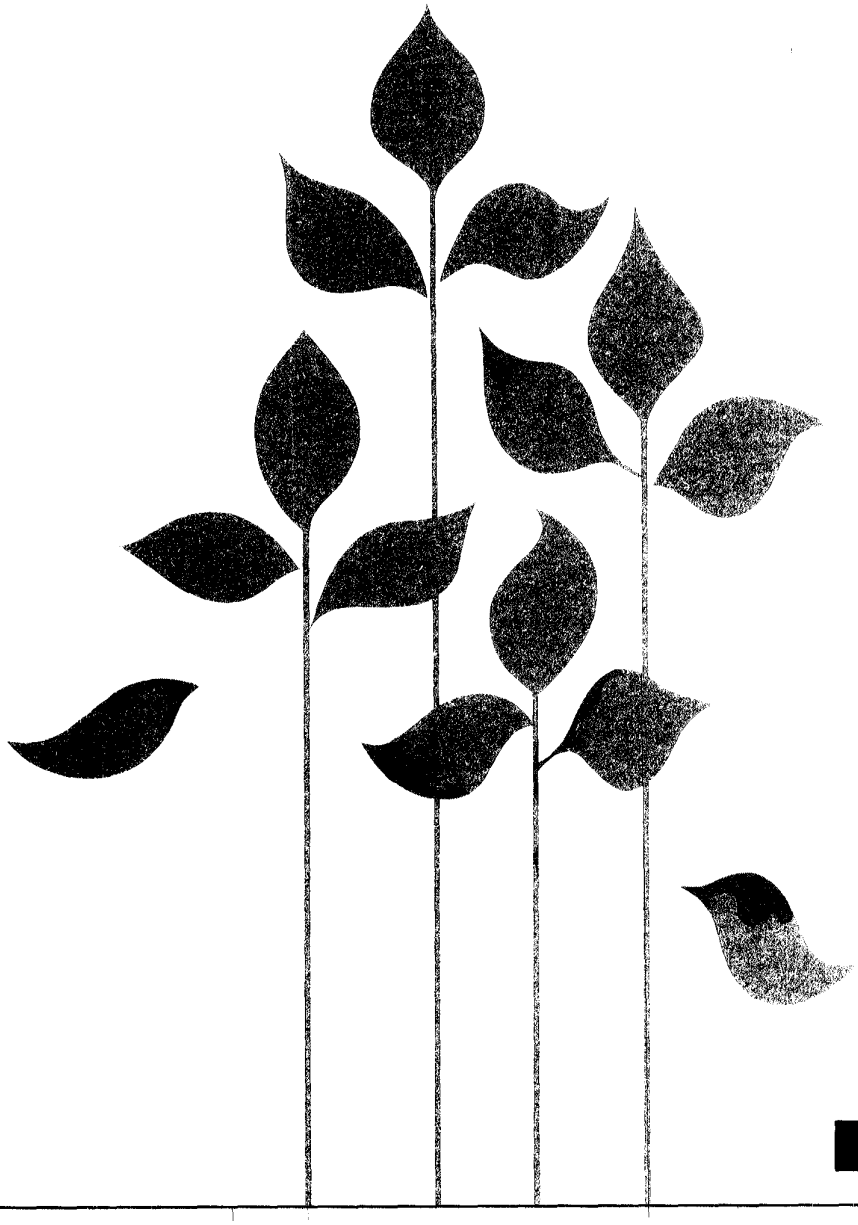

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Contents

The *Canadian Plant Disease Survey* is a periodical of information and record on the occurrence and severity of plant diseases in Canada and on the assessment of losses from disease. Other original information such as the development of methods of investigation and control, including the evaluation of new materials, will also be accepted. Review papers and compilations of practical value to plant pathologists will be included from time to time.

Canadian Plant Disease Survey est un périodique d'information sur la fréquence des maladies des plantes au Canada, leur gravité, et les pertes qu'elles occasionnent. La rédaction accepte d'autres communications originales notamment sur la mise au point de nouvelles méthodes d'enquête et de lutte ainsi que sur l'évaluation des nouveaux produits. De temps à autre, il inclut des revues et des synthèses de rapports d'intérêt immédiat pour les phytopathologistes.

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Barley losses due to common root rot in the Prairie Provinces of Canada, 1970-72

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Barley (*Hordeum vulgare*) was surveyed in 1970-72 on the Canadian prairies for losses due to common root rot [*Cochliobolus sativus*]. It was estimated that 54 million bushels or 10.3% of the crop was lost annually to this disease. Over the 3-year period losses were more consistent in Alberta (8 – 11%) than in Manitoba (0 – 14%) and Saskatchewan (6 – 20%), where considerably higher lossess occurred in 1972. A decrease in the numbers of heads per plant with increasing severity of disease contributed to the yield loss.

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De 1970 à 1972, des études ont été effectuées dans les Prairies sur les pertes causées à l'orge par la pourriture commune des racines [*Cochliobolus sativus*]. On estime à 54 millions de boisseaux ou 10.3% de la récolte les pertes annuelles dues à cette maladie. Au cours de la période de trois ans, les pertes ont été plus constantes en Alberta qu'au Manitoba et en Saskatchewan où des pertes beaucoup plus graves ont été enregistrées en 1972. La baisse du nombre d'épis par plant en fonction de l'accroissement de la gravité de la maladie a contribué à baisser les rendements.

Several comprehensive surveys have been conducted in western Canada to estimate losses in yield of wheat due to common root rot caused by *Cochliobolus sativus* (Ito & Kurib.) Drechsl. ex Dastur, conidial state *Bipolaris sorokiniana* (Sacc. in Sorok.) Shoem., syn. *Helminthosporium sativum* Pamm. King & Bakke., and by *Fusarium* spp. (2,3). The most recent series of surveys, in 1969-1971 by Ledingham et al. (2), indicated an annual loss of some 30 million bushels for the Prairie Provinces.

Though some reports indicate substantial yield loss in certain cultivars of barley due to *C. sativus* (7), we are not aware of any comprehensive survey of root rot losses in barley in any major barley-producing country in the world.

Wheat and barley are important crops in western Canada and both have been subject to common root rot for as long as they have been grown in spite of the many changes in agronomic practices, crops, and cultivars. Rotation with crops other than wheat and barley could reduce the incidence of root rot but a period of several years between susceptible crops has been seldom practical on the prairies (2).

The need to determine the losses caused by common root rot should be appreciated at a time when research priorities are being critically evaluated. This report presents the results of a cooperative survey covering Manitoba, Saskatchewan, and Alberta for the crop years 1970, 1971, and 1972 designed to estimate the yield reductions in barley attributable to common root rot. The first 2 years of this survey were coincident with the last 2 years of a 3-year root rot survey in wheat (2).

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Methods and materials

Selection of survey routes and fields within crop districts (CD) in Manitoba and Saskatchewan and census districts (CD) in Alberta and the methods of sampling, of classifying plants for disease, and of calculating field, district, and provincial losses were similar to those described for wheat (2). In 1970 the sampling technique was that used in the wheat study in 1969 and 1970, i.e. plants taken from 1-yd^2 quadrats; in 1971 and 1972 plants were taken on a diagonal traverse similar to that used in the 1971 wheat survey (2). Samples in 1970, 1971, and 1972, respectively, were obtained from 72, 79, and 121 fields in Alberta; from 21, 28, and 42 fields in Saskatchewan; and from 11, 10, and 32 fields in Manitoba. Approximately 250 plants were collected in each field in 1970, and 130-150 plants in 1971 and 1972.

Results

Percentage loss by CD for the three provinces for the 3 years is given in Table 1. In Table 2 acreage, yield, total production, percent loss, potential production, loss in bushels, and number of fields involved in the survey are summarized by province and year. The percent losses in 1970, 1971, and 1972 were as follows: 11.1%, 8.4%, and 10.0% in Alberta; 8.2%, 6.0%, and 20.6% in Saskatchewan; and-2.0%, 2.3%, and 13.8% in Manitoba.

In Table 3 are shown the distribution of plants in the diseased, unclassified and clean (healthy) categories in

Table 1. Percent losses from root rot of barley in the Prairie Provinces, 1970–1972

	Alberta			Saskatchewan			Manitoba		
Year	C.D.*	Fields	Loss %	C.D.*	Fields	Loss %	C.D.*	Fields	Loss %
1970	1	1	– 7.2	6	11	8.1	1	2	– 5.0
	2	4	12.0	7	4	5.2	2	1	2.2
	3	3	6.2	8	1	20.5	4	2	– 0.6
	4	1	9.7	9	5	8.6	5	1	18.7
	5	4	18.5				10	2	–19.8
	6	8	2.2				13	2	5.1
	7	3	– 9.1						
	8	19	11.1						
	10	10	10.8						
	11	13	17.6						
	12	3	18.6						
	13	5	15.9						
	Mean		11.1			8.2			– 2.0
1971	1	4	– 6.6	2	3	– 4.4	2	1	– 8.6
	2	9	5.3	3	3	8.0	3	1	– 4.1
	3	6	12.9	5	1	6.1	4	1	–16.1
	4	5	7.8	6	13	9.1	5	1	9.7
	5	16	10.5	7	2	3.4	10	2	9.5
	6	10	9.8	8	1	0.7	11	3	1.0
	7	9	13.9	9	5	4.9	12	1	20.9
	8	15	11.9						
	10	8	9.3						
	11	11	14.1						
	15	16	0.3						
	Mean		8.4			6.0			2.3
1972	1	5	– 2.7	1	3	23.7	1	1	– 2.6
	2	8	17.4	2	2	15.2	2	3	3.7
	3	5	11.8	3	3	28.3	3	5	15.2
	4	3	– 4.1	4	2	25.3	4	1	0.3
	5	11	7.4	5	3	13.4	5	3	18.8
	6	9	2.9	6	9	25.8	7	2	13.4
	7	7	– 2.9	7	8	26.1	8	2	34.9
	8	26	13.3	8	7	10.5	9	2	–26.1
	10	16	17.4	9	5	16.0	10	4	16.7
	11	16	11.2				11	4	23.7
	12	5	20.2				13	3	18.9
	13	10	8.4						
	Mean		10.0			20.6			13.8

* C.D.= Census district (Alberta), crop district (Saskatchewan, Manitoba)

Table 2. Barley losses in Alberta, Saskatchewan, and Manitoba due to common root rot, 1970–72

Province and year	Acreage ('000)	Yield (bu/ac)	Production ('000 bu)	Loss %	Potential production ('000)	Loss ('000)	No. of fields sampled
Alberta							
1970	4,700	42.1	198,000	11.1	222,621	24,621	74
1971	6,100	39.3	240,000	8.4	262,114	22,114	109
1972	5,200	44.2	230,000	10.0	255,669	25,669	121
Saskatchewan							
1970	3,300	43.0	142,000	8.2	154,700	12,700	21
1971	6,300	45.2	285,000	6.0	303,191	18,191	28
1972	4,600	38.5	177,000	20.6	222,922	45,922	42
Manitoba							
1970	1,500	34.0	51,000	– 2.0			11
1971	2,200	45.7	100,500	2.3	102,866	2,366	10
1972	2,100	40.5	85,000	13.8	98,630	13,630	32

Table 3. Percentage of plants in the various disease categories in the three provinces, 1970–72

Province and year	Clean	Slight	Moderate	Severe	Unclassified
Alberta					
1970	20.8	21.3	15.5	27.3	15.0
1971	40.5	33.0	10.7	7.4	8.4
1972	33.9	30.6	11.5	12.1	11.9
Saskatchewan					
1970	62.9	21.8	6.3	4.3	4.5
1971	47.2	36.2	8.2	5.5	2.9
1972	22.2	42.2	14.7	4.8	16.1
Manitoba					
1970	3.1	37.4	8.5	5.2	45.7
1971	8.5	33.0	22.4	20.0	17.0
1972	10.5	26.9	18.7	11.6	33.7

the three provinces for the years 1970, 1971, and 1972. The average losses in yield of each disease class and the unclassified group, relative to the clean class, for the prairie provinces in each year are presented in Table 4. The mean reduction for the three years was 9.4%, 17.1%, and 29.7% for the slight, moderate, and severe disease categories respectively. It is obvious that root rot reduces the numbers of heads per plant (Table 5); in some cases by 33% (Alberta, 1971) and in others by as little as 6% (Alberta, 1972). Although average loss during the 3 years was greatest in the gray wooded and Luvisol soil zone and least in the brown soil zone, it was most consistent in the black soil zone.

Discussion

Losses in yield of grain of considerable magnitude were found to occur in barley crops, the estimated average annual loss during 1970-1972 for the Prairie Provinces being 10.3%. Generally, common root rot intensity is greater in barley than in wheat (unpublished survey data), and losses in barley may be proportionately higher than in wheat. Indeed, a comparison of estimated losses in these crops over the years 1970 and 1971 when parallel studies (2) were conducted supports this contention. The 2-year average losses in Alberta were 6.0% in wheat (2) and 10.5% in barley and in Saskatchewan 7.1% in wheat (2) and 14.4% in barley. Insignificant losses were recorded in both crops in Manitoba. The apparently greater resistance of wheat might be due to the relatively less diversified genetic composition of the commonly grown cultivar Thatcher and its derivatives compared to the much broader genetic base represented by barley cultivars.

During the 3-year period of the study, the average yields of barley (Table 2) exceeded the 10-year averages, 1962-1971, which were: Alberta 36.7, Saskatchewan 37.7, and Manitoba 35.3 bu/ac. Since the high yields probably reflected good growing conditions of 1970-1972 and since stress factors such as drought are believed to aggravate common root rot, even higher losses than those reported may occur frequently.

Table 4. Percent loss in yield in barley in root rot classes, derived from a comparison of yields from clean and diseased plants

Province and year	Slight	Moderate	Severe	Unclassified
Alberta				
1970	9.4	17.2	25.1	22.5
1971	12.3	17.7	30.5	6.0
1972	11.6	15.6	27.1	9.5
Mean	11.1	16.8	27.5	9.3
Saskatchewan				
1970	14.3	24.7	29.9	30.0
1971	13.1	27.5	35.6	6.4
1972	23.8	38.4	48.8	19.3
Mean	13.7	30.2	38.1	18.5
Manitoba				
1970	− 2.6	10.7	28.1	− 7.3
1971	4.3	− 5.7	27.0	4.2
1972	8.8	7.5	15.2	22.8
Mean	3.5	4.2	23.4	6.6
Grand mean	9.4	17.1	29.7	11.5

Table 5. Average number of heads per barley plant in different root rot disease classes from the three prairie provinces, 1970–72

Province and year	Clean	Slight	Moderate	Severe	Unclassified
Alberta					
1970	1.9	1.6	1.6	1.5	1.4
1971	2.1	1.8	1.7	1.4	1.6
1972	1.6	1.4	1.5	1.5	1.5
Saskatchewan					
1970	2.0	1.9	2.0	1.7	1.6
1971	2.4	2.1	1.9	1.7	1.6
1972	2.0	1.8	1.8	1.5	2.1
Manitoba					
1970	1.6	1.5	1.5	1.3	1.5
1971	1.5	1.7	1.5	1.1	1.5
1972	1.7	1.6	1.8	1.6	1.3

Losses by districts sometimes were derived from samples of one or a few fields (Table 1), particularly in Manitoba and Saskatchewan. If such samples contained few clean or conversely few diseased plants, the estimates of loss could be misleading. The sampling was considered minimal; however, in view of the vast area to be surveyed and the time available for collecting and processing samples, the input was considerable. The change in sampling procedures in 1971 was made in anticipation that a more representative field sample would result. Comparative data showing this is lacking, though this sampling method resulted in a saving in time and convenience.

In Manitoba and Saskatchewan, one person in each province sorted the plants into disease classes while in Alberta three workers were responsible. The multiplicity of observers was not considered a serious weakness. Any individual differences in placing plants into the various categories would not appreciably affect the overall loss estimates. They would affect only the distribution within the classes and not the total effect on yield.

The percent losses in the prairies over the 3-year period ranged from a slight negative loss in Manitoba in 1970 to a 20% loss in Saskatchewan in 1972. It is interesting to note that there was also a slight negative loss in wheat due to root rot in Manitoba in 1970 (2). The significance of the slight yield increase for barley in Manitoba is questionable in view of the rather small sample, the very large number (45.7%) of plants in the unclassified section, and the rather small number of plants in the severe and moderate classes. The slight gain in yield may be due to recovery from early infections followed by enhanced growth and yield (6).

As with wheat, the discer is the most common machine used for seeding barley in the Prairie Provinces. This seeder more or less broadcasts the seed and depth placement is not precise. Seeds near the surface produce plants with short internodes, which cannot reliably be rated for disease by the method we employed and such plants were placed into the unclassified category. Unpublished data prepared by Dr. M. L. Kaufmann at the Lacombe Research Station indicate that barley seeded at a depth of 2.5 cm generally gives higher yields than that sown 7.5 cm deep; however there were exceptions to this with some varieties and in certain years. This may explain the large number of heads in the unclassified category in the 1972 Saskatchewan sample (Table 5).

Plants in the slight, moderate, and severe categories generally suffered progressive reduction in tillering, as evidenced by numbers of heads produced. The effect of

Table 6. Yield losses due to common root rot in barley in the four major soil zones of the prairie provinces, 1970–72

Year	Soil zone	No. of fields	Percent loss
1972	Brown	19	13.4
	Dark brown	33	13.0
	Black	128	12.0
	Gray–wooded and luvisol	14	21.5
1971	Brown	17	3.4
	Dark brown	30	12.0
	Black	73	10.7
	Gray–wooded and luvisol	17	0.5
1970	Brown	8	4.1
	Dark brown	9	7.8
	Black	78	9.3
	Gray–wooded and luvisol	5	19.9

root rot may, therefore, cause yield reductions in several ways, such as by reducing the numbers of heads, the numbers of kernels per head, and the weight of kernels produced. Ledingham et al. (2) indicated that kernel weight reduction was minimal in wheat suffering from common root rot.

Unlike the loss data reported for wheat by Ledingham et al. (2), barley yield losses were lower in the brown soil zone than in the black or gray zones (Table 6). The greater loss in the latter zones may reflect the popularity in these regions of earlier maturing varieties such as Olli and Gateway, which have a shorter growing season. These varieties are very susceptible to root rot and they comprised 27% of all barley grown in Alberta in 1972 (1). The exception was the negligible loss in the Luvisol in 1971, which represented samples from the Peace River area of Alberta.

The 4-class rating system (2), which applies weights of 2, 5, and 10 to the slight, moderate, and severe disease categories, was not used in assessing losses in this study, though there is no doubt that in these categories significant yield reductions could be demonstrated where the sample was sufficiently large. This is clearly shown in Table 4. The percent loss for each class of disease in barley was slightly greater than the losses reported from wheat (2); the trend was similar except in the unclassified group, where a yield loss was found in barley but not in wheat. Also it is possible that not all varieties suffer similar yield losses from similar amounts of root rot. Little data is available on the effects of agronomic practices on the yield of crops affected by root rot. However Pittman and Horricks (5) stated that well-nourished plants are little affected by root rot, especially if severe infection occurs late in the growth of the plant. Some limited data (4) indicated that severe disease in some cultivars, such as Jubilee and Centennial, caused smaller yield reductions than a comparable level of disease in Gateway. Some indication of differential tolerance may also be derived from a comparison of loss estimates in Alberta and Saskatchewan. In 1970 and 1971 greater reductions in yield occurred in Alberta. In 1972 a similar situation also would be anticipated on the basis of cultivar reactions; in Saskatchewan 80% of the barley acreage consisted of the moderately resistant cultivars Conquest (41%), Betzes (23%), and Bonanza (16%); in Alberta (1) Conquest (23%), Betzes (23%), and Bonanza (7%) accounted for 53%, while 32% of the acreage consisted of the moderately susceptible cultivars Galt (14%), Olli (10%), and Gateway (8%). Despite the proportionately higher acreage of apparently resistant cultivars in Saskatchewan in 1972 the estimated loss was twice that of Alberta.

Losses in 1970, 1971, and 1972 in the Prairie Provinces were 37, 42, and 84 million bushels, respectively. It is obvious that common root rot does substantially reduce barley yields on the Canadian prairies and that research efforts should continue to be devoted to the control this disease by chemical, agronomic, or plant breeding methods.

Acknowledgment

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Literature cited

1. Brewing and Malting Research Institute. 1973. Barley varieties in western Canada 1964-1974. Barley Briefs, September 20, 1973. Brewing and Malting Barley Research Institute, Winnipeg, Manitoba.
2. Ledingham, R. J., T. G. Atkinson, J. S. Horricks, J. T. Mills, L. J. Piening, and R. D. Tinline 1973. Wheat losses due to common root rot in the prairie provinces of Canada, 1969-1971. Can. Plant Dis. Surv. 53:113-122.
3. Machacek, J. E. 1943. An estimate of loss in Manitoba from common root rot in wheat. Sci. Agric. 24:70-77.
4. Piening, L. J. 1973. Differential yield response of ten barley cultivars to common root rot. Can. J. Plant Sci. 53:763-764.
5. Pittman, U. J., and J. S. Horricks 1972. Influence of crop residue and fertilizers on stand, yield, and root rot of barley in southern Alberta. Can. J. Plant Sci. 52:463-469.
6. Sallans, B. J. 1959. Recovery in wheat from early infections by *Helminthosporium sativum* and *Fusarium culmorum*. Can. J. Plant Sci. 39:187-193.
7. Wood, L. S., J. J. Christensen, and J. W. Lambert. 1954. *Helminthosporium sativum* becomes destructive on hitherto resistant varieties of barley. Phytopathology 44:511. (Abstr.).

Adult plant reactions of commercial varieties of common wheat to new races of stem rust identified in 1974[1]

G. J. Green

Four of eleven new races of wheat stem rust [*Puccinia graminis* f. sp. *tritici*] identified in Canada in 1974 were moderately virulent on seedlings of important commercial varieties *Triticum aestivum*. Infection studies with adult plants in the greenhouse showed that Selkirk, Sinton, Glenlea, and Norquay were resistant to all four races, and Manitou and Neepawa were resistant to three races. One race had intermediate virulence on Manitou and Neepawa, but this race does not appear to threaten these varieties under field conditions in western Canada. The resistance of Thatcher and its derivatives to several of the races cannot be explained genetically.

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Quatre des onze nouvelles races de la rouille de la tige du blé [*Puccinia graminis* f. sp. *tritici*] identifiées au Canada en 1974 se sont révélées modérément virulentes sur des plantules de variétés commerciales importantes. Des études par inoculation sur des plants adultes en serre ont montré que Selkirk, Manitou, Neepawa, Sinton, Glenlea, et Norquay étaient résistantes aux quatre races, sauf une qui montrait une virulence intermédiaire sur Manitou et Neepawa. Cette race ne semble pas menacer ces variétés dans les conditions de culture au champ de l'ouest du Canada. Il est impossible d'expliquer génétiquement la résistance de Thatcher et de ses dérives à plusieurs des races de rouille.

Wheat stem rust [*Puccinia graminis* Pers. f. sp. *tritici* Eriks. and E. Henn.] was widespread in western Canada in 1974 although commercial varieties were not affected. Rust samples from susceptible varieties in experimental plots and from susceptible *Hordeum jubatum* L. were identified as 32 races, including 11 new virulence combinations (1).

The new races occurred rarely but three of them (C57[32], C59[31] and C63[32]) were moderately virulent on seedlings of the important commercial varieties Selkirk, Manitou and Neepawa. The three strains belong to "standard" race group 11-31-32-113 (5) that has increased in virulence on commercial varieties in recent years. One other new race (C58[29]) was virulent on the variety Selkirk, which has been important commercially in the rust area of western Canada.

Materials and methods

Pure cultures of races C33(15B-1L), C57(32), C58(29), C59(31) and C63(32) were used to inoculate plants at the heading stage in the greenhouse. The methods of inoculation, incubation and disease assessment have been described (2). Race C33(15B-1L) was included because it has predominated in western Canada since 1971.

Table 1. Varieties studied, their parentage, and genotypes for rust resistance as indicated by genetic studies, rust reactions, and parentage

Variety	Genotype	Parentage (3, 4)
Bread wheat		
Thatcher	*Sr5, Sr12, Sr16*	Mq/Im/ /Mq/Kr
Selkirk	*Sr6, Sr7b, Sr9d, Sr17, Sr23*	MM/Ech/ /3*Rm
Manitou	*Sr5, Sr6, Sr7a, Sr12, Sr16*	Tc*7/Ftn/ /6*Tc/KF /3/6*Tc/PI170929
Neepawa	*Sr5, Sr7a, Sr12, Sr16*	*Tc*7/Ftn/ /6*Tc/KF /3/2*Tc/ /Ftn/Tc
Sinton	*Sr5, Sr12, Sr16*	Tc*6/KF/ /6*Lee/ KF/3/Mit
Non–bread wheat		
Glenlea		Pb*2/Bage/ /Sn64/ TZPP/3/Nar 60
Norquay		LR/Sn64/ /Jt

The varieties studied, their parentage and genotype for rust resistance, as far as it is known, are presented in Table 1.

Results and discussion

The results of the infection studies (Table 2) indicate that none of the new races seriously threatens the common wheat varieties grown in the rust area of western Canada, although the reaction of Manitou and Neepawa to race C57(32) was intermediate. Manitou and Neepawa have been severely infected in other parts of the world (unpublished data) but it is unlikely that races

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Table 2. Adult plant reactions of eight wheat varieties to five stem rust races

Variety	Physiologic race				
	C33(15B–1L)	C57(32)	C58(29)	C59(31)	C63(32)
Thatcher	S*	Int	VR	MR	MR
Selkirk	VR	MR	R	R	VR
Manitou	VR	Int	VR	R	MR
Neepawa	R	Int	VR	R	R
Sinton	VR	VR	VR	VR	VR
Glenlea	VR	R	VR	VR	VR
Norquay	VR	R	VR	R	VR

* VR = very resistant, R = resistant, MR = moderately resistant, Int = intermediate, S = susceptible

Table 3. Reaction of wheat lines with single resistance genes to five races of stem rust

Resistance gene	Physiologic race				
	C33(15B–1L)	C57(32)	C58(29)	C59(31)	C63(32)
Sr5	S*	S	R	S	S
Sr6	R	S	S	S	S
Sr7a	S	S	S	S	R
Sr7b	S	S	S	S	S
Sr9d	S	R	R	R	R
Sr17	R	S	S	S	R

* S = susceptible, R = resistant

such as C57(32) would seriously damage them in western Canada.

The resistance of Thatcher and its derivatives, Manitou, Neepawa, and Sinton, to the five races (Table 2) cannot be accounted for by the resistance genes they are known to carry (Table 1). Gene *Sr5* is effective against race C58(29) (Table 3) but "single-gene" wheat lines with *Sr12* and *Sr16* have not shown good resistance to any field race found recently in Canada. The resistance of Manitou to race C33(15B-1L) is conferred by gene *Sr6* (Table 1) and its resistance to the other races is controlled by its Thatcher background. Neepawa is a Thatcher derivative similar to Manitou. It is usually more resistant than Manitou although it does not carry gene *Sr6*. It is possible that Neepawa inherited *Sr8* or *Sr9b* from its parent Frontana but the genes it carries, in addition to those from Thatcher, are unknown. Sinton is also a Thatcher derivative (Table 1) of unknown genotype for stem rust reaction. Selkirk's resistance to race C33(15B-1L) is conferred by gene *Sr6* inherited from McMurachy and to the other races by gene *Sr9d* inherited from H-44-24. Gene *Sr23* does not confer adult plant resistance. The genotypes of Glenlea and Norquay for stem rust resistance are unknown.

Acknowledgments

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Literature Cited

1. Green, G. J. 1975. Stem rust of wheat, barley and rye in Canada in 1974. Can. Plant Dis. Surv. 55:51-57.
2. Green, G. J., and T. Johnson. 1955. Specificity in the effect of high temperature on the adult plant reaction of wheat varieties to races of stem rust. Can. J. Bot. 33:197-201.
3. Briggle, L. W., J. W. Schmidt, E. G. Heyne, and H. C. Young, Jr. 1960. Rules for abbreviating wheat variety names. Agron. J. 52:613.
4. Purdy, L. H., W. Q. Loegering, C. F. Konzak, C. J. Peterson, and R. E. Allan. 1968. A proposed standard method for illustrating pedigrees of small grain varieties. Crop Sci. 8:405-406.
5. Stakman, E. C., D. M. Stewart, and W. Q. Loegering. 1962. Identification of physiologic races of *Puccinia graminis* var. *tritici*. United States Dep. Agric. Bull. E617 (Revised).

A powdery mildew on sugar beet in Alberta

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Powdery mildew was found in January 1975 on sugar beet (*Beta vulgaris*) plants that had been lifted from the field in September 1974 and planted in a greenhouse at Taber, Alberta. A trace of the disease was also found in 7 of 15 fields of sugar beets examined in October 1975 just before harvest. This powdery mildew appears to be the same as that which caused serious losses in the western United States in 1974 and was also widespread in 1975. No cleistothecia of the fungus were found but the conidia were similar in morphology and size to those of *Erysiphe polygoni* DC. and *E. betae* (Vanha) Weltzien. The original infection on sugar beets in the greenhouse was eradicated by repeated fumigation with sublimed sulfur over a 1-month period. This, plus the fact that the disease appeared just before harvest in 1975, indicate that powdery mildew did not overwinter in Alberta. This is the first report of powdery mildew on sugar beet in Canada.

Can. Plant Dis. Surv. 56: 48-52. 1976

En janvier 1975, on a observé du blanc sur des plants de betterave à sucre (*Beta vulgaris*) prélevés au champ en septembre 1974 et plantés en serre à Taber (Alberta). On a également constaté une légère infection dans 7 des 15 champs de betterave à sucre examinés en october 1975, juste avant la récolte. Ce type de blanc semble être le même que celui qui a causé de lourdes pertes dans l'ouest des Etats-Unis en 1974 et qui était aussi largement répandu en 1975. On n'a observé aucun cleistothèce de champignons, mais les conidies avaient une morphologie et une taille semblables à celles d'*Erysiphe polygoni* et d'*E. betae*. L'infection originale sur betterave à sucre en serre a été enrayée par fumigation répétée de soufre sublimé durant 1 mois. Ce traitement, plus le fait que la maladie est apparue immédiatement avant la récolte de 1975, montrent que le blanc n'a pas hiverné en Alberta.
C'est le premier signalement de la présence du blanc sur la bettrave à sucre au Canada.

A powdery mildew of sugar beet, considered by Vanha (11) to be *Microsphaera betae*, was first reported in 1903 from Europe. The disease appears to have been of little importance for the next half-century except under greenhouse conditions. In the 1960's, however, serious outbreaks were reported from several sugar-beet growing areas in Europe and the Middle East (2, 5, 8, 12). The incitant of the powdery mildew on sugar beet in Eurasia is now generally considered to be *Erysiphe betae* (Vanha) Weltzien (8, 12). In the United States, powdery mildew was first reported on sugar beet in 1937 (13). Since then, it has been found occasionally in California and Washington but has caused little damage (1, 9, 10). In 1974, however, powdery mildew spread throughout the western States from an initial outbreak in California and reduced sugar-beet yields by up to 6.8 t/ha and sugar concentrations by up to 1.5% (9, 10). In 1975, the disease was more widespread, although less severe, than in 1974 (Personal communication, E. G. Ruppel, USDA Crops Research Laboratory, Fort Collins, Colorado). Powdery mildew on sugar beet has not previously been reported in any of the sugar-producing areas of Canada or in British Columbia where sugar-beet seed is produced.

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Observations

In early January 1975, sugar beet breeding material lifted from the field plots at Taber, Alberta, in September 1974 and grown in a nearby greenhouse showed evidence of powdery mildew on much of the upper and lower surfaces of the older leaves (Fig. 1). Young plants in an adjoining greenhouse remained almost free from the disease. Because this infestation was considered a potential hazard to the 1975 crop in the surrounding area, the pathogen was eradicated by repeated fumigations with vaporized sulfur. The infected plants showed no evidence of leaf infection during the next 4 months in the greenhouse or during their continued growth in the field in the summer of 1975.

Powdery mildew was not found during periodic field inspections of sugar beets in the summer of 1975. However, during the harvest period in October, a survey of 15 sugar-beet fields scattered throughout the production area of southern Alberta revealed trace infections in seven. Only a few lightly infected plants were found at scattered locations in each of the seven fields. Rarely a more severely diseased plant was observed, but even then it was invariably surrounded by apparently uninfected plants. All fields examined and virtually all sugar beets grown commercially in Alberta in 1975 were Canadian Sugar Factories variety CS 43.

When assessed for powdery mildew at harvest, a sugar-beet variety test containing several European and American cultivars revealed a range of disease reaction.

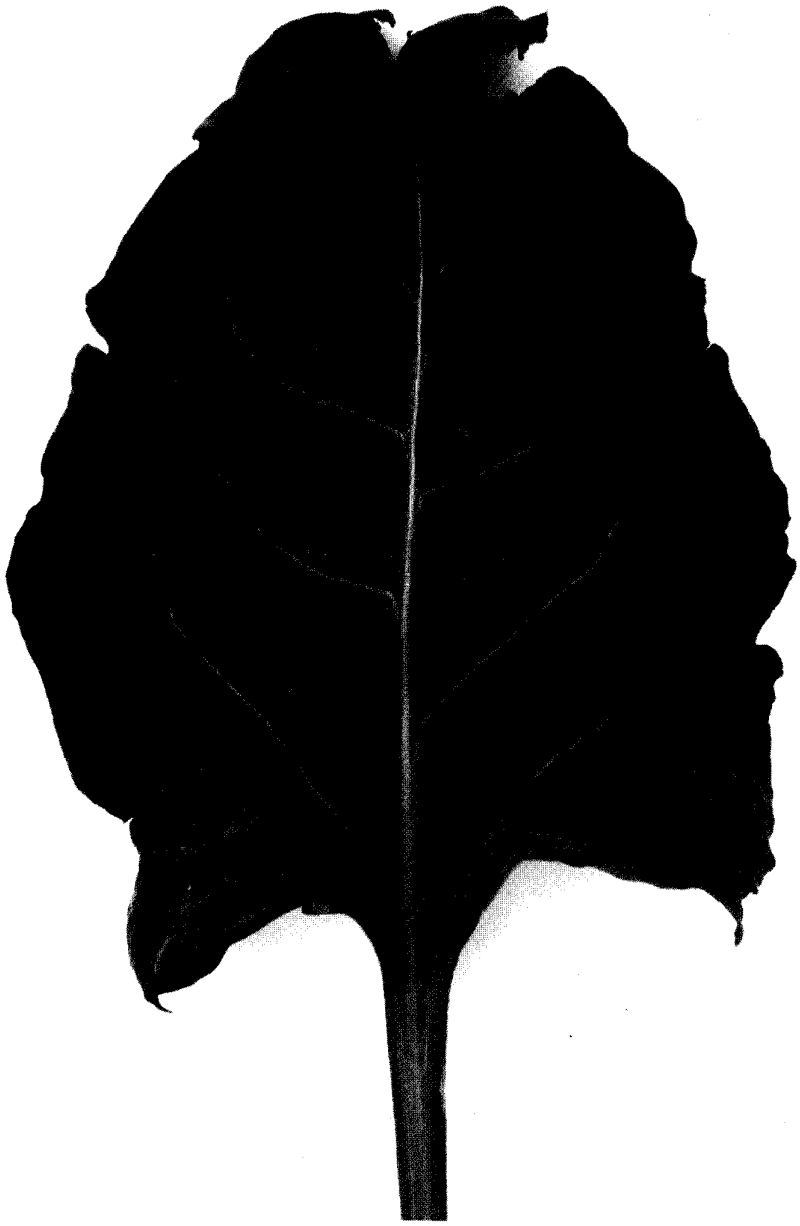

Figure 1. Sugar–beet leaf, collected from a field near Picture Butte, Alberta, showing evidence of powdery mildew.

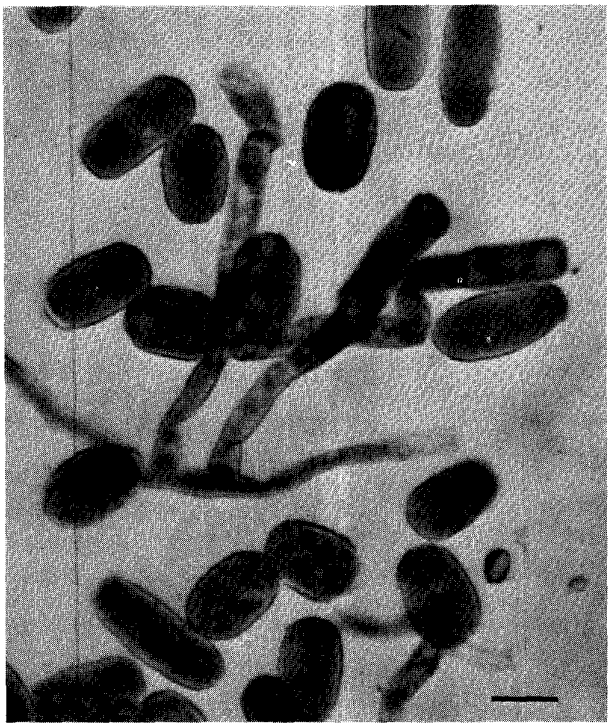

Figure 2. Conidiophores and conidia of an *Erysiphe* sp., collected from an infected sugar-beet leaf in a field near Picture Butte, Alberta, Bar represents 20 μm.

Several cultivars, including CS 43, appeared to be resistant to the disease.

Condiophores from diseased leaves were unbranched, hyaline, mycelial in appearance, arising as branches at right angles to hyperdermal hyphae (Fig. 2). Conidia were hyaline, oblong to oblong-elliptical or ovate, usually occurring in chains of two to five, measuring 16.6 μm (range 12-22) by 38.5 μm (range 30-51). No cleistothecia were found on diseased leaves.

Discussion

The occurrence of powdery mildew on sugar beets in a greenhouse after the 1974 crop was harvested and its occurrence in the field only at the end of the 1975 growing season suggest that the initial inoculum of the pathogen arrived in southern Alberta late in the growing season each year. The 1974 epiphytotic of powdery mildew in the United States was detected in Montana and eastern Washington, the states nearest to Alberta, only in September (10). Eastern Washington is about 350 miles west-south-west of southern Alberta and in the direction from which the most frequent and strongest winds blow. This rather long distance between foci of infection is no greater than others recorded during the 1974 epiphytotic in the United States (10). Long-distance dissemination of *Erysiphe* spp. has also been recorded in Europe (7).

The fungus that caused the 1974 and 1975 powdery mildew epiphytotics in the United States was designated as *E. polygoni* DC. (3, 9). Our evidence indicates that the Canadian pathogen is the same organism, although proof based on the sexual stage is lacking. Whether *E. polygoni* found in North American is the same as or different from *E. betae* found in Eurasia is not known at present. It is curious that powdery mildew has only recently become an important disease of sugar beets in Eurasia even though it was first recognized at the beginning of this century and that the more recent experience with the disease in North America appears to parallel that in Eurasia. Possibly more pathogenic biotypes of the pathogen(s) have arisen recently, or increased susceptibility to the pathogen was inadvertently introduced into newly developed cultivars.

Powdery mildew is a potential threat to the Canadian sugar-beet industry. The disease was less serious in the western United States in 1975 than in 1974 because of early and general use of sulfur to control it, especially in the southwest, but, nevertheless, infection was more widespread (Personal communication, E. G. Ruppel). If *E. polygoni* is the same fungus as *E. betae*, its host range is restricted to *Beta* spp. (4), and there appears to be little danger from its overwintering in Canada as mycelium in its hosts except in British Columbia where sugar beets are overwintered for seed production. The conidia of *E. betae* are not viable after short periods at -10 to -22°C (6), temperatures that frequently occur on the Great Plains of North America. If the sexual stage of the fungus is rare in the United States and Canada (3, 9), overwintering by this means may be of little importance. However, infected beets growing in a greenhouse during the winter could serve as sources of inoculum for the next year's crop in nearby fields, as could infected, overwintering *Beta* spp. in the field in seed-producing areas.

Literature cited

1. Carsner, E. 1947. Powdery mildew on sugar beet. Phytopathology 37:843.
2. Chebolda, V. F., and B. V. Gettis. 1967. Resistant varieties of sugar beet [in Russian]. Zashch. Rast. (Mosc.) 12(12):25-26. (Abstr. in Rev. Appl. Mycol. 47:947. 1968.)
3. Coyier, D. L., O. C. Maloy, and J. C. Zalewski. 1975. The ascigerous stage of *Erysiphe polygoni* on sugar beets in the United States. Proc. Amer. Phytopathol. Soc. 2:112.
4. Drandarevski, C. A. 1969. Untersuchungen über den echten Rübenmehltau *Erysiphe betae* (Vanha) Weltzien) I. Morphologie und Taxonomie des Pilzes. Phytopathol. Z. 65:54-68.
5. Drandarevski, C. A. 1969. Untersuchungen über den echten Rübenmehltau *Erysiphe betae* (Vanha) Weltzien) III. Geophytopathologische Untersuchungen. Phytopathol. Z. 65:201-218.
6. Dzhanuzakov, A. 1965. [Conidial germination of the causal agent of powdery mildew of sugar beet [in Russian]. Tr. Kaz. Nauchno-issled Inst. Zashch. Rast. 9:244-245. (Abstr. in Rev. Appl. Mycol. 46:2557. 1967).

7. Hermansen, J. E., and E. Stix. 1974. Evidence of wind dispersal of powdery mildew conidia across the North Sea. Pages 87-100 *in* Yearbook, Royal Veterinary and Agricultural University, Copenhagen. (Abstr. in Rev. Plant Path. 53:4384. 1974).
8. Jensen, A. 1966. Meldug (*Erysiphe betae* (Vanha) Weltzien) pa bederoer i Danmark. Ugeskr. Landm. 1966:663-666.
9. Kontaxis, D. G., H. Meister, and R. K. Sharma. 1974. Powdery mildew epiphytotic on sugarbeets. Plant Dis. Rep. 58:904-905.
10. Ruppel, E. G., F. J. Hills, and D. L. Mumford. 1975. Epidemiological observations on the sugarbeet powdery mildew epiphytotic in western U.S.A. in 1974. Plant Dis. Rep. 59:283-286.
11. Vanha, J. 1903. Eine neue Blattkrankheit der Rüben, der echte Mahltau der Rübe, *Microsphaera betae*. Z. Zuckerind., Böhmen 27:180.
12. Weltzien, H. C. 1963. *Erysiphe betae* (Vanha) comb. nov., the powdery mildew of beets. Phytopathol. Z. 47:123-128.
13. Yarwood, C. E. 1937. Unreported powdery mildews. Plant Dis. Rep. 21:180-182.

Barley stripe mosaic in the Canadian prairies, 1974-75[1]

Arthur W. Chiko

In southern Alberta, southwestern Saskatchewan, and southeastern Manitoba, respectively, barley stripe mosaic (BSM) was detected in 41.1%, 20.0%, and 20.0% of the fields of two-row barley (*Hordeum distichum*) surveyed in 1974 and in 45.2%, 30.0%, and 25.2% of those surveyed in 1975. The incidence of affected plants in these fields varied from a trace to 40%. In both years, the disease was encountered at generally low levels in a few fields of six-row barley (*H. vulgare*) in southern Alberta, but was not observed elsewhere in this crop. Evidence is presented which suggests that BSM in southern Alberta is widely distributed in Betzes barley, the most commonly grown two-row variety in this region.

Can. Plant Dis. Surv. 56: 53-55. 1976

Dans le sud de l'Alberta, le sud-ouest de la Saskatchewan et le sud-est du Manitoba respectivement, la strie virale de l'orge a été décelée dans 41.1, 20.0 et 20.0% des plantations d'orge à deux rangs (*Hordeum distichum*) échantillonnées en 1974, et dans 45.2, 30.0, et 25.2% respectivement de celles échantillonnées en 1975. La fréquence des plants atteints a varié de très faible à 40%. Au cours des deux années, la maladie a été observée à des niveaux généralement bas dans quelques plantations d'orge à six rangs (*H. vulgare*) du sud de l'Alberta, mais pas ailleurs pour la même culture. Tout porte à croire que la strie virale de l'orge du sud de l'Alberta est largement répandue chez l'orge Betzes, la variété à deux rangs la plus cultivée dans cette région.

Surveys for the seed-borne virus disease barley stripe mosaic (BSM) were conducted in southern Alberta, southwestern Saskatchewan, and southeastern Manitoba from July 1 to 26, 1974, and in the same regions and in southwestern Manitoba from June 27 to July 15, 1975. Fields of either two-row barley (*Hordeum distichum* L. emend. Lam.) or six-row barley (*H. vulgare* L. emend. Lam.) in the early tillering to soft dough stage were generally examined at intervals of about 5 miles along preselected routes. In 1975, however, only fields of two-row barley were examined in southwestern Saskatchewan and southwestern Manitoba. The surveys in southwestern Saskatchewan were confined to a single route, primarily along Highways 1 and 13 between the Alberta-Saskatchewan border and Assiniboia. In southwestern Manitoba a single route along Highway 2 between the Saskatchewan - Manitoba border and Holland was surveyed. The most intensive surveys for BSM were conducted in southeastern Manitoba and southern Alberta, since previous surveys (2, 3, 4) suggested that the disease was most common in these regions. In southeastern Manitoba surveys were made along routes passing through Crop Reporting Districts 3, 4, 5, 6, and 12 (7), while in southern Alberta they were made along routes passing through Agriculture Reporting Areas 1, 2, and 3 (1). In each field where BSM was detected leaf samples were collected from plants with symptoms, and the presence of barley stripe mosaic virus (BSMV) was verified by infectivity and serological tests (3).

Data on acreage occupied by specific barley varieties were obtained from reports prepared by the three Wheat Pools. Since a small acreage of barley in these reports is listed under the category of "other varieties", statistics calculated from these data and reported in this paper should be considered approximations.

The results of surveys for BSM in 1974 and 1975 are summarized in Table 1. In two-row barley, the disease was observed in all regions surveyed except southwestern Manitoba. It was detected most frequently in this crop in southern Alberta, where the average proportion of affected plants in surveyed fields was 2.6% and 1.6% in 1974 and 1975, respectively. In six-row barley, BSM was detected in a few fields in southern Alberta but was not observed elsewhere.

The distribution of BSM in fields of two-row barley in southern Alberta in 1975 is shown in Fig. 1. The disease was detected throughout the region surveyed and differed little in its distribution from the previous year. The proportion of acreage of two-row barley occupied by different varieties in southern Alberta in 1974 and 1975 is presented in Table 2. These data, compared with the proportion of two-row barley fields in which BSM was detected in southern Alberta in these years (Table 1), strongly suggests that the disease was encountered primarily in fields of the variety Betzes.

BSMV has been detected in breeder seed of Compana barley (4) and, therefore, it is likely that BSM occurs in most, if not all, commercial fields of this variety. The proportion of acreage of two-row barley occupied by Compana in southern Alberta, however, was much too low to account for the relatively high proportion of two-row barley fields in which BSM was detected in this region in 1974 and 1975. BSMV has not been detected in breeder seed of any other barley variety currently grown commercially in Canada (4, and Chiko, unpub-

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Table 1. Occurrence of barley stripe mosaic (BSM) in fields of two– and six–row barley in the Canadian prairies in 1974 and 1975

Region, type of barley and year of survey	No. fields examined	No. fields affected*	% fields affected	No. fields in each infection category (% of plants with BSM)				
				Tr	1–5	6–10	11–20	21–40
Southern Alberta								
2–row 1974	56	23	41.1	9	5	5	2	2
2–row 1975	73	33	45.2	18	7	4	3	1
6–row 1974	29	3	10.3	2		1		
6–row 1975	26	3	11.5	3				
Southwestern Saskatchewan								
2–row 1974	5	1	20.0					1
2–row 1975	10	3	30.0	1	2			
6–row 1974	10	0	0.0					
Southwestern Manitoba								
2–row 1975	7	0	0.0					
Southeastern Manitoba								
2–row 1974	115	23	20.0	15	5		2	1
2–row 1975	107	27	25.2	16	5	2	3	1
6–row 1974	25	0	0.0					
6–row 1975	29	0	0.0					

* BSMV transmitted to Black Hulless barley and reacted with BSMV antiserum.

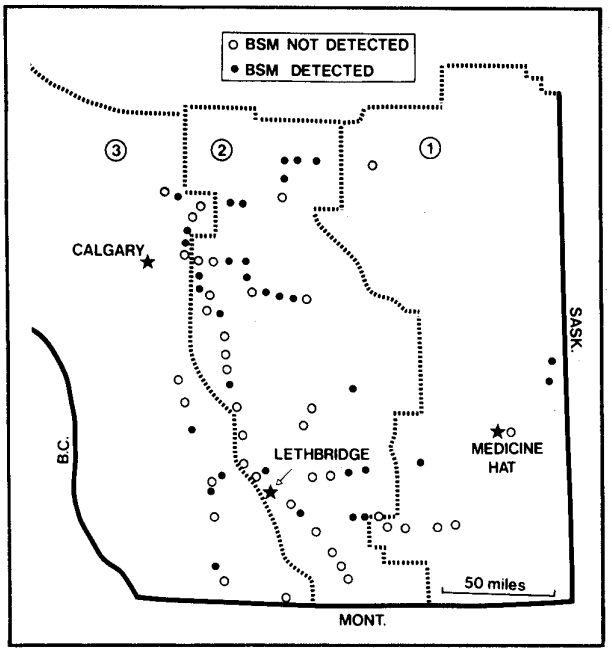

Figure 1. Distribution of barley stripe mosaic in fields of two-row barley in southern Alberta in 1975. Numerals designate Agriculture Reporting Areas, which are delimited by broken lines.

lished), and thus its origin in most growers' fields is unknown. Several possible ways in which the virus might contaminate previously virus-free barley crops have been discussed (4). With respect to the possibility of infected wild grasses serving as sources of contamination, it may be worthy to note that BSMV was recently found to occur naturally and to be seed-borne in wild oats (*Avena fatua* L.) (6).

In Manitoba almost all the two-row barley grown in recent years has consisted of the varieties Herta and Fergus, which were licensed for sale in Canada in 1956 and 1968, respectively. In 1971, BSM in two-row barley in this province appeared to be confined to the older variety Herta (3), but traces of the disease were detected in a few fields of Fergus the following year (4). Changes in the occurrence of BSM in two-row barley and in the varietal composition of the crop in southeastern Manitoba from 1971 to 1975 are shown in Fig. 2. From 1971 to 1973, a decline in the proportion of acreage of two-row barley occupied by Herta was accompanied by a decline in the proportion of two-row barley fields with BSM. The proportion of acreage occupied by Herta continued to decline in 1974 and 1975 but this was accompanied by increases in the proportion of two-row barley fields with BSM (cf. Fig. 2A and 2B). These increases could be attributable to the

Table 2. Percentage of acreage of two–row barley occupied by different varieties in southern Alberta in 1974 and 1975

Variety	Date licensed	% of acreage* 1974	1975
Betzes	1960	85.8	83.3
Palliser	1960	8.8	7.8
Compana	1949	3.7	–
Hector	1973	0.8	7.3
Centennial	1967	0.8	1.6

* Combined estimates for Agriculture Reporting Areas 1, 2, and 3.

disease recently becoming more common in fields of Herta or Fergus, or both. From 1971 to 1975 there has been a slight upward trend in the average proportion of two-row barley plants with BSM (Fig. 2C). Results of a survey for BSM in Manitoba in 1970 (2) were not included in Fig. 2 because a relatively small number of two-row barley fields were examined that year, and because disease incidence was based on rough approximation rather than on counts of plants (5), which were made in all succeeding years.

In North Dakota, where BSM was very common in the 1950's and early 1960's, the disease was eradicated by rapid changes to new virus-free barley varieties (8). In Manitoba, varietal changes probably had little effect on the occurrence of BSM in two-row barley because such changes were gradual and incomplete. Even rapid changes to new virus-free barley varieties may not permanently eliminate the disease, however, as evidenced by the fact that BSM was recently again encountered at low levels in North Dakota (R. G. Timian, personal communication).

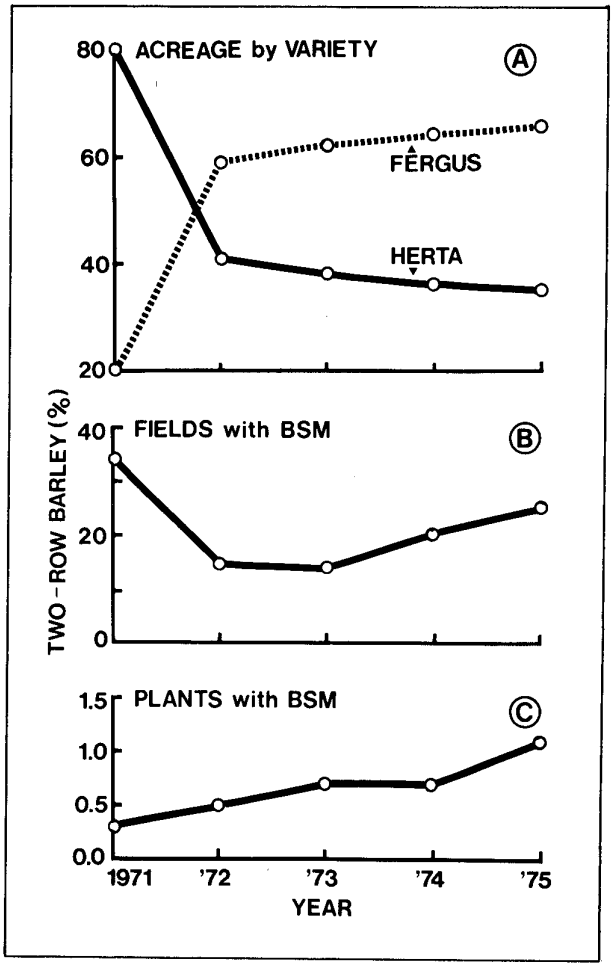

Figure 2. Varietal composition of and barley stripe mosaic (BSM) incidence in two-row barley in southeastern Manitoba from 1971 to 1975. A) Percentage of acreage of two-row barley occupied by the varieties Herta and Fergus (combined estimates for Crop Reporting Districts 3, 4, 5, 6, and 12). Other varieties, which occupied a small amount of acreage in some years, have been disregarded. B) Percentage of surveyed fields of two-row barley in which BSM was detected. C) Average percentage of two-row barley plants with BSM in surveyed fields. Data for 1971 to 1973 in B and C were obtained from previous reports (3, 4, 5).

Acknowledgment
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Literature cited

1. Alberta Agriculture. Agriculture statistics yearbook 1974. Publication 853-8. 81 pp.
2. Chiko, A. W. 1971. Distribution of barley stripe mosaic virus in Manitoba in 1970. Can. Plant Dis. Surv. 51:111-115.
3. Chiko, A. W. 1971. Barley stripe mosaic virus in Manitoba in 1971. Can. Plant Dis. Surv. 51:159-160.
4. Chiko, A. W. 1973. Barley stripe mosaic in the Canadian prairies in 1972. Can. Plant Dis. Surv. 53:107-111.
5. Chiko, A. W. 1974. Barley stripe mosaic in Manitoba in 1973. Can. Plant Dis. Surv. 54:21.
6. Chiko, A. W. 1975. Natural occurrence of barley stripe mosaic virus in wild oats (*Avena fatua*). Can. J. Bot. 53:417-420.
7. Manitoba Department of Agriculture. 1974 yearbook Manitoba agriculture. 116 pp.
8. Timian, R. G. 1971. Barley stripe mosaic virus in North Dakota. N.D. Agric. Exp. Sta. Farm Res. 28:3-6.

Some aspects of Sclerotinia sclerotiorum in Saskatchewan, 1970–75[1]

R. A. A. Morrall[2], J. Dueck[3], D. L. McKenzie[2], and D. C. McGee[3]

Sclerotinia stem rot occurred in 62% of fields of *Brassica* spp. surveyed in Saskatchewan in 1975, with a mean percentage infection of 1.9%. It was most commonly found, and most widely distributed, in fields in the traditional rapeseed-growing areas of the northern cultivated regions of the province. Preliminary data suggest that in heavily affected fields yield losses of 10 - 15% can occur and these result largely from reductions in thousand kernel weight. Six new Canadian and eight new Saskatchewan host records for *Sclerotinia sclerotiorum* (syn. *Whetzelinia sclerotiorum*) are presented. Pod infections on *B. campestris* and *B. napus* are described in detail.

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En 1975 une enquête a été réalisée sur la pourriture sclérotique de *Brassica* spp. dans les champs de producteurs en Saskatchewan. Soixante-deux pourcent des champs ont été infectés et le taux moyen d'infection a été 1.9 pourcent des plantes. Des champs infectés ont été plus courants et la maladie a été plus reparties dans chaque champ infecté dans les régions traditionelles de la culture de colza de la Province. Ce sont au nord de la région récoltée de la Saskatchewan. Des donnés preliminaires suggèrent que dans les champs très atteints les pertes de rendement de 10 à 15% peuvent arriver et que ces pertes sont principalement dues à la diminution du poids des graines. On signale pour la première fois le *Sclerotinia sclerotiorum* sur six éspèces au Canada et sur huit éspèces en Saskatchewan. On decrit aussi en détail les infections de la cosse de *B. campestris* et *B. napus*.

An extensive survey of *Sclerotinia sclerotiorum* (Lib.) deBary, the cause of stem rot of various plant species, was done in Saskatchewan in 1970 (2). At that time it appeared that the disease on *Brassica* spp. was becoming more widely distributed in the province since it was found in a higher percentage of rapeseed fields than during earlier surveys. Future surveys at intervals of several years were suggested to monitor further spread of the disease.

The present paper deals primarily with a survey of the incidence of sclerotinia stem rot in fields of *Brassica* spp. in Saskatchewan in 1975. The results are compared with data from 1970 and subsequent years (2,9). In addition, some new or noteworthy records of *S. sclerotiorum* from 1971 to 1975, and some preliminary data on the effect of stem rot on rapeseed yield, are presented.

Methods

Survey of Brassica spp.

Fifty-two fields, mostly in Crop Districts 8 and 9, the traditional rapeseed growing regions of Saskatchewan, were visited in the period August 23 - September 4, 1975. The locations of the fields and the species of *Brassica* in each field are shown in Figure 1. The choice of fields was essentially arbitrary, but no major bias was involved. At the time of the survey all fields were ready or almost ready to be swathed.

Samples of 25 plants were scored for the disease in four widely separated areas of each field; usually each sample area was at least 100 m from the others. A distinction was made between basal stem infection, in which the diseased bleached portion of the stem extended to the soil surface, and aerial infection, in which there was at least some healthy tissue between the infected tissue and the soil surface. Presumably aerial infection resulted from ascospores. Percentage infections were calculated for each field. When the disease was observed in a field, but not among the plants sampled, the infection was recorded as a trace, but the manner in which the disease was distributed relative to the four sample areas was noted.

New or noteworthy records of S. sclerotiorum, 1971–75

In the period 1971–75, infections by *S. sclerotiorum* were observed on many plant species in Saskatchewan. In some cases these represented new records of the fungus or unusual symptom types. Isolations from diseased material were generally made using routine laboratory procedures, and cultures of *S. sclerotiorum* were retained.

Effects of stem rot infection on rapeseed yield and quality

Unsuccessful attempts were made to study the effects of disease on rapeseed yield in the field in 1970 and 1971

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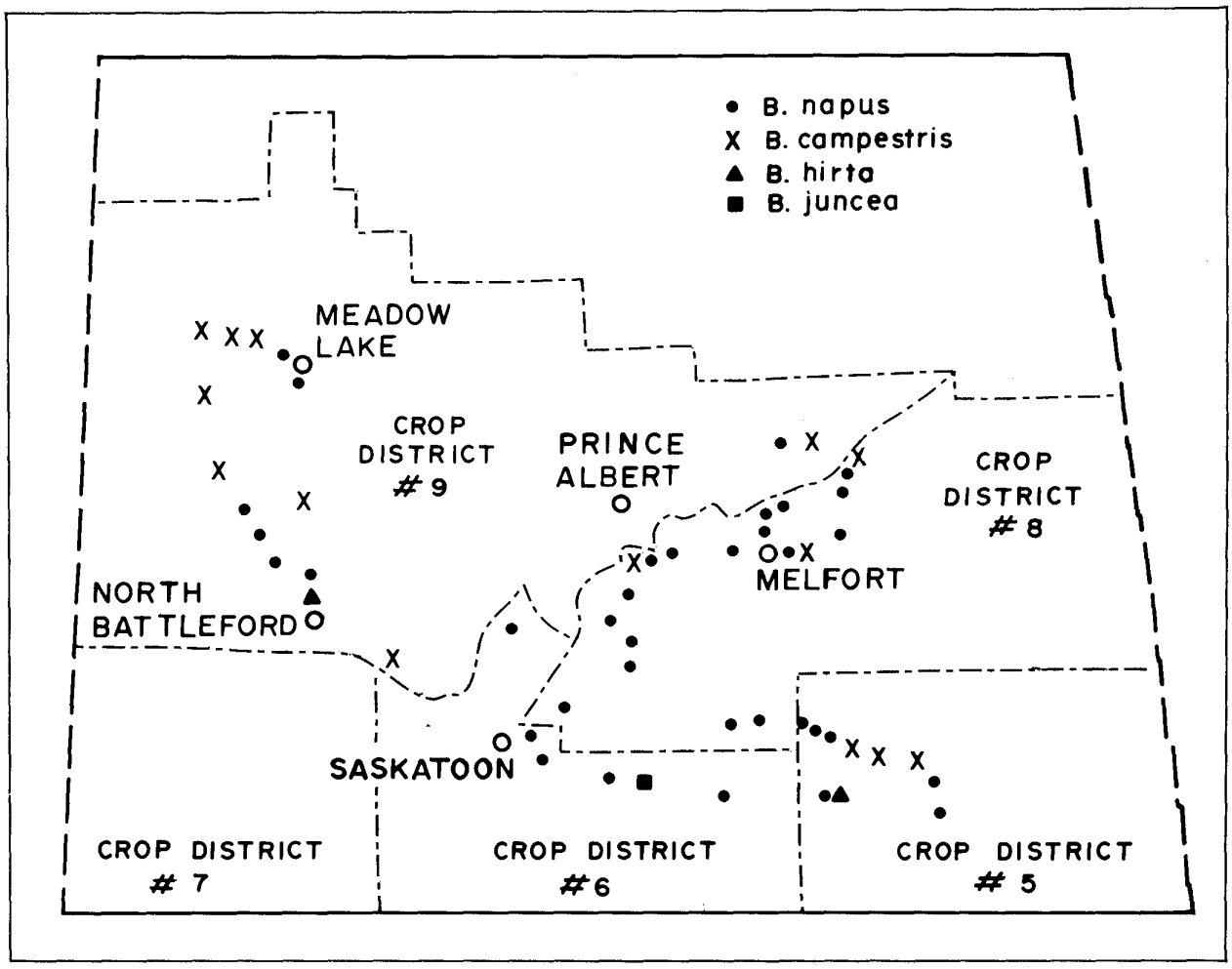

Figure 1. Map of central Saskatchewan showing locations of fields of *Brassica* spp. surveyed in 1975.

by artificial inoculation in replicated plots (L. J. Duczek, R. A. A. Morrall, and D. L. McKenzie, unpublished data). Very low levels of infection were achieved and such experiments were abandoned. A different approach was used in 1975.

In the Maidstone area [50 miles NW of North Battleford (Figure 1)], which was not included in the quantitative survey but where infection occurred in nearly all fields, four fields were selected for yield loss assessment. Samples were collected after swathing by randomly gathering bundles of plants from the swaths. Plants were separated into diseased and healthy categories and threshed. Yield losses were calculated on the basis of the percentage difference in yield between healthy and diseased plants. Thousand kernel weights and oil and protein content were determined on the samples.

Results and discussion

Survey

Sclerotinia stem rot was much more common in Crop Districts 8 and 9 than in 5 and 6 (Table 1). In Districts 5 and 6 the disease was not found in any of the 25-plant samples from the 16 fields visited; in those fields plants affected by stem rot were seen occasionally but in only 2 fields was the disease found in more than 1 of the 4 areas examined. On the other hand, in Districts 8 and 9 combined, 78% of the fields contained infections, the disease was quite widely distributed in 50% of the fields, and a mean of 2.7% of the plants was infected.

Basal stem infection was usually more common than aerial infection, although most fields contained both types (Table 1). The mean percentages of basal stem

Table 1. Distribution and levels of Sclerotinia infections in fields by Crop District

	Crop District 5	6	8	9	Total (whole province)
No. of fields surveyed	10	6	20	16	52
Rapeseed acreage* ($\times 10^3$)	310	208	596	483	1,800
Relative intensity of survey index**	1.1	1.0	1.2	1.1	1.0
Percentage of fields of occurrence of disease					
Basal stem infection	20	33	70	63	54
Aerial infection	10	17	55	69	44
Total infection	20	33	80	75	62
Percentage of fields where disease is present in various numbers of sample areas***					
0	80	67	20	25	38
1	10	17	25	13	17
2	0	0	5	13	6
3	10	0	10	18	12
4	0	17	40	31	27
Mean percentage					
Basal stem infection	0	0	2.0	1.6	1.3
Aerial infection	0	0	0.6	1.3	0.6
Total infection	0	0	2.6	2.9	1.9

* Saskatchewan Department of Agriculture, official estimates.

** The index, which is based on a standard of one for the whole province and the assumption that the mean size of fields surveyed was the same in each crop district, was computed as follows:

$$\text{Index} = 1 \times \frac{\text{No. fields surveyed in C.D.}}{52} \times \frac{1800 \times 10^3}{\text{acreage of rapeseed in C.D.}}$$

*** Either in 25–plant samples or nearby.

infections and of aerial infections were largely additive, since very few plants had two independent zones of infection on the stem. The overall provincial percentage infections of 1.3 (basal stem), 0.6 (aerial), and 1.9 (total) (Table 1), became 1.2, 0.6, and 1.8% respectively, when they were adjusted according to the different intensity of survey in different crop districts.

There is no evidence to suggest that sclerotinia stem rot has become more widely distributed in Saskatchewan since 1970, except perhaps in Crop District 9 (Table 2). Differences between years in the percentage of fields where the disease was observed must be considered in relation to the fact that several different sampling methods were used to obtain the data. Two independent surveys in 1970 gave quite different results even for Crop Districts 8 and 9, where the numbers of fields examined were substantial. Ironically, higher values were recorded in a survey which considered only basal stem infection (2); however that survey was more than twice as extensive as the other (9). Variations in weather between years will affect the incidence of stem rot, although it is expected that weather would have more effect on the percentage of infected plants within a field than on the percentage of fields with infection. Probably the only significant increase between 1970 and 1975 was in Crop District 9, where the fields in which basal stem infection occurred increased from 48% to 63%. However, it is worth noting that in 1975 the total percentages of fields infected in Crop Districts 8 and 9, and in the whole province, were the highest ever recorded (2,9).

New or noteworthy records

Conners (1) listed 85 species or varieties distributed among 26 families on which *Sclerotinia sclerotiorum*

Table 2. Percentage of *Brassica* spp. fields in which sclerotinia stem rot was observed

Survey data	Crop District 5	6	7	8	9	Combined 8 + 9	Total (whole province)
1970 – Basal stem infection only (Reference 2)	17	25	33	69	48	60	53
1970 – Total infection (Reference 9)	0	33	–*	42	41	42	40
1971 – Total infection (Reference 9)	0	67	0	23	22	22	19
1972 – Total infection (Reference 9)	0	50	–	42	7	26	25
1975 – Basal stem infection	20	33	–	70	63	67	54
1975 – Total infection	20	33	–	80	75	78	62

–* not sampled

Table 3. New host records for *Sclerotinia sclerotiorum* from Saskatchewan, 1971–75

Host	Location of Collection	Date of Collection	New Record for Canada (C) or for Saskatchewan (S)
Liliaceae			
Asparagus officinalis L. var. *altilis* L., Asparagus	Saskatoon	9/71	C
Umbelliferae			
Anethum graveolens L., Dill	Saskatoon	9/71	C
Compositae			
Senecio vulgaris L., Groundsel	Meadow Lake	4/9/75	C
Tagetes erecta L., Aztec marigold	Saskatoon	20/9/75	C*
Solanaceae			
Petunia hybrida Vilm., Common garden petunia	Saskatoon	9/71	C*
Campanulaceae			
Campanula rapunculoides L., Rampion	Saskatoon	10/71	C*
Urticaceae			
Urtica dioica L. ssp. *gracilis* (Ait.) Selander U. *gracilis* Ait., Nettle	Rapid View	4/9/75	S
Leguminosae			
Trifolium pratense L., Red clover	Codette	8/71	S

* In these cases previous records of *S. sclerotiorum* exist on unidentified species of the host genus.

Table 4. Effect of sclerotinia stem rot on yield in four fields of rapeseed

Field No.	No. of samples	No. of plants	Percent plants infected	Healthy: Yield per plant (g)	Healthy: Thousand kernel wt. (g)	Diseased: Yield per plant (g)	Diseased: Thousand kernel wt. (g)	Percent reduction in yield per plant	Percent reduction thousand kernel wt.	Percent yield loss
1	5	543	61.9	1.55	3.22	1.31	2.56	22.2	20.5	13.7
2	2	369	30.1	2.47	3.89	1.58	2.39	38.0	38.6	11.4
3	2	259	62.2	1.54	3.20	1.19	2.33	22.7	20.9	14.9
4	2	365	20.3	2.20	4.11	1.04	2.20	54.5	46.5	11.1

[sensu Purdy (13)] had been found in Canada. In Saskatchewan the fungus had been reported on 16 different species or varieties. Duczek and Morrall (2) erroneously stated in 1971 that no reports of *Sclerotinia* on new hosts in Canada had appeared since Conners' compendium (1), and listed a number of new Canadian and Saskatchewan records. A detailed search of the *Canadian Plant Disease Survey* from 1965 to the present, and of other sources (6, 14), reveals 13 new host species records for Canada and 18 for Saskatchewan in the last 10 years. To these may be added 6 Canadian and 8 Saskatchewan records on miscellaneous plants collected from 1971 to 1975 (Table 3). This brings the number of species and families from which *S. sclerotiorum* has been reported in Canada to 104 and 28 respectively. Corresponding figures for Saskatchewan are 42 and 12. A complete list of recorded host species in Canada of this highly destructive pathogen is available on request from the senior author.

In 1975 two previously unreported types of sclerotinia disease symptom on rapeseed were observed. The first involved pod infection, in which, on otherwise healthy, maturing inflorescences, individual pods and their peduncles were bleached and brittle (Figure 2A). These symptoms were distinct from those of general premature ripening and discoloration of the inflorescence that result from stem infections. The insides of infected pods contained cottony fungal mycelium and shrivelled seeds (Figure 2B); surface sterilized seeds consistently yielded *S. sclerotiorum* when plated on agar, indicating internal mycelial infection. Occasionally small sclerotia of the fungus developed on the pod surface (Figures 2A & 2C). Pod infections were found in two of the fields included in the survey, one each of *B. napus* and *B. campestris*. It is noteworthy that in the field of *B. napus* there were few stem infections. Pod infections were also observed in 1975 in several heavily diseased fields in the Maidstone area. Platford and Bernier (12) mentioned the occurrence of pod infections in Manitoba in 1973 but did not describe them; pod infections have also been seen in Central Alberta (D. Stelfox and A. W. Henry, personal communication).

In view of the fact that lesions on the upper stem of rapeseed, and head blight of sunflower, both due to late-season aerial infection by *S. sclerotiorum*, are common in western Canada, it is surprising that pod infections have seldom been reported before. *Sclerotinia sclerotiorum* has also been reported to be only very rarely seedborne on rapeseed, either in the form of sclerotia mixed with seedlots (after commercial cleaning), or in the form of mycelium in the testa (10). However, extensive pod infections could lead to a much higher incidence of seedborne infection in future.

The second new type of disease symptom was the secondary infection by *S. sclerotiorum* of "staghead inflorescences" caused by *Albugo cruciferarum*. In this case the previously formed stagheads were bleached, and sclerotia developed on their surface (Figure 2D). These symptoms were found in two fields. Petrie and Vanterpool (11) reported on a substantial number of secondary fungi that had been found on, or isolated from, stagheads over a period of 15 years, but they never observed *S. sclerotiorum*.

Effects on yield and quality

In the four fields in the Maidstone area selected for yield loss assessment, infection ranged from 20% to 62% of the plants; these values were much higher than those in the majority of fields included in the survey (Table 1). In the four fields infection appeared to have occurred at flowering time or later, permitting diseased plants to set seed. All diseased plants produced some seed. Reduction in yield per plant varied from 22.2% to 54.5% (Table 4). There appeared to be an inverse relationship between the percentage of plants infected and the reduction in yield per plant. The overall yield loss, however, was highest in the fields with the highest ratio of infected to healthy plants. The losses, ranging from 11.1% to 14.9% were surprisingly low, considering that in two of the fields over 60% of the plants were infected. Percent reduction in thousand kernel weight of samples from diseased plants closely paralleled percent yield reduction per plant. Most of the loss in yield could

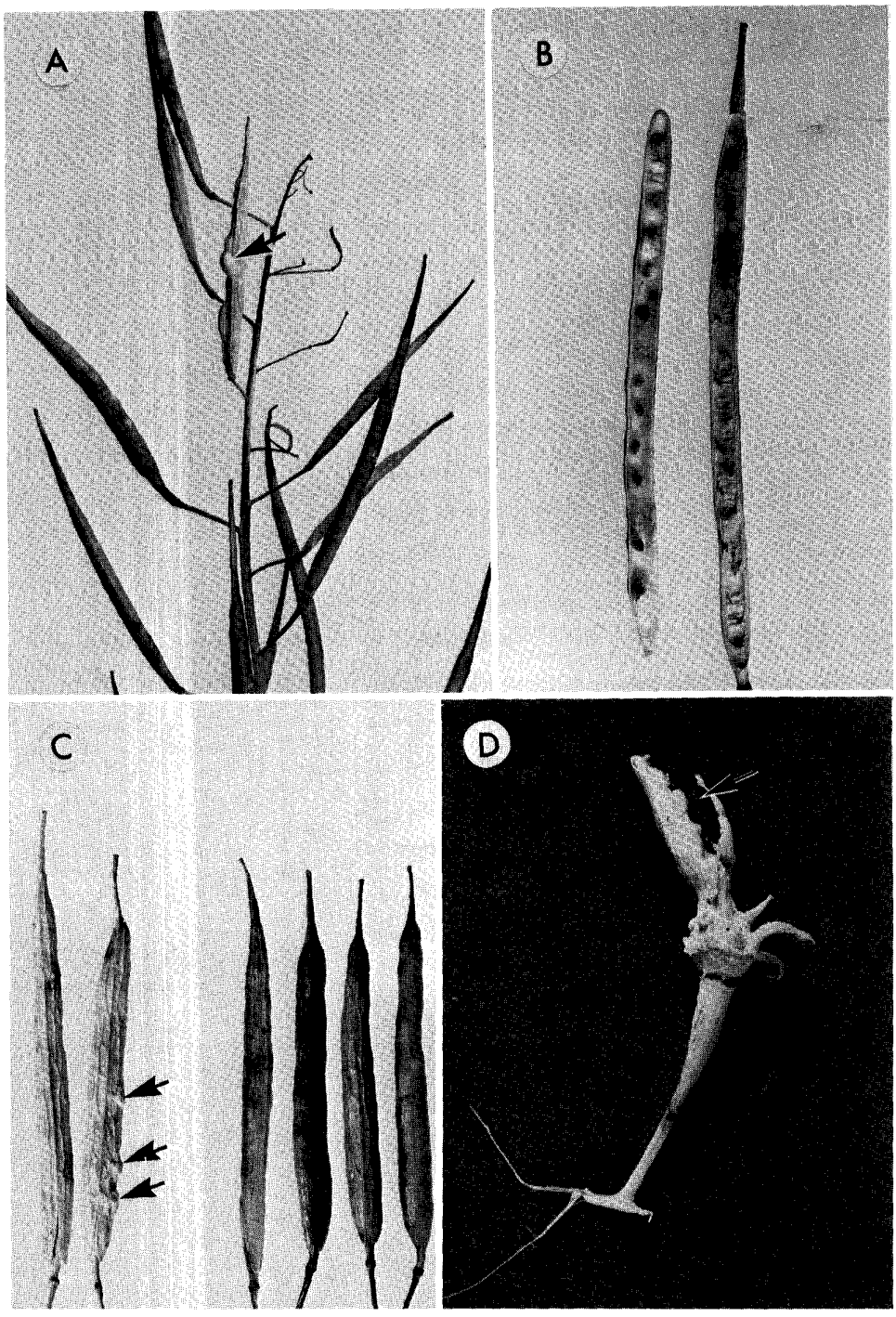

Figure 2. Symptoms of *Sclerotinia sclerotiorum* infection on rapeseed. 2A) Single infected pod on mature inflorescence. 2B) Infected pod split open to show fungal mycelium and shrivelled seed. 2C) Two infected pods beside four healthy pods from identical plants. 2D) Staghead caused by *Albugo* infection secondarily infected with *S. sclerotiorum*. (Note: arrows indicate developing or mature sclerotia of the pathogen).

thus be attributed to a reduction in seed size. However the loss assessment method used may underestimate on-the-farm losses because infected plants ripen prematurely, resulting in shattering before the crop is harvested, and some of the smaller, shrunken seed from diseased plants may be lost with the chaff during combining.

Protein content of samples from diseased plants was comparable to samples from healthy plants. Although a trend towards slightly reduced oil content occurred in seed from diseased plants, the reduction was not consistent.

General conclusions

Although stem rot of rapeseed does not affect a large percentage of plants on an overall provincial basis (Table 1), and there is little evidence that it has become more widely distributed in Saskatchewan since 1970 (Table 2), *Sclerotinia sclerotiorum* remains a substantial threat to production. Under favorable conditions it severely affects individual fields (2,9). In the present study there were four fields in the quantitative survey with over 10% infected plants and four fields in the Maidstone area with over 20% infected plants. When the disease is present at such high levels it has a marked effect on yield (Table 4). While it apparently does not affect oil and protein content, its most serious effect on quality is perhaps the occurrence of sclerotia mixed in the seed. Sclerotia in the upper parts of the stem due to airborne infection are of nearly the same density as seed and are not separated during combining. Notwithstanding the observations of Petrie (10), data obtained from the Canadian Grain Commission indicate that sclerotia are now commonly found in the harvested crop.

Since 1970 *Sclerotinia sclerotiorum* has been reported in Saskatchewan as a common pathogen of sunflower and field pea (3, 5, 7, 8) in addition to rapeseed; it also occurs occasionally on the mustards, lentil, fababean, and buckwheat (3, 4, 7, 8). Its wide alternative host range on crop plants and weeds, and the ability of sclerotia to survive more than one year in the soil, have to be considered in relation to crop rotations. Crop diversification programs and a possible trend towards reduced summerfallowing could add new dimensions to the sclerotinia problem.

Acknowledgments

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Literature cited

1. Conners, I.L. 1967. An annotated index of plant diseases in Canada and fungi recorded on plants in Alaska, Canada and Greenland. Can. Dep. Agric. Publ. 1251. 381 pp.
2. Duczek, L.J., and R.A.A. Morrall 1971. *Sclerotinia* in Saskatchewan in 1970. Can. Plant. Dis. Surv. 51:116-121.
3. McKenzie, D.L., and R.A.A. Morrall 1973. Diseases of three specialty legume crops in Saskatchewan in 1972: field pea, lentil and fababean. Can. Plant Dis. Surv. 53:187-190.
4. McKenzie, D.L., and R.A.A. Morrall 1975. Fababean diseases in Saskatchewan in 1973. Can. Plant Dis. Surv. 55:1-7.
5. McKenzie, D.L., and R.A.A. Morrall 1975. Diseases of specialty crops in Saskatchewan II. Notes on field pea in 1973-74 and on lentil in 1973. Can. Plant Dis. Surv. 55: 97-100.
6. Morrall, R.A.A., L.J. Duczek, and J.W. Sheard 1972. Variations and correlations within and between morphology, pathogenicity and pectolytic enzyme activity in *Sclerotinia* from Saskatchewan. Can. J. Bot. 50:767-786.
7. Morrall, R.A.A., and D.L. McKenzie 1975. Diseases of specialty crops in Saskatchewan I. Notes on buckwheat and sunflower, 1972-73. Can. Plant Dis. Surv. 55:69-72.
8. Morrall, R.A.A., D.L. McKenzie, L.J. Duczek, and P.R. Verma 1972. A qualitative survey of diseases of some specialty crops in Saskatchewan in 1970 and 1971: sunflower, safflower, buckwheat, lentil, mustards and field pea. Can. Plant Dis. Surv. 52:143-148.
9. Petrie, G.A. 1973. Disease of *Brassica* species in Saskatchewan, 1970-72. III. Stem and root rots. Can. Plant Dis. Surv. 53:88-92.
10. Petrie, G.A. 1974. Fungi associated with seeds of rape, turnip rape, flax, and safflower in western Canada, 1968-73. Can. Plant Dis. Surv. 54:37-42.
11. Petrie, G.A., and T.C. Vanterpool. 1974. Fungi associated with hypertrophies caused by infection of Cruciferae by *Albugo cruciferarum*. Can. Plant Dis. Surv. 54:37-42.
12. Platford, R.G., and C.C. Bernier. 1975. Diseases of rapeseed in Manitoba, 1973-74. Can. Plant Dis. Surv. 55:75-76.
13. Purdy, L.M. 1955. A broader concept of the species *Sclerotinia sclerotiorum* based on variability. Phytopathology 45:421-427.
14. Watson, A.K., R.J. Copeman, and A.J. Renney. 1974. A first record of *Sclerotinia sclerotiorum* and *Microsphaeropsis centaureae* on *Centaurea diffusa*. Can. J. Bot. 52:2639-2640.

Control of Xanthomonas campestris in Brussels sprouts with hot water and Aureomycin seed treatment[1]

C. L. Lockhart, C. O. Gourley, and E. W. Chipman

Eight chemicals employed at various temperatures, concentrations, and time periods were screened for the control of *Xanthomonas campestris* on inoculated seed of cabbage *Brassica oleracea* var. *capitata*. Excellent control was obtained when seed was soaked in 500 ppm Aureomycin (22.5% chlortetracycline hydrochloride) at 50°C for 25 minutes; seed exposed to 16% acetaldehyde was also free of *X. campestris*. In field tests Brussels sprouts, *B. oleracea* var. *gemmifera*, were free from black rot when grown under good cultural conditions and sanitary practices from naturally infected seed that had been treated with aureomycin at 50°C. Aureomycin residues were not detected in Brussels sprouts at harvest.

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On a comparé l'efficacité de huit antiparasitaires à diverses températures, concentrations et durées de traitement dans la lutte contre *Xanthomonas campestris* sur des semences inoculées de choux (*Brassica oleracea* var. *capitata*). D'excellents résultats ont été obtenus lorsque les semences ont été trempées dans une solution contenant 500 ppm d'auréomycine, maintenue à 50°C pendant 25 minutes. Les semences traitées à l'aide d'une solution à 16% d'acétaldéhyde étaient également indemnes. Dans les essais de plein champ, les choux de Bruxelles (*B. oleracea* var. *gemmifera*) issus de semences naturellement infectées et traitées à l'auréomycine à 50°C étaient exempts de la nervation noire lorsque les pratiques culturales et sanitaires étaient satisfaisantes. Aucun résidu d'auréomycine n'a été décelé dans les choux de Bruxelles au moment de la récolte.

Black rot of crucifers caused by the bacterium *Xanthomonas campestris* (Pamm.) Dowson, is a seed- and soil-borne disease that is found throughout the world (2,6). Recent evidence indicates that the bacterium may survive for as long as 615 days in the soil and that one infected seed may produce enough inoculum to cause an epidemic (4,5).

In 1974 a serious outbreak of black rot occurred in Brussels sprouts in the province of New Brunswick. A survey of 26 ha showed an average loss of 24%, with losses in individual fields ranging from 0 to 50%. Although the seed used to plant these fields had been hot-water treated, it was found to be infected with *X. campestris*. Subsequent tests revealed that the recommended treatment of soaking seed in water at 50°C for 25 minutes was ineffective.

In rutabaga, *Brassica napobrassica*, *X. campestris* was controlled by soaking infected seed in Aureomycin for 30 minutes (6). However Aureomycin has not replaced the hot-water treatment of crucifer seed, apparently because the Aureomycin treatment discolors young seedlings, and because it does not control seed-borne alternaria and phoma diseases, which are controlled by hot water. This paper reports the successful use of Aureomycin in hot water and the screening of seven other chemicals for the control of *X. campestris* in seed of Brussels sprouts and cabbage.

[1] *Contribution No. 1578, Research Station, Agriculture Canada, Kentville, Nova Scotia B4N 1J5*

Materials and methods

Inoculated cabbage, *B. oleracea* var. *capitata*, seed was used in screening tests for treatments to control *X. campestris*. Seeds were inoculated by dipping them in a strong suspension of a pathogenic isolate of the bacterium followed by drying for 3 days at 23°C. For each of the liquid treatments (Table 1) 100 inoculated seeds loosely bagged in cheesecloth were soaked for the required interval. In the hot water treatments the time required to raise the temperature of the seed to 50°C is not included in the treatment times recorded. Following treatment the seeds were spread out on the cheesecloth to dry for 2-3 hours at room temperature. The volatile, acetaldehyde, was injected into 3.6-liter sealed jars each containing 100 inoculated seeds and left for 24 hours. Treated seeds were plated on potato dextrose agar (PDA) and after 7 days were examined for the presence of bacteria, seed germination, and evidence of phytotoxicity.

To test the effect of Aureomycin (22.5% chlortetracycline hydrochloride, Cyanamid of Canada Ltd.) and hot water seed treatment on Brussels sprouts, *B. oleracea* var. *gemmifera*, inoculated seed was treated (Table 2) and sown in a mixture of soil, peat, and sand (1:2:1) containing added nutrients in 10-cm clay pots. These were placed in a mist bed until seedling emergence and then moved to the greenhouse bench, temperature ca. 18°C. Samples of the seeds were also tested for *X. campestris* on PDA.

Table 1. The effect of various treatments on the recovery of *Xanthomonas campestris* from inoculated cabbage seed

Treatment	Treatment time	*X. campestris*	Germination %	Discoloration of seedlings
Penicillin G—potassium 1000 ppm at 50°C	30 min	+*		–
Cycloheximide 1000 ppm at 50°C	30 min	+		–
Streptomycin sulfate 1000 ppm at 50°C	30 min	+		–
Candicidin 1000 ppm at 50°C	30 min	+		–
Acetic acid 0.5 M	10 min	+	66	–
Acetic acid 0.25 M	20 min	+	50	–
Ethanol 95%	5 min	+	80	–
Acetaldehyde 2%	24 h	+	82	–
Acetaldehyde 4%	24 h	+	72	–
Acetaldehyde 8%	24 h	+	76	–
Acetaldehyde 16%	24 h	–	78	–
Water at 50°C	25 min	+	46	–
Water at 50°C	30 min	+	36	–
Water at 50°C	35 min	+	46	–
Aureomycin 2000 ppm at 50°C	25 min	–	45	+
Aureomycin 1500 ppm at 50°C	25 min	–	46	+
Aureomycin 1000 ppm at 50°C	25 min	–	61	+
Aureomycin 750 ppm at 50°C	25 min	–	75	+
Aureomycin 500 ppm at 50°C	25 min	–	78	+
Untreated seed		+	78	–

*+ denotes presence, – denotes absence of X. *campestris*, and blank space denotes no observation recorded.

Table 2. The effect of aureomycin seed treatments on control of *X. campestris*, on germination, and on the health of seedlings of Brussels sprouts

Treatment	Agar plate tests		Seedling discoloration in greenhouse after		Appearance
	X. campestris	Germination %	7 days	10 days	
Aureomycin 1000 ppm at 50°C for 25 min	–	57	+	–	Fair
Aureomycin 750 ppm at 50°C for 25 min	–	73	+	–	Fair
Aureomycin 500 ppm at 50°C for 25 min	–	77	+	–	Good
Water at 50°C for 25 min	+	53	–	–	Good
Untreated	+	64	–	–	Good

In 1975 field trials on the use of Aureomycin for black rot control were done at Kentville, Nova Scotia, and at Grand Falls and Rogersville, New Brunswick. At Kentville they were incorporated in a trial of 24 cultivars of Brussels sprouts from various seed companies. The incidence of naturally occurring *X. campestris* on the seed was determined by plating 100 seeds of each cultivar on D5 medium (3). The remaining seed from each cultivar was then divided into two equal parts; one part was treated with 500 ppm Aureomycin at 50°C for 25 minutes and the other was left untreated. The treated seed was planted in nursery rows in an area considered to be free of *X. campestris* and the untreated seed in the regular garden area at the Research Station. Seedlings

Table 3. Decay in Brussels sprouts at harvest (average of 24 cvs)

Seed treatment	% of decay losses (based on weight) caused by				
	X. campestris	*Alternaria*	*Botrytis*	Bacteria	Tipburn
Aureomycin 500 ppm at 50°C for 25 min	0	0.5	1.8	1.4	0.8
Untreated	12.7	0.2	1.4	2.2	2.2

from both areas were later transplanted into each of four randomized blocks located in the same areas in which they had been growing. At transplant time the seedlings from each garden were examined internally and externally; in addition cross sections of the stems at the soil line were taken from nine cultivars that had been found to have infected seed in the plating test and were plated on D5 medium. The plants were examined periodically. At harvest in October the weight of healthy and diseased sprouts was recorded. The diseased sprouts were examined visually for diseases and the quantity of each was recorded.

In New Brunswick at each location a comparison was made on single 0.8 ha adjoining plots between Brussels sprouts seed, cultivar Jade regular, treated with 500 ppm Aureomycin at 50°C for 25 minutes and seed soaked in water at 50°C for 25 minutes. The land at each location was considered to be free of *X. campestris*. An agar test prior to treatment showed that 10% of the seed carried *X. campestris*. After treatment, sample lots of 100 seeds of each treatment were plated on D5 medium to check for the presence of the pathogen. The plots were examined for black rot on September 22 and 23; in each plot 100 plants were examined in each of four sections selected at random.

For residue analysis 1000-g samples of Brussels sprouts were collected from each treatment at each location and stored at -20°C until required for bioassay. The samples were assayed against *Bacillus cereus*, ATCC, No. 11778, using the methods for detecting Aureomycin described by the Association of Official Analytical Chemists (1).

Results and discussion

Two of the chemical treatments tested were effective in freeing inoculated seed of Brussels sprouts and cabbage from *X. campestris*. Cabbage seed soaked in Aureomycin at 50°C for 25 minutes or exposed to 16% acetaldehyde for 24 hours was free of *X. campestris* (Table 1). Treatment with Aureomycin at 50°C for 25 minutes was selected for further study because, in addition to its effectiveness in controlling black rot, it, like hot water alone, also controlled alternaria and phoma diseases.

Brussels sprouts seedlings grown in the greenhouse from Aureomycin-treated seeds had a reddish discoloration which under good growing conditions disappeared in 7 – 10 days (Table 2). Other experiments not described here showed that this discoloration continued almost indefinitely under poor growing conditions of low light intensity or short days. Treatment with Aureomycin at 1000 ppm or 750 ppm at 50°c for 25 minutes caused stunting of Brussels sprouts seedlings; however at 500 ppm seedling growth was good and *X. campestris* was controlled.

Seed of 15 of the 24 commercial cultivars tested at Kentville yielded *X. campestris* on agar medium. Seed infection ranged from 1% to 20%. However *X. campestris* was not isolated from any of the seed treated with Aureomycin at 50°C for 25 minutes, and all cultivars grown in the field from treated seed remained free of black rot. Seedlings from untreated seed appeared healthy, but the bacterium was isolated from stems at transplanting. Black rot symptoms were first observed in plants from untreated seed on September 9, and by mid October plants of all 24 cultivars grown from untreated seed exhibited symptoms of black rot. Although plants grown from infected seed were the first to exhibit black rot symptoms, the disease spread so rapidly throughout the plots that at harvest time there was no correlation between the incidence of black rot in the field and that of infected seed. Black rot infections in decayed sprout samples ranged from 14% to 100% at harvest, but the average loss by weight of the harvested crop of the 24 cultivars was 12.7% (Table 3). All plants grown in the black-rot-free area from seed treated with 500 ppm Aureomycin at 50°C for 25 minutes remained free from the disease. There were some losses from other diseases in cultivars grown from treated seed (Table 3).

In the New Brunswick trial the agar test showed that 10% of the Brussels sprouts seed lots selected for the commercial test plots were infected with the black rot organism. After treatment with 500 ppm Aureomycin at 50°C for 25 minutes all samples were free of *X. campestris*; however 2% of those soaked in water at 50°C for 25 minutes yielded *X. campestris*.

In the plots at Grand Falls black rot was not observed in Brussels sprouts grown from Aureomycin treated seed but 1% of those grown from hot water treated seed were

infected. At Rogersville 1% of the plants from both Aureomycin-treated and hot-water-treated seed became infected with *X. campestris*. Before cultivating or working the plots at Grand Falls the equipment was cleaned by washing with hot water and steam, whereas this precaution was not taken at Rogersville. The plots in both areas were harvested before the disease spread further.

Losses from black rot in commercial Brussels sprouts fields in New Brunswick were less in 1975 than in 1974. In 1975, a survey of 18 ha showed an average loss of 3% with individual losses ranging from 0 to 10% compared with a loss of 24% in 1974. The lower incidence in 1975 is attributed to the better use of crop rotations and, the planting of later maturing crops. Observations in 1974 suggested that black rot was more severe in crops maturing in early September than in those maturing later in September or in early October and in fields where Brussels sprouts had been grown the previous year.

Samples of sprouts grown from Aureomycin-treated seed were collected at harvest time and bioassayed against *Bacillus cereus*; none had any detectable residues of Aureomycin.

The methods described here may be applied to other crucifer crops as tests in the greenhouse have shown that 500 ppm Aureomycin at 50°C for 25 minutes also freed cabbage seed from natural infections of *X. campestris*.

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Literature Cited

1. Association of Official Analytical Chemists. 1975. Official methods of analysis. 12th ed.
2. Hunter, J. E., G. S. Abawi and R. F. Becker. 1975. Observations on the source and spread of *Xanthomonas campestris* in an epidemic of black rot in New York. Plant Dis. Rep. 59:384-387.
3. Kado, C. I., and M. G. Hiskett. 1970. Selective media for isolation of *Agrobacterium, Corynebacterium, Erwinia, Pseudomonas* and *Xanthomonas*. Phytopathology 60:969-976.
4. Schaad, N. W., and R. Kendrick. 1975. A qualitative method for detecting *Xanthomonas campestris* in crucifer seed. Phytopathology 65:1034-1036.
5. Schaad, N. W., and W. C. White. 1974. Survival of *Xanthomonas campestris* in soil. Phytopathology 64:1518-1520.
6. Sutton, M. D., and W. Bell. 1954. The use of Aureomycin as a treatment of swede seed for the control of black rot (*Xanthomonas campestris*). Plant Dis. Rep. 38:547-552.

Crown rot of rhubarb in Alberta

J. R. Letal[1]

A bacterium isolated from rhubarb (*Rheum rhaponticum*) plants showing symptoms of crown rot was identified as *Erwinia rhapontici*. These diseased plants were found at two locations in the city of Edmonton.

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Une bactérie isolée de plants de rhubarbe manifestant des symptômes de pourriture de la couronne a été identifiée comme *Erwinia rhapontici*. Les plants atteints ont été observés à deux endroits dans la ville d'Edmonton.

Crown rot of rhubarb (*Rheum rhaponticum*) has been described by Millard (8) and Metcalfe (7) provides a comprehensive description of the disease and the causal organism, *Bacterium rhaponticum*, classified in the eighth edition of Bergey's manual (2) as *Erwinia rhapontici* (Millard) Burkholder 1948. Dye (4) compared four isolates of *E. rhapontici* as to their cultural, biochemical, and physiological characteristics. Graham (5) reported on the characteristics of three *E. rhapontici* isolates.

In June 1975 rhubarb plants showing extensive soft-rotting of the crown area and lower petioles were obtained from two gardens located in the city of Edmonton. A study was undertaken in an attempt to isolate and identify the cause of this disorder.

Materials and methods

Rotting tissue taken from the crown area of the rhubarb roots was plated on nutrient-yeast agar (beef extract, 0.1%; yeast extract, 0.2%; peptone, 0.5%; NaCl, 0.5%; agar, 1.5%; pH 7.2-7.4). Individual colonies were checked for cultural, biochemical, and physiological characteristics using methods described by Bradbury (1), Dye (3), and Graham (5). Oxidation and fermentation of glucose was tested using the method of Hugh and Liefson (6) as modified by Riggle and Klos (9). In addition detached surface-sterilized rhubarb petioles were inoculated with the bacteria isolated and incubated in a moist chamber of 27°C. Controls were inoculated with sterile distilled water.

Results and discussion

The biochemical, physiological, and cultural characteristics of the bacterial isolate from the crown-rot disorder of rhubarb are listed in Table 1, in conjunction with those of *E. rhapontici* as reported by Dye (4) and Graham (5). The Edmonton isolate shows close correlation with those properties listed for *E. rhapontici*. It differs only in failing to produce a pink diffusible pigment, as did some of the isolates tested by Dye (4).

Table 1. Biochemical, physiological, and cultural characteristics of an Edmonton, Alberta, isolate of *E. rhapontici*, compared with those for *E. rhapontici* as listed by Dye (4) and Graham (5)

Characteristic	Edmonton isolate	Dye (4)*	Graham (5)
Pectate liquefaction	–	–	–
Potato–slice rot	S1+**	–	S1+
Pink diffusible pigment	–	d	+
Gas from glucose	–	–	
Reducing substances (sucrose)	+	+	+
Gelatin liquefaction	–	–	
Production of indole	–	–	–
Levan	+	d	
Acid from glucose aerobically	+		
Acid from glucose anaerobically	+		+
Acid from maltose	+	+	+
Acid from lactose	+	+	+
Nitrate reduction	+	+	+
Soft–rot of rhubarb	+		

* Dye (4): + = 80 – 100% of isolates positive
d = 21 – 79% of isolates positive
– = 0 – 21% of isolates positive
** S1+ = slow positive

In addition, the detached petioles that were inoculated with this organism rotted within 2 days, whereas controls showed no signs of rotting. This test and the pectate liquefaction test indicate that this organism is a soft-rot bacterium.

Based on the characteristics listed in Table 1, it is reasonable to conclude that the bacterial species isolated from the crown-rot disorder in Edmonton is an isolate of *E. rhapontici*, a bacterial disorder of rhubarb not previously reported in Canada.

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Acknowledgments

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Literature cited

1. Bradbury, J.F. 1970. Isolation and preliminary study of bacteria from plants. Rev. Plant Pathol. 49: 213-218.
2. Buchanan, R.E., and N.E. Gibbons. 1975. Bergey's manual of determinative bacteriology. 8th ed. Williams and Wilkins, Baltimore, Md. 1268 pp.
3. Dye, D.W. 1968. A taxonomic study of the genus *Erwinia*. I. The "*amylovora*" group. N.Z. J. Sci. 11:590-607.
4. Dye, D.W. 1969. A taxonomic study of the genus *Erwinia* II. The "*carotovora*" group. N.Z. J. Sci. 2:81-97.
5. Graham, D.C. 1971. Identification of soft-rot coliform bacteria. Pages 273-279 *in* Proc. 3rd Int. Conf. Plant Pathogenic Bacteria.
6. Hugh, R., and E. Liefson. 1953. The taxonomic significance of fermentative versus oxidative metabolism of carbohydrates by various gram-negative bacteria. J. Bacteriol. 66:24-26.
7. Metcalfe, G. 1940. *Bacterium rhaponticum* (Millard) Dowson, a cause of crown-rot disease of rhubarb. Ann. Appl. Biol. 27:502-508.
8. Millard, W.A. 1924. Crown-rot of rhubarb. Bull. Univ. Leeds Yorks. Coun. Agric. Educ. 134: 1-28.
9. Riggle, J.H., and E.J. Klos. 1972. Relationship of *Erwinia herbicola* to *Erwinia amylovora*. Can. J. Bot. 50: 1077-1083.

Control of lophodermium needle cast of Scots pine Christmas trees in British Columbia

D. J. Ormrod[1]

Needle cast of Scots pine caused by *Lophodermium pinastri* was first recognized as a major problem in North America in 1966. Serious losses were noted in British Columbia in 1970 and a control experiment was commenced in 1971. Treatments consisting of various fungicides and spray schedules were applied to replicated trees in the third, fourth, and fifth years of growth. Of the chemicals tested, mancozeb, chlorothalonil, and benomyl were most effective. The minimum acceptable spray schedule requires three applications between late July and mid September each year.

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C'est en 1966 que le rouge du pin sylvestre causé par *Lophodermium pinastri* a constitué pour la première fois un problème important en Amérique du Nord. Des pertes appréciables ont été enregistrées en Colombie-Britannique en 1970, et des expériences témoins ont commencé l'année suivante. Des traitements faisant appel à divers fongicides et calendriers de pulvérisations ont été appliqués à des arbres en parcelles répétées dans leur troisième, quatrième et cinquième année de croissance. Parmi les antiparasitaires utilisés, le mancozèbe, le chlorothalonil et bénomyl ont été les plus efficaces. Le minimum de pulvérisation acceptable exige au moins trois applications chaque année entre la fin de juillet et la mi-septembre.

In the USA lophodermium needle cast of red pine and Scots pine was first observed causing severe damage in several Lake States nurseries in 1966 (1). By 1971, severe damage had also been reported in Scots pine Christmas tree plantations in 12 states and in British Columbia (2).

The outbreak of Lophodermium needle cast in British Columbia was first identified and confirmed in 1970 in Christmas tree plantations of Scots pine (*Pinus sylvestris* L.) (T.H., Nicholls, personal communication) and ornamental nursery beds of Scots pine and Monterey pine (*P. radiata* Don) (W.G., Ziller, personal communication). The main symptom in Christmas tree plantations was the yellowing, then browning of year-old needles especially near the bottom of the trees in early summer. By fall such infected needles were virtually all shed so that only the current years needles remained and the trees were unsaleable. In nurseries and seedbeds the symptoms were even more severe as entire beds turned brown in early summer and the trees either died or struggled to push out a few very weak buds.

Lophodermium pinastri (Schrad. ex Hooke) Chev., has been known as a serious pathogen of Scots and certain other pines in Europe for at least 50 years (3,4). In North America, it has long been recognized as a widely distributed fungus of little or no pathogenicity. As a result of the explosive outbreak since the mid-sixties it must be recognized that pathogenic strains or new species (Staley, J.M., personal communication) of *Lophodermium* are now widely distributed throughout North America.

Although numerous cultural methods of control are known (6), many are not practical for nurseries and Christmas tree plantations so that chemical control is desirable. As an interim measure following the outbreak of the disease in British Columbia, growers were advised to use Bordeaux mixture, as recommended in Europe (4,6). At the same time a trial comparing other fungicides and varying times of application was commenced on a Christmas tree farm at Hatzic, B.C.

Materials and methods

The following fungicide treatments were applied with a hand sprayer in a volume of 150 Imp. gal/acre (1685 liters/ha):

1. Benlate 50 W (50% benomyl, WP, Dupont), 2 lb (0.8 g active ingredient (a.i.)/liter)
2. Dithane M-45 (80% mancozeb, WP, Rohm & Haas), 3 lb (1.9 g a.i./liter)
3. Bordeaux mixture, 8-8-100
4. Funginex (20% triforine, EC, Cela-Merck), 20 fl oz (0.2 ml a.i./liter)
5. EL273 (7.2% triarimol, EC, Eli-Lily), 20 fl oz (0.08 ml a.i./liter)
6. Bravo W-75 (75% chlorothalonil, WP, Diamond Shamrock), 2 lb (1.2 g a.i./liter)
7. Benlate 50W, 1 lb (0.4 g a.i./liter) + Dithane M-45, 2 lb (1.3 g a.i./liter)

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Table 1. Effect of summer and fall fungicide applications on control of lophodermium needlecast of Scots pine Christmas trees

Fungicide	No. of applications* 1971	1972	1973	Needle color rating Mar/72 †	Length of 1973 needles Nov/73 (inches)	Infected needles 1 year after treatment (%) §	Harvest value in Oct/74 ($/acre)**	Cost of treatment ($/acre) ††	Net gain compared to control ($/acre)
Benlate	8	6	5	7.6 a §§	2.0 ab	23 a	5,307 ab	513	494
Benlate	5	5	4	7.8 a	2.4 a	30 abc	5,268 ab	405	563
Benlate	4	3	3	7.7 a	2.3 ab	26 ab	4,713 ab	270	143
Benlate	2	2	2	6.2 a	2.1 ab	42 abcde	4,670 ab	162	208
Dithane M–45	8	6	5	7.9 a	2.2 ab	24 a	4,872 ab	196	376
Dithane M–45	5	5	4	7.3 a	2.5 a	26 ab	5,625 a	154	1171
Dithane M–45	4	3	3	7.6 a	1.9 ab	38 abcde	4,938 ab	103	535
Dithane M–45	2	2	2	7.8 a	2.2 ab	35 abcde	5,332 ab	62	970
Bordeaux	8	6	5	7.2 a	1.5 c	51 abcdef	4,047 ab	281	–534
Bordeaux	5	5	4	8.0 a	1.4 c	55 abcdef	3,573 b	222	–949
Bordeaux	4	3	3	7.8 a	1.8 bc	47 abcde	4,147 ab	148	–201
Bordeaux	2	2	2	7.6 a	2.3 ab	43 abcde	4,848 ab	89	459
Funginex	8	6	5	8.0 a	2.2 ab	70 ef	3,663 b	266	–903
Funginex	5	5	4	7.7 a	2.2 ab	60 bcdef	3,997 ab	210	–513
Funginex	4	3	3	8.1 a	2.2 ab	64 def	4,317 ab	140	–123
Funginex	2	2	2	7.9 a	2.0 ab	81 f	4,192 ab	84	–315
Unsprayed				7.8 a	2.2 ab	62 cdef	4,300 ab		

* No. and date of applications:
1971 8 applications: 27 May, 16 & 30 June, 14 & 27 July, 11 August, 3 & 16 September. 6: 30 June–16 September. 4: 27 July–16 September. 2: 3–16 September.
1972 6: 30 June, 13 & 28 July, 18 August, 20 October, 16 November. 5: 13 July–16 November. 3: 18 August–16 November. 2: 20 October–16 November.
1973 5: 5 June, 3 July, 2 & 30 August, 22 October. 4: 3 July–22 October. 3: 2 August–22 October. 2: 30 August– 22 October

† On a visual rating of 0 – 10, where 0 = poorest,10 = best.

§ Each figure is a mean of 6 reps and 3 years for a total of 18 observations.

** Dollar value per foot x height in feet x 1500 trees per acre.

†† Assuming application cost of $7/acre and fungicide cost of $20.00, $3.30, $7.80, and $7.00 per acre for Benlate, Dithane M–45, Bordeaux, Bordeaux, and Funginex, respectively.

§§ 5% level, Duncans Multiple Range Test.

Experiment 1

The main trial began 1 June 1971, when a randomized complete block experiment consisting of 17 treatments and 6 single tree replications was set out in a field of 3-foot Scots pines. The test fungicides (treatments 1 to 4) were applied to the same trees during the summer and fall of 1971, 1972, and 1973 (Table 1). In 1972, 1973, and 1974, disease development was assessed by carefully examining the previous year's needles on the third whorl from the top of the tree. Needle length and color were also rated once during the trial. At the conclusion of the experiment, the harvest value of the trees was determined by two experienced growers who assigned values for each tree ranging from $0.25 to $0.65 per foot. This figure × height in feet × 1500 trees per acre gives an approximation of harvest value per acre.

Experiment 2

To determine the effectiveness of a spring and early summer application schedule a second trial was commenced in the spring of 1972. Each fungicide (treatments 1 to 5) was applied five times between 11 April and 30 June 1972, and four times between 6 April and 5 June 1973. Needle infection and length were determined as in Experiment 1. Harvest value was not determined.

Experiment 3

To compare the effectiveness of Bravo W-75 and a mixture of Benlate 50W and Dithane M-45 (treatments 6 and 7), a trial with varying summer-fall times of application was carried out in 1973. Needle infection was determined in 1974.

Table 2. Effect of spring fungicide applications in 1972 and 1973 on control of lophodermium needlecast of Scots pine Christmas trees

Fungicide	Length of 1973 needles, Nov/73 (inches)	Infected needles 1 year after treatment (%)*
Benlate	2.0 a†	45 a
Dithane M–45	2.2 a	72 a
Bordeaux	1.4 b	58 a
Funginex	1.9 a	63 a
Triarimol	2.1 a	44 a
Unsprayed	2.2 a	48 a

* Each figure is a mean of 6 reps and 2 years for a total of 12 observations.

† 5% level, Duncan's Multiple Range Test.

Table 3. Effect of fall applications of Bravo and a mixture of Benlate and Dithane M–45 control of lophodermium needlecast of Scots pine Christmas trees

Fungicide	No. of applications in 1973*	Infected 1973 needles determined in 1974 (%)
Benlate + Dithane M–45	3	6 a †
Bravo	4	8 a
Bravo	5	16 ab
Benlate + Dithane M–45	4	18 ab
Bravo	3	20 ab
Bravo	2	26 ab
Benlate + Dithane M–45	5	26 ab
Benlate + Dithane M–45	2	30 b
Unsprayed		44 b

* 5 applications: 5 June, 3 July, 2 Aug., 30 Aug., 22 Oct.
4: 3 July–22 October.
3: 2 August–22 October.
2: 30 August & 22 October.

† 5% level, Duncan's Multiple Range Test

Results

Experiment 1

Infection of needles (mean of all treatments) was 60% in the 1971 needles, decreasing significantly to 43% in 1972 and 34% in 1973. This decrease was probably due in large measure to a gradual reduction of inoculum in the plot area. In 1971 the best treatment (8 applications of Benlate) reduced infection to 10% compared to 85% for the unsprayed trees. In the two subsequent years, however, differences between sprayed and unsprayed trees became less marked. The results given in Table 1 are the mean of 3 years, giving a good indication of what can be expected during a normal Christmas tree rotation.

It is apparent that Benlate and Dithane M-45 were the most effective materials. Bordeaux was intermediate and Funginex was totally ineffective. It is also apparent that two to four applications per year were as effective as five or six per year. Measurement of needle length revealed significant injury when Bordeaux was applied more than twice per year; this was also reflected in harvest value. Net gain from use of fungicides tended to be highest with the Dithane M-45 treatments due to the equal control and lower cost as compared to Benlate.

Experiment 2

A total of nine fungicide applications between early April and early June in 1972 and 1973 had no significant effect on needle infection (Table 2). However the Bordeaux applications did cause a significant reduction in mean needle length.

Experiment 3

Bravo and the mixture of Benlate and Dithane M-45 were both effective in reducing infection. However, due to the high random variation between replications, it was impossible to select a "best treatment" with confidence.

Discussion

The results of these trials agree closely with simultaneous findings in Wisconsin (2), Indiana and Michigan (5), and Washington (J.M. Staley, unpublished data). Briefly summarized, these findings are:

1. Bordeaux is definitely not effective and should not be recommended.
2. Most infections occur between mid-July and mid-September.
3. Maneb (or mancozeb), chlorothalonil, and benomyl are equally effective with the first two being the most economical.
4. Three applications spaced about 3 weeks apart beginning in late July are adequate for control in a Scots pine christmas tree plantation.
5. In nursery beds, where trees are closely spaced, an increase to four or five applications would be advisable.

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Literature cited

1. Nicholls, T.H., and D.D. Skilling. 1970. *Lophodermium pinastri* outbreak in Lake States Forest Nurseries. Plant Dis. Rep. 54:731-733.
2. Nicholls, T.H. 1973. Fungicide control of *Lophodermium pinastri* on red pine nursery seedlings. Plant Dis. Rep. 57:263-266.
3. Nicholls, T.H., and D.D. Skilling. 1972. Lophodermium needlecast disease of Scotch pine Christmas trees. Am. Christmas Tree J. 16:2:11-13.
4. Peace, T.R. 1962. Pathology of trees and shrubs. Oxford Univ. Press., London. 723 pp.
5. Skilling, D.D. 1974. Control of Lophodermium needlecast in Scotch pine Christmas tree plantations. Plant Dis. Rep. 58:853-856.
6. Ziller, W.G. 1972. Lophodermium needlecast of pines in nurseries and plantations. Forest Insect and Disease Survey Pest Leaflet 52. Pacific Forest Research Centre, Environment Canada, Victoria. 6 pp.

Fusarium oxysporum isolated from potato tubers in Newfoundland[1]

M.C. Hampson, K.G. Proudfoot, and C.R. Kelly

Fusarium oxysporum was isolated from lesions appearing at harvest on potato tubers grown in central and eastern Newfoundland in 1974 and 1975.

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Fusarium oxysporum a été isolé de lésions apparaissant à la récolte sur des tubercules de pommes de terre cultivés, en 1974-1975, dans le centre et l'est de Terre-Neuve.

Potato tubers bearing small sunken lesions at harvest were submitted for examination at the Agriculture Canada Research Station, St. John's, Newfoundland. The potato specimens originated in fields in central and eastern Newfoundland. It was reported that similar lesions appear on all types of potatoes yearly in the higher, well drained parts of the affected fields (M. Stapleton, personal communication).

In tubers submitted in 1974 and 1975 the sunken areas were smooth with darkened skin devoid of pycnidia and averaged 2 mm in depth and up to 15 mm in diameter. Occasionally brown, powdery cellular masses lined the skin. The edge of the lesion was crenulated or serrated. Tissue bits removed aseptically from the lesion borders and incubated on potato dextrose agar yielded pure colonies of *Fusarium* sp. Subcultures submitted to the Biosystematics Research Institute, Ottawa, were identified as *Fusarium oxysporum* Schlecht (R.A. Shoemaker, personal communication).

Dry rot caused by *Fusarium* spp. has been reported in Newfoundland as a storage problem (1). However the tubers under consideration were taken from fields in early harvest. Elsewhere in Canada wilt attributed frequently to *F. oxysporum* has been reported from many potato growing areas (1), and *F. oxysporum* has also been isolated from rotted tubers in storage (2,3). In Ontario *Fusarium* spp. have been associated with small shallow lesions surrounding the lenticels of potato tubers at harvest (4). This note is the first report in the literature of *F. oxysporum* affecting potato crops in Newfoundland.

Literature cited

1. Conners, I.L. 1967. An annotated index of plant diseases in Canada. Can. Dep. Agric. Publ. 1251. 381 p.
2. Gordon, W.L. 1941. Page 44 *in* Conners, I.L. [Compiler]. 20th Annu. Rep. Can. Plant Dis. Surv. 1940.
3. Hurst, R.R. 1942. Page 44 *in* Conners, I.L. [Compiler]. 21st Annu. Rep. Can. Plant Dis. Surv. 1941.
4. Richardson, F.K. 1954. Page 70 *in* Conners, I.L. [Compiler]. 33rd Annu. Rep. Can. Plant Dis. Surv. 1953.

[1] *Contribution No. 49, Research Station, Agriculture Canada, St. John's West, Newfoundland, A1E 3Y3*

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