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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.

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L'inventaire des maladies des plantes au Canada 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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OBITUARY

It is with deep regret that we acknowledge the death of Dr. Frank Richard Harper, beloved husband of Mrs. Alice Harper of Lethbridge, Alberta. Dr. Harper passed away in Lethbridge on July 9, 1991.

Born in Calgary, raised and educated in Lethbridge, the late Dr. Harper held a B.Sc. and M.Sc. in Agriculture from the University of Alberta. He continued his education at Iowa State University, Ames, Iowa, where he received his Ph.D. He was employed by Agriculture Canada, Research Station, Lethbridge, Alberta as a research scientist for thirty-five years and on his retirement was head of the Plant Pathology Section. During his career he published many papers relating to plant pathology in leading scientific journals and was well known and respected by agriculturalists for his research. He was a member of the American and Canadian Phytopathological Societies as well as the Plant Pathology Society of Alberta.

NOTICE NÉCROLOGIQUE

C'est avec grand regret que nous apprenons la mort du D^{r} Frank Richard Harper époux bien-aimé de M^{me} Alice Harper de Lethbridge en Alberta. Le D^{r} Harper est décédé à Lethbridge le 9 juillet 1991.

Né à Calgary, élevé et éduqué à Lethbridge, feu D^{r} Harper obtint son B.Sc. et sa maîtrise en agriculture de l'Université de l'Alberta. Il a continué son éducation à l'Université d'Iowa State, à Ames en Iowa où il a reçu son doctorat. Il fut engagé à Agriculture Canada à la station de recherches de Lethbridge en Alberta comme chercheur scientifique durant trente-cinq années et termina, avant sa retraite, comme chef de la section en pathologie végétale. Durant sa carrière il a publié plusieurs articles sur la pathologie végétale dans les principaux journaux scientifiques spécialisés et fut très connu et respecté par les agronomes pour ses recherches. Il était aussi membre du American and Canadian Phytopathological Societies aussi bien que du Plant Pathology Society de l'Alberta.

Distribution and severity of scald on winter barley in Ontario in 1988 and 1989

G. Xue and R. Hall [1]

All fields of winter barley examined in Ontario in 1988 (24 fields) and 1989 (31 fields) were affected by scald, caused by *Rhynchosporium secalis*. On a scale of 0 (no disease) to 9 (disease severe on the entire plant), average and maximum disease severities were 4.3 and 7.8 on cv. OAC Halton (n=27) and 2.4 and 7.0 on cv. OAC Acton (n=28). In nine research plots, disease severity averaged 5.1, 2.7 and 0.5 for cvs. OAC Halton, OAC Acton and OAC Elmira, respectively. The disease was most severe in Waterloo and nearby counties.

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Tous les champs d'orge d'automne examinés en Ontario en 1988 (24 champs) et 1989 (31 champs) ont été affectés par la tache pâle, causée par le *Rhynchosporium secalis*. Sur une échelle de 0 (aucune maladie) à 9 (maladie sévère sur la plante entière), les sévérités moyennes et maximales de la maladie ont été de 4,3 et 7,8 chez le cultivar OAC Halton (n=27) et de 2,4 et 7,0 chez le cultivar OAC Acton (n=28). Dans 9 parcelles expérimentales, la sévérité moyenne de la maladie a été de 5,1, 2,7 et 0,5 chez les cultivars OAC Halton, OAC Acton et OAC Elmira, respectivement. La maladie a été la plus sévère dans le comté de Waterloo et les environs.

Introduction

Scald, caused by *Rhynchosporium secalis* (Oud.) J. Davis, is a common disease of barley in many regions of the world (7). Epidemics of the disease can cause considerable reductions in the yield and quality of barley grain (6,7). Scald has been recorded in western Canada since the early 1950s (1,3) where it is considered to be highly destructive (1,8,9). In Ontario, the disease was reported to occur irregularly and in trace amounts in the period 1972-1975 (2) but has recently become increasingly widespread and severe (5). This paper reports the prevalence and distribution of scald on winter barley in Ontario during 1988 and 1989.

Materials and methods

The distribution and severity of scald on winter barley in southern Ontario were determined in twenty-four and thirty-one commercial fields in 1988 and 1989, respectively. The fields were distributed across seventeen counties. Research trials were examined at Arkell in 1988, at Nairn and Ridgetown in 1989 and at Elora, Woodstock and Listowel in both years. The counties examined accounted for 90% of the winter barley produced in Ontario those years. Cultivars OAC Halton and OAC Acton were examined in commercial fields and together with cv. OAC Elmira in research trials. Data were collected June 11-25 each year when the cultivars were at stage 73 (milky ripe) on the Zadoks scale (11).

Scald was rated at four random sampling sites in commercial fields and in 3, 4 or 6 replicate plots in research trials. Ten plants were assessed at each site. An assessment scale of 0 (no disease) to 9 (all leaves of the plant severely affected) was used (4).

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Results

Scald symptoms were observed in all fifty-five winter barley fields examined (Fig. 1). The disease was common but severity was variable. The southern county of Kent and northern counties of Grey, Dufferin and Bruce had relatively low levels of scald. The disease was most severe in Waterloo and nearby counties. Disease severity in commercial fields averaged 3.3 and ranged from 0.5 to 7.8. Disease severity did not differ significantly (contrast analysis, P=0.05) between years but did differ significantly between the two cultivars. Scald was more severe on OAC Halton (average 4.3, maximum 7.8) than on OAC Acton (average 2.4, maximum 7.0).

Scald was observed in all the research trials examined. Differences in severity were found among cvs. OAC Halton, OAC Acton and OAC Elmira in each trial. Scald was observed on OAC Halton in all nine trials; disease severity averaged 5.1 and ranged from 2.4 to 7.7. The disease was observed on OAC Acton in eight of the nine trials; the exception was Woodstock in 1989 where a severe infection with powdery mildew occurred. Scald severity on OAC Acton over the eight trials averaged 2.7 and ranged from 1.1 to 5.0. Scald was observed on OAC Elmira in only four of the nine trials; severity of the disease in these four trials averaged 0.5 and ranged from 0.3 to 0.8.

Discussion

The widespread distribution of scald on winter barley in southern Ontario during the years 1988 and 1989 at moderate to severe levels of infection indicates that the disease may have a significant impact on yield. Studies to determine the economic impact of the disease are warranted.

The disease was equally severe in commercial fields and research plots. This indicates that research plots are suitable sites for testing germplasm for resistance to the disease.

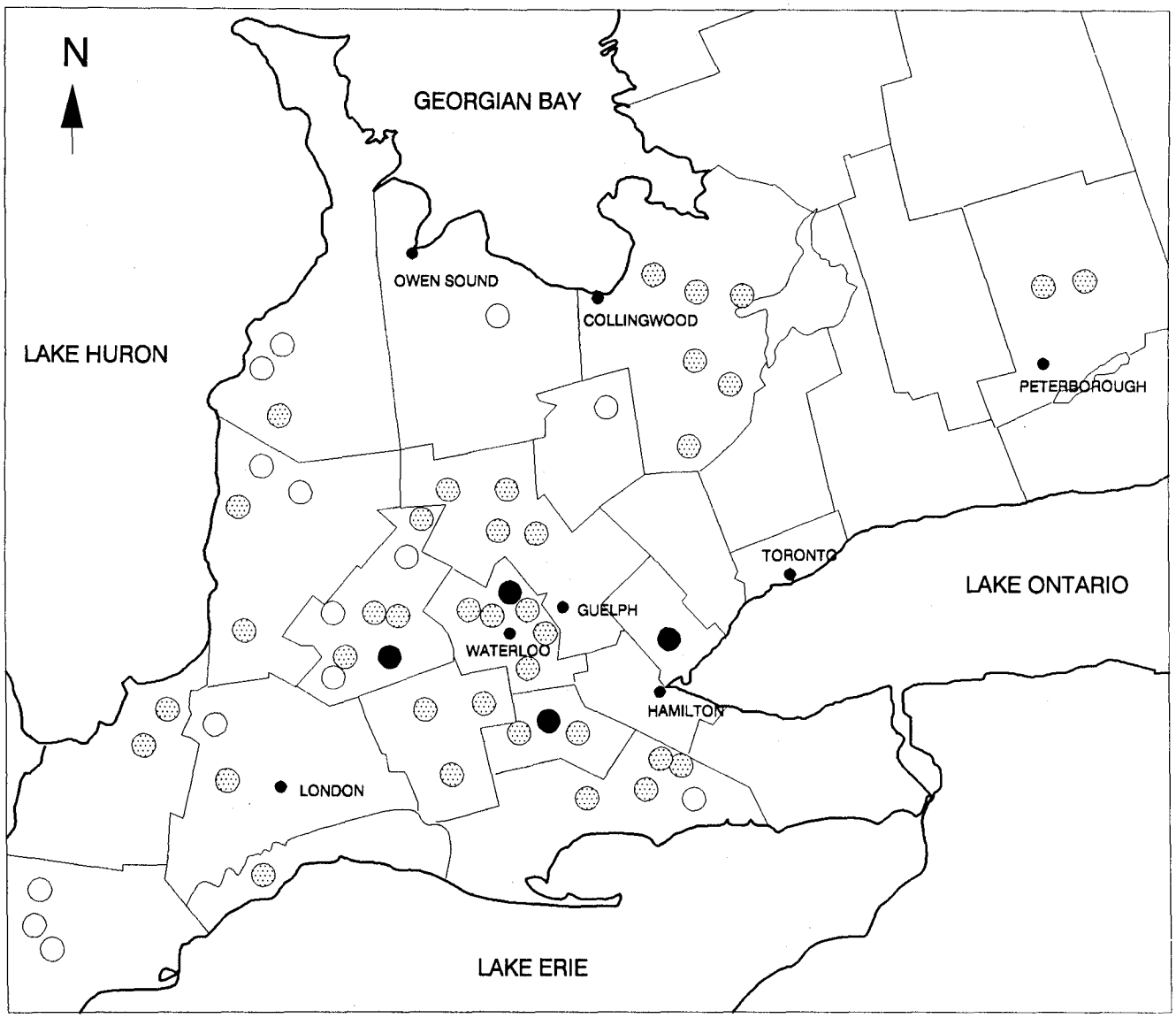

Fig. 1. Distribution and severity of scald in 55 winter barley fields in southern Ontario in 1988 and 1989. Scald severity >0-<2 (O), 2-6 (⊗), >6 (●) on a 0-9 scale.

Significant differences in disease severity were observed among the three commercial cultivars of winter barley examined. Scald was common on both OAC Halton and OAC Acton but was considerably more severe on the former in both commercial fields and research plots. OAC Elmira was developed to provide improved resistance to scald and this higher resistance is evident in the results obtained in research plots. The cultivar was not used to any extent commercially in Ontario during the years of the study.

The results show that agronomically adapted cultivars of winter barley with considerably improved resistance to the Ontario population of *R. secalis* can be developed. However, consideration should be given to the type of resistance deployed. We have identified two kinds of resistance in commercial winter barley in Ontario. OAC Elmira has race-specific resistance to the pathogen (10) which may be short-lived. OAC Acton has quantitative resistance to the disease (10) that appears to be race non-specific and therefore possibly more durable. Since the pathogenic characteristics of the fungus population can change rapidly (10), it will be important to use the various kinds of resistance judiciously.

Acknowledgements

Financial support from the Canadian International Development Agency through the Black Dragon River Consortium, the Natural Sciences and Engineering Research Council of Canada and the Ontario Ministry of Agriculture and Food is gratefully acknowledged.

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Reaction of additional barley cultivars to two aster yellows strains

L.N. Chiykowski [1]

All twelve cultivars of barley tested were susceptible to both strains of aster yellows mycoplasmalike organism (AY-MLO) transmitted by the aster leafhopper, *Macrosteles fascifrons*. Infection ranged from 8% to 68% depending on strain of MLO and barley cultivar. Overall, the eastern strain (NAY-MLO) infected a higher percentage of plants than did the western strain (CAY-MLO). On average, symptoms of NAY (37 days) took longer to develop than did those of CAY (29.6 days). Symptoms of CAY were generally more pronounced than were those of NAY, especially on spring cultivars. The winter cultivars, Huron and OAC Elmira, infected with NAY-MLO, proved to be excellent sources of inoculum for the leafhopper.

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Les douze cultivars d'orge évalués furent susceptibles aux deux souches du mycoplasme de la jaunisse de l'aster (AY-MLO) transmit par la cicadelle de l'aster, *Macrosteles fascifrons*. L'infection s'échelonne de 8 % à 68 % selon la souche du mycoplasme et selon le cultivar d'orge. Au total, la souche provenant de l'est (NAY-MLO) a infecté un plus grand pourcentage de plants que la souche provenant de l'ouest (CAY-MLO). En moyenne, les symptômes provoqués par le NAY se sont manifestés sur une période de 37 jours et par conséquent ont pris plus de temps à se développer que ceux provoqués par CAY (*i.e.* 29,6 jours). Les symptômes de CAY furent généralement plus prononcés que ceux de NAY, en particulier sur les cultivars de printemps. Les cultivars d'hiver (*i.e.* Huron et OAC Elmira) infectés avec NAY-MLO se sont avérés d'excellentes sources d'inoculant pour la cicadelle.

Introduction

The susceptibility of barley, *Hordeum vulgare* L., to aster yellows (AY) was first demonstrated by Banttari and Moore (1960) when they successfully transmitted the causal mycoplasmalike organism (MLO) to and from the cultivar Vantage with the aster leafhopper, *Macrosteles fascifrons* (Stal). Later, Banttari (1964) reported that the cultivars Trophy and Blackhulless also were susceptible and that the symptoms produced closely resembled those of the aphid-borne barley yellow dwarf virus. A subsequent study by Chiykowski (1965) added twenty-four cultivars to the list of susceptible barleys and also showed that all were susceptible to both eastern and western strains of AY-MLO.

Although all of the cultivars tested earlier have been supplanted, no information is available on how currently grown cultivars react to AY-MLO. The present paper reports on the reaction of several currently grown winter and spring cultivars to two strains of aster yellows transmitted by the leafhopper *M. fascifrons*.

Materials and methods

Healthy stock cultures of *M. fascifrons* leafhoppers were reared on oats *Avena sativa* L. 'Exposed' leafhoppers for inoculating plants were obtained by first caging late instar nymphs on infected China aster, *Callistephus chinensis* Nees, for two weeks and then maintaining them on healthy asters for an additional two weeks. The two pathogen isolates used in this study, one representing the eastern strain (NAY-MLO), and the other, the western strain (CAY-MLO), were the same as described previously (Chiykowski and Wolynetz 1981). The cultivars tested included five 6-row spring, three 2-row spring and four winter barleys (Table 1). For a test, five seedlings of each cultivar were grown in 13 cm fibre pots and inoculated one week after planting when the seedlings were about 12 cm high. The inoculation procedure consisted of caging three exposed leafhoppers on each seedling for 7 days in a growth room (9000 lx for 16 h/day) at 23°C. Following removal of the insects the plants were sprayed with malathion and placed in the greenhouse for symptom development. The test was repeated five times and the values reported are the percentages of plants infected of the twenty-five seedlings tested. The number of days for symptom expression was recorded and the average values for the five tests were calculated.

Two of the winter cultivars, Huron and OAC Elmira, also were evaluated as inoculum sources for NAY-MLO. Young adult *M. fascifrons* leafhoppers were caged on infected barley plants for two weeks and then maintained on healthy aster for an additional two weeks. Thirty exposed leafhoppers from each cultivar were tested singly for their inoculativity on aster seedlings for two weeks.

Results

All cultivars tested were susceptible to both strains of AY-MLO (Table 1). Percentage infection with CAY-MLO ranged from 16% on Huron, a winter barley, to 60% on Rodeo, a 2-rowed spring cultivar. With NAY-MLO, infection ranged from 8% on OAC Acton to 68% on OAC Elmira,

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both winter cultivars. There did not appear to be any correlation between barley type and susceptibility. With the exception of OAC Acton and Rodeo, NAY-MLO infected a higher percentage of plants than did CAY-MLO. OAC Acton was the only cultivar found to be considerably more susceptible to the western than to the eastern strain. Rodeo was the only cultivar that appeared to be equally susceptible to both strains.

Table 1. Susceptibility of barley cultivars to two strains of aster yellows transmitted by *Macrosteles fascifrons*.

Cultivar	Percentage infection by [a]	
	Western strain (CAY-MLO)	Eastern strain (NAY-MLO)
Spring		
6-row		
Bruce	28	56
Kippen	20	36
Leger	36	64
Mingo	36	56
Vanier	44	60
2-row		
Birka	36	52
Mic Mac	44	60
Rodeo	60	64
Winter		
Huron	16	36
OAC Halton	36	56
OAC Acton	32	8
OAC Elmira	24	68
Average	34	51

[a] Based on 25 inoculated seedlings per cultivar per MLO strain.

Although infected plants of all cultivars showed some of the symptoms described previously (Chiykowski 1965), differences in symptom expression were observed between pathogen strains on the same cultivars and between spring and winter cultivars. While plants of both spring and winter cultivars infected with CAY-MLO displayed a general, severe chlorosis of new leaves, only spring cultivars showed pronounced bright yellow blotches on older leaves. Symptoms of NAY-MLO infection consisted of a mild general chlorosis of new growth on both winter and spring cultivars and leaf blotching on spring cultivars that was considerably less pronounced than that caused by CAY-MLO. Leaf rolling of both spring and winter cultivars was more pronounced on plants infected with CAY-MLO than with NAY-MLO.

Disease symptoms on plants infected with CAY-MLO appeared in from 20 to 55 days (Table 2). The mean time for symptom expression ranged from a low of 24 days on OAC Kippen to a high of 37.6 days on OAC Elmira. Symptoms on plants infected with NAY-MLO appeared in from 22 to 58 days. The mean time for NAY symptom expression ranged from a low of 30.6 days on Mingo and Birka to a high of 50.1 days on Huron. On average, symptoms of CAY (29.6 days) required less time to develop than did those of NAY (37 days). With some cultivars, such as Birka and Mic Mac, symptom expression time was essentially the same for both pathogen strains. With others, such as Huron, the difference was quite pronounced, with symptoms of NAY taking twice as long to appear as those of CAY.

Both winter cultivars tested as acquisition hosts proved to be excellent sources of NAY-MLO inoculum for *M. fascifrons*. The percentage of insects that became inoculative after feeding on infected plants of Huron and OAC Elmira was 83% (25/30) and 70% (21/30), respectively.

Discussion

The susceptibility of all cultivars tested to the two strains of AY-MLO and the relatively high percentage infection in most cultivars suggests that aster yellows has the potential of being an economically important disease of barley. In addition, barley could play a role in the epidemiology of this disease in other crops, providing a source of both inoculum and leafhoppers during the growing season. Winter barley especially may be important in this regard, serving as a primary source of both disease inoculum and leafhoppers in the spring. The present study has shown

Table 2. Days required for symptom expression in cultivars of barley infected with aster yellows.

	Western AY-MLO		Eastern AY-MLO	
Cultivar	Range	Mean (SD)	Range	Mean
Bruce	20–41	28.0 (7.6)	32–57	44.9 (6.8)
OAC Kippen	22–26	24.0 (1.9)	39–58	47.3 (7.4)
Leger	21–55	32.6 (13.1)	23–52	36.6 (10.9)
Mingo	22–36	27.1 (6.2)	23–55	30.6 (7.9)
Vanier	20–50	27.0 (9.6)	25–51	33.4 (7.0)
Birka	21–50	30.9 (9.1)	22–47	30.6 (6.9)
Mic Mac	20–54	30.5 (10.6)	25–39	31.2 (4.6)
Rodeo	21–43	30.1 (7.0)	22–52	36.7 (7.9)
Huron	22–30	24.5 (3.7)	29–58	50.1 (9.5)
OAC Halton	20–47	29.9 (9.8)	25–56	37.2 (9.8)
OAC Acton	22–51	31.3 (10.4)	36–42	39.0 (4.2)
OAC Elmira	22–50	37.6 (11.4)	29–57	38.5 (9.9)
Average		29.6 (9.1)		37.0 (9.8)

that a high percentage of leafhoppers become inoculative after feeding on such cultivars as Huron and OAC Elmira. Winter barley also is a known overwintering host of the leafhopper vector (Miller and DeLyzer 1960). Insects emerging from and feeding on barley plants infected the previous fall would be inoculative by the time they mature and migrate to other susceptible crops such as vegetables, ornamentals and grains.

Acknowledgements

The author is indebted to Dr. Duane Falk, University of Guelph and Dr. Keh Ming Ho, Plant Research Centre, Agriculture Canada, for supplying the barley seed and to Amparo Jardine for technical assistance.

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A survey of carrot diseases on muck soils in the southwestern part of Québec

R. Arcelin[1] and A.C. Kushalappa[2]

Six diseases of carrots (*Daucus carotae* var. *sativa*), namely Cercospora blight (*Cercospora carotae*), Crown gall (*Agrobacterium tumefaciens*), Alternaria blight (*Alternaria dauci*), Root knot (*Meloidogyne hapla*), Sclerotinia rot (*Sclerotinia sclerotiorum*) and Aster yellows (Aster yellows mycoplasma), were observed in commercial fields on the muck soils in southwestern Québec. The prevalence and incidence of the diseases are discussed.

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On a constaté la présence de six maladies de la carotte (*Daucus carotae* var. *sativa*), soit la brûlure cercosporéenne (*Cercospora carotae*), la tumeur du collet (*Agrobacterium tumefaciens*), la brûlure alternarienne (*Alternaria dauci*), la nodosité des racines (*Meloidogyne hapla*), la pourriture sclérotique (*Sclerotinia sclerotiorum*) et la jaunisse (Aster yellows mycoplasma) dans les champs commerciaux des terres organiques du sud ouest du Québec. L'importance et l'incidence de ces maladies sont discutées.

Introduction

Carrot (*Daucus carotae* L. var. *sativa* DC.), an important vegetable in Canada, is the second most important vegetable crop in Québec. In 1989 the production was 3348 ha, with value of $16 million (11). In this province it is grown mainly on muck soils from May to October. Carrots are prone to many diseases. Cercospora blight and Alternaria blight have been considered as the two most common foliar diseases in the southwestern part of Québec (8,9,10). However, during the summer of 1987 it was not possible to isolate *Alternaria dauci* (Kuhn) Groves & Skolko, the fungus causing Alternaria blight. On the other hand, *Cercospora carotae* the causal agent of Cercospora blight was successfully isolated (1). Therefore a disease survey was conducted during the summers of 1988 and 1989 to identify and quantify the most common diseases attacking the carrots on the muck soils in the southwestern part of Québec. The prevalence and incidence of diseases are reported here.

Materials and methods

The survey was conducted in the muck soil region, located in the southwestern part of Québec. The seven districts chosen for survey were Hemmingford, Napierville, Ormstown, Sherrington, Saint-Edouard, Saint-Michel, Saint-Rémi, and Sainte-Clothilde (Fig. 1). All the districts were surveyed in both years except for the district of St. Edouard which was not surveyed in 1989. At the beginning of the survey thirty and thirteen sampling locations were established in which a total of 168 and 113 fields selected at random were surveyed in 1988 and 1989, respectively. In each field ten plants were selected at random while walking in a diagonal path. The plants were brought to the laboratory and visually examined for the presence of disease symptoms (2,7).

Leaves with symptoms resembling those caused by Alternaria blight, either fresh or after overnight incubation in moist petri-dishes, were observed under the microscope for the presence of *A. dauci* spores, using keys given by Groves and Skolko (3). Samples of lesions were also surface disinfested in a solution of 1% NaOCl for two minutes, rinsed twice in distilled water and plated on V8® juice agar (13). The plates were maintained for a week at 24°C under 16 hr day length provided by the cool white fluorescent light for the growth and sporulation of the pathogen (12). Many times the diseased leaves were collected early in the morning, before 0800 hr, to increase the chance of finding Alternaria spores prior to their release (6).

The prevalence of disease was calculated as the percentage of fields with a given disease and the incidence as the percentage of plants with a given disease.

Results and discussion

All six diseases were observed not only in most of the districts but also in most fields surveyed in 1988 and 1989 (Table 1a, 1b, 2a, 2b). In decreasing order of prevalence they were: Cercospora blight, Crown gall, Alternaria blight, Root knot, Sclerotinia rot and Aster yellows (Table 3).

Cercospora blight was the most common disease in all districts for both the years surveyed. It was present in 91% and 96% of the fields and in 99% and 92% of the plants sampled in 1988 and 1989, respectively (Table 3). Crown gall was present in all districts in 1988 but only in three districts, Ste. Clothilde, Sherrington and Napierville, in 1989 (Table 1a, 1b). It was present in 5% and 2% of the fields and in 28% and 14% of the plants sampled in 1988 and 1989, respectively (Table 3).

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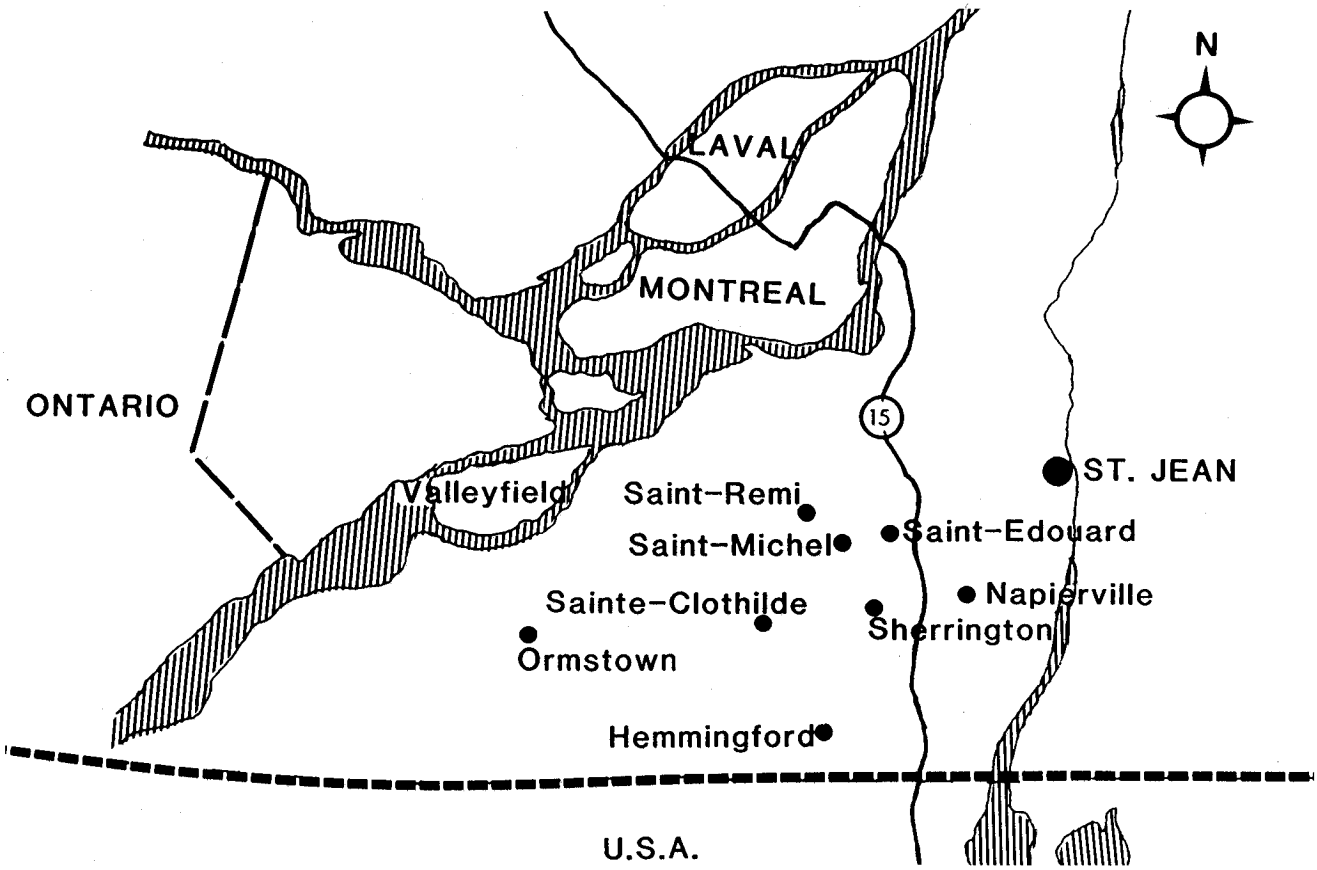

Fig. 1. Map of southwestern Québec indicating the districts in which the survey was conducted.

Symptoms similar to those produced by *A. dauci* were present in all districts in 1988 and in four districts, Ste. Clothilde, St. Michel, Sherrington and Ormstown, in 1989. They were present in 5% and 1% of the fields and in 25% and 7% of the plants sampled in 1988 and 1989, respectively (Table 3). However, *A. dauci* was not found in any of the samples, instead *Alternaria alternata* (Fr.) Keissler was observed in all the samples reported as Alternaria blight. It is possible that the *A. dauci* is absent in this region and the symptoms resembling Alternaria blight are induced by *A. alternata* rather than *A. dauci*. The latter can occasionally attack senescent leaves of carrot and cause lesions on the leaves (4). It appears that the *A. alternata* is a secondary pathogen.

Root knot was present in five districts, Ste. Clothilde, St. Michel, Sherrington, Napierville and Ormstown, in 1988 and in three districts, Ste. Clothilde, Sherrington and Napierville, in 1989 (Table 1a, 1b). It was present in 2% and 4% of the fields and in 16% and 20% of the plants sampled in 1988 and 1989, respectively (Table 3).

Sclerotinia rot and Aster yellows were observed occasionally and seemed to be of only minor importance. Sclerotinia rot was present in four districts, Ste. Clothilde, St. Michel, Sherrington and Napierville, in 1988 and in five districts, Ste. Clothilde, St. Michel, St. Rémi, Sherrington and Napierville, in 1989. It was present in both years in 2% of the fields surveyed and in 13% and 15% of the plants sampled in 1988 and 1989, respectively (Table 3). Aster yellows was found only in 1988. It was present in all districts surveyed except for St. Michel in 1% and 13% of the fields and plants sampled, respectively (Table 3).

A given disease did not necessarily occur in the same location in successive years (9). Cercospora blight was the most common disease in both years. It is well managed with fungicides. However, because of the disadvantages of fungicide usage (pollution, resistance), we should concentrate on other methods to manage the disease. *A. alternata* is not a major problem in the muck soil region, as it is very well controlled by the fungicides used to manage Cercospora blight.

Crown gall was more important in 1988 than in 1989 probably due to differences in climatic conditions. No management methods are used by the producers for the control of Crown gall except for the long term rotations with immune crops (2). However, it is an increasing problem and much research has been done on biological control of this disease in other crops (5). Root knot, Sclerotinia rot and Aster yellows were not prevalent at all in both years, so they may not cause a significant loss in yield.

Table 1a. Percentage of carrot fields with various diseases observed in seven districts located on muck soils, in the southwestern part of Québec, during the summer of 1988.

DST*	SL**	FLD***	Diseases****					
			Cercos. blight	Alternaria blight	Scler. rot	Root knot	Crown gall	Aster yellows
Ste .	1	3	100	33	33	67	0	0
Clothilde	2	5	100	100	0	20	0	0
	3	15	100	0	0	13	27	13
	4	9	100	22	33	11	11	22
	5	1	100	100	0	0	0	0
	6	4	100	75	0	75	100	0
	7	2	100	50	50	50	100	0
	8	3	100	0	33	0	33	0
	9	3	100	67	67	33	67	33
St. Michel	10	8	100	0	13	0	25	0
	11	3	100	0	33	33	0	0
	12	3	67	33	33	33	0	0
	13	3	100	67	0	33	33	0
St. Rémi	14	3	100	67	0	0	0	67
St. Edo.	15	7	100	29	0	0	14	58
Sher.	16	11	100	0	18	9	9	9
	17	5	100	20	40	0	40	0
	18	6	100	33	0	0	0	17
	19	4	100	25	0	50	75	0
	20	2	100	50	50	50	0	0
	21	3	100	67	0	33	0	0
	22	3	100	33	0	0	33	0
	23	26	100	19	12	19	50	4
	24	1	100	0	100	0	0	0
	25	5	100	20	0	20	40	0
Napierville	26	1	100	0	100	0	100	0
	27	15	100	13	0	0	40	7
	28	3	100	0	33	0	0	0
	29	1	100	100	100	100	0	100
Ormstown	30	10	100	20	0	10	10	50

* DST = Districts: St. Edo. = St. Edouard, Sher. = Sherrington.
** SL = Sampling locations where fields were selected.
*** FLD = Fields: Number of fields surveyed.
**** Diseases: Cercos. blight = Cercospora blight, Scler. rot = Sclerotinia rot.

Table 1b. Percentage of carrot fields with various diseases observed in six districts located on muck soils, in the southwestern part of Québec, during the summer of 1989.

DST*	SL**	FLD***	Diseases****					
			Cercos. blight	Alternaria blight	Scler. rot	Root knot	Crown gall	Aster yellows
Ste.	3	15	47	0	0	7	0	0
Clothilde	4	9	100	22	22	33	33	0
	6	4	100	0	50	100	75	0
St. Michel	10	8	75	13	38	0	0	0
St. Rémi	14	3	100	0	33	0	0	0
Sher.	16	7	100	0	0	0	0	0
	18	6	100	17	0	0	0	0
	19	4	100	0	0	25	0	0
	22	3	100	0	0	0	0	0
	23	26	100	8	12	42	15	0
	25	5	100	20	0	0	0	0
Napierville	27	15	100	0	33	13	40	0
Ormstown	30	6	100	17	0	0	0	0

* DST = Districts: Sher. = Sherrington.
** SL = Sampling locations where fields were selected.
*** FLD = Fields: Number of fields surveyed.
**** Diseases: Cercos. blight = Cercospora blight, Scler. rot = Sclerotinia rot.

Table 2a. Percentage of plants with various diseases, per field, observed in seven districts located on muck soils, in the southwestern part of Québec, during the summer of 1988.

DST*	SL**	FLD***	Diseases****					
			Cercos. blight	Alternaria blight	Scler. rot	Root knot	Crown gall	Aster yellows
Ste.	1	3	83	10	3	25	0	0
Clothilde	2	5	45	24	0	1	0	0
	3	15	100	0	0	2	4	2
	4	9	96	4	4	1	1	2
	5	1	100	20	0	0	0	0
	6	4	100	4	0	7	13	0
	7	2	87	7	3	3	7	0
	8	3	84	0	3	0	3	0
	9	3	96	8	5	1	11	1
St. Michel	10	8	93	0	3	0	3	0
	11	3	100	0	3	3	0	0
	12	3	67	10	7	3	0	0
	13	3	57	27	0	3	3	0
St. Rémi	14	3	83	10	0	0	0	6
St Edo.	15	7	94	6	0	0	1	7
Sher.	16	11	96	0	3	3	1	1
	17	5	98	4	8	0	10	0
	18	6	90	2	0	0	0	1
	19	4	91	2	0	4	6	0
	20	2	60	10	20	10	0	0
	21	3	72	7	0	3	0	0
	22	3	96	1	0	0	4	0
	23	26	98	4	1	2	10	0
	24	1	100	0	10	0	0	0
	25	5	82	3	0	2	8	0
Napierville	26	1	87	0	7	0	3	0
	27	15	94	4	0	0	7	1
	28	3	93	0	3	0	0	0
	29	1	58	6	6	1	0	1
Ormstown	30	10	95	2	0	1	1	7

* DST = Districts: St. Edo. = St. Edouard, Sher. = Sherrington.
** SL = Sampling locations where fields were selected.
*** FLD = Fields: Number of fields surveyed.
**** Diseases: Cercos. blight = Cercospora blight, Scler. rot = Sclerotinia rot.

Table 2b. Percentage of plants with various diseases, per field, observed in six districts located on muck soils, in the southwestern part of Québec, during the summer of 1989.

DST*	SL**	FLD***	Diseases****					
			Cercos. blight	Alternaria blight	Scler. rot	Root knot	Crown gall	Aster yellows
Ste.	3	15	96	0	0	3	0	0
Clothilde	4	9	98	1	2	2	2	0
	6	4	100	0	6	7	6	0
St. Michel	10	8	89	3	9	0	0	0
St. Rémi	14	3	82	0	2	0	0	0
Sher.	16	7	93	0	0	0	0	0
	18	6	98	3	0	0	0	0
	19	4	83	0	0	1	0	0
	22	3	86	0	0	0	0	0
	23	26	100	1	2	10	1	0
	25	5	93	1	0	0	0	0
Napierville	27	15	99	0	6	1	8	0
Ormstown	30	6	95	2	0	0	0	0

* DST = Districts: Sher. = Sherrington.
** SL = Sampling locations where fields were selected.
*** FLD = Fields: Number of fields surveyed.
**** Diseases: Cercos. blight = Cercospora blight, Scler. rot = Sclerotinia rot.

Table 3. Percentage of fields and of plants with different diseases observed in 1988 and 1989 on muck soils in the southwestern part of Québec.

Diseases	Fields %		Plants %	
	1988	1989	1988	1989
Cercospora	91	96	99	92
Alternaria	5	1	25	7
Sclerotinia	2	2	13	15
Root knot	2	4	16	20
Crown gall	5	2	28	14
Aster yellows	1	0	13	0

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Colletotrichum gloeosporioides causing anthracnose of *Lavatera* sp.

K. Mortensen[1]

A *Colletotrichum gloeosporioides* was isolated from severe disease symptoms on *Lavatera* sp., cultivar 'Mont Blanc', planted in flower beds at Indian Head Experimental Farm in the summer of 1989. By late July the disease had killed all plants of 'Mont Blanc'. The disease was also observed on another cultivar 'Silver Cup' but to a lesser degree. Laboratory tests indicated that this fungus was similar in host range to *Colletotrichum gloeosporioides* f. sp. *malvae* from round-leaved mallow. However, disease symptoms differed in that *C. gloeosporioides* from *Lavatera* sp. was most severe on leaves, whereas, *C. gloeosporioides* f. sp. *malvae* is a stem pathogen. Although severe on *Lavatera* sp. it did not kill weedy *Malva* species.

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Colletotrichum gloeosporioides fut isolé de l'espèce *Lavatera* un cultivar « Mont Blanc » présentant des symptômes d'infection sévères. Ce cultivar a été produit dans des plate-bandes à la ferme expérimentale d'Indian Head durant l'été 1989. À la fin juillet, la maladie a détruit tous les plants « Mont Blanc ». La maladie fut observée aussi sur un autre cultivar, le « Silver Cup », mais à un degré plus faible. Les tests en laboratoire ont indiqué que ce champignon était similaire à la lignée du *Colletotrichum gloeosporioides* f. sp. *malvae* de la mauve à feuilles rondes. Quoi qu'il en soit, les symptômes de la maladie se sont avérés différents puisque ceux-ci démontrèrent des symptômes foliaires plus sévères pour *C. gloesporioides* de l'espèce *Lavatera* que pour *C. gloeosporioides* f. sp. *malvae*. *C. gloeosporioides* f. sp. *malvae* est un pathogène s'attaquant plus à la tige du plant. Bien que la maladie fut sévère sur l'espèce *Lavatera*, le pathogène n'a pas tué les espèces *Malva*.

Introduction

Anthracnose symptoms were observed on *Lavatera* sp. cultivar 'Mont Blanc' in flower beds at Agriculture Canada, Experimental Farm, Indian Head, Saskatchewan. By late July, nearly all 'Mont Blanc' plants were killed in the flower beds. Another cultivar 'Silver Cup' was also attacked, but to a much lesser degree. A *Colletotrichum* sp. was consistently isolated from diseased plant tissue, and produced anthracnose symptoms when inoculated back on plants. The purpose of these studies was 1) to identify the species of *Colletotrichum*, 2) determine the source of the disease, 3) compare the fungus to *Colletotrichum gloeosporioides* (Penz.) Sacc. f. sp. *malvae* (C.g.m.) from round-leaved mallow (*Malva pusilla* Sm.) (Mortensen 1988) in terms of host range, since *Lavatera* is also a Malvaceae, and 4) determine its pathogenicity on weedy *Malva* spp. that C.g.m. does not control satisfactorily (Mortensen 1988), to see if it would be of potential as a bioherbicide.

Materials and methods

Seed of *Lavatera* sp., cultivar 'Mont Blanc' and 'Silver Cup', used for planting at Indian Head, were obtained from Jack Van Klaveren Ltd.[2], in April 1989 (Lawrence Kattler, personal communication). Additional seed of both cultivars were obtained for further testing in December 1989 from the same company. Diseased plant material of *Lavatera* 'Mont Blanc' was collected from flower beds at the Experimental Farm, Indian Head, surface sterilized in 0.6% sodium hypochlorite (10% Javex® solution) for 1 min, rinsed in sterile water and plated out on potato dextrose agar (PDA) and on moist filter paper in a petri dish. Infected material plated out was incubated for 6 to 8 days at 24°C during a 12 h light cycle of fluorescent light (28 $\mu Mol.m^{-2}.s^{-1}$) and 20°C for 12 h in the dark. Developing fungi were isolated and single spore cultures were increased on PDA, and inoculated on *Lavatera* plants to confirm pathogenicity.

To check if *C. gloeosporioides* was seed-borne, seed of *Lavatera* cultivar 'Mont Blanc' and 'Silver Cup' were planted in metal flats (28 cm by 50 cm) in a soil mixture (3:2:1 (v/v) autoclaved soil:peat moss:vermiculite), and grown on greenhouse benches at 23±4°C during a 16 h day extended with fluorescent and incandescent light (280 $\mu Mol.m^{-2}.s^{-1}$). Isolations were made from diseased seedlings in these flats. Seed in one flat was surface sterilized in a 20% Javex® solution for 3 min and rinsed in sterile water for 3 min, seed in another flat was rinsed in sterile water for 6 min before planting. The experiment consisted of 50 seeds per flat; 2 flats with surface sterilized seed and 2 flats with seed only rinsed in water each of 'Mont Blanc' and 'Silver Cup' (100 seeds per cultivar per treatment).

Test plants for the host range study (Table 3) were planted in 15-cm pots in a soil mixture as above and grown in growth chambers with a 16 h day at 24±0.5°C and a light intensity of 280 $\mu Mol.m^{-2}.s^{-1}$ from fluorescent and incandescent light and an 8 h dark period at 20±0.5°C. Seed for

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Table 1. Severity of disease symptoms on *Lavatera* sp. inoculated with *Colletotrichum gloeosporioides*.

		Disease rating *			
		after 7 days		after 14 days	
Cultivar	No. of plants	leaves	petioles	leaves	petioles
'Silver Cup'	23	5.7 (3–8)**	3.2 (1–5)	8.7 (7–9)	8.4 (6–9)
'Mont Blanc'	25	4.4 (3–6)	2.0 (0–5)	7.3 (5–9)	6.6 (1–9)

* Scale (0–9): 0 = no symptoms and 9 = >90% of plant material wilted.
** Average disease rating of 9 replications in 4 trials; range of disease ratings in brackets.

test plants were obtained from commercial seed sources where possible. The test plants were inoculated in the 4- to 6-leaf stage (3-wk-old plants) by spraying a spore suspension (concentration about 4×10^6 spores/ml) until runoff, using an airbrush. Inoculated plants were incubated in a dew chamber for 24 h in the dark at 18±1°C, then returned to the growth chamber. Disease severity was estimated visually at both seven and 14 days after inoculation using a scale from 0-9, where 0=immune and 9=causing more than 90% of plant material to wilt (Mortensen 1988). Host range tests were repeated once for species in the Malvaceae, and the disease rating in Table 3 is given as an average of both trials 14 days after inoculation.

Results and discussion

The *Colletotrichum* sp. isolated from diseased plant material of *Lavatera* cv. 'Mont Blanc' was pathogenic on both cultivars, 'Mont Blanc' and 'Silver Cup'. The symptoms were irregular necrotic lesions especially on the leaves (Fig. 1), but lesions were also observed on the leaf petioles and stems. Seven days after inoculation disease ratings were higher on leaves than on petioles, but after 14 days lesions on petioles and stems had also developed so the differences in ratings became less and about 75 to 80% of the plants were killed (Table 1). This *Colletotrichum* sp. was different from C.g.m. (Mortensen 1988), in culture on PDA it produced slightly more aerial mycelium and did not sporulate as readily as C.g.m. A culture of this *Colletotrichum* sp. was submitted to Biosystematics Research Institute, Agriculture Canada, Ottawa, and identified as *Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc. in Penz. "species group" (Daom No. 211155).

C. gloeosporioides has not previously been reported from *Lavatera* spp. (Conners 1967, Farr *et al.* 1989, Ginns 1986, and Sutton 1980). Thus, this is the first record of *C. gloeosporioides* causing anthracnose of *Lavatera* spp. in North America.

Out of the non-surface sterilized seeds of 'Mont Blanc' planted in flats, 86% produced seedlings. Of the 34 showing seedling blight, *C. gloeosporioides* was isolated from 15. Out of non-surface sterilized seeds of 'Silver Cup', 51% produced seedlings. Of the 5 showing seedling blight, *C. gloeosporioides* was isolated from one (Table 2). This indicates that *C. gloeosporioides* is seed-borne, and the anthracnose disease in the flower beds at Indian Head originated from infected seeds. The very low infection level of 'Silver Cup' agrees with the low incidence of the disease observed on 'Silver Cup' plants in the flower beds (Lawrence Kattler, personal communication). The number of diseased seedlings was reduced considerably from surface sterilized seeds, and *C. gloeosporioides* was not isolated from surface sterilized seeds (Table 2). This indicates that *C. gloeosporioides* can be eliminated by surface sterilizing seeds. However, the 20% Javex® solution had some detrimental effect on germination, especially of the cultivar 'Mont Blanc', where emergence were reduced from 86% to 72%. Therefore, a fungicide seed treatment might be a better solution.

Table 2. The number of emerged seedlings and seedlings with disease symptoms caused by *Colletotrichum gloeosporioides* of *Lavatera* sp. planted from seeds under greenhouse conditions.

		Seedlings emerged **	Number of seedlings with	
Cultivar	Treatment *	%	symptoms	*C. gloeosporioides*
'Mont Blanc'	SD	72	7	0
	NSD	86	34	15
'Silver Cup'	SD	52	2	0
	NSD	51	5	1

* SD = surface sterilized and NSD = non-surface sterilized.
** Total of 100 seeds per treatment per cultivar.

Table 3. Pathogenicity of *Colletotrichum gloeosporioides* on selected plant species.

Species	No. of plants	Disease rating*	
		leaves	stems
Malvaceae:			
Round-leaved mallow (*Malva pusilla* Sm.)	72	4.3	2.0
Small-flowered mallow (*M. parviflora* L.)	40	3.4	1.0
Common mallow (*M. neglecta* Wallr.)	58	3.2	0
Musk mallow (*M. moschata* L.)	25	3.2	3.4
M. alcea L. var. *fastigiata* (Cav.) C. Koch.	42	3.0	3.0
Hollyhock (*Althea rosea* (L.) Cav.)			
cv. 'Pinefore mixed'	2	2.0	0
cv. 'Charter's double mixed'	25	3.5	1.3
cv. 'Summer Carnival'	23	3.0	0
Prickly sida (*Sida spinosa* L.)	41	0.1	0
Spurred anoda (*Anoda cristata* (L.) Schlecht)	1	0	0
Velvetleaf (*Abutilon theophrasti* Medic.)	68	0.8	0.5
Scarlet mallow (*Malvastrum coccineum* (Purch) A. Gray)	9	0	0
Cotton (*Gossypium hirsutum* L.)			
cv. 'Stoneville 213'	40	0.3	0
cv. 'Pima S-5'	48	0.7	0
Flower-of-an-hour (*Hibiscus trionum* L.)	46	0.3**	0
Rose mallow (*Hibiscus* sp.)			
cv. 'Dixie Belle'	6	0	0
cv. 'Disco Belle'	20	0	0
cv. 'Southern Belle'	27	0	0
cv. 'Mallow Marvels'	2	0	0
Okra (*Abelmoschus esculentus* (L.) Moench.			
cv. 'Perkin's Mammoth Longpod'	18	0.6	0
cv. 'Blondy'	21	0	0
Non Malvaceae:			
Safflower (*Carthamus tinctorius* L.)			
cv. 'Girard'	13	1.3	1.0
cv. 'S208'	21	1.7	1.3
Cocklebur (*Xanthium strumarium* L.)	11	0.3	0
Purslane (*Portulaca oleracea* L.)	80	0	0
Field bindweed (*Convolvulus arvensis* L.)	10	0	0

Continued on next page.

Table 3 continued.

Sugar beet (*Beta vulgaris* L.)			
cv. 'Betaseed 2644'	20	0.3	0
cv. 'Hilleshoeg Mono 1254'	27	0	0
Lentil (*Lens culinaris* Medic.)			
cv. 'Indian Head'	26	0	0
cv. 'Laird'	28	0	0
Flax (*Linum usitatissimum* L.)			
cv. 'Noralta'	23	0	0
cv. 'Vimy'	24	0	0
Wheat (*Triticum aestivum* L.)			
cv. 'Katepwa'	26	0	0
cv. 'HY320'	26	0	0

* Scale (0–9): 0 = no symptoms and 9 = > 90% of plant material wilted. Average disease rating of at least 2 trials.
** Cotyledons only.

The host range of *C. gloeosporioides* from *Lavatera* sp. in Table 3 is similar to that of C.g.m. from round-leaved mallow (Mortensen 1988). Only species in the Malvaceae became seriously infected. Some infection occurred on safflower, which also was the case for C.g.m. The symptoms of irregular necrotic lesions on the leaves, with less attack on the leaf petioles (Fig. 1), is different from C.g.m. which is primarily a stem pathogen, producing few leaf lesions (Mortensen 1988). *Lavatera* plants, cv. 'Silver Cup' inoculated with C.g.m. resulted in severe infections and plants were killed after eight days. The infections from *C. gloeosporioides* were most severe on the two *Lavatera* cultivars, resulting in almost total kill of the plants two weeks after inoculation.

Leaf lesions similar to those shown in Fig. 1 occurred on the three weedy *Malva* spp. (round-leaved mallow, common mallow, and small-flowered mallow) but not severe, with only a disease rating of 3 to 4 (Table 3). Some stem lesions occurred on all three *Malva* spp. but the lesions did not develop further and the plants outgrew them.

In conclusion, the two strains of *C. gloeosporioides* have similar host ranges on plant species in the Malvaceae, but they cause somewhat different disease symptoms; C.g.m. is mainly a stem pathogen, whereas *C. gloeosporioides* from *Lavatera* is mainly a leaf pathogen. The pathogenicity of *C. gloeosporioides* on weedy *Malva* spp. was not sufficient to warrant further studies on this fungus as a bioherbicide, because C.g.m. is more efficient on all three *Malva* spp. than what was found for *C. gloeosporioides* from *Lavatera*.

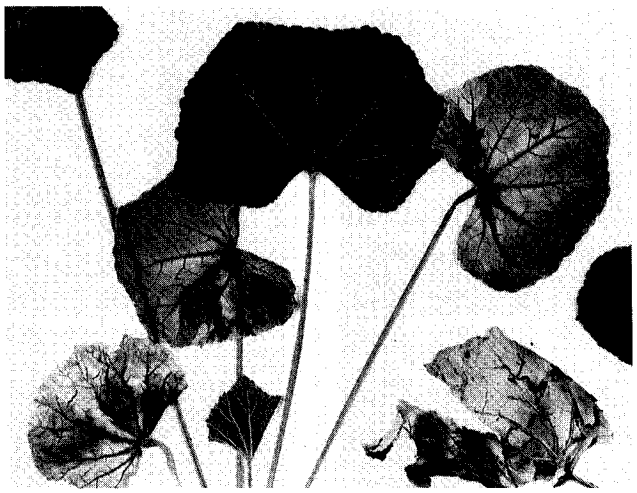

Fig. 1. Seedling of *Lavatera* sp. 'Mont Blanc' inoculated with a spore suspension of *C. gloeosporioides* under controlled conditions. Photograph showing healthy leaf in the center compared with typical leaf symptoms on either side 14 days after inoculation.

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Fusarium avenaceum, a pathogen of stored broccoli

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Fusarium avenaceum was identified as a new pathogen of broccoli kept in long-term storage at low temperature and controlled atmosphere. The first sign of the disease was growth of a white fluffy mycelium partly covering the inflorescence. Although disease development was very slow at 5°C, breaking the cold chain did cause outbreaks of infection in apparently healthy broccoli. Broccoli stored in ethanol vapour at 13°C; an experimental treatment that slows down yellowing, was also prone to infection by *F. avenaceum*. This disease could be a limiting factor in the long term storage of broccoli, if this storage practice is used commercially.

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Nous avons identifié un nouveau pathogène post-récolte chez le brocoli, le *Fusarium avenaceum*, qui se développe durant l'entreposage prolongé à basse température et sous atmosphère controllée. L'infection se manifeste par l'apparition d'un mycélium blanc soyeux qui couvre partiellement l'inflorescence. La maladie évolue très lentement à 5 °C. Cependant, lorsque le brocoli est transféré à température ambiante, l'infection progresse très rapidement. *F. avenaceum* s'est developpé également chez le brocoli entreposé à 13 °C dans une atmosphère d'air contenant des vapeurs d'éthanol, un traitement expérimental qui ralentit le jaunissement. Cette maladie peut devenir un facteur limitant de l'entreposage à long terme du brocoli s'il devient en usage sur le plan commercial.

Broccoli is a highly perishable produce and its quality greatly depends on storage conditions. Quality lost during storage is mainly due to yellowing, which can be reduced by using appropriate conditions of controlled or modified atmospheres (Lebermann *et al.*, 1968; Lipton and Harris, 1974). With the extended shelf-life obtained under these conditions, problems such as physiological disorders and post-harvest diseases become more important (Makhlouf *et al.*, 1989). A number of pathogens can develop on broccoli during storage or transit. Fungal pathogens reported in North America are *Sclerotinia sclerotiorum* (Lib.) De Bary, *Botrytis cinerea* Pers., *Cladosporium, Mucor, Alternaria* and *Rhizopus* spp. (Ceponis *et al.*, 1987; Lipton and Harris, 1974).

Experiments conducted at Laval University laboratory, with locally grown broccoli, and long-term storage, showed the development of white fluffy mycelium repeatedly on florets (Fig. 1). The fungus colonized the broccoli tissues superficially, but covered a large area on the inflorescences, making them unacceptable for marketing. The disease was present on broccoli stored at 5°C for four to six weeks in a controlled atmosphere of nitrogen containing 6% CO_2 and 2% O_2. The same pathogen was also observed on broccoli stored in 0.1% ethanol vapour at 13°C; an experimental treatment which slows down yellowing (unpublished data). In both cases the infected broccoli was still green and otherwise of good quality. At the same time, the control stored in normal air had turned yellow and become unmarketable. Healthy broccoli removed from controlled atmosphere storage and left at room temperature overnight developed white fluffy mycelium.

The fungus, isolated on PDA from infected florets, was identified as *Fusarium avenaceum* (Corda ex Fr.) Sacc. (Nelson *et al.*, 1983). Inoculation with these cultures on florets held in air or ethanol vapour (0.25 and 0.5%) induced the same infection in 48 h at room temperature. Growth of the pathogen was stimulated on florets stored in 0.25% ethanol vapour. The reason for this stimulated growth was not investigated, but an adverse effect of ethanol on the microflora competing with *F. avenaceum* is a possible cause. Infection was very slow on inoculated florets stored at 4°C, only half showed sign of infection after two weeks. However, when these florets were taken to room temperature, they all developed infections. According to Lacey (1989), *F. avenaceum* can grow in a range of temperatures between -3 to 31°C, with an optimum around 25°C. Breaking the cold chain, for even a short time, could bring a sudden outbreak of symptoms in broccoli that did not show signs of the disease. *F. avenaceum* has been reported to be an occasional pathogen of stored cabbage (Geeson, 1983). Long-term controlled atmosphere of broccoli allows the pathogen to grow, while the produce colour remains green. Adair (1971) studied the effects of controlled atmosphere on the growth and virulence of *F. roseum* on cabbage; which could have been *F. avenaceum*. In low oxygen, virulence was unaffected at 5°C and enhanced at 12°C as compared to air. This pathogen could thus be well adapted for infecting brassicas stored in low oxygen situations.

If long-term controlled atmosphere storage of broccoli is used on a commercial scale, this disease may be a new factor limiting the shelf life of this vegetable.

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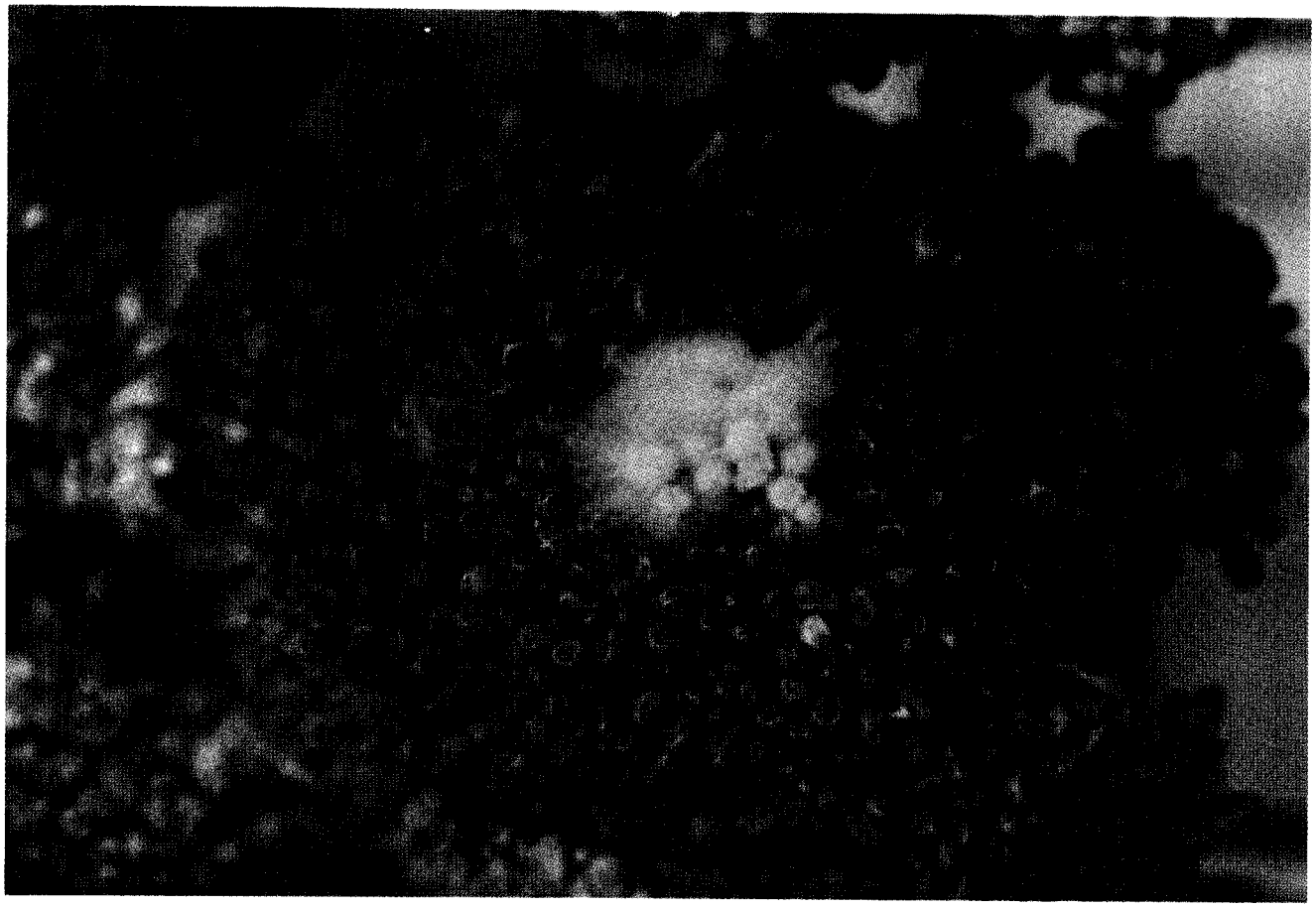

Fig. 1. Inflorescence of broccoli infected by *F. avenaceum* during storage.

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Yield of soybean cultivars differing in susceptibility to *Phytophthora megasperma* f. sp. *glycinea* on minimum tillage ridges

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Soybeans (*Glycine max* (L.) Merr.) were grown with reduced tillage on flat and ridged plots on poorly drained soil for two consecutive years. In the second year, yield was significantly less on the ridge plots. Cultivars differed significantly in plant loss and yield with flat and ridge tillage depending on level of susceptibility to root rot caused by *Phytophthora megasperma* f. sp. *glycinea*.

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Les fèves de soya (*Glycine max* (L.) Merr.) ont été cultivées avec un labour réduit sur des parcelles sans relief et sur des parcelles en billon dans un sol drainé pauvrement durant deux années consécutives. Lors de la deuxième année, le rendement fut significativement moindre sur les parcelles en billon. La perte de rendement et de plants fut significative pour différents cultivars selon le type de labour (*i.e.* à plat ou en billon) et selon le niveau de susceptibilité de la pourriture des racines causée par *Phytophtora megasperma* f. sp. *glycinea*.

Introduction

Soybean (*Glycine max* (L.) Merr.) cultivars recommended for southwestern Ontario differ in tolerance and resistance to *Phytophthora megasperma* f. sp. *glycinea* Kuan and Erwin (P.m.g.) (Buzzell and Anderson, 1982). Compaction of fine textured soils influences the incidence of disease (Fulton *et al.*, 1961; Kittle and Grey, 1979). Recent trends in energy and soil conservation have resulted in the development of new cultivation and planting systems involving minimum tillage that may influence soil conditions. One system involves planting row crops on permanent ridges. The purpose of this study was to determine the effect of flat and ridge minimum tillage on emergence, plant loss and yield of soybean cultivars that differ in tolerance to root rot.

Materials and methods

Experiments were conducted on Brookston clay loam soil with a history of moderate to severe root rot at the Whelan Research Farm at Woodslee, Ontario. Four soybean cultivars/lines differing in susceptibility to root rot were planted in 8-row plots, 5 m in length in a split-plot design with 4 replicates. The main plot treatments consisted of 4 soybean cultivars/lines as follows: OX20-8, Harcor, Kentland and Corsoy 79. These are very susceptible, moderately tolerant, tolerant and resistant to prevalent races of P.m.g., respectively (Buzzell and Anderson, 1982). The 4 row sub-plots received minimum tillage with a triple "K" cultivator in spring or minimum tillage ridges built in spring with a Hiniker Econ-O-Till planter (Model 7430) just prior to planting. Fertilizer (8-32-16) was applied broadcast at 540 kg/ha prior to tillage. Seeds were planted in both sub-plots with the Hiniker planter at the rate of 30 seed/m at a depth of 5 cm. Chloramben was applied pre-emergence at 4 kg a.i./ha to control weeds. In 1984, the experiment was planted 11 May, emergence counts were made 19 June and final stand counts were made 27 August. In 1985, tillage methods were similar to 1984. Treatments were planted directly over previous plots in the same randomized pattern. In 1985, the experiment was planted 15 May; plots were sprinkle irrigated with 2.5 cm of water to assist emergence. Emergence counts were made 5 July and final stand counts were made 7 October. Percent plant loss was determined from the difference between all plants that emerged and the number of plants that produced seed at the time of final stand counts. Significant differences were determined at $P = 0.05$.

Results and discussion

In 1984, emergence of Corsoy 79, Kentland and OX20-8 did not differ significantly between flat and ridged planting. Emergence of Harcor in flat plots (15 plants/m) was significantly less than in ridge plots (19 plants/m). The overall mean emergence of all four cultivars was less in flat plots (19 plants/m) than in ridge plots (21 plants/m) (Table 1). Plant loss during the growing season and yield of the four cultivars did not differ significantly between flat and ridge plots, however, significant differences in plant loss and yield occurred among cultivars (Table 1).

In 1985 an interval of dry weather after planting delayed seedling emergence on both flat and ridge plots. As in 1984, emergence of Corsoy 79, Kentland and OX20-8 did not differ significantly between flat and ridge plots (Table 1). Emergence of Harcor was significantly higher on flat plots (19 plants/m) than ridge plots (15 plants/m). Yield of Harcor was significantly greater on flat plots (2122 kg/ha) than on ridge plots (985 kg/ha). Although yields of Corsoy 79, Kentland and OX20-8 did not differ significantly

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Table 1. Plant loss and yield of 4 soybean cultivars differing in susceptibility to Phytophthora root rot grown under conditions of flat and ridged minimum tillage.

Cultivar	Susceptibility **	Emergence (plants/m)				Plant loss (%)				Yield (kg/ha)			
		1984		1985		1984		1985		1984		1985	
		Flat	Ridge	Flat	Ridge	Flat	Ridge	Flat	Ridge	Flat	Ridge	Flat	Ridge
OX20-8	VS	18[a]	19[a]	18[a]	19[a]	82[a]	93[a]	91[a]	95[a]	576[a]	88[a]	265[a]	77[a]
Harcor	MT	15[a]	19[a]*	19[ab]	15[a]*	11[b]	8[b]	16[ab]	17[b]	2791[b]	2687[b]	2122[b]	985[a]*
Kentland	T	24[b]	25[b]	27[bc]	27[b]	5[b]	9[b]	10[b]	14[b]	3077[b]	3116[b]	2243[b]	1995[b]
Corsoy 79	R	18[a]	20[a]	32[c]	30[b]	1[b]	1[c]	4[c]	7[c]	3318[b]	2732[b]	3632[c]	2936[c]
$\bar{x}$		19	21*	24	23	25	28	30	33	2441	2156	2066	1498*

Means within column followed by the same letter do not differ significantly according to Duncan's Multiple Range Test, P = 0.05.
* Indicates ridge treatment differs significantly from flat treatment within the same year (P = 0.05).
** VS = very susceptible, MT = moderately susceptible, T = tolerant, R = resistant.

between ridge and flat planting, the overall mean yield of all cultivars was significantly greater on flat plots (2066 kg/ha) compared to ridge plots (1498 kg/ha).

Plant loss and yield differences reflected differences in tolerance and/or resistance to P.m.g. root rot among cultivars regardless of tillage system. Increased plant loss and decreased yield of all entries except the resistant cultivar in the second year of the experiment may also be related to increased compaction (Kittle and Gray, 1979) or increased soil inoculum as a result of monoculture of soybean cultivars (Anderson, 1986).

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Field susceptibility of scab-resistant apple cultivars and selections to frogeye leaf spot

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The susceptibility of scab-resistant apple cultivars and selections to frogeye leaf spot, the foliage symptom of black rot caused by *Botryosphaeria obtusa* (Schwein) Shoemaker, was evaluated in a fungicide-free orchard planting from 1988 to 1990. The cultivars and selections most susceptible to frogeye leaf spot were Redfree, 0-591, 0-533, 0-664 and 0-667. These had from 6 to 50 lesions per leaf depending on cultivar and year. Cultivars and selections which had very low frogeye leaf spot ratings (less than 5 lesions per terminal shoot) included Jonafree, Richelieu, Co-op 6, Co-op 9, Co-op 12, Co-op 15, 0-638, 0-648, 0-661 and 0-662.

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La susceptibilité des cultivars de pomme résistant à la tavelure et des sélections pour la tache ocellée (un symptôme foliaire de la pourriture noire causé par *Botryosphaeria obtusa* (Schwein) Shoemaker), furent évalués dans un verger sans fongicide durant les années 1988 à 1990. Les cultivars et les sélections les plus susceptibles à la tache ocellée furent Redfree, 0-591, 0-533, 0-664 et 0-667. Ceux-ci ont montrés 6 à 50 lésions par feuille selon le cultivar et l'année. Les cultivars et les sélections qui ont montré de faibles répartitions de la tache ocellée (*i.e.* moins que 5 lésions par pousse terminale) sont Jonafree, Richelieu, Co-op 6, Co-op 9, Co-op 12, Co-op 15, 0-638, 0-648, 0-661 et 0-662.

Introduction

Apple scab caused by *Venturia inaequalis* (Cke.) Wint. is the most serious disease affecting apple, *Malus domestica* Borkh., in apple growing areas of northeastern North America and may require 12 or more fungicide sprays for control. Growing cultivars resistant to apple scab eliminates the need for fungicides for scab control. However, when fungicide programs are reduced or eliminated, other diseases may become more prevalent on apple.

Black rot caused by *Botryosphaeria obtusa* (Schwein.) Shoemaker has caused serious fruit losses in southeastern United States (Jones and Aldwinckle 1990) but is not considered a serious problem in northeastern growing areas (Jones and Sutton 1984). The leaf spot phase of the disease, known as frogeye leaf spot, and the limb canker phase are more common in northeastern growing areas.

This paper reports the field susceptibility to frogeye leaf spot of scab-resistant apple cultivars, and selections derived from the Ottawa (O) breeding program and Co-op selections from the Purdue, Rutgers, and Illinois Agricultural Experiment Station Cooperative Apple Breeding Program.

Methods

A planting of scab-resistant apple cultivars and selections was established at the Smithfield Experimental Farm, Trenton, Ontario, in the spring of 1978 consisting of three trees of each cultivar and selection on each of M.26 and Ottawa 3 rootstocks. Some trees were added to the planting in later years. Trees were spaced at 2.5 × 4 m without randomization. McIntosh and Delicious, both scab-susceptible, were planted as guard trees along the periphery of the orchard. No fungicides were applied in this orchard. Insecticide and miticide sprays were applied as necessary to control insects and mites.

In late July or early August of 1988, 1989 and 1990, the three most severely infected leaves on each of 10 terminal shoots per cultivar and selection were rated for frogeye leaf spot infection. The number of frogeye leaf spot lesions per leaf was estimated using a scale of 0 to 3 (0 = no lesions; 1 = 1 to 5; 2 = 6 to 25; 3 = 26 to 50 lesions per leaf) and tr (less than 5 lesions per terminal shoot after all leaves on the shoot were examined). The mean rating for each cultivar and selection was recorded. The source of inoculum was likely from overwintering cankers on dead bark and twigs from within the orchard. Wetting periods in May and June provided suitable conditions for *B. obtusa* leaf infection (Arauz and Sutton 1989; Foster 1937).

Results and discussion

Frogeye leaf spot symptoms were observed on many of the cultivars and selections from 1988 to 1990, however, fruit infection from *B. obtusa* was not observed. Limb cankers were also observed in the orchard. The scab-resistant cultivars and selections differed in their susceptibility to frogeye leaf spot. The level of infection was generally lower from 1988 to 1990 than previously reported for 1985 (Warner 1986). The cultivars and selections which were reported resistant to frogeye leaf spot in 1985, Co-op 15,

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Table 1. Susceptibility of scab-resistant apple cultivars to frogeye leaf spot, *Botryosphaeria obtusa*, at the Smithfield Experimental Farm, 1988 to 1990.

Cultivar or selection	Leaf spot rating[x]		
	1988	1989	1990
Britegold	0	tr	1
Co-op 6	0	0	tr
Co-op 7	2	1	1
Co-op 8	0	1	1
Co-op 9	0	tr	0
Co-op 10	0	1	1
Co-op 11	tr	tr	2
Co-op 12	0	0	0
Co-op 14	1	tr	1
Co-op 15	0	tr	0
Delicious[y]	0	tr	1
Jonafree	0	0	0
Macfree	1	tr	1
McIntosh[y]	tr	tr	1
Moira	2	tr	1
Murray	0	0	2
Nova Easygro	tr	1	1
Novamac	1	2	1
0-521	0	1	tr
0-533	2	2	1
0-546	1	1	1
0-5410	tr	1	1
0-591	2	2	2
0-625	0	tr	2
0-634	0	1	2
0-637	1	1	1
0-638	0	tr	0
0-641	0	1	1
0-644	1	1	2
0-645	0	tr	1
0-648	0	tr	0
0-6410	1	tr	1
0-6413	tr	1	1
0-6414	1	tr	1
0-6415	1	1	1
0-6416	0	tr	1
0-6417	1	1	1
0-653	2	1	1
0-654	2	1	1
0-655	tr	tr	1
0-656	tr	1	1
0-661	0	tr	tr
0-662	0	tr	0
0-663	tr	1	1
0-664	1	2	2
0-667	2	1.5	2
0-669	1	tr	1
Priscilla	0	1	1
Redfree	3	2	2
Richelieu	0	tr	0
Sir Prize	0	1	tr
Trent	tr	1	1

[x] 0 = no lesions, 1 = 1 to 5, 2 = 6 to 25, 3 = 26 to 50 lesions per leaf and tr = less than 5 lesions per terminal shoot.

[y] Scab susceptible.

Jonafree, 0-661 and Richelieu, had zero or tr ratings (less than 5 lesions per terminal shoot) for frogeye leaf spot in the present study. In addition, Co-op 6, Co-op 9, Co-op 12, 0-638, 0-648, and 0-662 had ratings of zero or tr in the present study and ratings of 1 (less than five lesions per leaf) in 1985 when frogeye leaf spot infection was more severe. The most susceptibile cultivar and selection to frogeye leaf spot were Redfree and 0-591, respectively. Ratings of 2 or 3 (6 to 50 lesions per leaf) for each year were observed for these. The selections 0-533, 0-664 and 0-667 had ratings of 2 (6 to 25 lesions per leaf) for at least two of the three years evaluated. Where several lesions occurred in close proximity, (2 or 3 rating) the spots tended to coalesce forming a larger necrotic area. A rating of 2 or 3 was sufficient to cause leaf abscission.

Frogeye leaf spot is normally controlled by a combination of cultural practises and fungicide control sprays (Jones and Aldwinckle 1990; Jones and Sutton 1984). When fungicide sprays are reduced or eliminated as is the case when growing scab-resitant apple cutivars, diseases such as frogeye leaf spot may become more prevalent. This report helps to identify cultivars and selections which are susceptible to frogeye leaf spot. Susceptible cultivars should be avoided in areas where high disease pressure occurs or fungicide sprays may be required for control.

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Effects of seed infection by *Ascochyta* spp., fungicide seed treatment, and cultivar on yield parameters of field pea under field conditions

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Field trials were conducted to determine the effects of seed infection by *Ascochyta* spp., fungicide seed treatment, and cultivar on seed yield and nutrient composition of field pea seed. Emerged seedling number and bushel weight of harvested seed were significantly reduced for seed with high *Ascochyta* spp. infection and also for the pea after pea site. Seed yields, however, were not affected by high or low levels of seed infection. No significant differences were observed for seed yield and nutrient content amongst the fungicide seed treatments. Cultivar SS7 consistently out-yielded cv. Tipu by approximately 25%. In a cultivar trial, significant differences were observed among cultivars for seed yield and resistance to Ascochyta blight.

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Des essais au champs furent effectués afin de déterminer les effets de l'infection des semences par *Ascochyta* spp., les traitements fongicides des semences, le rendement des semences et la composition des substances nutritives des cultivars de semences de pois de grande culture au champs. Le nombre des jeunes plants émergés du sol et le poids des boisseaux de semences récoltées furent significativement réduits pour les semences ayant une infection élevée avec *Ascochyta* spp. ainsi que les pois cultivés une seconde fois sur la même parcelle. Les rendements de semences, quoi qu'il en soit, ne furent pas affectés par des niveaux élevés ou bas d'infection de semence. Aucune différence significative ne fut observée pour le rendement des semences et le contenu des substances nutritives parmis les traitements fongicides des semences. Le cultivar SS7 a régulièrement donné un rendement approximatif de 25 % supérieur comparé au cultivar Tipu. Dans un essai de cultivars, des différences significatives furent observées parmis les cultivars pour le rendement des semences et la résistance à la brûlure Ascochyta.

Introduction

Ascochyta blight of field pea (*Pisum sativum* var. *arvense* L.) is a disease complex comprising three distinctly recognizable symptoms, each associated with a different species of *Ascochyta*: leaf and pod spot caused by *A. pisi* Lib., foot-rot caused by *A. pinodella* Jones, and seedling blight caused by *A. pinodes* (Bark. and Blox.) Jones (5,8,13,14). The importance of this disease complex on field pea is well documented (13,14). The disease complex is usually most severe in areas of high rainfall (12). Primary inoculum of these pathogens can be either seed-borne or stubble-borne (5,8,12). Ascochyta-infected seeds usually have low germination and poor emergence (2,8). Effective seed treatments reduce the seed-borne inoculum and slow introduction of the pathogens to new areas (4,8,9,12,15). The dramatic increase in acreage devoted to field pea production in the prairies in recent years (1,6) prompted this study to assess the importance of fungicide seed treatment and cultivar on seed yield. The objectives of this study were: 1) to evaluate the effects of fungicide seed treatments and levels of seed infection on seed yield and on crude protein and phosphorus contents; and 2) to compare the yield of different pea cultivars and their resistance to Ascochyta blight under field conditions.

Materials and methods

Effects of seed infection and fungicide seed treatments. Experimental field plots were established at two sites near Barrhead in the spring of 1988: Site I, pea grown after barley and Site II, pea grown after pea. At each site, Treflan (trifluralin) was incorporated into the clay loam soils at a rate of 2.5 L/ha as a pre-emergence herbicide. A split-plot randomized complete block design with three replications was employed. The level of seed infection (SI) by *Ascochyta* spp. served as main plots, this being cv. SS7 seed with high SI (27.5%) and low SI (<0.5%), and cv. Tipu seed with low SI (<0.5%). Fungicide seed treatments served as subplots; these were Agrosol (thiram 0.40 g + thiabendazole 0.06 g a.i./kg seed), Apron 69T (metalaxyl 0.69 g + thiabendazole 0.35 g a.i./kg seed), Captan (captan 1.8 g a.i./kg seed), Thiram (thiram 0.90 g a.i./kg seed), UBI 2521 (carbathiin 0.55 g + thiabendazole 0.35 g a.i./kg seed), and a control. Seeds were treated in a cement mixer and planted 5 cm deep with a grain drill at a rate of 18 seeds/m. Each subplot consisted of 150 45-m rows, with 18 cm row-spacing. Adjacent subplots were separated by 1.5 m guard strips of barley; replicates were spaced 9 m apart. Peat-based inoculant was used as a source of root-nodule bacteria.

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Emerged seedlings were counted in 10 1-m^2 quadrants along a W-pattern transect through each subplot one month after sowing, and the mean number of plants per 1 m length of rows was calculated. At maturity, plants from each subplot were swathed and combined. Seeds were dried to 16% moisture content and weighed. Crude protein and phosphorus contents were determined using a near infrared reflectance spectrometer (11); bushel weight was determined at 10% moisture content.

Comparisons of pea cultivars. One field plot was established in the spring of 1988 near Westlock, Alberta. A pre-emergence herbicide, Edge (ethalfluralin), was incorporated into the soil at a rate of 1.6 kg/ha along with 60 kg/ha fertilizer (8-36-15-5, N-P-K-S). Twenty-four field pea cultivars were seeded in a randomized complete block design with three replications. Each single cultivar plot consisted of thirty-two 45-m rows spaced 15 cm apart. There were 30 cm between treatments and 15 m between replicates. Seeding rate and inoculant were as described above. Towards the end of the growing season, equal numbers of leaflets were removed from the upper, middle, and lower parts of the stem and arranged in sets of three leaflets each. The percentage of leaf area affected by *Ascochyta* spp. was determined using the disease assessment key designed by James (7) for Stemphylium leaf spot of red clover. One hundred and twenty sets of leaflets were rated for each plot. In addition, 20 plants from each plot were selected randomly, and the lengths of the blue-black lesions on their lower stems were measured and averaged. Seed yields were determined after harvesting the plots.

Data analysis. Analysis of variance and Student-Newman-Keuls' test were used to statistically analyze the data on number of emerged seedlings, disease severities, seed yield, and seed crude protein and phosphorus contents.

Results

Effects of seed infection. At both Sites I and II, seedling number and bushel weight of pea cv. SS7 with low seed infection significantly exceeded those of cv. SS7 with high seed infection (Table 1). The percentages of crude protein and phosphorus, and seed yield of cv. SS7, did not differ significantly between low and high seed infection. Seed crude protein content, seed yield, and bushel weight of cv. SS7 with low seed infection was significantly greater than that of cv. Tipu with low seed infection.

Effects of fungicide seed treatments. At Site I, no significant differences occurred among treatments in number of emerged seedlings, percentage of seed phosphorus, and bushel weight (Table 2). Significantly greater seed yield, however, was observed for the Agrosol treatment relative to other treatments, and in the Thiram treatment, the percentage of crude protein was significantly higher than in the Apron 69T treatment. At Site II, none of the fungicide treatments had any significant effect on seedling number, seed yield, bushel weight, and percentages of seed crude protein and phosphorus.

Comparison of pea cultivars. Greatest seed yield (4098 to 4470 kg/ha) was observed for cvs. Express, SS5, and Tara, compared with Banff, Meteor, PF70, Poppet, Puget, Scout, Signet, and Trojan, which yielded the least (1844 to 2891 kg/ha). Yield of the remaining 11 cultivars was intermediate (3000 to 3936 kg/ha) (Table 3). All cultivars were affected to varying degrees by Ascochyta blight (Table 3). Lowest percentages of infected leaf area were observed for cvs. Alaska, Jasper, Maple, Miranda, Princess, Rhonda, Signet, SS3, SS5, SS7, and Tara (11 to 13%), whereas greatest infection levels were observed for Sunset 85 and Victoria (31 and 32%, respectively). Infected leaf areas of remaining cultivars were intermediate (16 to 22%) infection. Of twenty-four cultivars examined for stem lesions,

Table 1. Effects of different levels of Ascochyta seed infection (SI) on field pea emergence, yield, and nutrient content at two sites with different cropping histories in central Alberta, Canada.

Site Treatment	Number of Seedlings (per m)	Seed Yield (kg/ha)	Crude Protein (%)	Phosphorus (%)	Bushel Weight (kg/bu)
I (Pea after Barley)					
cv. SS7 Low SI	19.7a*	4689.1a	21.9a	0.40a	29.9a
cv. SS7 High SI	17.2b	4516.0a	21.7a	0.39a	29.2b
cv. Tipu Low SI	18.6a	3608.3b	19.8b	0.39a	29.1b
II (Pea after Pea)					
cv. SS7 Low SI	17.2a	4103.8a	22.3a	0.38a	29.3a
cv. SS7 High SI	13.7b	4126.0a	22.4a	0.37a	28.8b
cv. Tipu Low SI	16.8a	3135.0b	21.2b	0.37a	28.7b

* Values in the same column within a site followed by the same letters are not significantly different at the 5% level using Student–Newman–Keuls' test.

Table 2. Effect of fungicide seed treatments on field pea emergence, yield, and nutrient content at two sites with different cropping histories in central Alberta, Canada.

Site Treatment	Number of Seedlings (per m)	Seed Yield (kg/ha)	Crude Protien (%)	Phosphorus (%)	Bushel Weight (kg/ha)
I (Pea after Barley)					
Agrosol	18.4a*	4484a	21.0ab	0.39a	29.0a
Apron 69T	17.8a	4269b	20.9b	0.40a	29.5a
Captan	18.0a	4302b	21.0ab	0.40a	29.6a
Thiram	19.1a	4238b	21.4a	0.39a	29.2a
UBI 2521	19.0a	4150b	21.1ab	0.40a	29.6a
Control	18.8a	4184b	21.2ab	0.39a	29.6a
GRAND MEAN	18.5	4271	21.1	0.39	29.4
II (Pea after Pea)					
Agrosol	15.7a	3709a	21.7a	0.38a	28.8a
Apron	15.9a	3805a	21.8a	0.38a	29.0a
Captan	16.0a	3754a	21.9a	0.37a	28.7a
Thiram	16.4a	3831a	22.1a	0.38a	29.0a
UBI 2521	15.9a	3788a	22.2a	0.37a	29.1a
Control	15.5a	3842a	22.1a	0.37a	28.9a
GRAND MEAN	15.9	3382	22.0	0.37	28.9

* Values in the same column within a site followed by the same letters are not significantly different at the 5% level using Student-Newman-Keuls' test.

twenty-one were classified as intermediate in disease resistance. Banff was the most resistant cultivar; whereas Century and Sunset 85 were the least resistant (Table 3).

Discussion

Previous studies reported that seed can become infected by mycelial growth through the pod wall when prolonged periods of precipitation occur before harvest (5,8,9,10). Seed infected by *Ascochyta* spp. usually has lower germination and poorer plant emergence in the field than does healthy seed (2,3,8,9). This is especially noticeable when seed is planted under environmental conditions adverse to rapid germination, such as low soil temperature and high moisture content (8). The results of the present study support these observations. The proportion of emerged cv. SS7 seedlings from the seed lot with a high rate of seed infection was 15% (Site I) and 26% (Site II) less than that of low SI. Therefore, it is important to use seed with a minimal level of seed infection.

The severity of Ascochyta blight fluctuates from year to year, depending upon weather conditions. The hot, dry weather experienced in 1988 would have been severely limiting to disease development and may explain some of the lack of significance among fungicide seed treatments. However, there is no doubt that pathogen populations can increase quickly and spread rapidly when environmental factors favour their development, especially where peas have been intensively cropped (14,15). The use of resistant cultivars is a highly desirable method of disease control. Results of this study demonstrate that even when environmental factors are unfavourable for disease development, the disease severity (based on percent leaf area infected and basal stem lesion length) varies among pea cultivars. This confirms previous work (2,3,13,15) which suggested that cultivars possessing a high level of genetic resistance to Ascochyta blight could be made available after an extensive breeding program.

Table 3. Comparative seed yield and Ascochyta disease severity among twenty-four field pea cultivars grown under field conditions in central Alberta, Canada.

Cultivar	Seed Yield (kg/ha)	Leaf area infected (%)	Stem lesion (cm)
Alaska 81	3068cdefg*	12c	2.3bc
Banff	2552fgh	22abc	1.0c
Century	3000cdefg	18abc	2.7b
Express	4470a	17abc	2.0bc
Jasper	3456abcdef	12c	2.3bc
Maple	3362bcdef	11c	2.0bc
Meteor	1844h	22abc	2.0bc
Miranda	3149cdefg	12c	1.3bc
PF 70	2886defg	16bc	2.0bc
Poppet	2087gh	21abc	2.0bc
Princess	3142cdefg	11c	2.0bc
Puget	2891defg	22abc	2.0bc
Rhonda	3866abcde	11c	2.0bc
Scout	2362fgh	18abc	2.0bc
Signet	2550fgh	12c	2.3bc
SS3	3258cdef	11c	2.0bc
SS5	4319ab	13c	1.3bc
SS7	3936abcd	11c	1.7bc
Sunset 85	3509abcdef	31ab	3.7a
Tara	4098abc	11c	2.0bc
Tipu	3931abcd	18abc	1.7bc
Trapper	3082cdefg	16abc	1.7bc
Trojan	2610fgh	17abc	2.0bc
Victoria	3764abcde	32a	2.3bc

* Values in the same column followed by the same letters are not significantly different at the 5% level using Student-Newman-Keuls' test.

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