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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.

Research Branch, Agriculture and Agri-Food Canada

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L'inventaire des maladies des plantes au Canada est u périodique d'information sur la fréquence des maladies de plantes au Canada, leur gravité, et les pertes qu'elle occasionnent. La rédaction accepte d'autre communications originales notamment sur la mise au poir de nouvelles méthodes d'enqête et de lutte ainsi que su l'évaluation des nouveaux produits. De temps à autre, inclut des revues et des synthèses de rapports d'intéré immédiat pour les phytopathologistes.

Direction de la recherche, Agriculture et Agro alimentaire Canada

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Foreword

This issue of the Canadian Plant Disease Survey includes a compilation of plant disease survey results for the 1994 crop year. This is the eighth year the Canadian Phytopathological Society and Information and Planning Services, Research Branch, Agriculture and Agri-Food Canada have undertaken this co-operative project.

The Society recognizes the continuing need for publication of plant disease surveys which benefit both federal and provincial agencies in planning appropriate research for the control of plant diseases. These surveys become an intrinsic part of the literature of plant pathology in Canada.

The publication of this report depends upon voluntary contributions by Canadian plant pathologists and the collation of the survey results by experts familiar with the diseases of the major crop categories. The survey is published annually in the spring issue of *Canadian Plant Disease Survey*. To meet publication deadlines all the results are due to the collators by the first of December. Instructions for submissions and forms are available from the collators. The list of collators is appended.

We wish to thank the contributors and collators who devoted their time to the production of this publication, and look forward to future contributions.

L.W. Stobbs
National Coordinator

R.M. McNeil and B.A. Morrison
Compilers, Canadian Plant Disease Survey

Avant-propos

Ce numéro de l'*Inventaire des maladies des plantes au Canada* contient les résultats compilés d'études effectuées sur les maladies des plantes pour la campagne agricole de 1994. Ce périodique, publié conjointement par la Société canadienne de phytopathologie et les Services d'information et de planification de la Direction générale de la recherche d'Agriculture et Agroalimentaire Canada, en est à sa huit année.

La Société reconnaît la nécessité de publier ces résultats sur lesquels s'appuient les organismes fédéraux et provinciaux pour planifier les travaux de recherche qui s'imposent pour lutter contre les maladies des plantes. De plus, ces études viennent enrichir incontestablement la documentation sur la pathologie des plantes au Canada.

La publication de ces rapports est réalisable grâce à la contribution bénévole de phytopathologistes canadiens et au collationnement de leurs résultats par des spécialistes des maladies des grandes cultures. Comme la publication des résultats se fait chaque année dans le numéro du printemps de l'*Inventaire des maladies des plantes au Canada*, les rapports doivent être remis aux analystes avant le 1er décembre. On peut s'adresser à eux pour obtenir les formulaires et la marche à suivre pour présenter ces rapports. On trouvera en annexe la liste des analystes faisant le collationnement.

Nous tenons à remercier tous les contributeurs et analystes qui ont consacré une grande partie de leur temps à la production de cette publication et nous espérons vous compter de nouveau parmi nos collaborateurs.

L.W. Stobbs
Coordonnateur national

R.M. McNeil et B.A. Morrison
Compilateurs, de l'*Inventaire des maladies des plantes au Canada*

Response of cultivars and breeding lines of *Phaseolus vulgaris* L. to the new alpha-Brazil race of *Colletotrichum lindemuthianum* in southwestern Ontario

J.C. Tu[1]

Fifty commercial cultivars and 34 breeding lines of white and colored beans were tested for resistance to the alpha-Brazil race of *Colletotrichum lindemuthianum* (Sacc. & Magn.) Briosi. & Cav. Among the 84 tested, 55 had disease ratings between 0 (fully resistant) and 4 (moderately susceptible). There were 15 lines or cultivars of white beans and 19 of colored beans with ratings between 0 and 1 which appear to be excellent sources of resistance.

Can. Plant Dis. Surv. 75:1, 5-8, 1995.

Cinquante cultivars commerciaux et trente-quatre lignées généalogiques de haricots blancs et de haricots colorés ont subi un test de résistance à la race alpha-Brazil de *Colletotrichum lindemuthianum* (Sacc. & Magn.) Briosi. & Cav. De ce nombre, cinquante-cinq présentaient une résistance à la maladie se situant entre 0 (entièrement résistants) et 4 (modérément sensibles). Quinze cultivars ou lignées de haricots blancs et dix-neuf de haricots colorés se sont classés entre 0 et 1, ce qui semble indiquer qu'ils soient d'excellentes sources de résistance.

Introduction

Bean anthracnose [*Colletotrichum lindemuthianum* (Sacc. & Magn.) Briosi & Cav.] is an important disease of white beans (*Phaseolus vulgaris* L.). In 1976, bean anthracnose became epidemic in southern Ontario (Tu and Aylesworth, 1979) and was caused largely by race delta and to a lesser extent by race lambda (Wallen, 1976; 1979; Tu, 1988). In 1977, a backcross program was initiated at the Harrow Research Centre, Agriculture and Agri-Food Canada, to transfer a resistant gene (Are) from PI 326418 (Cornell 49-242) to the recommended cultivars, because at that time, all recommended Ontario bean cultivars were susceptible to both races.

In addition, a strict program of seed treatment with benzimidazoles (Edgington and MacNeill, 1978), and field inspections of all pedigreed seed plots for zero anthracnose tolerance was instituted in Ontario. The disease mainly caused by the alpha and/or delta races was last observed in commercial fields during the 1983 growing season (Tu *et al.*, 1984).

During surveys of field trials in the summer of 1993, anthracnose was found in 6 of 9 locations in southwestern Ontario (Tu, 1994a). Various bean lines, including those carrying the Are gene for resistance were severely affected. Bean cultivars or lines that carry the Are gene should have been resistant to alpha, beta, gamma, delta, lambda and epsilon races (Tu *et al.*, 1984). The occurrence of the anthracnose in these lines suggested two possibilities: first that the Are lines are not homogenous for resistance to anthracnose and the genes are segregating Are/are; and second that the causal agent may be a new race of *C.lindemuthianum*.

Subsequent investigations have revealed that the 1993 anthracnose disease was caused by a new alpha-Brazil race introduced into Canada from Michigan (Tu, 1994b). The arrival of this new race necessitated a reevaluation of all existing cultivars as well as lines that are currently in variety trials for their susceptibility to the new race. This report shows that a range of resistant plant materials are available that would be a benefit to the Ontario growers and ones that will provide parental lines for bean breeders.

Materials and methods

The cultivars and breeding lines of white and colored bean that were submitted to the Ontario Cooperative Bean Variety Trial were sown in 10-cm pots with four pots per test and 5 seeds/pot. All pots were kept in a growth chamber at 21 ± 1°C on a 14-h photoperiod with a light intensity of 4.7 $\mu Mm^{-2}s^{-1}$. At the primary-leaf-stage the bean seedlings were inoculated with a spore suspension of the race

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alpha-Brazil of *C.lindemuthianum* from 3-week old colonies cultured on Mathur's agar (MA) (Champion *et al.*, 1973). Five mL of sterilized distilled water was added to each plate and the surface of the culture was scraped to dislodge the spores. The spore suspensions derived from several plates were pooled, filtered through cheese cloth and the spore concentration used in this experiment was determined with a haemacytometer. Unless stated otherwise, the spore concentration was adjusted to 10^7 spores/ml H_2O.

The spore suspension was brushed gently onto the upper- and lower-surfaces of the primary leaves and the hypocotyl with a camel hair brush. The inoculated seedlings were then covered with a transparent plastic bag (Tu and Aylesworth, 1979) and the open end of the bag was fastened to the pot with an elastic band. In general, the inoculated seedlings were kept under the plastic cover for 4 days at 20°C in a growth chamber with 14 h light. The light source was a row of cool white fluorescent lamps supplemented with incandescent lamps. The light intensity was 4.7 $\mu Mm^{-2}s^{-1}$ at bench level. Upon removal of the plastic bags, the plants were kept in the same growth chamber for symptom development. The percentage of leaf area diseased was scored 6 days after inoculation using a 0-9 scale where 0 = no disease, 1 = < 10% of leaf vein with symptoms, 2 = 10-19% .... and 9 = leaf dead. Thus, a score of 0 is considered resistant and scores between 1 and 9 show various degrees of susceptibility. The experiment was repeated once.

Results and discussion

Fifty-five commercial cultivars and breeding lines had a disease severity rating of 0 to 4 indicating a high to moderate resistance to the disease caused by race alpha-Brazil in southwestern Ontario (Table 1 and 2). Among these resistant cultivars seventeen are currently recommended cultivars and could be adopted readily into commercial production in Ontario while the breeding lines could be used by breeders in the development of resistance to this disease.

These results should be helpful to growers, breeders, seed companies, and the Ontario bean industry.

Acknowledgement

The author wishes to thank the individuals and companies for supplying the seed used for testing. The technical assistance of Mr. Jing-Ming Zheng is also acknowledged.

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Table 1. Reaction of white bean cultivars and lines to alpha-Brazil race of bean anthracnose in southwestern Ontario.†

Cultivar*	Disease severity Index‡ (0-9 scale)	Line*	Disease severity Index‡ (0–9 scale)
Ac Mariner[a]	6	GTS 525[e]	5
Shetland[a]	9	GTS 526[e]	0
OAC Cygnus[b]	0	HR43-1582[a]	5
Avanti[d]	7	HR44-1585[a]	4
Ex Rico 23[a]	8	HR46-1657[a]	5
OAC Sprint[b]	9	HR52-1712[a]	9
Centralia[a]	8	HR53-1712[a]	6
OAC Gryphon[b]	9	OAC 91-2[b]	0
Fleetside[e]	0	OAC 92-1[b]	0
Envoy[e]	0	OAC 93-1[b]	6
OAC Laser[b]	6	OAC 93-2[b]	4
OAC Speedvale[b]	0	OAC 93-3[b]	5
Vista[e]	8	OAC 93-4[b]	6
Dresden[a]	0	T9006[c]	0
Midland[c]	7	T9203[c]	0
Mitchell[a]	2	T9301[c]	5
Crestwood[e]	5	T9302[c]	4
Schooner[d]	0	T9303[c]	0
Stinger[c]	3	T9304[c]	0
OAC Seaforth[b]	4		
Wesland[c]	0		
Rocket[c]	0		
OAC Rico[b]	8		
Harowood[a]	7		

† This list may include some private cultivars and lines. Interested parties wishing to obtain seeds should write directly to the respective sources.

‡ Based on a 0–9 scale, where 0 = no disease, 1 = <10% of leaf vein with symptoms, 2 = 10–19% ... and 9 = leaf dead. Thus, a score of 0 is considered resistant and a score of 1 to 9 shows various degrees of susceptibility.

* The superscripts following each cultivar indicate the source of seeds: (a) Harrow Research Station; (b) Crop Science, University of Guelph, Ontario; (c) Thompson & Sons Ltd., Ontario; (d) Rogers N.K., Idaho; (e) Gentec Seeds, Ontario.

Table 2. Reaction of colored bean cultivars and lines to alpha-Brazil race of bean anthracnose in southwestern Ontario.†

Cultivar*	Disease severity Index‡ (0–9 scale)	Line*	Disease severity Index‡ (0–9 scale)
AC Darkid[a]	0	CCY0101[i]	7
AC Harblack[a]	6	CCY9103[i]	7
AC Litekid[a]	0	GTS 039[e]	2
Alphine[f]	7	GTS 103[e]	0
Aresteuben[a]	0	GTS 306[e]	1
Aztec[f]	6	GTS 1701[e]	0
Berna[h]	2	HR21 DL[a]	5
Blackjack[e]	8	HR33-941[a]	0
Calif. DRK[c]	0	HR41-923[a]	1
Calif. WK[c]	1	HR48-1290[a]	0
Calif. LRK[c]	0	HR49-1404[a]	4
Camelot[d]	2	HR50-1607[a]	9
Chinook[f]	0	HR54-1491[a]	0
Cran 34[e]	4	OAC 90-C1[b]	6
Cran 09[e]	6	SMV 37-16[g]	5
Drake[k]	1		
Foxfire[d]	6		
Lassen[g]	1		
Montcalm[f]	0		
OAC Tomahawk[b]	9		
Ouray[j]	0		
Pinray[e]	1		
Sacremento[g]	0		
SVM Taylor[g]	6		
T-39[c]	5		
UI-114[e]	9		

† This list may include some numbered cultivars, private breeding lines and PI accessions. Interested parties wishing to obtain seeds should write directly to the respective sources.

‡ Based on a 0–9 scale, where 0 = no disease, 1 = < 10% of leaf vein with symptoms, 2 = 10–19% ... and 9 = leaf dead. Thus, a score of 0 is considered resistant and a score of 1 to 9 shows various degrees of susceptibility.

* The superscripts following each cultivar indicate the source of seeds: (a) Harrow Research Station; (b) Crop Science, University of Guelph, Ontario; (c) Thompson & Sons Ltd., Ontario; (d) Rogers NK, Idaho; (e) Gentec Seeds, Ontario; (f) Dr. J. Kelly, Michigan State University; (g) Sacremento Milling Co., California; (h) Great Canadian Bean Co., Ontario, (i) Centralia College of Agriculture and Technology, Ontario; (j) Colorado State University and (k) Asgrow Seeds, Idaho.

Frequency and distribution of seedborne fungi infecting canola seed from Ontario and western Canada – 1989 to 1993

R.M. Clear and S.K. Patrick[1]

From 1989 to 1993, composite samples of canola from crop districts in western Canada and, from 1991 to 1993, individual producer samples of canola from Ontario were tested for the presence of seedborne fungi. Each year, 600 seeds from each western crop district and between 150 and 300 seeds from each Ontario sample were surface disinfected before plating onto 20% V-8 agar. Seventy species representing 36 genera were recovered. *Alternaria alternata* was the most common species recovered, followed by *Alternaria brassicae* and *Alternaria raphani*. The frequency with which *Alternaria alternata* was recovered from seed was higher in samples from the more easterly provinces, whereas that of *Alternaria brassicae* and *Alternaria raphani* were highest in samples from the more westerly ones.

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Entre 1989 et 1993, des échantillons composites de Canola provenant des districts agricoles de l'Ouest du Canada ont été testés afin de détecter la présence de champignons transmis par la graine. Les mêmes tests ont été effectués entre 1991 et 1993 sur des échantillons de Canola provenant de différents producteurs ontariens. Chaque année, 600 graines de semence en provenance de chacun des districts agricoles de l'Ouest et entre 150 et 300 graines de semences puisées dans chacun des échantillons de l'Ontario ont été désinfectées en surface avant d'être plantées dans du V-8 agar (20 %). Soixante-dix espèces représentant 36 genres ont été retrouvées. Parmi les espèces retrouvées, *Alternaria alternata* s'est révélée la plus abondante suivie par *Alternaria brassicae* et *Alternaria raphani*. La fréquence avec laquelle on a retrouvé *Alternaria alternata* dans les semences a été plus élevée dans les provinces plus à l'est, tandis que *Alternaria brassicae* et *Alternaria raphani* ont été retrouvées en plus grande quantité dans les échantillons provenant des provinces plus à l'ouest.

Introduction

Seedborne fungal pathogens are commonly found on canola seed harvested in Canada (Petrie, 1974; Martens *et al.*, 1984). Three of the more important pathogens are *Alternaria brassicae* (Berk.) Sacc. and *A. raphani* Groves & Skolko, the causal agents of alternaria blackspot, and *Leptosphaeria maculans* (Desm.) Ces. & de Not., the causal agent of blackleg. In Canada, the most recent field surveys for these pathogens and the diseases they cause are those of Mathur and Platford (1994), Petrie (1994), Evans *et al.* (1994), Harrison and Kharbanda (1994), Turkington and Harrison (1994) and Jesperson (1994). However, much less is known about the frequency and distribution of other seedborne fungi infesting Canadian canola seed. The most recent information is in the report by Petrie (1974). The purpose of this survey was to obtain representative samples of canola seed harvested over several years in western Canada and Ontario, and to identify the fungi infecting these seeds.

Materials and methods

Between 1989 and 1993, 14,267 samples of canola seeds (grades 1 and 2) from 28 crop districts (Fig. 1) were submitted in envelopes capable of holding 500g of seed to the Grain Research Laboratory (GRL) (Table 1) by primary elevator managers, oilseed crushing companies and canola producers in Manitoba, Saskatchewan and Alberta. In addition, 112 samples (primarily spring, but some winter canola) were received from Ontario between 1991 and 1993. All samples used herein were graded as 1 or 2 by the Industry Services Division (formerly the Inspection Division) of the Canadian Grain Commission. Samples from the three western provinces were composited at the GRL according to grade and crop districts, whereas those from Ontario were maintained as individual samples. Subsamples of the seeds were surface disinfected by soaking in a 0.3% sodium hypochlorite solution for 1 min then air-dried in a laminar flow cabinet. Usually, 300 disinfected seeds from each Ontario sample and the No. 1 and No. 2 grade of canola from the western composites from each crop district were placed onto 20% V-8 agar in petri dishes, with 15 seeds per plate. The plates were incubated for 7 days at room

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temperature under a cycle of 12 hours darkness and 12 hours of mixed UV and fluorescent light. Although the seeds from the western crop districts were tested separately, the results in the grades 1 and 2 were combined and reported in the table. In the high quality crop for 1991, there was not enough grade 2 seed to prepare composites for the western crop districts, so 600 seeds of grade 1 per western crop district were tested. Also in 1991, 150 seeds per Ontario sample were plated. Between 1989 and 1993, 53,100 seeds from western Canada and between 1991 and 1993, 27,150 seeds from Ontario were examined in this study. For samples harvested in 1989 and 1990, the virulence of the *L. maculans* isolates was established by inoculating wounded cotyledons of 7-day-old canola seedlings of the cultivar Westar with 10 µL of a 1 x 10^6 spore suspension. After growth for 10 days at 22°C, the cotyledons were examined for signs of necrosis caused by virulent isolates. For isolates collected in the years after 1990, only the cultural characteristics of the *L. maculans* isolates on V-8 agar were used to classify them as virulent or non-virulent (McGee and Petrie, 1978).

Results and discussion

The number of samples within the composites from the three prairie provinces (Table 1) ranged from 2 for crop districts where little canola is grown to 712 for districts which are centers of production (DeClercq *et al.*, 1989). Seventy species of fungi from 36 genera were recovered and identified as seedborne organisms (Table 2). The most common organism was *Alternaria alternata* (Fr.) Keissl., which was recovered from never less than 4.88% of the seeds in a crop district composite, and on average from 8.4% to 43.5% of the seeds from the four provinces (Table 2). Differences in the frequency of infection by several fungal species were recorded among the provinces. In an easterly direction from Alberta to Ontario, the frequency of seed infection by *Alternaria alternata* increased, whereas that of *A. brassicae* and *A. raphani* decreased (Table 2). *Alternaria brassicae* and *A. raphani* were 8 and more than 20 times more common, respectively, in Alberta than in Ontario. However, *A. alternata* was recovered over 5 times more often from Ontario seed than from Alberta seed. We observed that *A. brassicae* and *A. raphani* occurred more frequently on seeds from northern crop districts than southern ones, which agrees with the reports by Petrie (1974) and Clear (1992). The higher levels of these two *Alternaria* species on seeds in northern districts may be due to environmental conditions such as moisture (Tewari, 1985), and to the seeding of the earlier maturing *Brassica rapa* L. (syn. *B. campestris* L.) cultivars which are more susceptible to blackspot than are the *B. napus* L. varieties (Skoropad and Tewari, 1977; Conn and Tewari, 1989). In previous seed surveys, Petrie (1974) also found that *B. rapa* cultivars contained higher levels of *A. brassicae* and *A. raphani.*

In the western provinces, the virulent strain of *L. maculans* was most commonly recovered from seeds grown in Saskatchewan crop district 6, one of the areas where it was first detected in Canada (McGee and Petrie, 1978; Petrie, 1978), and least common in Alberta seed, where it was found only in crop districts 2 and 6 in 1992 and 1993, respectively. Ontario also had a high percentage of seeds infected by the virulent (highly aggressive) strain, and in both Ontario and Saskatchewan, this strain was more frequent than the non-virulent (weakly aggressive) one. We noted that almost all of the virulent isolates from Ontario produced a greenish pigment in the agar, whereas the western isolates rarely produced a green pigment. Chigogora and Hall (1990) reported that 85% of Ontario winter rapeseed samples they examined were contaminated by *L. maculans* and that the average seed infestation was 0.9%. Over the three years in our study of Ontario canola (primarily spring varieties), the average infection level was 0.18%. This seedborne pathogen is readily transported to uninfested fields, and even the use of seed with low infection levels can result in considerable numbers of infected seeds being sown (Clear 1992).

Eleven species of *Fusarium* were recovered, but only *F. avenaceum* (Fr.) Sacc., *F. acuminatum* Ell. & Everh., and *F. equiseti* (Corda) Sacc. were detected in each province. *Fusarium avenaceum* was the most common species of *Fusarium* recovered, and was found most often in Ontario seed samples (average of 0.54%), followed by samples from Alberta (0.14%), but particularly those from northern Alberta. One Ontario sample in 1992 had over 17% seed infection by *F. avenaceum* (Table 3). The maximum level of *Fusarium* spp. in any western crop district seed composite was 2.33% from Manitoba crop district 8, which also was identified as *F. avenaceum* (Table 3). Petrie (1974) reported *F. roseum* Lk. emend Snyder & Hansen (largely the "Acuminatum" type) to be the most frequent *Fusarium* spp. infesting the seed of rape in western Canada, but that surface disinfestation eliminated almost all of the Fusaria. Likely the reduced recovery from seed of *Fusarium* spp. by Petrie after disinfecting is due to the elimination of Fusaria present merely as a surface contaminant. *Fusarium graminearum* Schwabe (mainly group II, but also group I) was found on seed collected in Ontario and from the area of southern Manitoba where this species has been responsible for fusarium head blight of cereals in recent years (Clear *et al.*, 1994). Its presence on canola seed is likely due to saprophytic ability and its abundance in the local environment.

In Ontario, the *Arthrinium* state of *Apiospora montagnei* Sacc. was considerably more common (11%) than *Arthrinium phaeospermum* (Corda) M.B. Ellis (2%), but in the west they were recovered at about the same frequency (Table 2). *Arthrinium* was not identified to species in 1989. It is these *Arthrinium* spp. recovered from the 1989 samples

which comprise virtually all of the category entitled *Arthrinium* spp. not identified (Tables 2 and 3).

Stemphylium vesicarium (Wallr.) Simmons and *S. herbarum* Simmons were both found and the former was one of the more common fungi isolated from canola seed, especially from Ontario (Table 2). Although *S. vesicarium* is a destructive seedborne pathogen of onion (Aveling *et al.*, 1993), little is known of its effect on canola seed or its importance in canola production.

Cladosporium cladosporioides (Fres.) de Vries was most common in canola seed from Ontario and the eastern prairies, whereas *C. herbarum* (Pers.) Link ex Gray was more frequent in the western prairies. *Cladosporium macrocarpum* Preuss was only found on seed samples from the prairies. *Cladosporium cladosporioides* was identified as the dominant *Cladosporium* species infecting Ontario winter wheat seed (Clear and Patrick, 1993).

Although not usually infecting a great number of seeds, *Chaetomium* spp. were recovered from a number of samples. Species such as *C. erectum* Skolko & Groves, *C. funicola* Cooke, *C. globosum* Kunze ex Steud., *C. indicum* Corda, *C. perlucidum* Sergejeva, *C. reflexum* Skolko & Groves, and *C. spinosum* Chivers were isolated from the seed samples. They were recovered more often from canola seed than from Ontario winter wheat seed (Clear and Patrick, 1993). Their effect on canola seed quality is unknown, but soybean seed quality was not affected by *Chaetomium* sp. when artificially inoculated within the pods (Gupta and Schmitthenner, 1984).

On average, few storage fungi were detected in the samples, although a few individual Ontario samples had high infection rates (Table 3). *Aspergillus glaucus* Link ex Gray group species (teleomorph *Eurotium* Link ex Fr.) was the dominant group species, others being rarely recovered. The low levels of storage fungi reflect the short time the seed was in commercial storage before sampling.

Other species identified but not listed in the tables include *Preussia fleischhakii* (Auersw.) Cain, an unnamed *Preussia* species similar to *P. aemulans* Arx but of smaller dimensions, *Sordaria fimicola* (Rob.) Ces. & de Not., and *Verticillium nigrescens* Pethybr.

Infected seed can be an important source of disease spread. In Alberta, considerable effort has been expended to control the spread of the virulent form of *L. maculans*. Growers there are advised to purchase seed that has been tested for the virulent blackleg, and to treat all canola seed for planting with a recommended fungicide (Anonymous, 1994). Besides transporting pathogens of canola, it is evident that pathogens of other crops may be recovered from canola seed. The importance of this type of spread is unknown. However, the direct impact of seed infection on canola is likely minimal, although some seed samples may suffer germination or emergence problems due to seedborne pathogens. The most common fungi, the *Alternaria* species, have little effect on canola seed (Petrie, 1974), and in general seedborne fungi are rarely significant in rapeseed emergence problems (Martens *et al.*, 1984). There are reports of non-traditional pathogens such as *Epicoccum nigrum* Link ex Link affecting canola seed (Khulbe *et al.*, 1992), but the low frequency of this and other fungi suggests that their potential impact is minimal. However, soilborne diseases of the seedling and resulting plant are important (Tewari, 1985) and their occurrence on seed may be used as one indicator of the frequency and distribution of these organisms in the field as well as being a means of dispersal over time and space.

Acknowledgements

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Table 1. Number of canola samples (grades No. 1 and No. 2) in each western crop district composite from 1989 to 1993.

Crop District *	1989	1990	1991	1992	1993	Total
Manitoba						
1	60	54	39	37	49	239
2	60	117	122	119	74	492
3	60	119	77	62	81	399
4	33	53	33	17	27	163
5	51	69	44	20	31	215
6	32	43	77	35	47	234
7	60	105	112	85	105	467
8	60	116	135	56	110	477
9 & 10	54	38	77	35	49	253
11	46	37	78	17	26	204
12	21	25	10	6	16	78
Total	537	776	804	489	615	3221
Saskatchewan						
1	142	102	131	286	103	764
2	22	16	33	78	65	214
3	106	24	39	40	41	250
4	6	2	9	11	6	34
5	147	328	424	712	421	2032
6	171	145	148	319	233	1016
7	82	66	43	140	119	450
8	167	346	353	472	227	1565
9	128	430	271	612	221	1662
Total	971	1459	1451	2670	1436	7987
Alberta						
1	16	14	26	12	22	90
2	102	114	85	39	173	513
3	56	55	47	5	68	231
4	135	249	178	156	232	950
5	91	100	59	40	96	386
6	79	67	53	45	82	326
7	136	168	65	60	134	563
Total	615	767	513	357	807	3059

* See Fig. 1. Crop districts of western Canada.

Table 2. Average level of fungal infection (%) of Canadian canola seed between 1989 and 1993.

Fungi	Alberta*	Saskatchewan*	Manitoba*	Ontario**
Acremoniella atra	0	0	0.01	0.19
Acremonium spp.	0	0	tr	tr
Actinomycetes	0	0	0	0.01
Alternaria alternata	8.40	9.30	14.99	43.48
A. brassicae	3.40	1.20	1.15	0.42
A. raphani	1.66	0.48	0.34	0.07
Apiospora montagnei	0.19	0.14	0.16	0.60
Arthrinium phaeospermum	0.20	0.09	0.13	0.03
Arthrinium not ID	0.11	0.13	0.18	0.01
Ascomycetes	0	0	0.01	tr
Aspergillus candidus	0	0	0	0.01
A. flavus	0	0	0	0.06
A. glaucus	0.04	0.10	0.03	0.39
A. niger	0	0	0	tr
A. ochraceus	0	0	tr	0
A. terreus	0	0	0	tr
A. versicolor	tr	0	tr	tr
Aureobasidium pullulans	tr	0	0	0
Botrytis cinerea	tr	0	0	0.02
Cephalosporium spp.	0.02	0	tr	0
Chaetomium spp.	0.07	0.07	0.03	0.17
Cladosporium cladosporioides	0.05	0.03	0.07	0.32
C. herbarum	0.11	0.04	0.01	0.03
C. macrocarpum	0.03	0.05	tr	0
Cladosporium not ID	0	0	0	0.03
Cochliobolus bicolor	0	0	0	tr
C. sativus	0	0.1	0.03	0.03
C. spicifera	0	0	tr	0
Coelomycetes	0.01	0.02	0.02	0.04
Curvularia lunata	tr	0	tr	tr
Drechslera biseptata	0	0	0	0.26
Epicoccum nigrum	0.05	0.03	0.06	0.57
Fusarium acuminatum	tr	0.03	0.03	0.07
F. avenaceum	0.14	tr	0.10	0.54
F. culmorum	0	0	0	tr
F. dimerum	0	0	tr	0
F. equiseti	0.01	0.01	0.03	0.04
F. graminearum	0	0	0.02	0.11
F. oxysporum	0	0	0	tr
F. poae	tr	0.01	0	0.01
F. semitectum	0	0	0	tr
F. sporotrichioides	0	0	0.03	0.14
F. tricinctum	0	0	0	0.01
Fusarium spp. not ID	0	tr	0	0.01
Gonatobotrys spp.	0.09	0.07	0.15	2.23
Leptosphaeria maculans (avirulent)	0.10	0.05	0.09	0.01
L. maculans (virulent)	0.01	0.15	0.05	0.18
Microascus longirostrus	0	0	tr	0
Mucor spp.	tr	0.01	0.01	0.08

(cont'd.)

Fungi	Alberta*	Saskatchewan*	Manitoba*	Ontario**
Myrothecium spp.	0.02	tr	0.01	0
Nigrospora oryzae	tr	0.02	0.05	0.01
N. sphaerica	0	0	0	0.01
Papulospora spp.	0	0.03	0.01	tr
Penicillium spp.	0.01	0.03	0.02	0.55
Phaeoramularia spp.	0.01	0.03	0	0
Plectosphaerella cucumerina	tr	tr	0.02	0.39
Preussia spp.	tr	0	0.01	0
Pseudomicrodochium spp.	0	0	tr	0
Pyrenophora teres	tr	0	0	0
Rhizoctonia solani	0	0.01	0.01	0.01
Sclerotinia sclerotiorum	tr	0	0.01	0.07
Scopulariopsis spp.	0	0	tr	0
Sphaeronaemella fimicola	0	0	0	0.13
Stemphylium herbarum	tr	0.01	tr	tr
S. vesicarium	0.12	0.07	0.16	1.38
Stemphylium not ID	0	0	0.01	0
Trichothecium roseum	0	0	0	tr
Ulocladium atrum	0.03	0.01	tr	0
Verticillium spp.	0	0.01	0.02	0.03
Yeast	0	tr	0	0.01

* Five-year average, 1989 to 1993.
** Three-year average, 1991 to 1993.
tr Trace (<0.01%).

Table 3. Maximum percentage of fungal infection of Canadian canola seed in any one sample between 1989 and 1993.

Fungi	Alberta*	Saskatchewan*	Manitoba*	Ontario**
Acremoniella atra	0	0	0.33	4.67
Acremonium spp.	0	0	0.33	0.33
Actinomycetes	0	0	0	0.33
Alternaria alternata	33.00	46.00	61.67	95.00
A. brassicae	24.33	8.67	11.33	6.00
A. raphani	13.67	4.33	8.00	1.67
Apiospora montagnei	2.67	1.33	2.67	11.33
Arthrinium phaeospermum	1.33	1.00	1.33	2.00
Arthrinium not ID	4.00	2.00	12.00	1.00
Ascomycetes	0	0	0.33	0.33
Aspergillus candidus	0	0	0	0.33
A. flavus	0	0	0	0.33
A. glaucus	0.67	3.67	2.00	9.00
A. niger	0	0	0	0.33
A. ochraceus	0	0	0.33	0
A. terreus	0	0	0	0.33
A. versicolor	0.33	0	0.33	0.67
Aureobasidium pullulans	0.33	0	0	0
Botrytis cinerea	0.33	0	0	0.67

(cont'd.)

Fungi	Alberta*	Saskatchewan*	Manitoba*	Ontario**
Cephalosporium spp.	0.67	0	0.33	0
Chaetomium spp.	0.67	1.00	0.67	11.00
Cladosporium cladosporioides	0.67	0.67	1.00	14.67
C. herbarum	1.00	1.00	0.33	0.67
C. macrocarpum	.67	1.00	0.33	0
Cladosporium not ID	0	0	0	2.00
Coelomycetes	0.33	0.67	0.33	1.00
Cochliobolus bicolor	0	0	0	0.33
C. sativus	0	0.33	0.33	1.33
C. spicifera	0	0	0.33	0
Curvularia lunata	0.33	0	0.33	0.67
Drechslera biseptata	0	0	0	22.67
Epicoccum nigrum	0.33	1.00	1.00	3.67
Fusarium acuminatum	0.17	1.00	0.67	1.00
F. avenaceum	2.00	0.33	2.33	17.33
F. culmorum	0	0	0	0.33
F. dimerum	0	0	0.33	0
F. equiseti	0.33	0.33	1.00	1.00
F. graminearum	0	0	0.67	1.33
F. oxysporum	0	0	0	0.33
F. poae	0.33	0.33	0	0.67
F. semitectum	0	0	0	0.33
F. sporotrichioides	0	0	1.00	2.00
F. tricinctum	0	0	0	0.33
Fusarium spp. not ID	0	0.33	0	0.33
Gonatobotrys spp.	1.33	1.00	4.00	24.00
Leptosphaeria maculans (avirulent)	1.00	0.67	1.67	0.67
L. maculans (virulent)	0.67	1.33	1.00	5.33
Microascus longirostrus	0	0	0.33	0
Mucor spp.	0.33	0.33	0.33	3.33
Myrothecium spp.	1.00	0.17	0.67	0
Nigrospora oryzae	0.33	0.33	0.33	1.33
N. sphaerica	0	0	0	0.33
Papulospora spp.	0	0.67	0.33	0.33
Penicillium spp.	0.33	0.67	0.67	41.33
Phaeoramularia spp.	0.33	0.33	0	0
Plectosphaerella cucumerina	0.33	0.33	1.00	18.00
Preussia spp.	0.33	0	0.33	0
Pseudomicrodochium spp.	0	0	0.33	0
Pyrenophora teres	0.17	0	0	0
Rhizoctonia solani	0	0.33	0.33	0.67
Sclerotinia sclerotiorum	0.33	0	0.33	1.33
Scopulariopsis spp.	0	0	0.33	0
Sphaeronaemella fimicola	0	0	0	11.33
Stemphylium herbarum	0.33	0.33	0.33	0.33
S. vesicarium	1.00	1.00	1.33	21.00
Stemphylium not ID	0	0	0.33	0
Trichothecium roseum	0	0	0	0.33
Ulocladium atrum	0.33	0.33	0.33	0
Verticillium spp.	0	0.33	0.33	1.67
Yeast	0	0.17	0	0.33

* Samples collected from 1989 to 1993.
** Samples collected from 1991 to 1993.

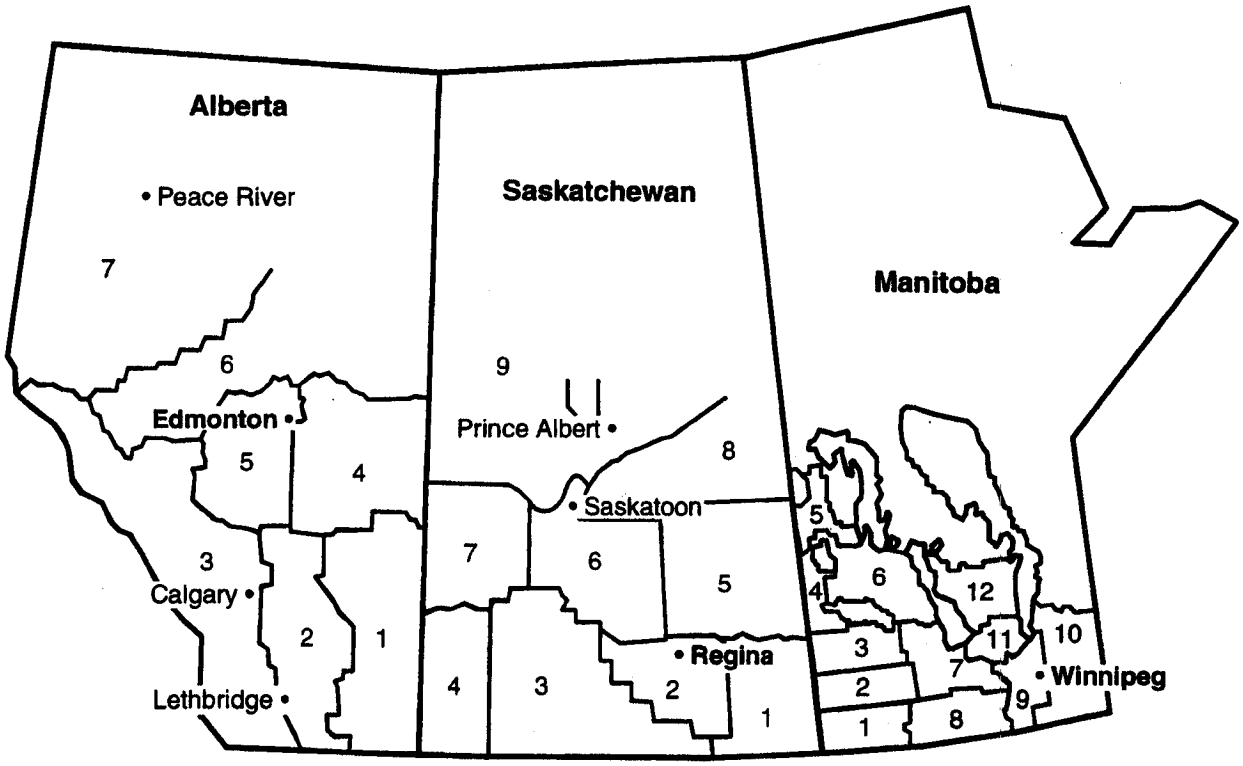

Fig. 1. Crop districts of western Canada.

Survey for rupestris stem-pitting and corky bark diseases of grapevine in the Niagara peninsula, Ontario

L.W. Stobbs and J.G. Van Schagen[1]

To determine the incidence of rupestris stem-pitting (RSP) and corky bark (CB) diseases in grapevine, dormant wood was collected from ten susceptible varieties from 350 vineyards across the Niagara peninsula. Chipbuds taken from twenty vines of each cultivar available at each site were grafted onto *Vitis rupestris* St. George for the detection of RSP and onto LN33 to differentiate RSP from CB. The cuttings were rooted, planted in nursery rows and observed over 3 years for the presence of RSP or CB symptoms. The plants were dug in November 1987, trunk sections were peeled, and the wood was examined for the characteristic pitting and grooving of the two diseases. Buds from wood collected in the Niagara vineyards failed to produce disease symptoms on St. George or LN33 typical of RSP or CB. Detailed questionnaires sent to over 350 growers similarly did not identify any significant production losses or decline in vine vigor which might be attributable to RSP or CB.

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Afin de déterminer l'incidence de la maladie du bois strié de rupestris (BSR) et de l'écorce ligneuse (EL) dans les vignes, on a recueilli du bois dormant issu de dix variétés vulnérables. Le bois provenait de 350 vignobles de la péninsule du Niagara. Des implants tissulaires puisés dans 20 différentes vignes de chacun des cultivars disponibles, à chacun des sites, ont été greffés sur *Vitis rupestris* St. George afin de détecter le BSR et sur LN33 pour différencier le BSR de l'EL. Les boutures ont été enracinées et plantées en pépinière. Elles ont été ainsi gardées en observation pendant 3 ans, au cas où on détecterait les symptômes du BSR et de l'EL. Les plants ont été arrachés en novembre 1987. Des sections de tronc ont été écorcées et le bois a été examiné au cas où les caractéristiques des deux maladies s'y trouveraient (stries et sillons). Des bourgeons ramassés dans les vignes du Niagara et greffés sur les cultivars St. Georges ou LN33, tous les deux sensibles au BSR ou à l'EL, n'ont affiché aucun des symptômes de ces maladies. Un questionnaire détaillé, envoyé à 350 producteurs, n'a pas non plus révélé de pertes importantes dans la production ou la vigueur des vignes qui auraient pu être attribuées au BSR ou à l'EL.

Introduction

Rupestris stem-pitting (RSP) and corky bark (CB) diseases of grapevine are widespread throughout many of the viticultural regions of the world (3,4). Both diseases produce no obvious symptoms on the leaves or fruit of most *Vitis vinifera* cultivars, but cause a slow decline in vine vigor and production (2,4,5,6). Both diseases may delay bud break in the spring, while in some cultivars CB may cause stunting at bud break and shoot dieback later in the growing season (3,4,6). Both diseases are graft transmissible and are spread mainly through propagation. RSP was introduced into North America from grape wood that was imported from western Europe since 1950 (4), and is now widespread in many French American and American hybrids in vineyards across the northern and eastern United States (1,6). Symptoms associated with these diseases have not been reported in the grape industry in southern Ontario. However, since these diseases may remain latent on scion or rootstock cultivars, there is a potential for a serious decline in grape production which has a yearly farm gate value of 23 million dollars. In this study, the incidence and distribution of RSP and CB was assessed to determine their potential impact on grape production in the Niagara peninsula.

Materials and methods

Surveys were made of 350 grape growers across the Niagara peninsula (Fig. 1) and grapevine varieties for this study were selected on the basis of their production and susceptibility to rupestris stem-pitting disease (RSP). Varieties sampled included Baco Noir, DeChaunac, Gamay, Gamay Beaujolais, Gewurtztraminer, Le Commandant, Niagara, Chardonnay, Pinot Noir and Riesling. Two meters of dormant wood was collected from each of 20 vines per variety available at each site from late October 1983 through February 1994. The wood was stored in polybags at 4°C for up to 4 months until used for grafting. Healthy wood of the

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10 varieties was obtained from the virus-indexed nuclear stock planting at this station and used as controls.

Dormant cuttings (20–30 cm long) were collected from plants of *Vitis rupestris* St. George which was used as an indicator for RSP and from Cultivar LN33 which was used to differentiate RSP from corky bark. The cuttings were treated with 0.5% (aq.) Chinosol W (Hoechst Aktiengesellschaft, Frankfurt, Germany) to control rot and stored at 4°C until grafting.

A chipbud of the candidate selections was grafted onto St. George or LN33approximately 5 cm below the growing shoot of the indicator. Wood from vines infected with a California isolate of RSP and CB was obtained from the Center for Plant Health, Agriculture and Agri-Food Canada, Sidney, British Columbia, and chipbud grafted as infected standards. Virus-free chipbuds grafted onto uninfected rootstocks were used as non-infected controls. The grafts were wrapped with grafting tape, covered with grafting wax, and rooted in Perlite (Grace and Co. Canada, Ajax, Ontario) in a mistbed for 2 months. Rooted cuttings were transferred to a cold frame for hardening off, and then planted in nursery rows in May 1984. The cuttings were spaced 45 cm apart in rows with 1 m between the rows. The plants were evaluated annually over 3 years for the presence of RSP or CB symptoms, based on examination for leaf and shoot symptoms and differences in bud break and vine vigor. Differences in time of leaf abscission in the fall and bud break in the spring were noted.

The plants were dug in November 1987 and trunk sections were autoclaved for 20 minutes at 121°C to soften the bark. The bark and wood on each trunk was examined for severity of pitting and/or grooving.

Results and discussion

Questionnaires received from 350 growers did not identify any significant production losses or decline in vine vigor. Thirty-two growers indicated declining yields in the cultivar Niagara, but field inspection of these vineyards attributed losses primarily to poor cultural conditions or other disease problems. An additional thirty-eight growers cited production losses in vinifera cultivars which were generally attributable to phylloxera infestations (*Daktulosphaira vitifoliae* (Fitch), severe powdery mildew infections (*Uncinula necator* (Schw.) Burr.), or crown gall infection (*Agrobacterium vitis* (Ophel and Kerr). Symptoms typical of RSP or CB were not evident in field plantings during this study.

Buds from the plant materials collected in vineyards failed to produce symptoms which were typical of RSP or CB on St. George or LN33 respectively. No differences were observed in budbreak or leaf abscission between test and control vines. St. George indicator plants, inoculated with RSP-infected buds and grown in the station plots, developed swollen graft unions and pitting of the woody cylinder directly below the inoculation bud which are typical symptoms of RSP (6). Infected vines had poor vigor and were more susceptible to winter injury than healthy plants. Within 3 years of inoculation, 70% of the infected control plants were dead. No symptoms were produced on LN33 that were grafted with buds from the Niagara vineyards, confirming the absence of CB disease. The infected controls produced stunting and spongy bark with longitudinal fissures on the LN33 indicator and the underlying woody cylinder was frequently pitted or grooved. Low levels (ca. 1 %) of grapevine fanleaf virus (GFLV) were detected in grafted St. George, producing diffuse foliar chlorotic spots and rings. GFLV identity was confirmed by enzyme-linked immunosorbent assay.

Routine indexing of diagnostic samples collected from commercial vineyards after 1987 were free of RSP or CB.

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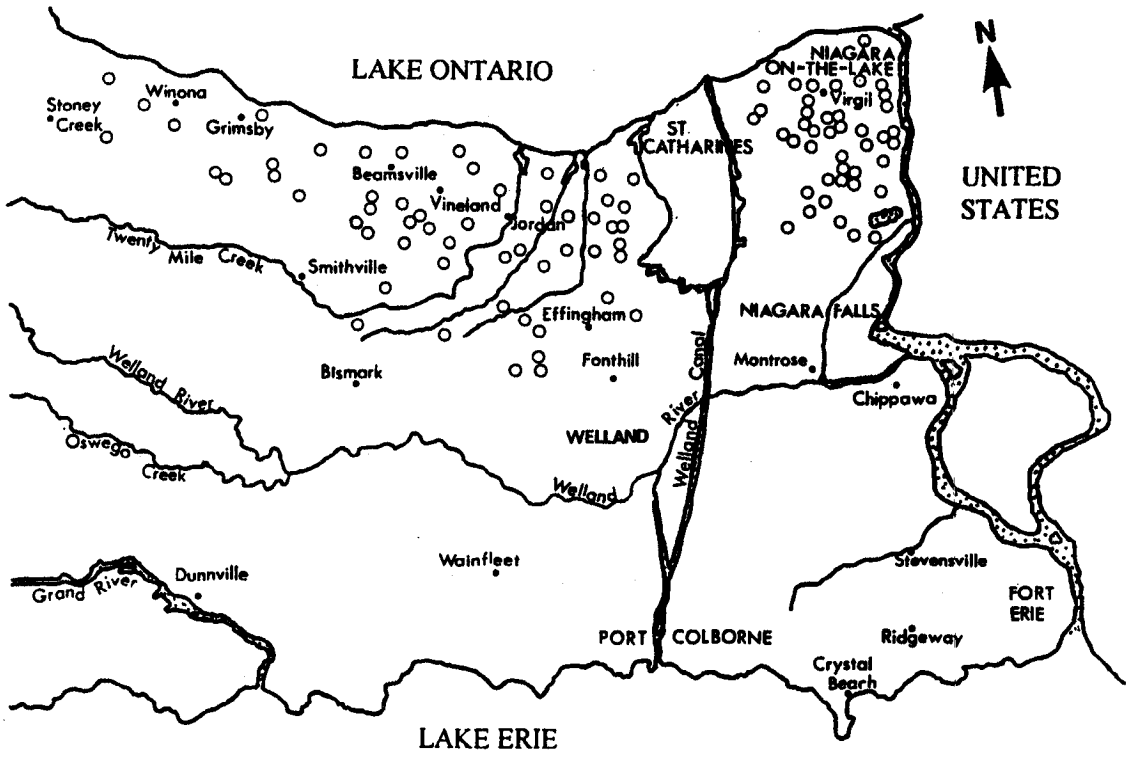

Fig. 1. Distribution of sampling sites across the Niagara peninsula in the rupestris stem-pitting and corky bark disease survey. Many circles represent more than one site and more than one grapevine variety.

Long-term survival and sporulation of *Leptosphaeria maculans* (blackleg) on naturally-infected rapeseed/canola stubble in Saskatchewan

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In semi-arid Saskatchewan, Canada, peak ascospore discharge by *Leptosphaeria maculans* from blackleg-infected rapeseed/canola (*Brassica napus* and *B. rapa*) stubble residue generally occurred in the second year following the year of crop growth. Over 90% of the original stubble had disappeared by that time, leaving infected crowns and taproots that deteriorated slowly under the prevailing dry surface soil conditions. Ascospores of *L. maculans* continued to be discharged from this residue for a further 3-5 years, greatly exceeding the mean 3.3 year length of rotations out of rape followed by producers. Ascospore discharge from stubble residue could be intermittent, occasionally missing entire years. Burial or flooding of infected 19-month-old stubble for 10 days almost entirely eliminated the production of ascospores. Rape stems with severe basal cankers produced *L. maculans* ascospores earlier and in greater numbers than did stems with extensive superficial lesions taken from the same field.

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Dans les conditions semi-arides de la Saskatchewan (Canada), la période de pointe d'éjection des ascospores, attribuable à *Leptosphaeria maculans* sur les résidus de chaume de Canola infectés par la jambe noire, se produit habituellement pendant l'année suivant la récolte. À ce moment, plus de 90 % du chaume original avait disparu, laissant des couronnes et des pivots infectés qui se sont détériorés lentement étant donné les conditions de sol sec à la surface. L'éjection d'ascospores de *L. maculans* à partir de ces résidus s'est poursuivie pendant 3 à 5 ans, dépassant largement la durée moyenne de rotation de 3,3 ans, sans colza, que les producteurs ont adoptée. L'éjection d'ascospores dans les résidus de chaume peut être intermittente. Il arrive occasionnellement que des années complètes en soient épargnées. L'enfouissement ou l'immersion pendant 10 jours de chaume infecté, vieux de 19 mois, a pratiquement éliminé toute production d'ascospores. Les tiges de colza présentant des chancres basilaires importants ont produit plus rapidement et davantage d'ascospores de L. maculans que ne l'ont fait les tiges portant de larges lésions superficielles dans le même champ.

Introduction

The virulent form of *Leptosphaeria maculans* (Desm.) Ces. & de Not. has become endemic in the parts of Saskatchewan where rapeseed/canola (*Brassica napus* L. and *B. rapa* L.) is grown (14). After harvest the fungus develops saprophytically on stubble of both blackleg-susceptible and resistant cultivars of *Brassica* spp. (8). Elimination or neutralization of infected stubble is of prime importance in blackleg control strategies. Ascospores produced on stubble are the most important agents of infection of canola crops in Canada (12) and abroad (5,17). Genetic recombination of the fungus on stubble may produce pathotypes capable of attacking important sources of genetic resistance, such as *Brassica juncea* (L.) Coss. Such pathotypes have already been found in Australia (3). Long-term survival of *L. maculans* on canola stubble residue in the semi-arid Saskatchewan environment has not been studied in depth. In Australia, over 90% of the residue of a rapeseed crop disappeared during the first 12 months following harvest (11). However, ascospores continued to be produced on the remaining crop debris for at least three years after harvest (11). In France, infected pieces of rapeseed stubble were found in some fields for at least seven years (16).

The virulent form of *L. maculans* has been slow to spread into northern canola-producing parts of Saskatchewan from areas farther south (14). This is likely due, in part, to more moist conditions in the north that permit more frequent field cultivation, more complete burial of trash, and hence its accelerated decomposition. Water frequently stands in depressions in producers' fields for considerable periods every spring because drainage is impaired by frozen underlying soil. The effect of flooding on infected stubble is not known.

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Objectives of this study were: (1) to examine the effect of cropping practices in central Saskatchewan on blackleg severity and on the rate at which canola stubble disappeared from farm fields; (2) to examine the effect of the immersion in water or burial of ascospore-producing canola stubble on spore production; (3) to examine the possibility of resumption of ascospore production on apparently "spent" material.

Materials and methods

Survey. From 1977–94, crop rotations and the incidence of blackleg were recorded for a total of 100 fields in 11 rural municipalities around Saskatoon (15). Sixty of the 100 fields were seeded to canola in May of 1994 and after harvest these fields were surveyed for blackleg as previously described (15).

Flooding. The effect of artificial flooding of naturally-infected 1-year-old stems of *B. napus* on ascospore production by the virulent form of *L. maculans* was studied in 1992. Thirty samples of 18 6-cm segments of basal stem were prepared from stubble collected March 27, 1992. Initial sporulation levels were determined on March 31 using ascospore liberation tunnels (7). Air flow through each tunnel was adjusted to 13,000 cc/min using a Rotameter (Brooks Rotameter Co., Lansdale, PA). The stems were moistened with water and ascospores caught on vaseline coated microscope slides for 1.5 hours. Spores were stained with cotton blue in lactophenol (1). Spore numbers were expressed per 10 g stubble per 1.5 h. The individual samples were placed in transparent plastic containers 11 cm dia. x 13 cm high, each fitted with a wire grid 7.2 x 8.0 cm to keep the stems immersed. Four hundred mL of deionized water were added to each, except the controls, and the grids adjusted so that the stem pieces were covered by 3 cm of water. Five lots of 18 stem pieces each were immersed for 0, 1, 3, 6, 10 or 15 days, the water was removed, the stems were placed outdoors and 4, 8, 14, 18 and 26 weeks later were tested for ascospores. The stems were returned outdoors for the winter and retested in June, 1993. Spore numbers were transformed to natural logarithms and the data analyzed using the SAS GLM statistical package procedure (SAS Institute Inc. 1989).

Burial. Samples of naturally-infected canola stubble were buried 3-4 cm deep in a sandy loam soil with a field capacity (F.C.) of 30.7%. The time required for cessation of sporulation was determined at soil moisture levels ranging from 13–70% F.C. Ascospore discharges prior to and after periods of burial were measured as previously described. The soil and stems were kept in wooden flats lined and covered with aluminum foil and maintained at 20–25°C. Control samples were left exposed to the air in 10-cm plastic pots on the soil surface. Samples, once dug up, were not reburied.

Long-term survival studies. Selected producers' fields were sampled at least once annually for four or more years. Standing stubble in six 1-m^2 quadrats was pulled, air-dried, counted and weighed. Subsequently the fields were resampled by removing the top 5 cm of soil in six 1-m^2 quadrats per field and passing it through a wire sieve having a 0.5 cm mesh. The rape stubble residue present in each quadrant was weighed, the number of pieces counted, and the number of ascospores present / 10 g stubble / 1.5 hours determined. Studies of longer duration started with 7 to 19-month-old naturally infected canola stubble and were continued for seven years or more. Initially, material collected in April was cut into 6-cm lengths, each piece including a portion of the taproot. Samples were stored outdoors in well-drained wooden flats. Every year spore discharge was tested monthly from April to October.

Preliminary experiments indicated that severely cankered stems produced more ascospores over a longer period than stems having relatively mild symptoms. Collections were made from two crops infected by the virulent strain of *L. maculans*, one grown in 1990 and the other in 1991. Material from each field was divided into stems having superficial lesions and those with severe basal cankers. Material was incubated outdoors and was tested for ascospore discharges once monthly from June to September, starting in the year after crop growth.

Results

Survey. Of the total crops grown in the 100 fields over 17 years, 46.5% were cereals and 22.1% were *Brassica* crops, chiefly rapeseed/canola. Other crops made up 7% and summerfallow, 24.4% (Fig. 1). Eighty-four percent of the fields were fallowed in the year preceding a canola crop, while 87% of the crops following canola were cereals (Fig. 2). Thirty fields had three or more canola crops during the study. On average, 2.1 years elapsed between canola crops 1 and 2, 3.4 years between canola crops 2 and 3, and 2.9 years between crops 3 and 4. For 80 fields the mean number of summerfallow years between 1984 and 1988 and between 1989 and 1993, was 1.4. Although some producers had adopted continuous cropping, this practice was not common in the fields surveyed.

A three-year rotation (two years out of canola) was the most common one in the 60 fields surveyed in the autumn of 1994 (Table 1). The mean overall blackleg incidence was highest (97.7%) in fields with a 2-year rotation. Mean blackleg incidence still exceeded 63% in fields which had not grown canola for 6-12 years. Two fields which had not grown canola for 12 years had incidences of 90%. However, the mean percentage of severe basal stem cankers declined sharply after one year and remained relatively low when fields were out of canola for three or more years (Table 1). Some results for individual fields are shown in Fig. 3. In

general, the incidence of virulent blackleg increased in successive canola crops grown in the same field if they were separated in the rotation by one to three years. When they were separated by five or more years, the incidence of blackleg usually declined sharply. Field 11 is an example of relatively short intervals between canola crops, and fields 6 and 25 illustrate the results usually seen with longer rotations of four to six years. Exceptions to the pattern were seen. Although seven years elapsed between the second and third canola crops in field 80, the incidence of the weakly virulent strain commonly found on canola increased greatly in crop 3 and incidence of the virulent strain remained unchanged (Fig. 3).

Flooding. Prior to flooding, the pathogen produced approximately 4,000 ascospores per 10 g stubble per 1.5 h. Immersion in water for six days or more permanently reduced ascospore discharge to very low levels (Table 2). Samples immersed for three days showed a temporary increase in sporulation eight weeks after flooding but spore production was erratic. The numbers of ascospores discharged by the five replicate samples ranged from 6–406% of those recorded prior to treatment. Sporulation in samples immersed for one day recovered slowly to greater than pre-flooding levels, producing more spores than the controls at 18 and 26 weeks after treatment. However, 15 months after flooding, sporulation in all samples had dropped below pre-treatment levels. Even ascospore production in the 1-day treatment exhibited a much greater decline than the controls. Statistically significant differences were found between treatments and dates. Results for all treatments except one day's flooding were significantly different from the unmoistened checks (Table 3).

Burial. Immediately prior to burial in soil, samples discharged between 1,000 and 6,000 ascospores per hour. Those samples retested following burial for 24 h showed an increase in spore numbers of up to 400%, regardless of soil moisture content. This was commonly observed and is attributed to the moistening required for the initial test of spore numbers prior to burial. At soil moistures of 40–70% F.C., spore discharge declined sharply by the fourth day after burial and depletion occurred in 10-13 days. *L. maculans* did not recover its ability to produce ascospores after these samples were removed from the soil. Spore release from samples buried in soil of 13–20% F.C. and from exposed control samples remained at high levels for six weeks. Depletion at 13–20% F.C. took 105 days or more. Several weeks' burial of fresh infected stubble on which production of ascospores had not started completely prevented their formation.

Long-term survival. The rate of loss of surface stubble residue from field 12 was typical of that in many fields sampled between 1981 and 1990. Stubble residue from a 1978 rape crop was present in field 12 when a second rape crop was grown in 1981. In May, 1982, an average 8.2 ± 3.3 g/m^2 of 1978 residue remained and this declined to 5.8 ± 2.3 g/m^2 by the fall of 1982. Small numbers of ascospores (approximately 10/10 g stubble/1.5 h) were discharged from this material in 1982. The amount of 1981 stubble remaining on or near the soil surface declined rapidly under normal cultivation practices (Fig. 4). An initial cultivation of standing stubble reduced the weight of surface trash/m^2 by 55% (Table 4). Twenty-four months after the crop was harvested only 10% by weight of the original stubble remained. The mean number of ascospores produced by the stubble in field 12 per m^2 24 months after harvest was 0.1% of that produced 13 months after harvest. However, it is important to note that spore numbers fluctuated over the growing season each year, being higher in May-June and lower in July-August (Table 4). Sporulation continued on the 1981 stubble for at least four years. It was sufficient to cause heavy infection in a 1984 crop in field 12 and substantial stand reduction in portions of a neighbouring rape crop planted in 1985. The percent incidence of infection in the 1984 crop was 96.5 ± 2.7 and the average estimated percent yield loss, 69.4 ± 2.0. The mean weight of stubble/m^2 in August, 1984, was 168.4 ± 28.6 g. This had declined to 100.8 ± 26.9 g one year later, a reduction of 40.1%. Twenty-three months after the crop 25.9% of the stubble remained, and 33 months later, 12.3%.

The amount and seasonal timing of sporulation recorded in field 12 and in many others was more than sufficient to bridge the interval between successive rape crops. Field 10 grew its last rape crop in 1981. The disappearance of rape stubble from this field mirrored that in field 12. Blackleg-infected rape stubble was collected from the soil surface in field 10 over the following 10 years. Ascospore discharges were obtained from freshly collected rape stubble residue as late as 1989.

Ascospore production by *L. maculans* on stubble residue at the soil surface generally reached its maximum level in the second year after crop growth and declined thereafter. When conditions were unfavourable to the initiation of ascospore production in the year after crop growth, as in 1987 and 1988, maximum sporulation was often not achieved until the third year after a rape crop (Table 5). Numbers of spores usually had dropped to low levels or sporulation had ceased by the fifth year after crop growth, although occasionally sporulation continued in the sixth or seventh year. In field 11, residue from at least two rape crops, grown in 1986 and 1989, produced ascospores simultaneously for at least three years (1990–92). Sporulation on residue of the 1989 crop stopped before that on residue of the 1986 crop. Sporulation on the latter had built up to a peak more slowly (Table 5).

Several examples were found where sporulation ceased on stubble that was continually exposed, only to resume later (Table 6). In 1983 material from field 7, sporulation stopped

in August 1986, but resumed in May 1987. Little or no sporulation then occurred on the material in 1988, but ascospores were again detected in July, 1989. The mean number of ascospores discharged in early July, 1987 / 10 g residue / 1.5 h was 363 ± 343 (range: 38–853). In early July, 1989, it was 15 ± 17 (range: 1–37).

Blackleg severity in a crop has important implications for long-term inoculum levels originating from the residue of that crop. Ascospores were discharged earlier and in greater numbers in the year after crop growth from severely cankered stubble plants than from stubble with extensive superficial lesions taken from the same field (Table 7). This relationship continued in subsequent years. For example, in 1992 the average number of spores produced on eight trapping dates by severely cankered 1990 material/10 g residue/1.5 h was 4,973 ± 793, and by lightly cankered material 2,676 ± 577. The more severely cankered stems likely had been the earliest infected, although they could have represented more susceptible plants within the population.

Discussion

It is evident that in Saskatchewan's semi-arid environment, blackleg-infected canola stubble residue may continue producing ascospores for 5-7 years, much longer than the average rotations out of canola practiced by producers. Although 90% of the original stubble frequently had broken down after two years, and by the fifth year after crop growth spore production was generally low, sufficient spores produced at critical times were present to perpetuate the disease at a high level. Unlike the situation in Australia (11) and parts of Europe (5), infected canola residue more than two years old plays a major role in the epidemiology of blackleg in Saskatchewan. Where the surface soil is dry much of the time, rotations would have to be unreasonably long to completely eliminate stubble-borne inoculum. The fact that ascospore production on stubble residue can be intermittent often makes it difficult to predict the subsequent course of sporulation. Rotations longer than three or four years out of canola are economically unattractive to producers. However, avoiding planting canola on 2- or 3-year-old *Brassica* stubble may substantially reduce the severity of blackleg in the next canola crop. The fields with long rotations (up to 12 years) out of canola likely were contaminated by ascospores carried by wind from adjacent fields having blackleg-infected canola stubble residue.

Crop rotations practiced in the study area continued to be traditional ones, with summerfallow in the year preceding canola to permit good seedbed preparation and a cereal following canola to facilitate chemical control of volunteer canola and other broadleaved species. Rotations recently have been augmented by legumes and other specialty crops, mainly lentils (*Lens culinaris* Medik). Twenty years ago, the suggested rotation involving rapeseed in western Canada was rape-cereal-summerfallow-rape. With the advent of virulent blackleg, three or more years between rapeseed/canola crops were recommended. These longer rotations have been generally adopted by producers, although the present study indicates that four to six years between canola crops are preferable to three. Rotations out of canola may now be shortening again given the relatively high monetary value of canola and the availability of *B. napus* cultivars with improved blackleg resistance. The replacement of older blackleg-susceptible cultivars such as Westar has resulted in reduced blackleg incidence in *B. napus* relative to *B. rapa* cultivars (15).

Flooding of infected stubble, even for relatively short periods, irreparably damaged the pathogen's ability to produce ascospores. This may be a natural means whereby inoculum levels of *L. maculans* are reduced in the field, as water has been observed to stand in large parts of some fields for periods in excess of 15 days. Burial of stubble in soil having a moisture content of over 40% F.C. was effective in eliminating ascospore production over a time span similar to that of the flooding experiment. The effect also appeared to be irreversible. Spore release from samples buried in soil of 13–20% F.C. declined after six weeks. Therefore, despite fluctuations in soil moisture content, infected stubble buried at the time of spring seeding should be depleted of ascospores by autumn. Infected stubble that is buried during fall cultivation should be depleted by the time of seeding the following spring, after being subjected to autumn rains and melting snow in early spring.

Plowing under the remains of a severely diseased broccoli crop resulted in a 67% reduction in blackleg in the succeeding broccoli crop (6). This, however, is not a practical solution to the blackleg problem for western Canadian producers, who, of necessity, are increasingly adopting minimum tillage to conserve moisture and soil. Others have questioned whether burial of stubble is a fully effective means of blackleg control. An Australian study (10) found that 67% of residues buried for 18 months produced fructifications of *L. maculans* when placed under black light. In France, stubble residue still contained ascocarps of *L. maculans* which were capable of producing spores after two to four years' burial (2).

Deep burial of stubble followed by shallow cultivation is a means of avoiding re-exposing infected residue (10). However, some material would inevitably escape burial. Even small amounts of residual stubble could produce sufficient numbers of ascospores to initiate scattered primary infections throughout a crop. Subsequently, pycnidiospores from the primary lesions could cause a blackleg epiphytotic under favourable environmental conditions (4). This may

explain some blackleg outbreaks in Saskatchewan fields (Fig. 3) following long rotations out of canola.

As the use of cultivation to control blackleg runs counter to present recommendations, chemical treatment of infected stubble has been suggested as an alternative (5). A number of fungicides, herbicides and surfactants applied to stubble before pseudothecial formation were more than 90% effective in preventing further development (9). They also stopped ascospore production when applied to stubble bearing mature ascocarps. However, the effectiveness of treatments on a field scale, possible contamination from adjacent untreated fields, the economic viability of such treatments, and their environmental implications must be fully evaluated.

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Table 1. Effect of length of rotation on incidence and severity of blackleg (*Leptosphaeria maculans*) in central Saskatchewan.*

	Number of growing seasons between canola crops						
	1	2	3	4	5	6–8	9–12
% fields in each category	8.3	30.0	15.0	11.7	8.3	11.7	15.0
Mean blackleg incidence (1994)	97.7	88.1	82.0	81.9	65.0	69.2	63.2
Range	95.0–100.0	71.7–98.8	47.1–100.0	55.0–96.7	38.3–88.3	40.4–100.0	10.0–90.0
% severe basal stem cankers	42.6	11.9	4.1	3.1	1.0	0.5	0.9
Range	1.7–72.0	0.0–58.8	0.0–21.7	0.0–8.3	0.0–3.3	0.0–1.7	0.0–5.0

* Results of 1994 survey of 60 canola stubble crops in fields of known cropping history.

Table 2. Effect of immersion of blackleg-infected rape stubble in water for from 0 to 15 days on subsequent ascospore production by the virulent strain of *Leptosphaeria maculans*.

No. days immersed in water	Weeks or months after flooding and ascospore production (% of number prior to flooding)*					
	4	8	14	18	26 weeks	15 months
0	68.30	123.88	111.50	94.10	225.84	61.11
1	88.00	79.38	62.48	133.70	252.06	29.98
3	15.42	112.66	30.90	48.84	67.02	15.43
6	0.70	12.68	5.00	4.66	7.56	1.99
10	0.00	0.00	0.03	0.00	0.01	0.93
15	0.00	0.02	0.05	0.00	0.03	0.32

* Ascospore production prior to flooding averaged approximately 4000/10 g/1.5h.

Table 3. ANOVA of Log (no. spores + 0.5) showing the effects of length of flooding treatment and time elapsed after treatment on spore numbers, and linear contrasts of various flooding treatments.*

Source	df	Mean square	F value	Pr > F
Replicate (R)	4	7.8412	3.90	0.0169
Treatment (T)	5	315.1234	156.65	0.0001
Error a	20	2.0166		
Date (D)**	5	81.0513	130.03	0.0001
Interaction T X D	25	14.2846	22.92	0.0001
Error b	120	0.6234		
Contrasts*	**df**	**Mean square**	**F value**	**Pr > F**
0 vs remainder	1	350.3845	174.18	0.0001
0,1,3 vs 6,10,15	1	1276.1938	634.41	0.0001
0, 1 vs 3, 6	1	275.1056	127.81	0.0001
0 vs 1	1	2.8837	1.43	0.2452
0 vs 3	1	49.1222	24.42	0.0001
0 vs 6	1	195.1426	97.01	0.0001
Error a		2.0116		

* Contrast of treatments: 0 = non-immersed control; 1, 3, 6, 10, 15 = number of days blackleg-infected stubble immersed in water.
** Dates = time elapsed after treatment (See Table 2).

Table 4. Breakdown of 1981 rape stubble in a commercial field (#12) and reduction in number of ascospores of *Leptosphaeria maculans* released, 1982–85.

Amount of 1981 stubble residue and sporulation	Sampling date and crop grown							
	April,[1] 1982	May,[2] 1982	Sept., 1982	August, 1983	June, 1984	August, 1984	May, 1985	Sept., 1985
		cereal		none		rapeseed		cereal
Average weight (g/m^2)	163.0 ±27.7	73.9 ±11.8	51.7 ±17.8	15.4 ±7.9		6.6 ±2.6		6.2 ±1.5
% of original weight	100.0	45.3	31.7	9.5		4.0		3.8
No. stubble pieces	96.2 ±18.9	44.8 ±8.2	35.2 ±13.3	30.0 ±10.2		25.0 ±7.6		34.7 ±5.9
% of original number	100.0	46.6	36.6	31.2		26.0		36.1
Average weight/piece (g)	1.70 ±0.22	1.66 ±0.21	1.47 ±0.49	0.45 ±0.09		0.26 ±0.07		0.18 ±0.03
Average number ascospores /10 g stubble/1.5 h	0.0	0.0	7574 ±5896	29 ±43	985 ±1476	11 ±18	152 ±209	33 ±72
Average number spores $/m^2/1.5$ h	0.0	0.0	51017 ±49190	54 ±76		9 ±15		19 ±43
Highest number spores $/m^2/1.5$h	0.0	0.0	122799	196		42		116

[1]Standing stubble. [2]Stubble worked up once.

Table 5. Annual peak discharge of ascospores by *Leptosphaeria maculans* over seven years from infected rape stubble residue exposed on the soil surface.

Year crop grown	Year after crop grown and mean no. ascospores discharged X 10^3 /10 g residue/1.5 h ± s.d.						
	1	2	3	4	5	6	7
1979	3.33 ± 1.49	11.47 ± 4.28	0.38 ± 0.22	0	0	0	0
1980	3.77 ± 3.68	2.29 ± 0.62	0.12 ± 0.08	Another rape crop in year 3			
1983	0	0.04 ± 0.04	0.14 ± 0.09	0.16 ± 0.07	<0.01	0.02 ± 0.02	<0.01
1984	0.11 ± 0.03	0.83 ± 0.22	3.23 ± 0.99	0.01	0.02	<0.01	0
1985	<0.01	1.21 ± 1.11	0.85 ± 1.99	1.87 ± 2.87	0.26 ± 0.37	0.21 ± 0.28	
1985	<0.01	2.29 ± 1.87	0.13 ± 0.25	0.60 ± 0.49	<0.01	<0.01	0
1986	0.70 ± 0.45	0.07 ± 0.09	2.32 ± 0.61	<0.01	<0.01	0	0
1986[1]	1.54 ± 0.96	1.55 ± 1.29	17.12 ± 7.14	3.12 ± 0.62	0.96 ± 1.08	0.14 ± 0.18	0.15 ± 0.16
1987	0	0.54 ± 0.32	2.57 ± 2.38	0.20 ± 0.45	<0.01	<0.01	0
1987	<0.01	3.66 ± 1.55	0.05 ± 0.04	<0.01	0	0	0
1988	5.35 ± 1.72	13.37 ± 7.77	10.51 ± 2.46	1.52 ± 2.10	0.63 ± 0.54	--	--
1988	28.15 ± 9.70	8.92 ± 2.45	2.19 ± 1.17	0.06 ± 0.05	<0.01	--	--
1989[1]	4.13 ± 1.59	11.57 ± 6.82	<0.01	0	--	--	--
1990	10.80 ± 2.56	26.46 ± 5.49	1.67 ± 0.42	New rape crop in year 3			

[1] Field 11 (See text).

Table 6. Intermittent production of ascospores by *Leptosphaeria maculans* from 1983 rapeseed stubble residue exposed on the soil surface.

Field	Year	Month and % samples* discharging >1 ascospore /10 g residue/1.5 h					
		May	June	July	August	September	October
7	1984		0	0	0	0	50
	1985	100	100	100	100	100	100
	1986	100	100	100	40	0	0
	1987	100	100	100	80	60	
	1988	0	0	0	0	20	
	1989	0		80	100		
16	1984	0	0	0	0	50	0
	1985		50				
	1986	0	75	50	25	0	
	1987	0	0	0	0	40	
	1988	0	0	20	40	80	
	1989	100		100	80		

*Maximum number of samples = 5.

Table 7. Ascospore discharge by *Leptosphaeria maculans* from slightly and severely cankered stems of *Brassica napus* taken from the same field.

Year crop grown	stem canker severity	Mean numbers of ascospores discharged* /10 g stubble/1.5 h ± s.d.			
		June	July	August	September
1990	severe**	0	4,711 ±1,182	5,304 ±2,407	3,188 ±2,819
1990	slight**	0	571 ±372	1,571 ±892	1,553 ±386
1991	severe	0	182 ±370	333 ±239	2,243 ±1,714
1991	slight	0	0	201 ±164	926 ±1,069

* Mean of five replicate samples, each consisting of 20 basal stem segments seven cm long. Data are for one trapping date per month in the year after crop growth.

** Differences between means for "severe" and "slight" for July and for August significant at $P \leq 0.05$.

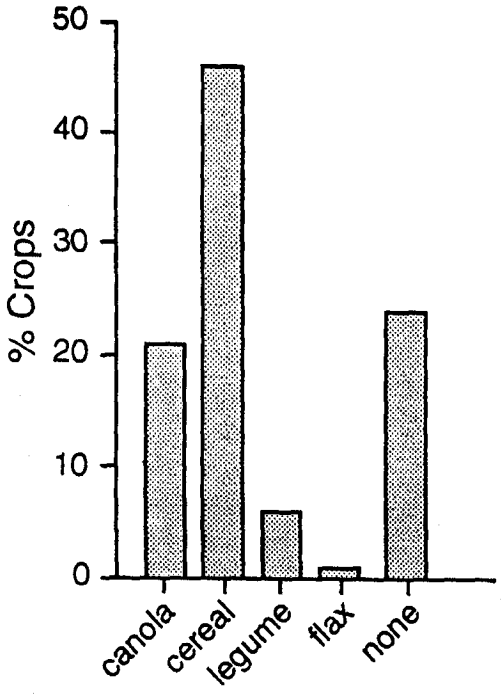

Fig. 1. Proportions of different crops grown in 100 fields in central Saskatchewan, 1977-94.

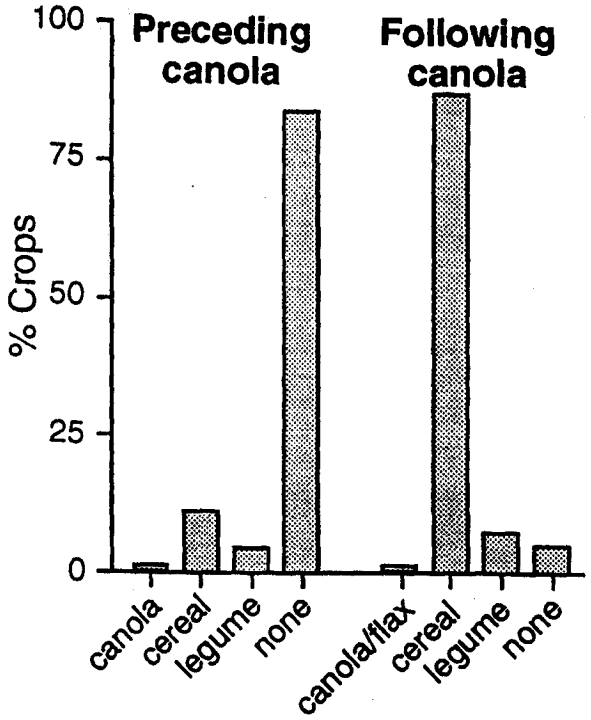

Fig. 2. Proportions of different crops preceding and following rapeseed/canola in rotations in 100 fields in central Saskatchewan, 1977-94.

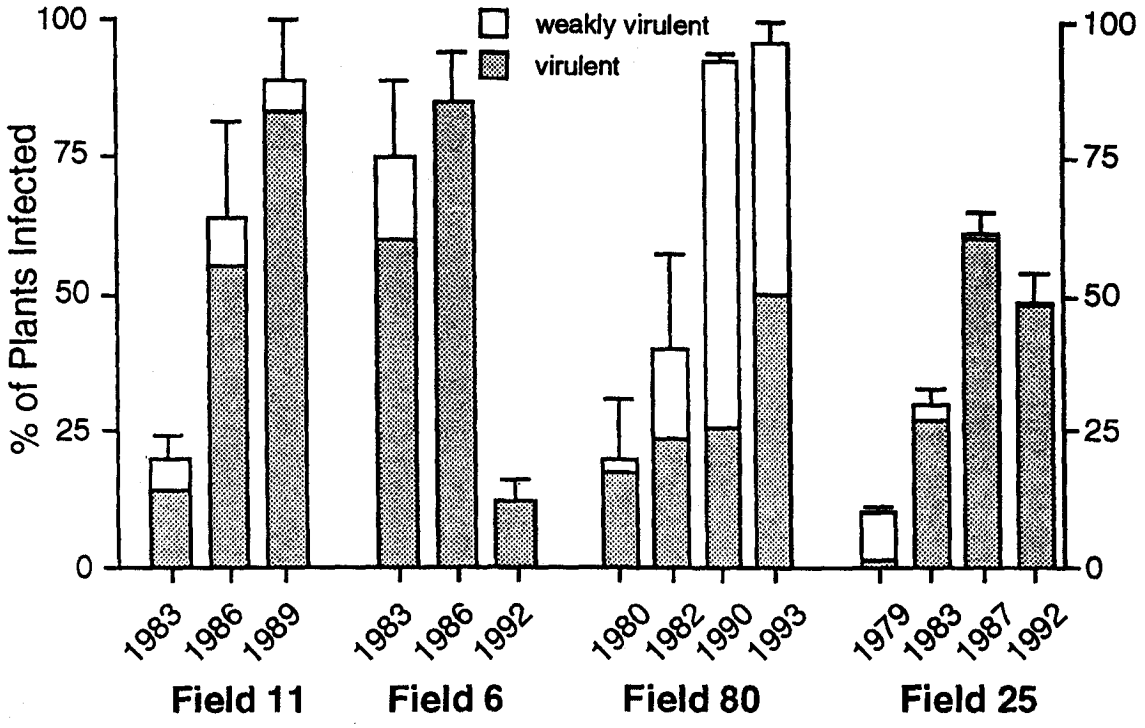

Fig. 3. Changes in incidence of blackleg infection in four Saskatchewan fields and proportions of virulent and weakly virulent strains in succeeding rapeseed/canola crops separated in rotations by from one to seven years.

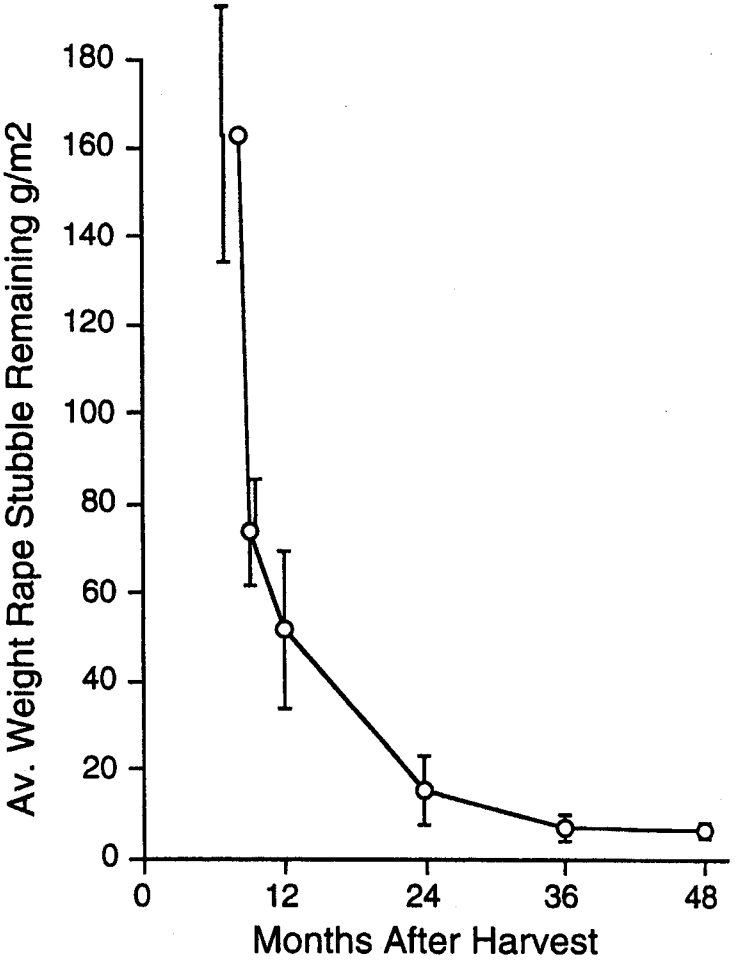

Fig 4. Weight of rape stubble residue remaining/m^2 in field 12 from nine to 48 months after harvest of a 1981 rapeseed crop. Vertical bars represent standard error.

Patterns of ascospore discharge by *Leptosphaeria maculans* (blackleg) from 9- to 13-month-old naturally-infected rapeseed/canola stubble from 1977 to 1993 in Saskatchewan

G.A Petrie[1]

Ascospores of *Leptosphaeria maculans* (blackleg) often began to be produced on rapeseed/canola stubble in Saskatchewan in June, nine months after harvest. However, few ascospores usually were discharged before July 31, and rapeseed crops generally were flowering or podding by mid-July and were more resistant to infection. The number of samples discharging ascospores was positively correlated with the number of days with measurable rainfall in April, June, and various combinations of months from April to July. The mean number of ascospores caught per trapping date and maximum number of spores collected (most productive date) were also related to days with measurable rainfall in the April to July period. Total rainfall was less important than its frequency. Ascospore numbers were negatively correlated with number of days from April to June or July having a maximum temperature of 30°C or more. Strains of *L. maculans* differed in numbers of ascospores produced and in seasonal ascospore discharge patterns, with those from cruciferous weed hosts sporulating earlier and producing larger numbers of spores.

Can. Plant Dis. Surv. 75:1, 35–43, 1995

En Saskatchewan, les ascospores de *Leptosphaeria maculans* (jambe noire) font leur apparition sur le chaume de Canola en juin, c'est-à-dire neuf mois après la récolte. Par contre, avant le 31 juillet, en général, peu d'ascospores avaient été éjectés. Le colza fleurissait ou produisait des cosses vers la mi-juillet, ce qui augmentait sa résistance à l'infection. Le nombre d'échantillons où des ascospores avaient été éjectés était directement corrélé au nombre de jours pour lesquels on a pu enregistrer des précipitations en avril et en juin, et la combinaison de différents mois entre avril et juillet. La moyenne des ascospores retrouvés le jour de la capture et les quantités maximales de spores recueillies (le jour le plus productif) étaient également liées aux jours pour lesquels on a pu enregistrer des précipitations pendant la période allant d'avril à juillet. Le taux de précipitations a été moins important que la fréquence. Le nombre d'ascospores était anticorrélé au nombre de jours, entre avril et juin ou juillet, où la température maximale a été de 30 °C ou plus. Le nombre d'ascospores dans les souches de *L. maculans* ainsi que le mode d'éjection des ascospores ont varié. Les ascospores provenant des mauvaises herbes cruciformes ont produit des spores plus tôt dans la saison et en plus grand nombre.

Introduction

Rapeseed/canola (*Brassica napus* L. and *B. rapa* L.) is most susceptible to infection by *Leptosphaeria maculans* (Desm.) Ces. & de Not. (blackleg) prior to the 6-leaf stage of growth (6). In western Canada canola is usually seeded between mid-May and early June and most stem infections are initiated 20-40 days after a crop is seeded (13). Therefore, June is a critical period in the development of blackleg in Saskatchewan. Earlier evidence indicated that, in the current year, ascospore discharge by *L. maculans* from the previous year's infected canola stubble began in July, which is too late to have a major impact on developing crops (6). In Australia and Europe, ascospores from the remains of the preceding crop were discharged as early as the seedling stage of the current crop, causing severe losses (2,3). In Ontario, pseudothecia of *L. maculans* were produced on the current year's spring rape stubble one month after harvest, and mature ascospores were available to infect seedlings of the next crop of either winter or spring rape. The foregoing does not take into account the role played by inoculum from 2-year-old and older stubble residue. Limited data from Saskatchewan are available (6,10).

Shortly after a virulent strain of *L. maculans* was found in Saskatchewan on stubble from three 1975 crops (5) it exhibited the mid- to late-season pattern of ascospore discharge typical of indigenous weakly virulent strains.

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However, a few exceptions to this seasonal pattern were detected in samples of 1976 stubble residue. Ascospore discharge by virulent *L. maculans* began from the crop residue in one individual field in May and June, 1977 (6). This raised the possibility of the initiation of basal stem cankers during the stage of greatest host susceptibility. It was important to determine whether ascospore discharge by virulent *L. maculans* could occur from 9- to 10-month-old stubble sufficiently often to materially raise the level of blackleg incidence and severity. The present study examined the induction of ascospores on field-infected stubble on which they had not occurred previously. It was continued over a number of years to define trends in sporulation patterns, principally to more early-season discharges by the virulent form of blackleg.

Materials and methods

Blackleg-infected stubble of rapeseed/canola from the previous year's crop and stems of cruciferous weeds were collected annually in April throughout central Saskatchewan. Strains of *L. maculans* present in the material were determined by plating pieces on V-8 agar (8). A 7-cm piece including a portion of the basal stem and taproot was cut from each plant. At least 50 samples, each consisting of 20 stem segments, were prepared annually and tested for sporulation at least monthly between April and October in ascospore liberation tunnels (4). Samples were weighed and spore numbers expressed per 10 g of residue. They were placed on 17 x 9 cm wire grids, moistened thoroughly with water and inserted in the tunnels. The air flow was adjusted to 13,000 cc/min using a Rotameter (Brooks Rotameter Co., Lansdale, PA). Five tunnels were run concurrently for 1.5 hours. Spores were caught on vaselined slides and stained with cotton blue in lactophenol (1) prior to being counted. Samples were stored outdoors in well-drained wooden flats or white plastic pots 8 cm high x 11 cm in diameter. Rainfall was recorded on site using a Springfield rain gauge and temperature extremes recorded using a Springfield maximum/minimum thermometer (Springfield Instrument Co., Wood-ridge, NJ). Reference also was made to the Monthly Meteorological Summary for Saskatoon prepared by the Atmospheric Environment Service of Environment Canada. Correlations between measurements of sporulation and temperature and moisture variables were sought using the SAS GLM statistical package procedure (SAS Institute Inc., 1989) following transformation of spore numbers to LOG (no. spores + 0.5).

Attempts were made to correlate stage of crop development in the current year with abundance of ascospores discharged from the remains of the previous year's rapeseed crop. The percentage of the Saskatchewan rapeseed crop planted and the stage of crop development on certain dates were obtained from crop and weather reports compiled by the Economics (formerly Statistics) Branch of Saskatchewan Agriculture and Food, Regina. Most blackleg stem infections are initiated between 20 and 40 days after seeding (13). This range was used to calculate the "window" which occurred annually for the initiation of stem infections.

Results

At least three patterns of sporulation were recognizable during the 16-year period: an early, a late, and a very late pattern (Tables 1 to 3). The early pattern, which was found in 1979, 1981, 1982, 1984, 1987, 1989, 1990, 1991, and 1993 (and perhaps in 1977) was characterized by the initiation of ascospore production in a high percentage of samples in June and/or July in the year after crop growth. This was often accompanied by the production of abundant ascospores in July. Sometimes an early start to sporulation was followed by a summer and/or autumn of poor ascospore production, as in 1984 and 1989. The late pattern was typified by the production of few ascospores prior to August or September, as in 1980, 1983 and 1992. In the very late pattern, little or no sporulation occurred in the year following crop growth, and appreciable numbers of ascospores were not discharged until June or July of the second year after crop growth, as in 1985, 1986 and 1988. Five of the 16 years stand out as having relatively low overall ascospore productivity: 1984, 1985, 1986, 1988 and 1990 (Table 1). Three of these (1985, 1986 and 1988) fall into the very late pattern of ascospore discharge. The mean percentages of total ascospores discharged before July 31 were 1.8 for the years 1977–82, 14.1 for 1983–88, and 10.0 for 1989–93.

A number of statistically significant correlations were obtained between measurements of sporulation and temperature, and between sporulation and moisture variables. Selected rainfall and temperature data have been summarized in Table 4. Total rainfall in May + June was correlated with the mean annual sporulation (Table 5). The correlation between total May rainfall and the mean annual sporulation or maximum sporulation (the mean number of ascospores caught annually on the most productive date) approached significance but the correlations between total April or June rainfall and the mean annual sporulation or maximum sporulation did not. Total rainfall was less important than its frequency. The number of days with measurable rainfall produced a number of significant correlations. However, when the number of days with "trace" precipitation were added to those with measurable rainfall, no significant correlations were found. The number of samples producing ascospores in July was significantly correlated with days with measurable rainfall in April, June, and for various combinations of months. The number of samples producing ascospores in August was significantly correlated with days with measurable rainfall in July and from April to July. Days of measurable rainfall in August was correlated with the mean annual sporulation and maximum

sporulation. Maximum sporulation generally occurred in late summer or in autumn (Table 3). The total number of days from April to July, inclusive, with a maximum temperature of 30°C or more was negatively correlated with the number of samples producing ascospores in August (Table 5). The total number of days from April to June, inclusive, having a temperature maximum of 30°C or more was negatively correlated with LOG of the mean annual sporulation and LOG of the maximum sporulation. Other negative correlations which approached significance were number of days in June with temperature maxima of 25°C or more and LOG of the mean annual sporulation or LOG of the maximum sporulation. In addition, the number of samples producing ascospores in June was positively correlated with both the mean annual sporulation and maximum sporulation.

Rapeseed cultivars changed frequently during the 16 years of the study. In 1977, Torch, Tower and Midas were most commonly grown (Prairie Grain Variety Surveys by the three Prairie Wheat Pools, 1977–92). By 1982, Candle, Regent and Altex predominated. From 1984 to 1989, Tobin and Westar took up most of the hectarage, but these were quickly replaced after 1989 by more blackleg-resistant cultivars such as Legend. By 1993, the very blackleg-susceptible cultivar, Westar, had almost disappeared.

Seeding of the Saskatchewan rapeseed crop generally was completed before the end of the first week of June, and the "window" for the initiation of blackleg stem infections was usually closing by mid-July. Very few ascospores were caught in June, and most of the sporulation in July occurred in the latter half of the month. Early sporulation by the pathogen and late completion of seeding of the rapeseed crop coincided infrequently, examples being 1982 and 1991. In July 1982, ascospores were obtained from 94% of the 1981 samples. Also, crop development was unusually late in 1982, and the blackleg infection "window" occurred from June 6 to July 24. However, ascospore production in July 1982, was very variable and several samples produced no ascospores before August, whereas others discharged several hundred ascospores on July 13. On this date, 32% of the crops were still at the rosette stage and 5% at the seedling stage. The remaining 63% were flowering or podded and therefore more resistant to infection. Both early- and late-sporulating 1981 samples originated from several different parts of Saskatchewan, and were obtained even from individual fields. In 1991, the infection window was June 1 to July 21. Sporulation from July 8 to 15 was abundant on 1990 stubble, averaging 418 spores/10 g/1.5 hrs. However, development of rapeseed crops was more advanced by July 15 than in 1982, with 1% in the seedling stage, 15% in the rosette stage, and 83% flowering or podded. In 1987, the infection window was May 23 to July 10. On average, 96 spores were caught in 1.5 hours during the second week of July. However, by this time only 2% of the crop remained at a susceptible stage of growth. In most other years, July sporulation by *L.maculans* was poor. For example, in 1981 and 1990, crop development by mid-July was similar to that in 1991, but very few ascospores were produced before July 31. In Saskatchewan, a cereal crop usually follows rapeseed in the rotation. By July 10, 1982, 20% of Saskatchewan cereal crops were at the jointed stage, over 40% at the shot blade stage, and 30% were heading (Saskatchewan Agriculture Crop and Weather Reports). By July 8, 1991, the corresponding percentages were 26, 53, and 17, respectively.

Sporulation by two weakly virulent strains of *L. maculans* on rapeseed stubble was also examined. However, the material available was limited because the virulent form of *L. maculans* predominated in rapeseed fields over most of the study period. There was only sufficient material infected by the "Puget Sound" strain (11) to provide data for five years and only three years' data were available for the "sisymbrium" strain (7) (Table 6). The sisymbrium strain consistently produced larger numbers of ascospores on rapeseed stubble than did the Puget Sound strain or the virulent strain (Table 2 and 6). The sisymbrium strain discharged ascospores from its "natural" hosts, *Sisymbrium loeselii* L. and *Descurainia sophia* (L.) Webb (Table 7), earlier and often in greater numbers than it did from rapeseed stubble, although the opportunities for direct comparisons are limited. The "thlaspi" strain (7) of *L. maculans* from *Thlaspi arvense* L. discharged large numbers of ascospores annually, beginning well before July 31 (Table 7). This strain was found only very rarely on rapeseed stubble.

Discussion

The different seasonal patterns of sporulation in *L. maculans* were caused primarily by environmental factors. Temperature and frequency of precipitation from April to August in the year after crop growth had a profound effect on sporulation by *L. maculans* on year-old stubble. Poor and erratic ascospore production in several years between 1984 and 1990 is attributable to high temperatures and low moisture. Nevertheless, when conditions improved, the pathogen's ascospore production on year-old stubble reached unprecedented levels in 1989 and 1993.

An examination of weather records suggests possible explanations for the sporulation patterns observed in individual years. High temperatures appear to be responsible for reduced sporulation of *L. maculans* in 1984 and 1988. In July and August, 1984, the temperature reached or surpassed 30°C on 31 days. The mean temperature for both July and August 1984, was 28°C. The mean maximum temperature for June 1988, was 29°C, compared to the long-term average of 22°C. Temperature maxima for June 3-6, 1988, ranged from 36–41°C. Very dry conditions in June 1985, and June 1992, are implicated in

poor or delayed sporulation in those years. Rainfall in June 1985 was 19%, and in June 1992 it was 25% of the 30-year average. Cool wet conditions in July and August 1992, appeared to stimulate sporulation, as 56% of the samples began to produce spores in August. There was little beneficial effect of above average rainfall in April, May, and July 1985, as 77% of the samples failed to produce ascospores. In 1980, rainfall for April to July was 56% of the 30-year average, which likely contributed to delayed sporulation. Cool moist conditions in August 1980 coincided with induction of sporulation in 76% of the samples. Rainfall in May 1989, was 236% of normal, and in June, 104% of normal. This may explain the early start to sporulation. Then hot weather intervened from mid-July to mid-August and no additional samples produced ascospores until September. Relatively poor sporulation in 1986 may have resulted from hot weather (31–35° maxima) between May 26 and June 1. In 1990, the typical late-season increase in spore numbers did not materialize (Table1) likely because the rainfall from August to October was 22% of the average for these three months.

Higher than average temperatures and lower than average rainfall appear to have contributed substantially to poor, delayed or interrupted sporulation in 8 of the 16 years. In the five years when *L. maculans* exhibited very early sporulation and released large numbers of spores, wet conditions prevailed in May and June in 1981, 1982, 1991, and 1993. In 1987, April to July rainfall was only 64% of normal. However, above average temperatures were recorded in March, April and May, which may have provided a stimulus to sporulation by the pathogen.

Strains of *L. maculans* from cruciferous weeds produced spores in much greater numbers and earlier in the growing season on their "natural" hosts than did the "brassica" strains (the Puget Sound and virulent strains). Some of the former strains also appeared to respond in a different manner to environmental conditions (Petrie, unpublished). As some of the cruciferous weed hosts are winter annuals, the strains developing on them could have become established earlier than could strains inhabiting *Brassica* species.

This study shows that ascospore discharge by *L. maculans* from the previous year's stubble generally will not occur early enough in the current year to have a great impact on developing rapeseed crops. Over the 16 years, ascospores were discharged in June from 21% of the samples (Table 2) but with few exceptions, only very low numbers were trapped, i.e. only a mean of 9% were discharged before July 31 (Table 1). As a cereal is almost always planted in the year following rapeseed, it appears unlikely that significant numbers of ascospores discharged under a cereal crop in early July could escape the plant canopy and be blown to adjoining rapeseed crops. Therefore, the number of rapeseed crops at a very susceptible stage of growth would usually be limited, the number of ascospores available from year-old stubble would usually be small, and only a fraction of the available spores likely would reach susceptible crops. Inoculum from 2-year-old and older rapeseed stubble residue would have a much greater impact on developing rapeseed crops, as ascospores from this material usually are discharged in considerable numbers in May and June, and old stubble residue capable of producing ascospores (and pycnidiospores) often is present under developing rapeseed crops (Petrie, unpublished).

No trend toward an earlier seasonal pattern of sporulation (i.e. consistent heavy sporulation in May and June) is evident from the data. Early sporulation in the virulent strain, as in 1991, was paralleled by earliness in the Puget Sound strain, was not repeated in subsequent years, and is attributed to environmental conditions. The frequent replacement of rapeseed cultivars further complicates attempts to identify trends in sporulation. However, environmental factors appear to have a much greater impact on sporulation patterns in *L. maculans* than differences in cultivars (Petrie, unpublished). For example, between 1984 and 1989, when Westar made up 50% or more of the hectarage, sporulation levels were low in four of the six years (Table 1). Periodic monitoring for trends in seasonal ascospore discharge patterns in *L. maculans* should continue, as the ability to sporulate profusely on 9- to 10-month-old stubble could confer a competitive advantage to a virulent strain which would be significant epidemiologically.

Acknowledgements

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Table 1. Average numbers of ascospores released by *Leptosphaeria maculans* from rapeseed/canola stubble in the year after crop growth.

Year spores produced	Mean % spores off before July 31 (and range)	Mean no. spores per 10 g sample / date*	Mean maximum no. spores per 10 g (best date)
1977	0.37 (0.02 – 0.97)	1,264 ± 315	4,344 ± 1,301
1979	2.42 (0.00 – 6.81)	508 ± 169	1,862 ± 612
1980	0.01 (0.00 – 0.03)	939 ± 188	3,112 ± 450
1981	3.23 (1.20 – 8.21)	365 ± 119	1,122 ± 387
1982	3.15 (0.08 – 5.51)	1,698 ± 285	5,301 ± 1,221
1983	0.09 (0.00 – 0.34)	538 ± 84	2,106 ± 324
1984	39.57 (2.59 – 91.94)	270 ± 92	575 ± 152
1985	1.74 (0.00 – 49.28)	22 ± 21	82 ± 86
1986	29.10 (0.00 – 100.00)	10 ± 3	32 ± 9
1987	14.03 (2.10 – 29.80)	1,425 ± 415	3,296 ± 1,074
1988	0.00	1	1
1989	1.09 (0.01 – 4.24)	4,234 ± 1,283	16,636 ± 2,494
1990	9.69 (3.40 – 15.79)	147 ± 44	423 ± 101
1991	30.95 (25.47 – 42.53)	2,815 ± 564	4,911 ± 1,215
1992	2.50 (0.00 – 8.11)	1,171 ± 366	3,635 ± 970
1993	5.83 (0.34 – 15.16)	4,041 ± 1,483	11,364 ± 4,486
Average	9.00 (2.20 – 23.70)	1,216 ± 339	3,675 ± 930

* For mean number of ascospores discharged per year, multiply the values in this column by 4.

Table 2. Pattern of ascospore discharge by *Leptosphaeria maculans* from stubble of rapeseed/canola in the year after crop growth.

Year spores produced and pattern*		Month and % samples in which sporulation was initiated				% samples producing ascospores
		June	July	August	September	
1977	E	11.9	36.9	46.0	5.1	100.0
1979	E	31.4	33.3	11.8	20.6	97.1
1980	L	0.0	11.9	76.1	11.9	100.0
1981	E	10.0	70.0	20.0	0.0	100.0
1982	E	17.0	76.6	6.4	0.0	100.0
1983	L	7.5	22.5	30.0	37.5	97.5
1984	E	38.6	7.1	0.0	21.4	67.1
1985	VL	2.7	0.0	4.1	16.2	23.0
1986	VL	9.1	10.6	27.3	6.3	53.0
1987	E	36.4	61.8	1.8	0.0	100.0
1988	VL	0.0	0.0	0.0	5.5	5.5
1989	E	78.0	0.0	0.0	25.0	100.0
1990	E	37.7	27.3	21.7	13.3	100.0
1991	E	17.7	82.3	0.0	0.0	100.0
1992	L	7.3	34.6	56.4	1.8	100.0
1993	E	28.0	52.0	20.0	0.0	100.0
16-yr. average		20.6	32.9	20.1	10.3	84.0

* Seasonal pattern of ascospore discharge: E = early, L = late, VL = very late.

Table 3. Three seasonal patterns of ascospore discharge by virulent *Leptosphaeria maculans* from rapeseed/canola stubble in the year after crop growth illustrated using one representative field for each year.

Year spores produced	Month and number of ascospores discharged / 10 g residue / 1.5 h ± s.d.			
	June	July	August	Sept. - Oct
Early discharge pattern				
1984	275 ± 103	1,856 ± 2,191	39 ± 34	31 ± 36
1987	1	1,584 ± 687	8,683 ± 1,713	3,228 ± 734
1993	2	2,744 ± 1,904	27,617 ± 3,677	7,295 ± 2,309
Late discharge pattern				
1980	0	0	640 ± 544	8,000 ± 2,400
1983	0	0	3	1,767 ± 1,336
1992	0	1	60 ± 80	5,028 ± 1,251
Very late discharge pattern				
1985	0	0	0	6
1986	8	1	2	0*
1988	0	0	0	6 ± 8**

* Spores caught June, 1987 = 1,874 ± 1,193.
** Spores caught July, 1989 = 3,663 ± 1,552.

Table 4. Selected meteorological data for Saskatoon, 1977-1993.*

Year	No. days with measurable rain in					Total rainfall May + June (mm)	Total days April-June		Total days April-July
	April	May	June	July	August		≥ 25°	≥ 30°C	≥ 30°C
1977	6	18	6	11	8	164	23	3	5
1979	17	10	17	10	4	114	12	3	11
1980	3	4	11	9	14	63	29	8	12
1981	11	5	16	14	8	94	12	3	7
1982	10	13	11	11	13	136	10	2	3
1983	6	13	11	12	7	161	12	2	6
1984	5	10	11	4	8	99	14	4	12
1985	8	9	8	7	9	88	7	0	6
1986	4	9	13	13	7	108	19	6	8
1987	6	8	12	11	11	61	24	6	12
1988	2	5	8	7	11	34	35	14	23
1989	5	13	10	9	11	155	14	3	10
1990	10	6	16	10	5	87	21	3	5
1991	10	7	17	10	7	208	8	0	1
1992	7	13	7	15	11	61	16	2	2
1993	10	9	11	10	16	95	13	3	4

* Monthly Meteorological Summary, Atmospheric Environment Service, Environment Canada.

Table 5. Correlations between ascospore numbers, temperature, and moisture variables obtained over a 16-year study from 1977 to 1993.

Variables		Correlation coefficient, r[1]
LOG of the mean annual sporulation and:		
Total rainfall, May + June		+ 0.52*
Days with measurable rain,	April + May	+ 0.51*
	May + June	+ 0.54*
	April + May + June	+ 0.51*
	April to July, inclusive	+ 0.53*
	April to August, inclusive	+ 0.68**
LOG of maximum sporulation and:		
Total rainfall, May + June		+ 0.52*
Days with measurable rain,	April + May	+ 0.54*
	May + June	+ 0.54*
	April + May + June	+ 0.51*
	April to July, inclusive	+ 0.53*
	April to August, inclusive	+ 0.69**
No. samples producing ascospores in July and:		
Days with measurable rain,	April	+ 0.55*
	June	+ 0.54*
	May + June	+ 0.58
	April + May + June	+ 0.63**
	April to July, inclusive	+ 0.62**
No. samples producing ascospores in August and:		
Days with measurable rain,	July	+ 0.55*
	April to July, inclusive	+ 0.51*
	April to August, inclusive	+ 0.52*
Days with measurable rain, August and:		
Mean annual sporulation (av. no spores/date/year)		+ 0.51*
Maximum sporulation (av. no. spores on most productive date)		+ 0.50*
No. samples producing ascospores in June and:		
Mean annual sporulation		+ 0.54*
Maximum sporulation		+ 0.63**
No. days with temp. maxima of 30°C and over (April-July) and:		
No. samples producing ascospores in August		- 0.57*
LOG mean annual sporulation		- 0.59*
LOG maximum sporulation		- 0.58*
No. days with temp. maxima of 30°C and over (April-June) and:		
LOG mean annual sporulation		- 0.61*
LOG maximum sporulation		- 0.62*

[1] Probabilities: *P ≤0.05, **P ≤0.01

Table 6. Average numbers of ascospores released by the weakly virulent "Puget Sound" and "sisymbrium" strains of *Leptosphaeria maculans* from rapeseed/canola stubble in the year after crop growth.

Year spores produced	Mean % spores trapped before July 31 (and range)	Mean no. spores per 10 g sample/date ± S.E.	Mean maximum no. spores per 10 g (best date)
Puget Sound strain			
1977	0.80 (0.0 - 4.4)	1,246 ± 314	4,061 ± 984
1979	3.62 (0.0 - 16.0)	241 ± 77	854 ± 246
1980	0.05 (0.0 - .2)	771 ± 221	2,756 ± 820
1990	4.92 (0.8 - 13.3)	824 ± 218	1,805 ± 405
1991	32.05 (8.5 - 59.1)	2,161 ± 494	4,445 ± 1,123
Sisymbrium strain			
1977	0.23 (0.0 - 1.4)	1,772 ± 498	5,998 ± 901
1979	5.97 (0.1 - 20.8)	1,053 ± 294	3,577 ± 1,008
1980	0.18 (0.0 - 1.8)	1,473 ± 159	4,524 ± 850

Table 7. Average numbers of ascospores released by the "sisymbrium" and "thlaspi" strains of *Leptosphaeria maculans* from their "natural" weed hosts in the year after plant growth.

Year spores produced	Host*	Mean % spores trapped before July 31	Mean no. spores per 10 g sample / date	Mean maximum no. spores per 10g (best date)
Sisymbrium strain				
1976	DS	30.9	2,442 ± 530	3,750 ± 1,399
1977	SL	0.6	11,194 ± 393	40,000 ± 2,828
1979-1	DS	23.2	1,570 ± 747	2,780 ± 2,662
1979-2	SL	44.5	2,337 ± 541	3,179 ± 1,370
1991	SL	42.4	9,812 ± 1,566	16,607 ± 6,057
Thlaspi strain				
1979	TA	57.9	15,750 ± 1,560	32,500 ± 6,455
1980	TA	22.6	10,645 ± 1,680	21,908 ± 5,994
1982	TA	51.6	21,000 ± 2,848	29,333 ± 1,155
1991-1	TA	37.5	34,342 ± 9,674	75,386 ± 58,950
1991-2	TA	78.7	13,723 ± 5,645	31,039 ± 18,171

* Host species: DS = *Descurainia sophia*, SL = *Sisymbrium loeselii*, TA = *Thlaspi arvense*.

Effects of chemicals on ascospore production by *Leptosphaeria maculans* on blackleg-infected canola stubble in Saskatchewan

G.A Petrie[1]

Chemical treatment of blackleg-infected stubble was often very effective in inhibiting or eliminating the production of ascospores by *Leptosphaeria maculans*. Among the most effective fungicides were the ergosterol biosynthesis inhibitors, nuarimol, propiconazole, and triadimenol, which at 0.1 g a.i./L reduced spore numbers by 99–100%. Prochloraz, imazalil, chlorothalonil, and benomyl also significantly reduced ascospore numbers at 0.1 g a.i./L. At 10 g a.i./L, the herbicide glyphosate completely prevented ascospore formation, whereas trifluralin increased sporulation. A role for chemical treatment of stubble for control of blackleg on canola is indicated in light of the trend toward minimum tillage practices by western Canadian producers.

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Les traitements chimiques du chaume contre la jambe noire ont permis très souvent d'empêcher ou d'éliminer la production d'ascospores par *Leptosphaeria maculans*. Parmi les fongicides les plus efficaces on compte les inhibiteurs de la synthèse des stérols, le nuarimol, le propiconazole et le triadimenol qui, à raison de 0,1 g de matière active par litre, ont réduit le nombre de spores de 99 à 100 %. Dans une proportion de 0,1 g de matière active par litre, le prochloraz, l'imazalil, le chlorothalonil et le benomyl ont également réduit de façon importante le nombre d'ascospores. À raison de 10 g de matière active par litre, l'herbicide glyphosate a permis de prévenir complètement la formation d'ascospores, tandis que la trifluraline a, quant à elle, fait augmenter la sporulation. Le recours au traitement chimique pour combattre la jambe noire qui s'attaque au chaume du Canola est tout indiqué si on prend en considération le fait que les producteurs de l'Ouest canadien semblent opter pour un travail réduit du sol.

Introduction

Work in Britain (3) has indicated that production of pseudothecia and ascospore release by *Leptosphaeria maculans* (Desm.) Ces. & de Not. (blackleg) are highly sensitive to some fungicides, herbicides, surfactants, or urea applied to naturally infected *Brassica* stems. Applications of these materials in the spring either before or after mature pseudothecia had formed were effective in suppressing further development of the pathogen.

To date, blackleg control strategies employed in western Canada have centred around the development of resistant cultivars, management practices such as crop rotation or burial of infected stubble, and fungicidal seed treatment. Recent work in Australia has revealed the presence of considerable genetic heterogeneity in populations of the blackleg pathogen (5), indicating a considerable potential for the appearance of new virulent pathotypes. In western Canada canola (*Brassica napus* L. and *B. rapa* L.) production recently has increased dramatically in response to very favourable prices relative to those for wheat. The combined effects of increased canola production and shorter crop rotations will increase blackleg inoculum levels, and put pressure on our presently available "resistant" cultivars. Therefore, alternative control strategies for blackleg may soon be required. The fungicide Tilt (propiconazole) has recently been approved for use on canola as an aerial spray at the rosette stage of growth for blackleg control (6). In western Canada, the pseudothecial stage of *L. maculans* is initiated in the spring or early summer on infected stubble of the previous year's canola crop. Chemicals applied as a stubble treatment in autumn or spring as part of more traditional chemical applications for weed control might be both effective and economically attractive.

Materials and methods

Canola stubble infected by the virulent strain of *L. maculans* was collected annually in April between 1984 and 1993 from blackleg-infested crops sown the previous year or two years earlier (one- and two-year-old stubble, respectively). Examination of the samples in May showed that while the

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one-year-old stubble was free of ascocarps, they were present on the two-year-old material. The harvested one- and two-year-old stubble was divided into lots each consisting of 15 basal stem segments. Four replicate stem lots were dipped for 10 seconds in a solution or suspension of each test compound, placed in 8 cm high by 11 cm. dia. plastic pots and transferred outdoors. The one-year-old samples were tested for sporulation in September; the two-year-old samples were tested before chemical treatment and again in mid-July or later. Estimates of sporulation were made using ascospore liberation tunnels (2) with the air flow adjusted to 13,000 cc/min using a Rotameter (Brooks Rotameter Co., Lansdale, PA). Ascospores were collected for one hour on microscope slides coated with vaseline. LSDs were calculated using log-transformed spore numbers. The chemicals used in the present study are listed in Table 1. Several had been tested earlier by Humpherson-Jones and Burchill (3), but prochloraz, nuarimol, imazalil, propiconazole, triadimenol, and chlorothalonil were not included in their study. Concentrations of 1.0, 0.5, and 0.1 g a.i./L were generally used for fungicides, 10 g a.i./L for herbicides, and 50 g product/L for surfactants and urea.

Results

For at least five years between 1984 and 1993, adverse environmental conditions resulted in low spore numbers (Petrie, unpublished). Sporulation in 1992 and 1993 was at a higher level and results for these two years will be reported. Additional data for propiconazole were obtained in 1994 using one- and two-year-old blackleg-infected stubble.

Several fungicides significantly reduced or entirely prevented sporulation by *L. maculans* when applied to the one-year-old stubble samples before pseudothecial development. Among the most effective were the ergosterol biosynthesis inhibitors, nuarimol, triadimenol and propiconazole (Tables 2, 3 and 5). Among the herbicides, glyphosate (Roundup) at 10 g a.i./L prevented ascospore production entirely, whereas trifluralin (Treflan) increased it significantly. Triallate (Avadex BW) reduced sporulation substantially but the results were not statistically significant. Metribuzin (Sencor) had only a slight effect (Table 2). Propiconazole, urea, benomyl and triton X-100 suppressed ascospore production substantially when applied to samples that were already producing ascospores (2-year-old material) (Tables 4 and 5). There was a slight increase in ascospore numbers with trifluralin (Table 4). The mean number of ascospores discharged by the water controls in mid-July was 6.9 times greater than that in mid-May (Table 4). An estimate of potential ascospore production was calculated for the four chemical treatments by multiplying their mid-May values by 6.9. These four potential values for the treatments were less than 25% of the control value and showed a 77 to almost 100% reduction in potential ascospore production. In 1994 propiconazole at a concentration of 0.01 g a.i./L or higher produced significant reductions in ascospore numbers in both one- and two-year-old material (Table 5). Sporulation by *L. maculans* on the untreated one-year-old stems was much better than on the untreated 2-year-old stems, a reflection of the relative fecundity of the pathogen on the individual collections, which originated in different fields.

Discussion

The results support the conclusion of the British workers (3) that chemical treatment of blackleg-infected stubble may be effective in breaking the life cycle of *L. maculans*. Stubble treatments would appear to be more effective than applications of the same materials as seed dressings (7,8) or aerial sprays of field plantings (6).

Sporulation of *L. maculans* can continue on exposed stubble for seven or more years; complete burial of stubble reduces inoculum levels more rapidly. However, it has proven difficult if not impossible to entirely eliminate blackleg from a field by rotations and conventional tillage, or even by burial of crop residues (1,4, and Petrie, unpublished).

The profound effect upon ascospore production shown by some commonly used herbicides indicates a need for further studies in this area. With the movement toward minimum tillage on the part of producers, and conservation of plant debris on the soil surface, it would be timely to investigate selected chemicals on a field scale and to obtain estimates of their economic returns.

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Table 1. Chemicals tested for their ability to suppress ascospore production in *Leptosphaeria maculans*.

Chemical	Active ingredient	Source
Fungicides		
Baytan	triadimenol	Uniroyal
Benlate	benomyl	DuPont
Bravo	chlorothalonil	SDS Biotech.
Fungaflor	imazalil	Elanco
Mertect	thiabendazole	Chipman
–	nuarimol	Elanco
Ronilan	vinclozolin	BASF
Rovral	iprodione	Rhône Poulenc
Sportak	prochloraz	Elanco
Tilt	propiconazole	Ciba-Geigy
Tersan	thiram	DuPont
Vitavax	carbathiin	Uniroyal/Gustafson
–	urea	BDH
Herbicides		
Avadex BW	triallate	Monsanto
Roundup	glyphosate	Monsanto
Sencor	metribuzin	Chemagro
Treflan	trifluralin	DowElanco
Surfactants		
Agral 90	alkyl phenol ethylene oxide	Chipman
Triton X-100	t-octyl phenol ethoxylates	Rohm & Haas

Table 2. Results of treating 1-year-old blackleg-infected canola stubble with chemicals prior to the development of pseudothecia of *Leptosphaeria maculans* (1992).

Chemical	Concentration	Mean no. ascospores**	% reduction or increase
Water (control)	—	2178	—
Urea (g/L)	50.0	1154	-47.0
Fungicides (g a.i./L)			
Benomyl	1.0	21*	-99.1
	0.25	691*	-68.3
Carbathiin	1.0	449*	-79.4
Iprodione	1.0	3127	+43.6
Thiabendazole	1.0	15*	-99.3
Herbicides (g a.i./L)			
Glyphosate	10.0	0*	-100.0
Metribuzin	10.0	1976	-9.3
Triallate	10.0	908	-58.3
Trifluralin	10.0	4974*	+128.4
Surfactants (g product/L)			
Agral-90	50.0	191*	-91.2
Triton X-100	50.0	1024*	-53.0

* Significantly different from the control at P = 0.05, according to LSD test.
** Values are means of four replications.

Table 3. Results of treating 1-year-old blackleg-infected canola stubble with chemicals prior to the development of pseudothecia of *Leptosphaeria maculans* (1993).

Chemical	Concentration (g a.i./L)	Mean no. ascospores**	% reduction
Water (control)	—	6718	—
Urea	50.0	457*	93.2
Fungicides			
Benomyl	1.0	0*	100.0
	0.5	94*	98.6
	0.1	1419*	78.9
Chlorothalonil	1.0	1299*	80.7
	0.5	1266*	81.1
	0.1	2275*	66.1
Imazalil	1.0	0*	100.0
	0.5	0*	100.0
	0.1	599*	91.1
Nuarimol	0.1-1.0	0*	100.0
Prochloraz	1.0	0*	100.0
	0.5	11*	99.8
	0.1	322*	95.2
Propiconazole	1.0	0*	100.0
	0.5	1*	99.98
	0.1	65*	99.0
Thiabendazole	1.0	651*	90.3
	0.5	2413	64.1
	0.1	4375	34.9
Thiram	1.0	731*	89.1
	0.5	1133*	83.1
	0.1	1878	72.0
Triadimenol	1.0	0*	100.0
	0.5	0*	100.0
	0.1	33*	99.5
Vinclozolin	1.0	430*	93.4
	0.5	792*	88.2
	0.1	1778	73.5
Surfactants	(g product/L)		
Agral-90	50.0	1200*	82.1
	25.0	3125	53.5
	5.0	2750	59.1

* Significantly different from the control at P=0.05, according to LSD test.
** Values are means of four replications.

Table 4. Results of treating 2-year-old blackleg-infected stubble with chemicals after the onset of production of fertile pseudothecia by *Leptosphaeria maculans* (1992).

Chemical and conc. (g a.i./L)	Original no. ascospores (mid-May)	No. ascospores (mid-July)	Potential no. of ascospores*	% of potential	Reduction in potential (%)
Water	1741 ± 742	12058 ± 3870	12058	100.0	0.0
Urea (50)	1892 ± 906	15 ± 23	13097	0.1	99.9
Benomyl (1)	1431 ± 860	421 ± 327	9910	4.3	95.7
Trifluralin (10)	3110 ± 485	5056 ± 2174	21537	23.5	76.5
Triton X-100 (50 g product/L)	3420 ± 2384	810 ± 884	23680	3.4	96.6

* Numbers based on 6.9-fold increase in the control from mid-May to mid-July.

Table 5. Results of treating one- and two-year-old blackleg-infected canola stubble with propiconazole (Tilt) in 1994.

Propiconazole conc. (g a.i./L)	Mean no. of ascospores**	% reduction in ascospore numbers
One-year-old stubble		
0.00	13500	—
0.01	6500*	51.9
0.10	2300*	83.0
1.00	0*	100.0
Two-year-old stubble		
0.00	343	—
0.01	31*	91.0
0.10	18*	94.8
0.50	0*	100.0
1.00	0*	100.0

* Significantly different from check at p = 0.05, according to LSD test.
** Values are means of four replications.

Screening of field pea cultivars for resistance to fusarium root rot under field conditions in Alberta

S.F. Hwang[1], R.J. Howard[2], K.F. Chang[2], B. Park[3], K. Lopetinsky[4] and D.W. McAndrew[5]

Field trials were conducted at sites near Vegreville and Namao, Alberta, to evaluate pea cultivars for their resistance to fusarium root rot. At Vegreville, significantly greater disease severities and lower seed yields were observed in *Fusarium solani* f. sp. *pisi*-inoculated plots than in noninoculated (control) plots. At both Vegreville and Namao, no significant differences in root rot reaction were observed. All cultivars evaluated were found to be susceptible to this disease. There were considerable variations among cultivars for seed yield in both 1992 and 1993.

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Des essais au champ ont été menés dans des sites situés à proximité de Vegreville et Namao, en Alberta, afin d'évaluer la résistance de cultivars de pois au pourridié fusarien. À Vegreville, une virulence sensiblement plus élevée et un rendement grainier plus faible ont été observés dans les parcelles inoculées à l'aide de *Fusarium solani* f. sp. *pisi* comparativement aux parcelles témoins non inoculées. À Vegreville tout comme à Namao, nous n'avons pas observé de différences marquées dans les réactions au pourridié. Tous les cultivars évalués se sont révélés sensibles à cette maladie. La récolte des semences a varié considérablement d'un cultivar à l'autre autant en 1992 qu'en 1993.

Introduction

Field pea (*Pisum sativum* L. var. *arvense* (L.) Poir.) is well-adapted to temperate climates and can withstand considerable frost. In recent years, the acreage of field pea in north-central Alberta has increased dramatically. Fusarium root rot, caused by *Fusarium solani* (Mart.) Sacc. f. sp. *pisi* (F.R. Jones) W.C. Snyder & H.N. Hans. is a world-wide disease of considerable economic significance. It can seriously reduce the yield and quality of the crop (Kraft and Roberts, 1969). Surveys conducted in 1988 in north-central Alberta showed that the mean incidence of this disease for each of the fields examined was 31% (Hwang and Chang, 1989). With repeated cultivation of the field pea, it is anticipated that populations of *F. solani* f. sp. *pisi* will build up in the soil and cause significant yield losses in subsequent crops. Moreover, fusarium root rot may suddenly become more serious because of the introduction of new susceptible cultivars, and, consequently, some fields could be abandoned simply because pea production is no longer profitable. Although the use of disease-resistant cultivars offers a very economical control method, current knowledge of sources and stability of resistance to fusarium root rot in field pea is limited because no cultivars have recently been evaluated in Alberta. The objectives of this research were: i) to evaluate the effect of fusarium root rot on seed yield, and ii) to screen existing and promising new pea cultivars for resistance to this disease.

Materials and methods

Preparation of grain inoculum

Three single-spored isolates of *Fusarium solani* f. sp. *pisi* (F-19, F-24, and F-32) were obtained from symptomatic roots of field pea seedlings and maintained on potato dextrose agar slants at 5°C. Three to five 4-mm-diameter agar discs of each isolate were placed in (1 L) screw-top jars, which had been half-filled with moist rye grain (120 g grain + 200 mL water) and autoclaved twice for 60 min. The inoculated jars were incubated at room temperature in natural light for two weeks and shaken periodically to ensure complete colonization of the grain. After incubation, infested grain was removed from the jars, air-dried in a laminar-flow microbial transfer hood for two days, and stored at 4°C until needed. The colonized grain of each of the *F. solani* f. sp. *pisi* isolates was mixed at 1:1:1 (v/v/v) and used as inoculum. A rate of 20 mL/row was applied at seeding.

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Field trials

Field experiments were conducted in the spring of 1992 and 1993 near Namao and Vegreville, Alberta. A pre-emergence herbicide, Edge 5G (ethalfluralin 5% GR), was incorporated into the soil at a rate of 16 kg/ha along with 60 kg/ha fertilizer (8-36-15-5, N-P-K-S). At Vegreville, a split-plot randomized complete block design with four replications was employed. Inoculation with *F. solani* f. sp. *pisi*-infested grain or sterile grain served as main plots and 20 field pea cultivars were seeded in four 6 m row subplots with 20 cm between rows. Seeds were planted 4 cm deep with a grain drill at 100 seeds/row, and peat-based root-nodule bacteria inoculant was sprinkled in the rows. The replicate main plots were separated by 2 m borders and the subplots by 1 m. At Namao, 20 cultivars of field pea were seeded with *F. solani* f. sp. *pisi*-infested grain inoculum in a randomized complete block design with four replications. Four weeks after sowing, the number of emerged seedlings in a 2 m length of the two middle rows of each subplot was counted in 1992 and 1993 at Vegreville. At both sites, 10 plants from each subplot were randomly sampled 4 and 8 wk after seeding in 1992 and after 8 wk in 1993. Roots were washed and root rot severities were assessed on a scale of 0 to 4, where 0 = healthy, 1 = 1—10% root discoloration, 2 = 11—25%, 3 = 26—50%, and 4 = 51—100% (Fig. 1). Cultivars with mean scores between 0 and 1.0 were considered to be highly resistant, 1.1 and 2.0 moderately resistant, 2.1 and 3.0 moderately susceptible, and 3.1 and 4.0 highly susceptible. At maturity, plants in a 2 m^2 area from each subplot or plot were swathed, threshed and the seeds were dried to 16% moisture content and weighed.

Data analysis

Data were subjected to an analysis of variance and means were compared using Duncan's Multiple Range or LSD Tests at the $P \leq 0.05$ level of significance on SAS software (SAS Inst. Inc, 1985). Separate analyses were performed for each year and location.

Results and discussion

At Vegreville, no significant differences in number of emerged seedlings occurred between control and *Fusarium*-inoculated treatments in both 1992 and 1993 (Table 1). However, significantly greater disease severities and lower seed yields were observed for the *Fusarium*-inoculated plots. For all cultivars, greater disease severity was observed 8 wk after seeding compared to 4 wk.

In 1992, the cultivars Trump and Tipu were moderately susceptible and the other 18 cultivars were moderately resistant to fusarium root rot 4 wk after seeding at Namao (Table 2). At Vegreville, all cultivars were moderately resistant 4 wk after seeding (Table 2). By 8 wk after seeding, disease severities varied from 3.1 to 3.9 at both sites, resulting in susceptible disease ratings for all cultivars.

In 1993 at Namao, cultivars Century, Bohatyr and Stehgolt had the least disease, with severity ratings of 2.5 to 2.6, whereas Princess and Titan had the highest ratings at 3.9 and 3.8, respectively (Table 3). The disease severity ratings of the rest of the cultivars were between 2.7 and 3.7; therefore, all cultivars were considered to be either moderately susceptible or susceptible. At Vegreville, all cultivars were moderately susceptible, with the exception of Titan, which was susceptible.

In 1992 at Namao, the highest average seed yields between 157 and 180 g/plot were recorded for cvs. Bohatyr, Miranda, Orb, SVG 14936, Danto and LU-SIB; and the lowest average seed yield values of 57 to 67 g/plot were recorded for Titan, Century and Trapper (Table 4). Average seed yields for the remaining 11 cultivars were between 87 and 147 g/plot. Average seed yield at Vegreville in 1992 varied from 137 to 227 g/plot. The best yielding cultivars included Orb, Stehgolt, Miranda, Topper and Bohatyr, which had yields equal to or greater than 200 g/plot. The poorest yielding cultivars included Tipu, Trapper, LU-SIB, Tara and Century, which had average yields equal to or less than 137 g/plot. In both 1992 and 1993, there were considerable variations among cultivars for seed yield and some of the higher yielding cultivars in 1992 would rank among the lower yielding cultivars in 1993. In part the differences in yields for the two years were due to some higher yield values in 1993 than in 1992 (Table 4).

This is the first report describing the reaction of pea breeding lines or cultivars to root rot caused by *F. solani* f. sp. *pisi* in north-central Alberta. All tested cultivars were considered to be moderately susceptible or susceptible. Significant differences in root rot severity and seed yield occurred between inoculated and noninoculated plots. These data suggest that fusarium root rot can seriously reduce yields of field pea and from visual observations it appeared that the seed from the inoculated plots were lower in quality. The use of cultivars resistant to this disease can offer a very effective method for the control of this disease control. The use of resistant cultivars could provide a way to maintain or increase crop production without increased land demands or adverse environmental consequences. More field pea breeding lines and plant introductions should be screened to identify high levels of genetic resistance to fusarium root rot and for suitable adaptation to growing conditions in Alberta which would enhance the desirability of growing field pea as an alternative cash crop.

Acknowledgements

We thank Drs. L.M. Dosdall and B.A. Darroch for reviewing the manuscript. This work was financially supported in part

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Table 1. Effects of *Fusarium solani* f. sp. *pisi* inoculation on mean number of seedlings, disease severity and seed yield in field pea grown at Vegreville, Alberta in 1992 and 1993.

Treatment	1992				1993			
	# of seedlings per 2 m of row	Root rot severity** 4 wk	Root rot severity** 8 wk	Seed yield g/m^2	# of seedlings per 2 m of row	Root rot severity 4 wk	Root rot severity 8 wk	Seed yield (g/m^2)
Control	18 a*	1.0 b	2.9 b	202 a	20 a	1.1 b	1.4 b	280 a
Inoculated	17 a	1.6 a	3.4 a	179 b	19 a	1.9 a	2.6 a	243 b

* Values are the means of four replicate main plots. Means in the same column followed by the same letter are not significantly (P = 0.05) different using Duncan's Multiple Range Test.

** Ratings of root rot severity: 0 = healthy, 1 = 1—10% root discoloration, 2 = 11—25%, 3 = 26—50%, and 4 = 51—100%. Data collected 4 and 8 weeks after seeding.

Table 2. Comparative root rot disease severity among 20 field pea cultivars grown in fields artificially infested with *Fusarium solani* f. sp. *pisi* at Namao and Vegreville, Alberta, in 1992. Values for disease severity are averages of 10 plants per subplot.

Cultivar	Namao				Vegreville			
	Severity* (4 wk)	Disease reaction	Severity (8 wk)	Disease reaction**	Severity (4wk)	Disease reaction	Severity (8 wk)	Disease reaction
AC Tamor	1.7	MR	3.5	S	1.9	MR	3.5	S
Bohatyr	2.0	MR	3.6	S	1.3	MR	3.5	S
Century	1.9	MR	3.3	S	1.4	MR	3.3	S
CL-85-13	1.7	MR	3.6	S	2.0	MR	3.2	S
Danto	1.6	MR	3.4	S	1.7	MR	3.2	S
Express	1.6	MR	3.5	S	1.5	MR	3.6	S
LU-SIB	1.9	MR	3.7	S	2.0	MR	3.5	S
Miranda	1.6	MR	3.4	S	1.5	MR	3.2	S
Orb	2.0	MR	3.6	S	1.7	MR	3.9	S
Patriot	1.5	MR	3.2	S	1.3	MR	3.5	S
Princess	1.6	MR	3.7	S	1.4	MR	3.7	S
Radley	1.1	MR	3.5	S	1.3	MR	3.1	S
SVG 14936	1.7	MR	3.5	S	1.9	MR	3.7	S
Stehgolt	1.7	MR	3.6	S	1.5	MR	3.5	S
Tara	1.7	MR	3.2	S	1.5	MR	3.3	S
Tipu	2.4	MS	3.5	S	1.5	MR	3.4	S
Titan	1.8	MR	3.6	S	1.8	MR	3.5	S
Topper	1.9	MR	3.6	S	1.9	MR	3.6	S
Trapper	1.4	MR	3.3	S	1.1	MR	3.5	S
Trump	2.2	MS	3.4	S	1.7	MR	3.6	S
LSD (0.05)	0.7		0.4		0.6		0.3	

* Ratings of root rot severity: 0 = healthy, 1 = 1—10% root discoloration, 2 = 11—25%, 3 = 26—50%, and 4 = 51—100%. Data collected 4 and 8 weeks after seeding.

** Disease reaction: R (resistant) = root rot severity of 0 to 1.0, MR (moderately resistant) = of 1.1 to 2.0, MS (moderately susceptible) = of 2.1 to 3.0, S (susceptible) = 3.1 to 4.0.

Table 3. Comparative root rot disease severity among 20 field pea cultivars grown in fields artificially infested with *Fusarium solani* f. sp. *pisi* at Namao and Vegreville, Alberta, in 1993. Values for disease severity are averages of 10 plants per subplot.

	Namao		Vegreville	
	Severity*	Disease reaction**	Severity	Disease reaction
AC Tamor	3.5	S	3.0	MS
Bohatyr	2.6	MS	2.2	MS
Century	2.5	MS	2.3	MS
CL-85-13	3.2	S	2.3	MS
Danto	3.2	S	2.8	MS
Express	2.8	MS	2.6	MS
LU-SIB	3.7	S	2.8	MS
Miranda	3.4	S	2.9	MS
Orb	2.9	MS	2.6	MS
Patriot	3.6	S	2.2	MS
Princess	3.9	S	2.7	MS
Radley	2.9	MS	2.0	MS
SVG 14936	3.5	S	2.7	MS
Stehgolt	3.4	S	2.3	MS
Tara	2.6	MS	2.8	MS
Tipu	2.8	MS	2.9	MS
Titan	3.8	S	3.1	S
Topper	3.3	S	2.9	MS
Trapper	2.7	MS	2.6	MS
Trump	3.5	S	2.7	MS
LSD (0.05)	0.7		0.6	

* Ratings of root rot severity: 0 = healthy, 1 = 1—10% root discoloration, 2 = 11—25%, 3 = 26—50%, and 4 = 51—100%. Data collected 8 weeks after seeding.

** Disease reaction: R (resistant) = root rot severity of 0 to 1.0, MR (moderately resistant) = of 1.1 to 2.0, MS (moderately susceptible) = of 2.1 to 3.0, S (susceptible) = 3.1 to 4.0.

Table 4. Comparative seed yield (g/m^2) among 20 field pea cultivars grown in fields artificially infested with *Fusarium solani* f. sp. *pisi* at Namao and Vegreville, Alberta, in 1992 and 1993. Values are the means of four replicate plots.

	1992		1993	
	Namao	Vegreville	Namao	Vegreville
AC Tamor	87	175	234	268
Bohatyr	180	200	284	305
Century	60	158	147	226
CL-85-13	103	177	303	389
Danto	159	18	259	232
Express	94	175	345	239
LU-SIB	157	153	272	237
Miranda	172	209	229	146
Orb	170	227	248	277
Patriot	93	181	302	258
Princess	141	166	177	117
Radley	147	161	239	199
SVG 14936	167	197	343	366
Stehgolt	139	212	268	163
Tara	125	192	377	262
Tipu	136	137	236	217
Titan	57	156	133	220
Topper	127	201	404	238
Trapper	67	152	287	255
Trump	131	161	311	227
LSD(0.05)	57	46	87	105

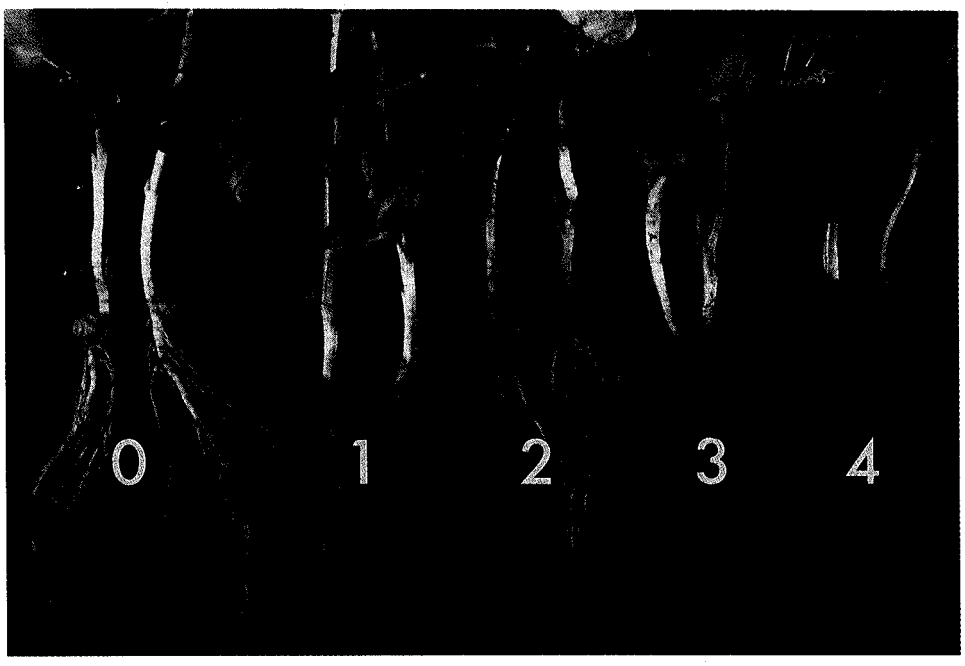

Fig. 1. Root rot severity rating of field pea on a scale of 0 to 4 where 0 = healthy, 1 = 1—10% root discoloration, 2 = 11—25%, 3 = 26—50%, and 4 = 51—100%.

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Diagnostic Laboratories / Laboratoires diagnostiques

CROP: Commercial Crops - Diagnostic Laboratory Report

LOCATION: British Columbia

NAME AND AGENCY:
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TITLE: DISEASES DIAGNOSED ON COMMERCIAL CROPS SUBMITTED TO THE BRITISH COLUMBIA PLANT DIAGNOSTIC LABORATORY IN 1994

METHODS: The B.C.M.A.F.F. Plant Diagnostic Laboratory provides the diagnosis of, and control recommendations for diseases of commercial crops. The following data reflects samples submitted to the laboratory by ministry extension staff, growers, agri-business, parks departments and Master Gardeners. Diagnoses were accomplished by microscope examination, culturing onto artificial media and ELISA. Assisting with the diagnoses were Leslie MacDonald and David J. Ormrod, Plant Pathologists at the B.C.M.A.F.F.

RESULTS AND COMMENTS: Summaries of the diseases and/or causal agents diagnosed on commercial crops are presented in Tables 1 to 8 by crop category. The total number of submissions for each crop category is listed at the bottom of each table. Only diseases of significance are listed in the attached summaries. Problems not listed include: nutritional stress; pH imbalance; water stress; poor sample; physiological responses to growing conditions; chemical damage; insect related damage; and damage where no conclusive disease-causing organism was identified. These submissions are grouped under the heading 'Other' at the bottom of each table. Sample numbers are based on submissions received from December 1, 1993 to November 30, 1994.

TABLE 1. Summary of diseases diagnosed on greenhouse vegetable samples submitted to the B.C.M.A.F.F. Plant Diagnostic Laboratory in 1994.

CROP	DISEASE/CAUSAL AGENT	NO. OF SAMPLES
Cucumber	*Penicillium oxalicum* stem rot*	1
	Didymella bryoniae	1
	Pythium root rot	2
	Fruit Rot - *Penicillium* sp.	1
	- *Didymella bryoniae*	1
Pepper	*Botrytis cinerea*	1
	Fusarium solani	5
	Fusarium sp.	2
	Verticillium fruit rot	1
	Erwinia soft rot	1
	Pythium root rot	3
Tomato	*Botrytis cinerea*	1
	Pythium root rot	6
	Corky root - *Humicola* sp.	6
Other		30
TOTAL		62

* First report of virulent strain in British Columbia (J. Menzies, Agriculture and Agri-Food Canada, Agassiz, British Columbia, pers. com.).

TABLE 2. Summary of diseases diagnosed on floriculture samples submitted to the B.C.M.A.F.F. Plant Diagnostic Laboratory in 1994.

CROP	DISEASE/CAUSAL AGENT	NO. OF SAMPLES
Anthurium sp.	Pythium root rot	1
Antirrhinum spp.	*Peronospora antirrhini*	1
	Root rot - Phycomycete	1
	INSV	1
Alyssum spp.	*Peronospora myosotidis*	1
	Pythium root rot	1
Begonia sp.	*Botrytis cinerea*	1
Brachycome sp.	INSV	1
Browalia sp.	INSV	2
Chrysanthemum x *morifolium*	*Sclerotinia sclerotiorum*	1
	TSWV	2
Cyclamen persicum	Cylindrocarpon crown rot	1
Dahlia sp.	INSV	1
Dendrobium sp.	Pythium root rot	1
Dianthus caryophyllus	Crown and root rot - Phycomycete	1
	Pythium damping off	1
Euphorbia pulcherrima	*Xanthomonas campestris*	1
	Crown and root rot - Phycomycete	2
	Thielaviopsis basicola	1
Exacum sp.	INSV	1
Fuchsia x *hybrida*	Root rot - Phycomycete	1
	Pucciniastrum epilobii	1
	Thielaviopsis basicola	2
	Botrytis cinerea	2
Gerbera sp.	*Sclerotinia sclerotiorum*	1
Hydrangea sp.	Anthracnose - *Colletotrichum* sp.	1
Impatiens wallerana	*Botrytis cinerea*	1
	INSV	3
	Pythium root rot	1
	Slime mold - Myxomycete	1
Lilium sp.	Pythium root rot	1
Lisianthus sp.	*Botrytis cinerea*	2
Matthiola sp.	Pythium root rot	1
Narcissus spp.	*Fusarium oxysporum* f. sp. *narcissi*	1
	Bulb and stem nematode	2
Pelargonium x *hortorum*	*Xanthomonas campestris* pv. *pelargonii*	5
	Botrytis cinerea	3
	Pythium root rot	5
	Rhizoctonia root rot	1
	Puccinia pelargonii-zonalis	1*
Pelargonium peltatum	Oedema	1
Petunia sp.	INSV	1

(cont'd.)

CROP	DISEASE/CAUSAL AGENT	NO. OF SAMPLES
Primula sp.	Root rot - Phycomycete	2
	Thielavopsis basicola	2
	Fusarium crown rot	1
	Erwinia carotovora	1
	Pseudomonas leaf spot	1
Ranunculus sp.	INSV	1
Saintpaulia sp.	Crown and root rot - Phycomycete	1
Senecio cruentus	INSV	1
Schizostylus sp.	Anthracnose - *Colletotrichum* sp.	1
Tagetes spp.	Pythium root rot	1
	Botrytis cinerea	1
	INSV	1
Tulipa sp.	Fire - *Botrytis* sp.	1
Verbena sp.	INSV	1
	Root rot - Phycomycete	1
Viola spp.	*Thielaviopsis basicola*	3
	Peronospora violae	1
	Alternaria violae	1
	Pythium root rot	1
Cactus sp.	*Fusarium oxysporum*	1
Other		58
TOTAL		143

* Sample from a home garden. Disease is not present in commercial operations in British Columbia.

TABLE 3. Summary of diseases diagnosed on small fruit samples submitted to the B.C.M.A.F.F. Plant Diagnostic Laboratory in 1994.

CROP	DISEASE/CAUSAL AGENT	NO. OF SAMPLES
Blueberry	*Botrytis* spp.	4
	Coryneum stem canker	2
	Godronia cassandrae	7
	Monilinia vaccinii-corymbosi	1
	Pseudomonas syringae	10
	Phomopsis vaccinii	1
	Phytophthora root rot	2
Blackberry	Coryneum cane canker	1
	Phytophthora root rot	2
Cranberry	Phytophthora root rot	3
	Rhizoctonia sp.	1
Currant	*Drepanopeziza ribis*	1
	Cronartium ribicola	1

(cont'd.)

CROP	DISEASE/CAUSAL AGENT	NO. OF SAMPLES
Raspberry	*Didymella applanata*	1
	Phragmidium rubi-idaei	1
	Phytophthora root rot	4
	Anthracnose	2
	Botrytis cane wilt	1
	Verticillium wilt	4
	Leptosphaeria coniothyrium	1
Saskatoon	*Botrytis cinerea*	1
	Gymnosporangium rust	2
Strawberry	*Verticillium dahliae*	1
	Rhizoctonia root rot	7
	Parasitic root nematodes	2
Other		9
TOTAL		72

TABLE 4. Summary of diseases diagnosed on specialty crop samples submitted to the B.C.M.A.F.F. Plant Diagnostic Laboratory in 1994.

CROP	DISEASE/CAUSAL AGENT	NO. OF SAMPLES
Agaricus bisporus	*Trichoderma* sp.	2
Basil	Damping off - Phycomycete	1
	Crown and root rot - Phycomycete	1
Dill	Alternaria leaf blight	1
Garlic	Botrytis bulb rot	1
	Sclerotium cepivorum	5
	Fusarium basal rot	2
	Thielaviopsis basicola root rot	1
	Rhizoctonia sp.	1
Ginseng	*Alternaria panax*	14
	Rusty root - *Cylindrocarpon destructans*	1
	Root and crown rot - *Rhizoctonia* sp.	5
	Root rot - *Phytophthora* sp.	8
	Damping off - *Rhizoctonia* sp.	2
	- *Pythium* sp.	1
	Leaf spot - *Botrytis* sp.	3
	Seed decay - *Fusarium* spp.	2
	- *Botrytis* sp.	1
	- *Alternaria* sp.	1
	- *Cylindrocarpon* sp.	1
Oyster mushroom	*Penicillium* sp.	2
	Trichoderma sp.	1
Rosemary	*Thielaviopsis basicola*	1
Tobacco	Damping off - Phycomycete	1
Other		19
TOTAL		78

Table 5. Summary of diseases diagnosed on tree fruit samples submitted to the B.C.M.A.F.F. Plant Diagnostic Laboratory in 1994.

CROP	DISEASE/CAUSAL AGENT	NO. OF SAMPLES
Apple	*Venturia inaequalis*	1
	Nectria galligena	2
	Diaporthe perniciosa	1
	Cytospora canker	2
	Alternaria sp.	1
	Phytophthora crown rot	2
	Erwinia amylovora	1
	Crown gall - *Agrobacterium* sp.	2
	Cork spot - Calcium deficiency	1
Cherry	*Pseudomonas syringae*	1
Filbert	*Xanthomonas campestris* pv. *corylina*	1
Pear	*Venturia pirina*	1
Other		3
TOTAL		19

TABLE 6. Summary of diseases diagnosed on field vegetable samples submitted to the B.C.M.A.F.F. Plant Diagnostic Laboratory in 1994.

CROP	DISEASE/CAUSAL AGENT	NO. OF SAMPLES
Asparagus	*Stemphyllium vesicarium*	1
Bean	Pythium crown and root rot	1
Broccoli/Cauliflower	Root rot - Phycomycete	2
Brussels sprout	*Pseudomonas* sp. pepper spot	2
	Fusarium sp. - superficial	1
	Alternaria sp. - superficial	1
Carrot	*Fusarium roseum*	1
	Pythium cavity spot	1
Celery	*Pseudomonas syringae* - bacterial blight	1
	Bacterial soft rot	1
	Fusarium root rot	1
	Thanatephoris cucumeris	1
	Cercospora apii	1
	Septoria apiicola	1
Corn	*Ustilago maydis*	1
Cucumber	Pythium crown and root rot	4
	Pseudomonas lacrymans	1
Lettuce	*Bremia lactucae*	1

(cont'd.)

CROP	DISEASE/CAUSAL AGENT	NO. OF SAMPLES
Melon	Fusarium wilt and root rot	1
Onion	Botrytis blast	1
	Peronospora destructor	1
	Aspergillus niger	1
Pea	Pythium/Rhizoctonia root rot	1
	Thielaviopsis basicola	1
Pepper	*Botrytis cinerea* stem blight	1
	Root rot - Phycomycete	1
	Damping off - *Fusarium* sp.	1
Potato	*Phytophthora erythroseptica*	1
	Phytophthora infestans	1
	Pythium cottony leak	1
	Scab - *Streptomyces* sp.	1
	Erwinia carotovora	5
	Dry rot - *Fusarium solani*	2
	Fusarium spp.	2
	Clavibacter michiganensis subsp. *sepedonicus*	1*
	Botrytis sp.	1
	Mosaic virus	1
Spinach	Pythium root rot	1
Tomato	Root rot - Phycomycete	3
Turnip	*Plasmodiophora brassicae*	1
Watermelon	Pythium damping off	1
Zucchini	*Cladosporium cucumerinum*	1
Other		38
TOTAL		93

* Ongoing problem in one area, no new outbreaks.

TABLE 7. Summary of diseases diagnosed on woody ornamental and perennial samples submitted to the B.C.M.A.F.F. Plant Diagnostic Laboratory in 1994.

CROP	DISEASE/CAUSAL AGENT	NO. OF SAMPLES
Abies sp.	*Rhizosphaera kalkhoffii*	1
Acer palmatum	Nectria canker	2
	Pseudomonas syringae	1
	Verticillium dahliae	2
	Kabatiella apocrypta	2
Acer sp.	Nectria canker	1
Adiantum sp.	Rhizoctonia aerial blight	1
Alcea rosea	Pythium root rot	1
Alnus sp.	*Pseudomonas syringae*	1
Aster sp.	Cercospora leaf spot	2
Araucaria araucana	Phytophthora root rot	1
Azalea spp.	Phytophthora crown and root rot	2
	Exobasidium vaccinii	2
	Microsphaeria sp. - powdery mildew	1
Campanula sp.	Pythium root rot	1
Catalpa sp.	*Verticillium dahliae*	1
Cedrus atlantica	*Rhizosphaera kalkhoffii*	1
Chamaecyparis sp.	Phytophthora root rot	1
Clematis spp.	*Ascochyta aquilegiae*	1
	Fusarium crown rot	1
Delphinium grandiflorum	Root rot - Phycomycete	1
Edgeworthia sp.	*Botrytis cinerea*	1
Forsythia sp.	*Pseudomonas syringae*	1
Gaillardia sp.	Root rot - Phycomycete	1
Hemerocallis sp.	Root rot - Phycomycete	1
Heuchera sanguinea	*Thielaviopsis basicola*	1
Hibiscus spp.	Sooty mold - Ascomycete	2
Humulus lupulus	*Pseudoperonospora humuli*	1
Hypericum calycinum	Phytophthora root rot	1
Ilex sp.	Phytophthora blight	1
Iris sp.	Crown rot - Phycomycete	1
Juniperus chinensis	Phytophthora root rot	1
Juniperus spp.	Twig dieback - *Cercospora* sp.	1
	Phytophthora root rot	6
	Kabatina sp.	1
Kalmia latifolia	Root rot - Phycomycete	1
Larix sp.	Phytophthora root rot	1
Liatris sp.	Stem rot - *Botrytis cinerea*	1
	Sclerotinia sp.	1
Limonium vulgare	*Colletotrichum gloeosporoides*	2
Lobelia sp.	Pythium root rot	1
Lunaria annua	*Alternaria brassicae*	1
Lupinus spp.	*Peronospora trifoliorum*	1
	Powdery mildew	1

(cont'd.)

CROP	DISEASE/CAUSAL AGENT	NO. OF SAMPLES
Malus floribunda	Phytophthora root rot	1
Malus spp.	Fungal canker	1
	Nectria galligena	1
	Phythophthora crown rot	1
Phlox sp.	Smut - *Entyloma* sp.	1
Pinus contorta	Lophodermium needle cast	1
P. flexilus	Phytophthora root rot	1
P. nigra	*Dothiostroma pini*	1
P. paniculata	Stem canker - *Phoma* sp.	1
P. ponderosa	*Lophodermella morbida*	1
P. thunbergiana	Lophodermella needle cast	1
Populus alba	Cytospora canker	1
Populus spp.	Taphrina leaf blister	1
	Venturia macularis	1
Prunus spp.	Thielaviopsis root rot	1
	Monilinia fructicola	1
	Pseudomonas bacterial blight	1
Pseudotsuga menziesii	Phytophthora root rot	2
	Rhabdocline needle cast	1
Rhododendron spp.	Phytophthora root rot	3
	Pestalotiopsis leaf blight	1
	Necrotic ringspot virus	1
	Microsphaeria sp. - powdery mildew	1
Rosa spp.	*Leptosphaeria coniothyrium*	2
	Root rot - Phycomycete	2
	Pseudomonas syringa	1
	Rose mosaic virus	1
Salix sp.	*Marssonina salicicola*	1
Sequoiadendron gigantium	*Phomopsis juniperova*	1
Syringa spp.	*Pseudomonas syringae*	1
	Pestalotiopsis twig blight	1
Thuja occidentalis	*Seiridium cardinale*	1
	Root rot - Phycomycete	3
	Pestalotiopsis twig blight	2
	Kabatina thujae	1
T. plicata	*Didymascella thujina*	7
	Seiridium cardinale	1
	Kabatina thujae	1
Thuja spp.	*Didymascella thujina*	1
	Seiridium cardinale	1
	Root rot - Phycomycete	2
	Pestalotiopsis twig blight	2
Tradescantia sp.	Root rot - Phycomycete	1
Other		251
TOTAL		367

TABLE 8. Summary of diseases diagnosed on turfgrass samples submitted to the B.C.M.A.F.F. Plant Diagnostic Laboratory in 1994.

DISEASE/CAUSAL AGENT	SOURCE OF SAMPLE*		
	Golf/Bowling Green	Sod Farm	Lawn
Pythium spp. root rot	63	7	1
Pythium spp. damping off	6		
Gaeumannomyces graminis	12	1	
Ascochyta agrostis	1		
Ascochyta spp.	4		6
Microdochium nivale	6		2
Colletotrichum graminicola	3	1	4
Rhizoctonia spp.	7	2	4
Cladosporium sp.		1	
Limonomyces roseipellis			1
Curvularia spp.			2
Drechslera spp.		2	1
Typhula sp.	1		
Puccinia spp.		2	1
Ustilago striiformis			1
Fusarium crown and root rot	1		
Basidiomycete dry spot	5		
Basidiomycete snow mold	1		
Basidiomycete fairy ring	2		1
Physarum sp. slime mold			2
Algae	1	1	
Other	34	0	35
TOTAL	147	17	61

* Golf and bowling greens are primarily creeping bentgrass and/or annual bluegrass. The remaining categories refer to mixtures of fescues, ryegrass, Kentucky bluegrass and annual bluegrass.

CROP: Commercial Crops, and others - Diagnostic Laboratory Report

LOCATION: Alberta

NAME AND AGENCY:
B.J. Penner, President
J. Calpas, Plant Pathologist
A. Henrickson, S. Lawrence, W. Voroney, Technologists
Brooks Diagnostics Limited
Box 1701, Brooks, Alberta T1R 1C5

TITLE: DISEASES DIAGNOSED ON PLANT SAMPLES SUBMITTED TO BROOKS DIAGNOSTICS LIMITED IN 1994

METHODS: Brooks Diagnostics Limited (BDL) diagnosed diseases on samples of commercial crops and other types of plants submitted by district agriculturists, agri-business, golf courses, farmers and the general public from January 1 to December 1, 1994. BDL, a private plant health clinic, assumed responsibility for operating the plant diagnostic laboratory at the Alberta Special Crops and Horticultural Research Centre, Brooks on July 1, 1993. This facility had previously been under the direction of Alberta Agriculture. Each diagnosis listed in the table below was made by carefully examining symptoms expressed on host plants and/or by isolating primary pathogens from diseased tissues.

RESULTS: All of the disease identifications made by BDL on all plant samples from Alberta in 1994 are summarized in Table 1. BDL also received samples from outside Alberta, which are not included in this report.

TABLE 1. Summary of diseases diagnosed on all commercial crops and other types of plants submitted to Brooks Diagnostics Limited in 1994.

SOUTHERN ALBERTA

CROP/PLANT	DISEASE/SYMPTOM	CAUSAL AGENT
Alfalfa	Chlorosis, wilting	Drought
	Common leaf spot	*Pseudopeziza medicaginis*
	Crown rot	*Fusarium* sp.
	Fusarium crown rot	*Fusarium* sp.
	Spring black stem and leaf spot	*Phoma medicaginis*
	Stunting	Cold temperature stress
	Stunting, chlorosis	Cold temperature stress
	Target spot	*Stemphylium sarcinaeforme*
	Verticillium wilt	*Verticillium albo-atrum*
Alyssum	Stunting, chlorosis	High soil salts
Ash	Leaf scorch	Transplant shock
Aspen	Leaf and stem blackening	High soil salts
	Leaf drop	Cold temperature injury

(cont'd.)

SOUTHERN ALBERTA

CROP/PLANT	DISEASE/SYMPTOM	CAUSAL AGENT
Barley	Barley scald	*Rynchosporium secalis*
	Net blotch	*Pyrenophora teres*
	Root rot	*Fusarium* sp.
		Pythium sp.
	Septoria leaf spot	*Septoria avenae*
Basil	Leaf spotting	Environmental stress
Bean	Leaf spotting, interveinal chlorosis/necrosis	Magnesium deficiency
Beet	Leaf spotting	Diquat spray drift
Begonia	Damping-off	*Fusarium* sp.
	Leaf spotting	Impatiens necrotic spot virus
Birch	Leaf scorch	Cygon injury
		Environmental stress
Cabbage (seedlings)	Damping-off	*Rhizoctonia solani*
Canola	Alternaria blackspot	*Alternaria brassicae*
	Blackleg	*Leptosphaeria maculans*
	Chlorosis/leaf purpling	Cold temperature stress
	Sclerotinia stem rot	*Sclerotinia sclerotiorum*
	Stem purpling	Phosphorous deficiency
	Stunting	Environmental stress
	Stunting, leaf purpling, chlorosis	Sulfonylurea herbicide injury
	White leaf spot and gray stem	*Pseudocercosporella capsellae*
Caragana	Leaf and stem blackening	High soil salts
	Leaf spotting	*Pleospora* sp.
Carrot	Alternaria leaf blight	*Alternaria dauci*
	Common scab	*Streptomyces scabies*
Cauliflower	Soft rot	*Erwinia* sp.
Cereal	Common root rot	*Cochliobolus sativus*
	White ear	*Fusarium* sp.
Chinese Vegetable	Rhizoctonia root rot	*Rhizoctonia solani*
Cherry	Leaf scorch	Winterkill and drought stress
Chokecherry	Leaf spot	*Rhizopus* sp.
Corn	Common smut	*Ustilago maydis*
	Poor cob development	High plant density
Cucumber	Damping-off	*Pythium* sp.
	Gummy stem blight	*Didymella bryoniae*
	Phosphorous deficiency	High soil pH
	Pythium root and stem rot	*Pythium* sp.
	Rapid bleaching and dieback	Response to high light intensity
	Rapid wilting	Fungicide toxicity
Dracena	Leaf spotting	Impatiens necrotic spot virus

(cont'd.)

SOUTHERN ALBERTA

CROP/PLANT	DISEASE/SYMPTOM	CAUSAL AGENT
Elm	Cytospora canker	*Cytospora* sp.
	Dieback	Drought stress
		Environmental stress
Evergreen	Needle browning/chlorosis	Drought stress
		High soil pH
		High soil salts
		High water table
Fir	Needle chlorosis and drop	Environmental stress
Flax	Pasmo	*Septoria linicola*
Flowering crab	Chlorosis	Iron deficiency
	Fireblight	*Erwinia amylovora*
Geranium	Interveinal chlorosis	Nutrient deficiency
	Interveinal chlorosis, leaf browning	Environmental stress
	Root and crown rot	*Pythium* sp.
Ginseng	Alternaria leaf blight	*Alternaria panax*
	Root rot	*Pythium* sp.
		Fusarium sp.
Lentil	Ascochyta	*Ascochyta lentis*
	Botrytis stem rot	*Botrytis cinerea*
	Seedling blight	Fusarium sp.
		Rhizoctonia solani
Lily	Basal rot	*Fusarium oxysporum*
	Leaf spotting	Potyvirus
Maple	Leaf distortion	Herbicide damage
	Sooty mold on leaves	*Cladosporium* sp.
Marigold	Leaf scorch	High soil salts
Mayday	Dieback	Soil sterilant
Oak	Leaf distortion and curling	Cold temperature injury
		Herbicide damage
Onion	Neck rot	*Botrytis allii*
Pepper	Necrosis, chlorosis	Oedema
	Soft rot	*Erwinia* sp.
	Stunting, leaf distortion	Environmental stress
	Yellow mosaic	Environmental stress
Petunia	Stunting,chlorosis	High soil salts
Pine	Dieback	High soil pH
	Needle browning	Drought stress
		Environmental stress
	Needle chlorosis	Environmental stress
Plum	Dieback	Environmental stress
Poinsettia	Leaf scorch	Environmental stress
	Root and stem rot	*Pythium* sp.
		Rhizoctonia solani

(cont'd.)

SOUTHERN ALBERTA

CROP/PLANT	DISEASE/SYMPTOM	CAUSAL AGENT
Poplar	Leaf drop, browning	Environmental stress
	Leaf spots, holes	Cold temperature injury
	Leaf twisting and cupping	Cold temperature stress
	Mycosphaerella leaf blight	*Mycosphaerella populorum*
Potato	Bacterial ring rot	*Corynebacterium sepedonicum*
	Bacterial soft rot	*Erwinia carotovora*
	Blackleg	*Erwinia carotovora* pv. *atroseptica*
	Bruising	Handling injury
	Common scab	*Streptomyces scabies*
	Early blight	*Alternaria solani*
	Enlarged lenticels	High soil moisture
	Fusarium dry rot	*Fusarium* sp.
	Internal browning	*Rhizoctonia solani*
	Internal cracking	Hollow heart
	Late blight	*Phytophthora infestans*
	Leaf damage	Wind injury
	Leaf scorch	Herbicide damage
	Leak	*Pythium* sp.
	Pink rot	*Phytophthora erythroseptica*
	Pythium	*Pythium* sp.
	Soft rot	*Erwinia carotovora*
	Surface mold	*Alternaria alternata*
	Vascular discoloration (tuber)	*Verticillium* sp.
	Vascular necrosis (tuber)	Net necrosis
Safflower	Root rot/leaf spot	*Pythium* sp.
		Fusarium sp.
		Rhizoctonia sp.
		Cladosporium sp.
Saskatoon	Black leaf and witches broom	*Apiosporina collinsii*
	Soft rot of fruit	*Rhizopus* sp.
Spruce	Browning	Cold temperature injury
	Dieback	Soil sterilant injury
		Transplanted too deep
		High water table
	Lophodermium needle cast	*Lophodermium picea*
	Needle browning, decline	Winter injury
	Needle chlorosis, tip browning	Drought stress
	Needle loss	Autumn needle shed
	Needle loss	Drought stress
Timothy	Browning of top leaves	Environmental stress
	Purple spot	*Cladosporium phlei*

(cont'd.)

SOUTHERN ALBERTA

CROP/PLANT	DISEASE/SYMPTOM	CAUSAL AGENT
Tomato	Bacterial speck	*Pseudomonas syringae*
	Blossom end rot	Calcium deficiency
	Botrytis ghost spot	*Botrytis* sp.
	Stem twisting	Ethylene injury
Turf	Chlorosis	Algae
	Dead patches in lawn	Annual bluegrass taking over lawn
	Dieback	Soil sterilant injury
	Fusarium patch	*Fusarium* sp.
		Fusarium nivale
	Pink snow mold	*Fusarium nivale*
	Pythium blight	*Pythium* sp.
	Rhizoctonia brown patch	*Rhizoctonia solani*
	Speckled snow mold	*Typhula ishikariensis*
	Take-all patch	*Gaeumannomyces graminis*
Wheat	Common root rot	*Cochliobolus sativus*
		Fusarium sp.
	Chlorosis	Environmental stress
		Nutrient deficiency
		Wind damage
	Leaf scorch	Spray damage
	Root rot	*Rhizoctonia* sp.
		Fusarium sp.
	Take-all	*Gaeumannomyces graminis*
	Tan spot	*Pyrenophora tritici-repentis*
	Wheat streak mosaic	Wheat streak mosaic virus
	Whitehead	*Fusarium* sp.
Wheatgrass	Stunting, flag leaf browning	Environmental stress
Willow	Dieback	Environmental stress
	Leaf scorch	Herbicide injury
Zucchini	Fusarium Wilt	*Fusarium* sp.

SOUTH CENTRAL ALBERTA

CROP/PLANT	DISEASE/SYMPTOM	CAUSAL AGENT
African Violet	Crown dieback	Environmental stress
	Leaf lesions	Sunscald
Apple	Apple scab	*Venturia inaequalis*
	Fireblight	*Erwinia amylovora*
	Leaf drop	Environmental stress
Ash	Cracking of trunk	Frost crack
	Fireblight	*Erwinia amylovora*
Aspen	Aspen leaf and twig blight	*Venturia macularis*
	Chlorosis	Iron deficiency
	Hypoxylon canker	*Hypoxylon mammatum*
	Weeping trunk	Sunscald
Barley	Net blotch	Pyrenophora teres
Bluegrass	Silvertop	*Fusarium* sp.
Cactus	Fusarium stem rot	*Fusarium oxysporum*
Canola	Alternaria black spot	*Alternaria brassicae*
	Blackleg	*Leptosphaeria maculans*
Caragana	Rapid decline/girdling	Environmental stress
		High soil salts
Chrysanthemum	Botrytis blight	*Botrytis cinerea*
	Crown rot	*Rhizoctonia solani*
	Gray mold	*Botrytis cinerea*
	Leaf scorch	Environmental stress
	Leaf spotting, wilt	Chemical damage
	Rhizoctonia root rot	*Rhizoctonia solani*
	Stem dieback	*Botrytis* sp.
Clematis	Stem canker	*Fusarium* sp.
		Rhizoctonia solani
Cucumber	Chlorosis and stunting	Possible virus problem
	Fruit and leaf lesions, wilt	*Cladosporium cucumerinum*
		Verticillium albo-atrum
	Marginal leaf necrosis	Potassium deficiency
	Wilt	Low temperature injury
Dogwood	Cytospora canker	*Cytospora* sp.
	Pseudomonas twig blight	*Pseudomonas syringae* pv. *syringae*
Dracena	Leaf scorch	Environmental stress
Elm	Wilt	*Dothiorella ulmi*
Geranium	Flower distortion, leaf dieback	Environmental stress
		Nutrient deficiency
Hops	Root dieback	Environmental stress
	Stem constriction	High soil salts
Impatiens	Leaf spotting	Symptomatic for impatiens necrotic spot virus
Ivy	Vein collapse, oedema	High soil salts

(cont'd.)

SOUTH CENTRAL ALBERTA

CROP/PLANT	DISEASE/SYMPTOM	CAUSAL AGENT
Lilac	Leaf scorch	*Pseudomonas syringae*
Lily	Stunting and chlorosis at top of plant	Carlavirus
Oats	Gray speck	Manganese deficiency
	Root rot	*Fusarium* sp.
		Pythium sp.
Palm	Leaf spotting	Environmental stress
Pea	Downy mildew	*Peronospora viciae*
Petunia	Purpling, chlorosis, stunting, necrosis	Cold temperature injury
Poplar	Leaf distortion, petiole bending	Dicamba injury
	Marssonina leaf spot	*Marssonina populi*
	Poplar leaf and twig blight	*Venturia macularis*
Potato	Blackleg	*Erwinia carotovora* pv. *atroseptica*
	Early blight	*Alternaria solani*
	Soft rot	*Erwinia carotovora*
Rhubarb	Bacterial soft rot	*Erwinia rhapontici*
Spruce	Chlorosis	Possible chemical damage
	Cytospora canker	*Cytospora kunzei*
	Decline	Overwatering
	Root rot	*Fusarium* sp.
	Spruce needle rust	*Chrysomyxa ledicola*
Strawberry	Berry rot	*Botrytis* sp.
		Penicillium sp.
Sunflower	Downy mildew	*Plasmopara halstedii*
Timothy	Marginal leaf necrosis	Environmental stress
Tomato	Cladosporium leaf mold	*Cladosporium fulvum*
	Fusarium wilt	*Fusarium oxysporum* f. sp. *lycopersi*
	Leaf scorch	High soil salts
	Pith necrosis	*Pseudomonas* sp.
Turf	Fusarium patch	*Fusarium* sp.
	Melting out	*Drechslera poae*
	Pythium blight	*Pythium* sp.
	Rhizoctonia patch	*Rhizoctonia* sp.
	Spring dieback	Freezing injury
	Summer patch	*Magnaporthe poae*
	Superficial fairy ring	Various basidiomycetes
Wheat	Chlorosis and browning of upper leaves	Environmental stress

NORTH CENTRAL ALBERTA

CROP/PLANT	DISEASE/SYMPTOM	CAUSAL AGENT
Canola	Twisting, chlorosis, stunting	Cold temperature stress
Chrysanthemum	Root rot	*Fusarium* sp.
		Rhizoctonia solani
		Rhizoctonia sp.
Elm	Leaf scorch	Environmental injury
		Herbicide damage
Freesia	Leaf scorch	Environmental stress
Ginseng	Alternaria leaf blight	*Alternaria panax*
Pea	Foot rot	*Mycosphaerella pinodes*
	Mycosphaerella blight	*Ascochyta pinodella*
	Root rot	*Fusarium solani*
Pine	Lophodermella needle cast	*Lophodermella* sp.
	Needle loss	Autumn needle shed
Poinsettia	Root and stem rot	*Pythium* sp.
		Rhizoctonia sp.
Poplar	Poplar leaf and twig blight	*Venturia macularis*
Potato	Leaf damage	Herbicide damage
	Leaf spot	Magnesium deficiency
Primula	Leaf spot	Impatiens necrotic spot virus
Saskatoon	Saskatoon-juniper rust	*Gymnosporangium* sp.
Spruce	Needle loss	Autumn needle shed
		Drought stress
Tomato	Leaf twisting, distortion, cupping	Chemical injury
	Necrotic leaf spots	Manganese deficiency
Turf	Dieback	Algae
		Fusarium sp.
		Pythuim sp.
		Rhizoctonia sp.
	Fusarium patch	*Fusarium* sp.
	Pythium blight	*Pythium* sp.

NORTH EAST ALBERTA

CROP/PLANT	DISEASE/SYMPTOM	CAUSAL AGENT
Apple	Fireblight	*Erwinia amylovora*
Begonia	Leaf spotting, wilt	Impatiens necrotic spot virus
	Root rot	Not specified
Canola	Blackleg	*Leptosphaeria maculans*
Maple	Twig blight	*Stigmina negundinis*
Pea	Herbicide damage symptoms	Picloram damage
	Root rot	*Rhizoctonia solani*
Raspberry	Cane blight	*Leptosphaeria coniothyrium*
	Crown and cane gall	*Agrobacterium radiobacter*
	Fireblight	*Erwinia amylovora*
	Gray mold	*Botrytis cinerea*
Saskatoon	Entomosporium leaf spot	*Entomosporium mespili*
Spruce	Needle drop	Environmental stress
		Drought stress
Turf	Fusarium patch	*Fusarium* sp.
	Pink snow mold	*Microdochium nivale*
	Take-all	*Gaeumannomyces graminis*
Wheat	Chlorosis	Herbicide damage
	Nitrogen deficiency	
Willow	Dieback	Environmental stress

NORTH WEST ALBERTA

CROP/PLANT	DISEASE/SYMPTOM	CAUSAL AGENT
Alfalfa	Downy mildew	*Peronospora trifoliorum*
Aspen (seedlings)	Aspen leaf and shoot blight	*Venturia macularis*
	Cytospora canker	*Cytospora* sp.
	Marssonina leaf spot	*Marssonina* sp.
Turf	Pythium blight	*Pythium* sp.

PEACE RIVER REGION

CROP/PLANT	DISEASE/SYMPTOM	CAUSAL AGENT
Canola	Root rot	*Rhizoctonia solani*
		Fusarium sp.
	Blackleg	*Leptosphaeria maculans*
Pea	Root rot	*Rhizoctonia solani*
		Fusarium sp.
Pine (Ponderosa)	Needles dropping, chlorotic, stunted	Transportation/ transplant stress
Spruce	Twisting, browning	Herbicide injury

CROP: Forage Legumes, Alfalfa - Diagnostic Laboratory Report

LOCATION: Manitoba

NAME AND AGENCY:
R.G. Platford
Manitoba Agriculture, Crop Diagnostic Centre
201 - 545 University Crescent, Winnipeg, Manitoba R3T 5S6

TITLE: DISEASES DIAGNOSED ON ALFALFA SAMPLES SUBMITTED TO THE MANITOBA AGRICULTURE CROP DIAGNOSTIC CENTRE IN 1994

METHODS: The Manitoba Agriculture Crop Diagnostic Centre (CDC) provides diagnoses and control recommendations for disease problems of agricultural crops and ornamentals. Samples are submitted to the CDC by Manitoba Agriculture extension staff, farmers, agri-business and the general public. Diagnosis is based on visual examination for symptoms and culturing onto artificial media.

RESULTS: The CDC received a total of 26 alfalfa samples for disease analysis. Results are summarized in Table 1. The most common problem affecting alfalfa was black stem. Wet weather in June and July resulted in a high incidence of leaf spot diseases. The lack of snow cover in the fall of 1993 and cold temperatures before permanent snow cover occurred resulted in a higher than normal amount of winter injury in the Eastern and Interlake areas. One sample of alfalfa submitted from southeastern Manitoba was found to be affected by rust which has only once been previously reported on alfalfa in Manitoba, (Platford 1992).

REFERENCES:

Platford, R.G. 1992. Diseases diagnosed on alfalfa samples submitted to the Manitoba Agriculture Plant Pathology Laboratory in 1991. Can. Plant Dis. Surv. 72:37.

TABLE 1. Summary of diseases diagnosed on alfalfa samples submitted to the Manitoba Agriculture Crop Diagnostic Centre in 1994.

DISEASE	SCIENTIFIC NAME	NUMBER OF SAMPLES
Black stem	*Phoma medicaginis*	8
Common leaf spot	*Pseudopeziza medicaginis*	7
Leptosphaerulina leaf spot	*Leptosphaerulina* sp.	2
Rust	*Uromyces striatus*	1
Root rot	*Fusarium* sp.	1
Physiological	winter injury, white spot	4
Nutrient deficiency		3

CROP: Cereals - Diagnostic Laboratory Report

LOCATION: Manitoba

NAME AND AGENCY:
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201 - 545 University Crescent, Winnipeg, Manitoba R3T 5S6

TITLE: DISEASES DIAGNOSED ON CEREAL CROP SAMPLES SUBMITTED TO THE MANITOBA AGRICULTURE CROP DIAGNOSTIC CENTRE IN 1994

METHODS: The Manitoba Agriculture Crop Diagnostic Centre (CDC) provides diagnoses and control recommendations for disease problems of agricultural crops and ornamentals. Samples are submitted to the CDC by Manitoba Agriculture extension staff, farmers, agri-business and the general public. Diagnosis is based on visual examination for symptoms and culturing onto artificial media.

RESULTS: Results of cereal crop submissions are shown in Tables 1 to 3. The major disease problems seen on wheat in 1994 were Septoria blotch which caused crop losses, primarily in the northwest region and Fusarium head blight which was severe in the southern Red River Valley, but did not have as detrimental effect on quality as in 1993. Net blotch was the major disease problem detected in barley. There was a moderate incidence of Fusarium head blight in the southern Red River Valley area. Flame chlorosis was detected in a few fields in the northwest region. The most serious disease problem affecting oats in 1994 was crown rust. Generally oat yields were good in Southern Manitoba, and disease loss (except in late planted fields) was low to moderate.

TABLE 1. Summary of diseases diagnosed on wheat samples submitted to the Manitoba Agriculture Crop Diagnostic Centre in 1994.

DISEASE	SCIENTIFIC NAME	NUMBER OF SAMPLES
Septoria	*Septoria* spp.	38
Head blight	*Fusarium graminearum*	9
Common root rot	*Fusarium* spp., *Cochliobolus sativus*	11
Barley yellow dwarf	Barley yellow dwarf virus	5
Tan spot	*Pyrenophora tritici-repentis*	3
Take all root rot	*Gaeumannomyces graminis* var. *tritici*	2
Ergot	*Claviceps purpurea*	1
Glume blotch	*Septoria* spp.	1
Leaf rust	*Puccinia recondita*	1
Loose smut	*Ustilago tritici*	1
Seedling blight	*Fusarium* spp., *Cochliobolus sativus*	1
Environmental stress		19
Herbicide injury		12
TOTAL		114

TABLE 2. Summary of diseases diagnosed on barley samples submitted to the Manitoba Agriculture Crop Diagnostic Centre in 1994.

DISEASE	SCIENTIFIC NAME	NUMBER OF SAMPLES
Barley yellow dwarf	Barley yellow dwarf virus	26
Net botch	*Pyrenophora teres*	14
Common root rot	*Fusarium* spp., *Cochliobolus sativus*	8
Loose smut	*Ustilago nuda*	3
Fusarium head blight	*Fusarium graminearum*	2
Septoria	*Septoria* spp.	2
Spot blotch	*Cochliobolus sativus*	2
Flame chlorosis	Flame chlorosis virus like agent	1
Scald	*Rhynchosporium secalis*	1
Environmental stress	Frost, deep seeding, nutrient deficiency, excess water	4
TOTAL		63

TABLE 3. Summary of diseases diagnosed on oat samples submitted to the Manitoba Agriculture Crop Diagnostic Centre in 1994.

DISEASE	SCIENTIFIC NAME	NUMBER OF SAMPLES
Barley yellow dwarf	Barley yellow dwarf virus	5
Crown rust	*Puccinia coronata*	2
Fusarium head blight	*Fusarium graminearum*	2
Bacterial blight	*Pseudomonas syringae*	1
Ergot	*Claviceps purpurea*	1
Septoria leaf blotch	*Septoria* spp.	1
Environmental stress	Blast	1
TOTAL		13

CROP: Oilseeds and Special Crops, Canola - Diagnostic Laboratory Report

LOCATION: Manitoba

NAME AND AGENCY:
R.G. Platford
Manitoba Agriculture, Crop Diagnostic Centre
201 - 545 University Crescent, Winnipeg, Manitoba R3T 5S6

TITLE: DISEASES DIAGNOSED ON CANOLA SAMPLES SUBMITTED TO THE MANITOBA AGRICULTURE CROP DIAGNOSTIC CENTRE IN 1994

METHODS: The Manitoba Agriculture Crop Diagnostic Centre (CDC) provides diagnoses and control recommendations for disease problems of agricultural crops and ornamentals. Samples are submitted by Manitoba Agriculture extension staff, farmers, agri-business and the general public. Diagnosis is based on visual examination for symptoms and culturing onto artificial media.

RESULTS: The CDC received a total of 246 canola samples for disease analysis. Results are summarized in Table 1. Weather conditions were very favourable for Alternaria black spot. Black spot was present at higher than normal levels for both Argentine and Polish type canola throughout southern Manitoba and caused premature pod ripening and shattering. Blackleg was present in most fields in the southwest and northwest regions south of Swan River and in occasional fields throughout the rest of the areas where canola was grown. It initially appeared in early July that sclerotinia would be a major problem but a major epidemic did not develop. A higher than normal amount of spraying of fields with benomyl occurred which prevented high losses in areas of the central and northwest regions. The downy mildew detected on canola was all from leaf samples submitted during June, following a period of wet weather.

TABLE 1. Summary of diseases diagnosed on canola samples submitted to the Manitoba Agriculture Crop Diagnostic Centre in 1994.

DISEASE	SCIENTIFIC NAME	NUMBER OF SAMPLES
Blackspot	*Alternaria* sp.	53
Downy mildew	*Peronospora parasitica*	20
Root rot, seedling blight	*Rhizoctonia solani, Fusarium* spp.	11
Sclerotinia	*Sclerotinia sclerotiorum*	10
Blackleg	*Leptosphaeria maculans*	9
Aster yellows		4
Staghead	*Albugo candida*	2
Herbicide injury		88
Nutrient deficiency	Sulphur deficiency	35
Environmental stress	Excess moisture, frost	14

CROP: Oilseeds and Special Crops, Lentil - Diagnostic Laboratory Report

LOCATION: Manitoba

NAME AND AGENCY:
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TITLE: DISEASES DIAGNOSED ON LENTIL SAMPLES SUBMITTED TO THE MANITOBA AGRICULTURE CROP DIAGNOSTIC CENTRE IN 1994

METHODS: The Manitoba Agriculture Crop Diagnostic Centre (CDC) provides diagnoses and control recommendations for disease problems of agricultural crops and ornamentals. Samples are submitted to the CDC by Manitoba Agriculture extension staff, farmers, agri-business and the general public. Diagnosis is based on visual examination for symptoms and culturing onto artificial media.

RESULTS: Results are summarized in Table 1. The major diseases detected were anthracnose and ascochyta, which were widepsread and caused losses up to 50% in some fields in the central region.

TABLE 1. Summary of diseases diagnosed on lentil samples submitted to the CDC in 1994.

DISEASE	SCIENTIFIC NAME	NUMBER OF SAMPLES
Root rot, seedling blight	*Fusarium* spp.	23
Ascochyta	*Ascochyta fabae* f.sp. *lentis*	14
Anthracnose	*Colletotrichum truncatum*	9
White mold	*Sclerotinia sclerotiorum*	4
Botrytis blight	*Botrytis cinerea*	2
Herbicide injury		6
Environmental stress	Deep seeding, excess moisture	4
Nutrient deficiency		3

CROP: Vegetables, Potatoes - Diagnostic Laboratory Report

LOCATION: Manitoba

NAME AND AGENCY:
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TITLE: DISEASES DIAGNOSED ON POTATO CROP SAMPLES SUBMITTED TO THE MANITOBA AGRICULTURE CROP DIAGNOSTIC CENTRE

METHODS: The Manitoba Agriculture Crop Diagnostic Centre (CDC) provides diagnoses and control recommendations for disease problems of agricultural crops and ornamentals. Samples are submitted to the CDC by Manitoba Agriculture extension staff, farmers, agri-business and the general public. Diagnosis is based on visual examination for symptoms and culturing onto artificial media.

RESULTS: The CDC received a total of 56 samples of potatoes for disease analysis. Results are summarized in Table 1. The major disease concern in potatoes in 1994 was late blight. An intensive survey and reporting program was undertaken. Late blight infected fields were detected near Winkler, Carman, and Portage. Late blight field symptoms were less severe in 1994 because of a greater awareness of growers about threat of late blight and earlier and more frequent application of fungicides. Also weather conditions during August were not as favourable for late blight in 1994 compared to 1993. The A_2 strain of late blight was detected in a potato leaf sample collected August 24 from a field south of Winkler and near the Manitoba - North Dakota border. The initial testing was done at the Agriculture and Agri-Food Canada, Central Plant Health Laboratory in Nepean, Ontario, and was confirmed at Agriculture and Agri-Food Canada, Charlottetown. This is the first report of the A_2 strain of late blight from Manitoba. The late blight strain had intermediate sensitivity to Ridomil fungicide. Moist weather in September, and the absence of frost, created conditions favourable for tuber infection. Several cases of severe tuber infestation were observed in the Portage la Prairie, and Winkler areas. Early blight was less severe than normal in 1994. Several cases of bacterial soft rot were detected in table stock potatoes harvested in August. Bacterial soft rot, fusarium dry rot, and pink rot were found to be associated with late blight in causing storage deterioration in potatoes.

TABLE 1. Summary of diseases diagnosed on potato samples submitted to the Manitoba Agriculture Crop Diagnostic Centre in 1994.

DISEASE	SCIENTIFIC NAME	NUMBER OF SAMPLES
Late blight	*Phytophthora infestans*	22
Early blight	*Alternaria solani*	8
Fusarium root rot	*Fusarium* spp.	4
Blackleg	*Erwinia caratovora* var. *atroseptica*	2
Bacterial soft rot	*Erwinia caratovora* var. *caratovora*	2
Gray mold	*Botrytis cinerea*	2
Pink rot	*Phytophthora erythroseptica*	5
Rhizoctonia canker	*Rhizoctonia solani*	2
Verticillium wilt	*Verticillium dahliae*	1
Herbicide injury		4
Environmental stress	Excess water, black heart, frost damage to tubers	4

CROP: Fruit Crops - Diagnostic Laboratory Report

LOCATION: Manitoba

NAME AND AGENCY:
R.G. Platford
Manitoba Agriculture, Crop Diagnostic Centre
201 - 545 University Crescent, Winnipeg, Manitoba R3T 5S6

TITLE: DISEASES DIAGNOSED ON FRUIT CROP SAMPLES SUBMITTED TO THE MANITOBA AGRICULTURE CROP DIAGNOSTIC CENTRE IN 1994

METHODS: The Manitoba Agriculture Crop Diagnostic Centre (CDC) provides diagnoses and control recommendations for disease problems of agricultural crops and ornamentals. Samples are submitted to the CDC by Manitoba Agriculture extension staff, farmers, agri-business and the general public. Diagnosis is based on visual examination for symptoms and culturing onto artificial media.

RESULTS: Results of fruit crop submissions are shown in Tables 1 to 5.
Winter injury was the main problem affecting apples in 1994. There was a higher level of fireblight in 1994 than in 1993. One commercial nursery had a high incidence of nectria canker that appeared to be entering the trees at pruning wound sites. Root rot was the major problem detected in strawberries. High temperatures during the summer were favourable for the development of Fusarium root and crown rot. Dieback of saskatoons caused by Cytospora canker and leaf diseases caused by *Entomosporium mispili* and powdery mildew were the main disease problems diagnosed in saskatoons in Manitoba.

TABLE 1. Summary of diseases diagnosed on apple samples submitted to the Manitoba Agriculture Crop Diagnostic Centre in 1994.

DISEASE	SCIENTIFIC NAME	NUMBER OF SAMPLES
Fireblight	*Erwinia amylovora*	5
Canker	*Cytospora* sp.	3
Canker	*Nectria cinnabarina*	2
Scab	*Venturia inaequalis*	2
Canker and leaf spot	*Botryosphaeria obtusa*	2
Environmental stress	Winter injury	10
Herbicide injury		4
Nutrient deficiency	Iron chlorosis	1
TOTAL		29

TABLE 2. Summary of diseases diagnosed on strawberry samples submitted to the Manitoba Agriculture Crop Diagnostic Centre in 1994.

DISEASE	SCIENTIFIC NAME	NUMBER OF SAMPLES
Crown rot, root rot	*Fusarium* spp.	7
Leaf spot	*Mycosphaerella fragariae*	1
Herbicide injury		2
Nutrient deficiency		1
TOTAL		11

TABLE 3. Summary of diseases diagnosed on raspberry samples submitted to the Manitoba Agriculture Crop Diagnostic Centre in 1994.

DISEASE	SCIENTIFIC NAME	NUMBER OF SAMPLES
Cane blight	*Leptosphaeria coniothyrium*	3
Spur blight	*Didymella applanata*	3
Anthracnose	*Elsinoe veneta*	1
Powdery mildew	*Sphaerotheca macularis*	1
Verticillium wilt	*Verticillium* sp.	1
Herbicide injury		1
TOTAL		10

TABLE 4. Summary of diseases diagnosed on saskatoon samples submitted to the Manitoba Agriculture Crop Diagnostic Centre in 1994.

DISEASE	SCIENTIFIC NAME	NUMBER OF SAMPLES
Cankers	*Cytospora* spp.	7
Leaf spot	*Entomosporium mespili*	3
Powdery mildew	*Podosphaera* spp.	3
Rust	*Gymnosporangium* sp.	1
Herbicide injury		3
Environmental stress		2
TOTAL		19

Table 5. Summary of diseases diagnosed on crabapple samples submitted to the Manitoba Agriculture Crop Diagnostic Centre in 1994.

DISEASE	SCIENTIFIC NAME	NUMBER OF SAMPLES
Fireblight	*Erwinia amylovora*	3
Canker	*Cytospora* sp.	1
Frogeye leaf spot	*Botryosphaeria obtusa*	1
Environmental stress		6
Nutrient deficiency		1
TOTAL		12

CROP: Ornamentals, Amenity turf - Diagnostic Laboratory Report

LOCATION: Manitoba

NAME AND AGENCY:
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TITLE: DISEASES DIAGNOSED ON AMENITY TURF SAMPLES SUBMITTED TO THE MANITOBA AGRICULTURE CROP DIAGNOSTIC CENTRE IN 1994

METHODS: The Manitoba Agriculture Crop Diagnostic Centre (CDC) provides diagnoses and control recommendations for disease problems of agricultural crops and ornamentals. Samples are submitted by Manitoba Agriculture extension staff, farmers, agri-business and the general public. Diagnosis is based on visual examination for symptoms and culturing onto artificial media.

RESULTS: The CDC received a total of 13 turf samples for disease analysis. Results are summarized in Table 1. Cool, moist weather prevented the normal appearance of the summer decline disease complex. Leaf diseases were not a major problem in 1994.

The number of samples submitted for analysis was down in 1994. Favourable weather conditions resulted in good growing conditions for lawns and lack of stress related problems in most areas.

TABLE 1. Summary of diseases diagnosed on amenity turf samples submitted to the Manitoba Agriculture Crop Diagnostic Centre in 1994.

DISEASE	SCIENTIFIC NAME	NUMBER OF SAMPLES
Fusarium	*Fusarium* spp.	4
Red Thread	*Laetisaria fuciformis*	1
Anthracnose	*Colletotrichum graminicola*	2
Ascochyta	*Ascochyta* sp.	2
Blister Smut	*Entyloma* sp.	1
Fairy ring	*Marasmius* sp.	1
Leaf spot	*Leptosphaerulina trifolii*	1
Melting out	*Drechslera* spp.	1

CROP: Ornamentals, Shade Trees - Diagnostic Laboratory Report

LOCATION: Manitoba

NAME AND AGENCY:
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TITLE: DISEASES DIAGNOSED ON SHADE TREE SAMPLES SUBMITTED TO THE MANITOBA AGRICULTURE CROP DIAGNOSTIC CENTRE IN 1994

METHODS: The Manitoba Agriculture Crop Diagnostic Centre (CDC) provides diagnoses and control recommendations for disease problems of agricultural crops and ornamentals. Samples are submitted to the CDC by Manitoba Agriculture extension staff, farmers, agri-business and the general public. Diagnosis is based on visual examination for symptoms and culturing onto artificial media.

RESULTS: Results of shade tree submissions are shown in Table 1.

TABLE 1. Summary of diseases diagnosed on shade tree samples submitted to the Manitoba Agriculture Crop Diagnostic Centre in 1994.

DISEASE	SCIENTIFIC NAME	NUMBER OF SAMPLES
Elm (28 samples)		
Dutch elm disease	*Ophiostoma ulmi*	1
Canker	*Cytospora* spp.	2
Canker	*Tubercularia ulmea*	1
Herbicide Injury		8
Environmental stress		5
Willow (22 samples)		
Willow scab	*Venturia saliciperda*	1
Herbicide injury		18
Environmental stress		2
Poplar (10 samples)		
Canker	*Cytospora* sp.	3
Shoot blight	*Pollaccia* sp.	2
Septoria leaf spot	*Septoria* sp.	1
Environmental stress	Winter injury	4
Birch (4 samples)		
Birch decline	Environmental stress	1
Herbicide injury		3

(cont'd.)

DISEASE	SCIENTIFIC NAME	NUMBER OF SAMPLES
Ash (22 samples)		
Herbicide injury		20
Environmental stress		2
Maple (22 samples)		
Canker	*Cytospora* sp.	3
Anthracnose	*Gloeosporium* spp.	2
Environmental stress		8
Herbicide injury		8
Nutrient deficiency		1
Oak (8 samples)		
Anthracnose	*Apiognomonia errabunda*	1
Herbicide injury		7

CROP: Ornamentals, Spruce - Diagnostic Laboratory Report

LOCATION: Manitoba

NAME AND AGENCY:
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TITLE: DISEASES DIAGNOSED ON SPRUCE SAMPLES SUBMITTED TO THE MANITOBA AGRICULTURE CROP DIAGNOSTIC CENTRE IN 1994

METHODS: The Manitoba Agriculture Crop Diagnostic Centre (CDC) provides diagnoses and control recommendations for disease problems of agricultural crops and ornamentals. Samples are submitted by Manitoba Agriculture extension staff, farmers, agri-business and the general public. Diagnosis is based on visual examination for symptoms and culturing onto artificial media.

RESULTS: The CDC received a total of 57 spruce samples for disease analysis. Results are summarized in Table 1. A major proportion of the spruce submitted showed non specific needle browning which was categorized as being caused by environmental factors such as winter injury, excess or deficiency of soil moisture and competition. Cytospora canker was the main disease problem associated with mature blue spruce.

TABLE 1. Summary of diseases diagnosed on spruce tree samples submitted to the Manitoba Agriculture Crop Diagnostic Centre in 1994.

DISEASE	SCIENTIFIC NAME	NUMBER OF SAMPLES
Cytospora canker	*Cytospora kunzei*	13
Needle cast	*Rhizosphaera kalkoffii*	6
Environmental stress	Winter injury, frost, excess moisture, competition	26
Nutrient deficiency		9
Herbicide injury		3

CROP: Commercial Crops - Diagnostic Laboratory Report

LOCATION: Ontario

NAMES AND AGENCY:
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Pest Diagnostic Clinic
Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Food Laboratory Services Centre
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TITLE: DISEASES DIAGNOSED ON CROP SAMPLES SUBMITTED TO THE OMAFRA PEST DIAGNOSTIC CLINIC IN 1994

METHODS: The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) Pest Diagnostic Clinic provides diagnosis and identification of plant diseases, nematodes, insects, weeds, and other pest problems. The service is offered to OMAFRA crop advisors, to employees of other public agencies, to growers and agriculture businesses and to the general public. Diagnoses were made by visual and microscopic examination of the samples. Isolation on selective media, the Biolog® bacterial identification system and pathogenicity tests were used, where necessary, to assist in the diagnosis of some samples.

RESULTS AND COMMENTS: In 1994, the Pest Diagnostic Clinic received 1129 samples excluding nematodes. OMAFRA crop advisors with other public agencies submitted about one third of the samples. Horticultural businesses including growers also submitted about one third. The remaining samples were submitted by homeowners. About 50% of the samples received were for disease diagnosis. Of these, nearly 70% were ornamentals, including both woody and herbaceous plants, occurring outdoors, in atria and in greenhouses. Remaining submissions were placed in the vegetable, turf, fruit, forage and cereal crop categories. Summaries of the diagnoses are presented in Tables 1 to 6.

TABLE 1. Summary of diseases diagnosed on cereal, field corn and forage crop samples submitted to the OMAFRA Pest Diagnostic Clinic in 1994.

CROP	CAUSAL AGENT/DISEASE	NO. OF SAMPLES
Alfalfa	*Phoma medicaginis*	1
	Pseudopeziza medicaginis	2
	Verticillium albo-atrum	1
	Boron deficiency	1
	Other physiological disorders	4
Barley	Physiological disorder	1
Canola	*Sclerotinia sclerotiorum*	1
Cereal (mixed)	Physiological disorder	1
Corn	Herbicide injury	2
	Other physiological disorder	1
Hay	*Epichloe typhina*	1
Wheat	*Tilletia controversa*	2
	Septoria tritici	2
	Black head molds	1
	Physiological disorders	3

TABLE 2. Summary of diseases diagnosed on legume samples submitted to the OMAFRA Pest Diagnostic Clinic in 1994.

CROP	CAUSAL AGENT/DISEASE	NO. OF SAMPLES
Bean	Bean Common Mosaic Virus	1
	Xanthomonas campestris pv. *phaseoli*	1
	Pseudomonas syringae pv. *phaseolicola*	1
	Herbicide injury	1
	Other physiological disorder	1
Pea	Fusarium root rot	1
	Aphanomyces euteiches f. sp. *pisi*	2
Soybean	Herbicide injury	3
	Other physiological disorders	4

TABLE 3. Summary of diseases diagnosed on vegetable samples submitted to the OMAFRA Pest Diagnostic Clinic in 1994.

CROP	CAUSAL AGENT/DISEASE	NO. OF SAMPLES
Basil	Root rot	1
Broccoli	*Xanthomonas campestris* pv. *campestris*	2
	Pseudomonas fluorescens	1
	Alternaria sp.	2
	Peronospora parasitica	1
	Wilt	2
	Black speck	1
Brussels sprouts	*Phoma lingam*	1
	Physiological disorder	1
Cabbage	*Xanthomonas* sp.	1
	Wilt	2
	Physiological disorders	2
Cauliflower	*Xanthomonas campestris* pv. *campestris*	2
	Physiological disorder	1
Crucifers	*Xanthomonas campestris* pv. *campestris*	1
	Fusarium sp.	1
Cucumber	Physiological disorder	1
Eggplant	*Alternaria solani*	1
	Verticillium albo-atrum	1
Garlic	Waxy breakdown	1
Lettuce	Physiological disorders	2
Pepper	*Xanthomonas campestris* pv. *vesicatoria*	2
	Alternaria solani	1
	Physiological disorders	2

(cont'd.)

CROP	CAUSAL AGENT/DISEASE	NO. OF SAMPLES
Potato	Bacterial soft rot	2
	Streptomyces scabies	2
	Phytophtora infestans	1
	Hollow heart	1
	Other physiological disorders	3
Radish	*Streptomyces scabies*	1
	Rhizoctonia solani	1
Radish (Chinese)	Physiological disorder	1
Rhubarb	Physiological disorder	1
Rutabaga	*Leptosphaeria maculans*	1
	Physiological disorder	1
Spinach	*Colletotrichum spinaciae*	1
Spinach (water)	Oedema	1
Sweet corn	*Setosphaeria turcica*	1
Tomato	*Pseudomonas syringae* pv. *tomato*	1
	Pseudomonas corrugata	1
	Septoria lycopersici	6
	Fusarium oxysporum f. sp. *radicis-lycopersici*	2
	Fusarium sp.	4
	Fulvia fulva	1
	Alternaria solani	1
	Erysiphe sp.	1
	Botrytis sp.	1
	Pythium sp.	4
	Blossom end rot	1
	Herbicide injury	1
	Other physiological disorders	10

TABLE 4. Summary of diseases diagnosed on fruit samples submitted to the OMAFRA Pest Diagnostic Clinic in 1994.

CROP	CAUSAL AGENT/DISEASE	NO. OF SAMPLES
Apple	*Cryptosporiopsis curvispora*	1
	Penicillium sp.	1
	Scald	1
	Hail damage	1
	Winter injury	2
	Other physiological disorders	7
Apricot	*Cladosporium carpophilum*	1
	Winter injury	1

(cont'd.)

CROP	CAUSAL AGENT/DISEASE	NO. OF SAMPLES
Cherry	Winter injury	1
	Other physiological disorder	1
Grape	Physiological disorder	1
Peach	Physiological disorder	1
Pear	*Venturia pirina*	1
	Botrytis cinerea	1
	Physiological disorders	4
Raspberry	*Erwinia amylovora*	1
	Elsinoe veneta	2
	Physiological disorder	1
Strawberry	*Phomopsis obscurans*	1
	Physiological disorders	4

TABLE 5. Summary of diseases diagnosed on turf samples submitted to the OMAFRA Pest Diagnostic Clinic in 1994.

CROP	CAUSAL AGENT/DISEASE	NO. OF SAMPLES
Turf	*Sclerotinia homeocarpa*	1
	Leptosphaeria korrae	6
	Rhizoctonia cerealis	1
	Laetisaria fuciformis	2
	Typhula ishikariensis	1
	Puccinia sp.	1
	Pythium sp.	2
	Drechslera sp.	1
	Fusarium patch	1
	Physiological disorders	28

TABLE 6. Summary of diseases diagnosed on ornamentals submitted to the OMAFRA Pest Diagnostic Clinic in 1994.

CROP	CAUSAL AGENT/DISEASE	NO. OF SAMPLES
Alternanthera	Stem blight	1
Alyssum	Physiological dieback	1
African violet	Crown and root rot	1
Ash	Anthracnose	7
	Other	1
Azalea	Wilt	1
Beech	Winter injury	1
	Other physiological disorders	2
Begonia	*Xanthomonas campestris* pv. *begoniae*	1
	Botrytis sp.	1
	Other	4
Birch	Powdery mildew	1
	Physiological disorders	3
Boxwood	Anthracnose	1
	Winter injury	2
	Other physiological disorder	2
Caragana	*Nectria cinnabarina*	1
	Root rot	1
Catalpa	Physiological disorders	2
Celosia	Physiological disorder	1
Cherry	Coccomyces leaf spot	2
	Canker	1
	Other	2
Chrysanthemum	*Erwinia chrysanthemi*	1
	Fusarium sp.	2
	Other	2
Clematis	*Ascochyta clematidina*	1
	Physiological disorders	3
Cotoneaster	Rodent damage	1
Crabapple	Anthracnose	1
	Physiological disorders	2
Currant	Physiological disorder	1
Cypress (False)	Winter injury	1
Dahlia	High salts	1
Delphinium	*Erwinia carotovora* pv. *atroseptica*	1
	Root rot	1
Digitalis sp.	Physiological disorder	1
Douglas fir	*Phaeocryptopus gaeumanni*	1
Elm (American)	*Ophiostoma ulmi*	1
Elm (Chinese)	Herbicide injury	1
English Ivy	Root rot	1
Eucalyptus	Oedema	1

(cont'd.)

CROP	CAUSAL AGENT/DISEASE	NO. OF SAMPLES
Euonymous	Anthracnose	1
	Physiological disorders	5
Euphorbia	Physiological disorder	1
Ficus sp.	Anthracnose	1
Fir	Pythium root rot	1
Forsythia	Scorch	1
Fuchsia	*Pythium* sp.	1
	Other	1
Geranium	*Xanthomonas campestris* pv. *pelargonii*	23
	Botrytis cinerea	1
	Puccinia pelargonii-zonalis	1
	Pythium sp.	6
	Oedema	4
	Other physiological disorders	15
German statice	Physiological disorder	1
Hawthorn	Physiological disorder	1
Hazel (Corkscrew)	*Nectria cinnabarina*	1
Helleborus niger	*Botrytis cinerea*	1
Hemlock	Physiological disorders	3
Hibiscus	Physiological disorder	1
Honey locust	*Nectria cinnabarina*	1
	Thyronectria austro-americana	1
	Other	4
Horsechestnut	Winter injury	1
	Leaf scorch	1
Ironwood	*Cylindrosporium* sp.	1
Juniper	*Gymnosporangium juniperi-virginiana*	1
	Winter injury	1
	Other	3
Lamium sp.	Physiological disorder	1
Laurel	Anthracnose	1
Lilac	*Pseudomonas syringae*	2
	Herbicide injury	1
	Other	3
Lily	Physiological disorders	2
Lupine	*Thielaviopsis basicola*	1
Magnolia	Winter injury	1
	Other physiological disorders	3
Maple	Anthracnose	8
	Nectria sp.	1
	Verticillium wilt	1
	Herbicide injury	2
	Bacterial wetwood	1
	Root decay	1
	Other physiological disorders	24

(cont'd.)

CROP	CAUSAL AGENT/DISEASE	NO. OF SAMPLES
Maple (Japanese)	Anthracnose	1
	Nectria cinnabarina	1
	Other	1
Maple (Norway)	*Didymosporina aceris*	1
	Other	1
Mock Orange	Physiological disorder	1
Morning glory	Fungal leaf spot	1
Mountain ash	*Venturia inaequalis*	1
	Bacterial canker	1
	Other	1
New Guinea Impatiens	Tomato spotted wilt virus	3
	Other	8
Oak	*Apiognomonia quercina*	1
	Herbicide injury	2
	Other	6
Orchid	Physiological disorders	2
Palm	Anthracnose	1
Peony	*Botrytis* sp.	1
Perennial plants	Physiological disorder	1
Philadelphus sp.	Physiological disorder	1
Pine	*Meloderma desmazierii*	1
	Sphaeropsis sapinae	1
	Natural autumn shed	2
	Other	10
Pine (Austrian)	*Dothistroma septospora*	1
	Sphaeropsis sapinae	1
	Other	2
Pine (Jack)	Crown and root rot	1
	Other	1
Pine (Red)	Physiological disorder	1
Pine (Scots)	*Cronartium quercuum*	1
Pine (White)	*Cronartium ribicola*	2
	Other	3
Poinsettia	*Botrytis* sp.	1
Poplar	*Marssonina* sp.	1
	Other	2
Potentilla	Physiological disorder	1
Pothos	Physiological disorder	1
Primula	Physiological disorder	1
Privet	Physiological disorder	1
Red Bud	Physiological disorder	1
Rhododendron	Transplant shock	1
Rose	*Botrytis* sp.	2
	Root rot	1
	Other physiological disorders	3
Snapdragon	*Pythium* sp.	1
Snow-On-The-Mountain	Physiological disorder	1

(cont'd.)

CROP	CAUSAL AGENT/DISEASE	NO. OF SAMPLES
Sorbaria sorbifolia	Physiological disorder	1
Sorrel	Physiological leaf drop	1
Spirea	Physiological disorder	1
Spruce	*Rhizosphaera kalkhoffii*	3
	Root rot	1
	Herbicide injury	3
	Winter injury	4
	Other	21
Spruce (Blue)	Winter injury	1
	Other physiological disorder	1
Star of Bethlehem	Physiological disorder	1
Stephanotis floribunda	Tomato spotted wilt virus	1
Sweet William	Physiological disorder	1
Sycamore	*Apiognomonia veneta*	1
	Microsphaera platani	1
Syngonium	*Xanthomonas* sp.	1
	Physiological disorder	1
Thuja	*Pestalotiopsis funerea*	2
	Other	12
Tilia sp.	*Glomerella cingulata*	2
	Other	3
Tulip	*Penicillium* sp.	2
Viburnum sp.	Physiological disorder	1
Vinca	*Phoma exigua*	1
Yew	Physiological disorders	3
Yucca	Physiological disorder	1

CROP: Commercial Crops - Diagnostic Laboratory Report

LOCATION: Québec

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TITLE: DISEASES DIAGNOSED ON COMMERCIAL CROPS SUBMITTED TO THE MAPAQ DIAGNOSTIC LABORATORY IN 1994

METHODS: The objective of the MAPAQ diagnostic laboratory is to provide diagnosis and control recommendations for disease problems of commercial crops. The following data reflects diagnoses of samples submitted to the laboratory by the extension staff of MAPAQ, by the "Régie des assurances agricoles du Québec", by the "Institut québécois du développement de l'horticulture ornementale" and by the agricultural industry. Diagnoses are based on visual examinations for symptoms and on the use of various laboratory tests to detect and to identify pathogens. The following tests are used in the laboratory: for nematodes, isolation with the Baermann funnel and microscope examination; for fungi, isolation on artificial media, microscope examination and pathogenicity testing; for bacteria, isolation on artificial media, classical biochemical tests including API-20E and Biolog, ELISA and PCR tests; and for virus, ELISA and double stranded RNA analysis.

RESULTS AND COMMENTS: The crop distribution of samples was: vegetable crops (field and greenhouse) 51%, small fruits 19%, herbaceous and woody ornamentals 18.5%, fruit trees 4.6%, field crops 3.9% and cereal crops 3.0%. Tables 1 to 7 show a summary of parasitic and non parasitic diseases diagnosed by the laboratory for the most representative field vegetable crops, greenhouse vegetables, small fruits, herbaceous and woody ornamentals, apple trees, cereals and other crops. Unidentified problems and samples for the detection of pathogens of seeds and substrates appear under the category "Other".

ACKNOWLEDGEMENTS: The authors gratefully thank Lucie Laverdière, Marlène Roger, Mario Tésolin and Lise Vézina for technical assistance.

TABLE 1. Summary of field vegetable crop diseases diagnosed by the MAPAQ diagnostic laboratory in 1994.

CROP	CAUSAL AGENT/PLANT PATHOGEN	NO. OF SAMPLES
Bean	*Bipolaris sorokiniana*	1
	Pythium crown and root rot	3
	Rhizoctonia root rot	2
	Sclerotinia sclerotiorum	1
	Thielaviopsis root rot	2
	Chilling injury (russeting)	3
	Ozone injury (bronzing)	1
	Other	3
Beet	Nitrogen deficiency (leaf chlorosis)	1
	Other	3

(cont'd.)

CROP	CAUSAL AGENT/PLANT PATHOGEN	NO. OF SAMPLES
Broccoli	*Alternaria brassicicola*	1
	Plasmodiophora brassicae	1
	Rhizoctonia crown rot	1
	Xanthomonas campestris pv. *campestris*	1
	Calcium deficiency (bud tip burn)	2
	Climatic stress (curd distortion)	1
	Oedema	1
	Other	3
Cabbage	*Alternaria brassicicola*	5
	Fusarium oxysporum	2
	Pythium root rot	1
	Rhizoctonia crown rot	1
	Erwinia carotovora subsp. *carotovora*	1
	Xanthomonas campestris pv. *campestris*	12
	Black midrib	1
	Black speck	2
	Calcium deficiency (leaf tip burn)	2
	Grey speck	1
	Lightning (leaf burn)	1
	Other	17
Cantaloupe	Alternaria leaf spot	1
	Septoria cucurbitacearum	2
Carrot	*Cercospora carotae*	2
	Pythium sp. (cavity spot)	1
	Sclerotinia sclerotiorum	1
	Meloidogyne hapla	2
	Abrasion injury (root injury)	1
	Boron deficiency (five o'clock shadow)	1
	Heat canker	1
	Other	3
Cauliflower	*Alternaria brassicicola* (leaf)	3
	Alternaria brassicicola (curd)	4
	Pythium stem rot	1
	Xanthomonas campestris pv. *campestris*	10
	Boron deficiency (brown curd)	3
	Riceyness	3
	Other	12
Celery	*Septoria apiicola*	3
	Erwinia carotovora subsp. *carotovora*	1
	Pseudomonas syringae pv. *apii*	1
	CMV	1
	Ozone injury (leaf spot)	1
Chinese cabbage	*Alternaria brassicicola*	1
	Erwinia carotovora subsp. *carotovora*	2
Chinese cabbage	*Xanthomonas campestris* pv. *campestris*	1
	Other	1
Corn	Zinc deficiency (leaf chlorosis)	1
	Other	1

(cont'd.)

CROP	CAUSAL AGENT/PLANT PATHOGEN	NO. OF SAMPLES
Cucumber	Alternaria leaf spot	1
	Phoma leaf spot	1
	Pseudoperonospora cubensis	1
	Pythium fruit rot	1
	Ulocladium leaf spot	1
	Pseudomonas syringae pv. *lachrymans*	2
	Erwinia carotovora subsp. *carotovora*	2
	CMV	2
	Poor pollination (fruit distortion)	1
	Other	3
Eggplant	*Sclerotinia sclerotiorum*	1
Leek	*Erwinia carotovora* subsp. *carotovora*	3
	Pseudomonas soft rot	2
	Mosaic (Potyvirus)	4
	Acid soil (root distortion)	1
	Nitrogen deficiency (leaf chlorosis)	1
	Other	7
Lettuce	Rhizoctonia crown rot	1
	Xanthomonas campestris pv. *vitians*	4
	Fertilizer burn (crown necrosis)	1
	Wind injury (leaf necrosis)	2
	Other	5
Onion	*Alternaria porri*	1
	Fusarium bulb rot	1
	Calcium injury (leaf burn)	3
	Hail injury (leaf spot)	1
	Ozone injury (leaf spot)	1
	Rain injury (leaf spot)	1
	Other	10
Pea	*Ascochyta pisi*	2
Pepper	Alternaria fruit rot	1
	Botrytis cinerea	1
	Pythium sp. (damping-off)	1
	Rhizoctonia solani (damping-off)	1
	Sclerotinia sclerotiorum	2
	Erwinia carotovora subsp. *carotovora*	1
	Xanthomonas campestris pv. *campestris*	15
	CMV	2
	TMV	1
	Atrazine injury (leaf chlorosis)	1
	Boron or calcium deficiency (leaf distortion)	3
	Excess water (root rot)	1
	High soil salinity (marginal leaf burn)	4
	Magnesium deficiency (leaf chlorosis)	1
	Nitrogen deficiency (leaf chlorosis)	1
	Oedema	3
	Ozone injury (leaf spot)	2

(cont'd.)

CROP	CAUSAL AGENT/PLANT PATHOGEN	NO. OF SAMPLES
Pepper	Paraquat injury (leaf spot)	2
	Potassium deficiency (marginal leaf burn)	3
	Chilling injury (russeting)	2
	Other	9
Potato	*Alternaria solani* (leaf blight)	2
	Colletotrichum coccodes	8
	Fusarium spp. (tuber rot)	10
	Phytophthora erythroseptica	1
	Phytophthora infestans	34
	Rhizoctonia solani	2
	Sclerotinia sclerotiorum	1
	Spongospora subterranea	1
	Verticillium sp.	3
	Clavibacter michiganensis subsp. *sepedonicus*	3
	Erwinia carotovora subsp. *carotovora*	26
	Pseudomonas syringae pv. *fluorescens* (pink eye)	1
	Streptomyces spp.	3
	Mosaic (Potyvirus)	1
	PLRV	2
	PVX	3
	Black heart	1
	Calcium deficiency (sprout tip burn)	1
	Dicamba injury (leaf distortion)	4
	2,4-D injury (leaf distortion)	1
	Elephant skin	1
	Excess water (skin necrosis)	4
	Genetic anomaly (pink pith)	1
	Hollow heart	2
	Mechanical injury	1
	Ozone injury (leaf burn)	1
	Wind injury (leaf burn)	2
	Other	30
Pumpkin	*Ascochyta* sp. (fruit rot)	1
	Colletotrichum sp. (fruit rot)	1
	Phoma sp. (fruit rot)	2
	Pythium sp. (fruit rot)	2
	Septoria cucurbitacearum	2
	Oedema (fruit)	2
	Other	2
Rutabaga	*Plasmodiophora brassicae*	1
	Sclerotium rolfii	1
	Brown heart	1
	Excess water (root distortion)	1
	Mechanical injury	1
	Other	1

(cont'd.)

CROP	CAUSAL AGENT/PLANT PATHOGEN	NO. OF SAMPLES
Squash	*Sclerotinia sclerotiorum*	1
	Septoria cucurbitacearum	3
	Phoma sp. (fruit rot)	1
	Pythium sp. (fruit rot)	1
	Erwinia carotovora subsp. *carotovora*	1
	CMV	2
Tomato	*Fulvia fulva*	1
	Phytophthora infestans	2
	Rhizoctonia solani	1
	Septoria lycopersici	3
	Clavibacter michiganensis subsp. *michiganensis*	2
	Pseudomonas syringae pv. *tomato*	7
	Xanthomonas campestris pv. *vesicatoria*	2
	TSWV	1
	Virus (leaf roll)	1
	Atrazine injury (leaf chlorosis)	1
	Oedema	1
	Physiological stress (leaf roll)	1
	Other	6

TABLE 2. Summary of greenhouse vegetable diseases diagnosed by the MAPAQ diagnostic laboratory in 1994.

CROP	CAUSAL AGENT/PLANT PATHOGEN	NO. OF SAMPLES
Cucumber	*Didymella bryoniae*	2
	Fusarium root rot	2
	Pseudoperonospora cubensis	1
	Pythium crown and root rot	3
	Ulocladium sp. (leaf spot)	1
	Erwinia carotovora subsp. *carotovora*	1
	Calcium deficiency (leaf distortion)	1
	Chilling injury (russeting)	1
	Phosphorus deficiency (leaf chlorosis)	1
	Physiological stress (leaf spot)	1
	Poor pollination (fruit distortion)	1
	Other	4
Lettuce	High salinity	3
	Other	2
Pepper	TSWV	2
	INSV	1

(cont'd.)

CROP	CAUSAL AGENT/PLANT PATHOGEN	NO. OF SAMPLES
Tomato	*Botrytis cinerea*	3
	Erysiphe sp.	4
	Fusarium oxysporum f. sp. *radicis-lycopersici*	7
	Humicola root rot	3
	Phytophthora infestans	11
	Phytophthora root rot	1
	Pyrenochaeta lycopersici	8
	Pythium root rot	10
	Rhizoctonia root rot	1
	Septoria lycopersici	2
	Verticillium sp.	1
	Clavibacter michiganensis subsp. *michiganensis*	4
	Erwinia carotovora subsp. *carotovora*	6
	Pseudomonas corrugata	2
	Pseudomonas syringae pv. *tomato*	1
	INSV	1
	PLRV	1
	PVX	1
	PVY	1
	ToMV	8
	TSWV	15
	Virus (yellow vein)	1
	Calcium deficiency (leaf distortion)	3
	Dicamba injury (leaf distortion)	1
	2,4-D injury (leaf distortion)	1
	Ethylene injury (leaf distortion)	1
	Glyphosate injury (leaf chlorosis)	1
	High salinity (marginal leaf burn)	4
	Iron deficiency (leaf chlorosis)	1
	Manganese deficiency (leaf chlorosis)	1
	Mechanical injury	2
	Oedema	2
	Physiological stress (leaf spot)	5
	Russeting	1
	Silver leaf	1
	Other	47

TABLE 3. Summary of small fruit diseases diagnosed by the MAPAQ diagnostic laboratory in 1994.

CROP	CAUSAL AGENT/PLANT PATHOGEN	NO. OF SAMPLES
Blueberry	*Aureobasidium* sp.	3
	Botrytis cinerea	1
	Cytospora sp.	1
	Monilia vaccinii-corymbosi	1
	Phomopsis sp.	2
	Pucciniastrum goeppertianum	1
	Septoria sp.	8
	Agrobacterium tumefaciens	1
	Glyphosate injury (leaf distortion)	1
	Hail injury	1
	Mechanical injury	1
	Winter injury	5
	Other	22
Strawberry	*Diplocarpon earliana*	1
	Mycosphaerella fragariae (leaf spot)	13
	Mycosphaerella fragariae (black seed)	1
	Myxomycete (slime mold)	1
	Phytophthora fragariae	25
	Sphaeropsis macularis	3
	Verticillium sp.	7
	Xanthomonas fragariae	9
	Mycoplasma-like organism	3
	Black rot	18
	Calcium deficiency (leaf distortion)	1
	Clopyralid injury (leaf distortion)	1
	Hail injury	1
	Lightning (leaf burn)	1
	Nitrogen deficiency (leaf chlorosis)	1
	Winter injury	8
	Other	31
Raspberry	*Didymella applanata*	4
	Elsinoe veneta	8
	Phytophthora root rot	30
	Agrobacterium tumefaciens	5
	Erwinia amylovora	3
	Excess water (root rot)	7
	Iron deficiency (leaf chlorosis)	1
	Winter injury	19
	Other	27

TABLE 4. Summary of herbaceous and woody ornamental diseases diagnosed by the MAPAQ diagnostic laboratory in 1994.

CROP	CAUSAL AGENT/PLANT PATHOGEN	NO. OF SAMPLES
Acer sp.	*Cryptosporiopsis* sp. (canker)	1
	Winter injury (canker)	1
Aegopodium sp.	Rhizoctonia root rot	1
Aglaonema sp.	*Pseudomonas marginalis* (soft rot)	1
	High salinity (leaf burn)	1
Aster sp.	Physiological stress (leaf spot)	1
Begonia sp.	*Erysiphe cichoracearum*	1
	INSV	2
	Physiological stress (leaf spot)	2
Betula sp.	Chilling injury	1
Calluna sp.	*Pseudophacidium* sp.	1
Canna sp.	Pythium bulb rot	1
Carthamus tinctorius	Ozone injury (necrotic speck)	1
Carya sp.	*Microstroma juglandis*	1
Celosia sp.	Pythium crown rot	1
Cereus sp.	*Helminthosporium cactivorum*	1
	Oedema	1
Chamaedora sp.	Phytophthora root rot	1
Clematis sp.	*Phyllosticta* sp.	1
Cotoneaster sp.	Iron deficiency (leaf chlorosis)	1
Cyclamen persicum	Fusarium crown rot	1
	INSV	1
	Physiological stress (leaf spot)	1
Delphinium sp.	Phytophthora root rot	1
	Pythium root rot	1
	Rhizoctonia crown rot	1
Diervilla lonicera	*Septoria diervillae*	1
Euphorbia pulcherrima	Pythium root rot	1
	Thielaviopsis root rot	1
Fuchsia x hybrida	Thielaviopsis root rot	1
Gladiolus sp.	*Stomatinia gladioli*	1
Hedera helix	Phytophthora root rot	1
Hemerocallis sp.	*Colletotrichum* sp.	1
Hibiscus sp.	Oedema	1
Hosta carnosa	INSV	2
Ipomoea aquatica	*Fusarium semitectum*	1
	Pythium root rot	3
Impatiens sp.	*Sphaerotheca* sp.	2
	Rhizoctonia crown rot	1
	Pseudomonas leaf spot	1
	INSV (leaf spot)	1
	TSWV (stem spot)	1
Iris sp.	Nitrogen deficiency (leaf chlorosis)	1

(cont'd.)

CROP	CAUSAL AGENT/PLANT PATHOGEN	NO. OF SAMPLES
Kalanchoe sp.	INSV	1
Limonium sp.	*Botrytis cinerea*	1
	*Glomerella cingulata*1	
Lupinus sp.	*Pleichaeta lupini*	1
Pachistema sp.	Phytophthora root rot	1
Paeonia sp.	*Botrytis cinerea*	1
Papaver sp.	*Entyloma fuscum*	1
Pelargonium sp.	Pythium crown rot	4
	Rhizoctonia crown rot	1
	Xanthomonas campestris pv. *pelargonii*	7
	Oedema	4
Petunia x hybrida	*Botrytis cinerea*	2
Picea sp.	*Chrysomyxa* sp.	1
	Phytophthora root rot	3
Pinus sp.	Phytophthora root rot	1
Rosa sp.	*Agrobacterium tumefaciens*	10
	Glyphosate injury (leaf distortion)	1
Santolina sp.	Rhizoctonia root rot	1
Senecio x hybridus	Phytophthora root rot	1
	Pythium crown rot	1
Sinningia speciosa	INSV	3
Sorbus sp.	*Botryosphaeria* sp.	1
	Erwinia amylovora	1
Spathiphyllum sp.	Rhizoctonia root rot	1
Syringa sp.	*Ascochyta syringae*	1
	Pseudomonas syringae	3
	Winter injury	1
Tagetes sp.	*Alternaria* sp.	1
Thuja sp.	Dicamba injury (leaf distortion)	1
Vinca sp.	Thielaviopsis root rot	1
	Other	133

TABLE 5. Summary of apple diseases diagnosed by the MAPAQ diagnostic laboratory in 1994.

CROP	CAUSAL AGENT/PLANT PATHOGEN	NO. OF SAMPLES
Apple	*Alternaria alternata* (leaf spot)	7
	Alternaria fruit rot	1
	Botryosphaeria obtusa	1
	Chondrostereum purpureum	1
	Cytospora sp.	10
	Nectria cinnabarina	1
	Phoma sp.	2
	Phomopsis sp.	2
	Phytophthora cactorum	1
	Agrobacterium tumefaciens	13
	Erwinia amylovora	2
	Brown heart	1
	Ozone injury (purple leaf)	1
	Russeting	1
	Winter injury	6
	Other	14

TABLE 6. Summary of cereal crop diseases diagnosed by the MAPAQ diagnostic laboratory in 1994.

CROP	CAUSAL AGENT/PLANT PATHOGEN	NO. OF SAMPLES
Barley	*Bipolaris sorokiniana*	10
	Fusarium graminearum	1
	Excess water (root rot)	2
	Other	1
Oat	*Ustilago avenae*	1
	BYDV	1
	Other	2
Wheat	*Bipolaris sorokiniana* (head blight)	1
	Fusarium graminearum	1
	Puccinia sp.	1
	Chlorotic fleck	1
	Excess water (root rot)	1
	Other	3

TABLE 7. Summary of diseases diagnosed on miscellaneous crops by the MAPAQ diagnostic laboratory in 1994.

CROP	CAUSAL AGENT/PLANT PATHOGEN	NO. OF SAMPLES
Alfalfa	*Fusarium* sp.	1
	Leptosphaerulina briosiana	2
	Phoma medicaginis	1
	Verticillium sp.	1
Ginseng	Rhizoctonia root rot	2
Soybean	*Peronospora manshurica*	1
	Colletotrichum sp.	1
	Metribuzin injury (leaf chlorosis)	1
Tobacco	*Alternaria longipes*	1
	Fusarium oxysporum	1
	Sclerotinia sclerotiorum	2
	Thielaviopsis basicola	1

CROP: Commercial Crops - Diagnostic Laboratory Report

LOCATION: Prince Edward Island

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TITLE: DISEASES DIAGNOSED ON COMMERCIAL CROPS IN PRINCE EDWARD ISLAND, 1994

METHODS: The P.E.I. Department of Agriculture, Fisheries and Forestry's Plant Health Services group provides diagnosis of, and control recommendations primarily for disease problems of commercial crops produced on P.E.I. The following data lists samples submitted to the laboratory by agriculture extension staff, producers, agri-business and the general public. Diagnoses are based on visual examination of symptoms, microscopic observation and culturing on artificial media.

RESULTS AND COMMENTS: A total of 339 samples were processed during the period November 1993 - November 1994. Results are summarized in Table 1.

TABLE 1. Diseases diagnosed on commercial crop samples submitted to the Plant Health Services group, Prince Edward Island Department of Agriculture Fisheries and Forestry, Prince Edward Island, 1994.

CROP	DISEASE	CAUSAL PLANT AGENT/ PATHOGEN	NO.OF TIMES AGENTS WERE IDENTIFIED
VEGETABLES:			
Beans	Common Blight	*Xanthomonas* sp.	1
Brussel	White Mold	*Sclerotinia* sp.	2
Sprouts	Gray Mold	*Botrytis cinerea*	1
	Leaf Spot	*Alternaria* spp.	1
Carrot	Dry Rot	*Fusarium roseum*	1
Cauliflower	Leaf Spot	*Alternaria* sp.	1
	Head Rot	*Pseudomonas* sp.	3
		Alternaria sp.	3
		Botrytis cinerea	3
	Physiological Disorders	Leaf Burn	1
		Boron Deficiency	3
Cucumber	Damping Off	*Fusarium* sp.	1
		Alternaria sp.	1
	Target Leaf Spot	*Corynespora cassiicola*	1
Garlic	Pink Rot	*Stemphylium* sp.	1

(cont'd.)

CROP	DISEASE	CAUSAL PLANT AGENT/ PATHOGEN	NO.OF TIMES AGENTS WERE IDENTIFIED
Green Pepper	Bacterial Spot	*Xanthomonas* sp.	1
Lettuce	Head Rot	*Botrytis cinerea*	1
		Pseudomonas sp.	1
		Erwinia sp.	1
	Physiological Disorder	Calcium Deficiency	1
Onion	Pink Rot	*Pyrenochaeta terrestris*	1
	Bulb Rot	*Fusarium* sp.	1
Potato	Early Blight	*Alternaria alternata*	31
		Alternaria solani	21
		Stemphylium spp.	2
	Gray Mold	*Botrytis cinerea*	26
	Late Blight	*Phytophthora infestans*	1
	Dry Rot	*Fusarium* spp.	7
		Phoma sp.	1
	Pink Rot	*Phytophthora erythroseptica*	3
	Skin Spot	*Polyscytalum pustulans*	1
	Black Dot	*Colletotrichum coccodes*	3
	White Mold	*Sclerotinia sclerotiorum*	7
	Seed Piece Decay	*Fusarium* spp.	6
		Erwinia spp.	2
		Rhizoctonia spp.	9
		Clostridium sp.	1
	Black Scurf	*Rhizoctonia solani*	6
	Stem Canker	*Rhizoctonia solani*	13
		Alternaria alternata	3
	Silver Scurf	*Helminthosporium solani*	2
	Scab	*Streptomyces scabies*	13
		Spongospora subterranea	10
	Pinkeye	*Pseudomonas* spp.	1
	Blackleg	*Erwinia* spp.	3
	Virus	Leaf Roll	1
	Physiological Disorders	Low Temperature Injury	1
		Chemical Damage	3
		Mechanical Damage	3
		Stem End Browning	3
		Nutritional Disorders	3
		Vascular Discoloration	1
		Glyphosate Damage	1
		Fertilizer Burning	7
		Little Tuber	5
		Wind Damage	4
		Elephant Hide	2
	Wilt	*Fusarium* spp.	4
		Verticillium spp.	9

(cont'd.)

CROP	DISEASE	CAUSAL PLANT AGENT/ PATHOGEN	NO.OF TIMES AGENTS WERE IDENTIFIED
Potato	Early Dying Syndrome	*Rhizoctonia solani*	10
		Fusarium spp.	12
		Verticillium spp.	13
		Colletotrichum sp.	9
		Alternaria alternata	8
	Insect Damage		3
Rutabaga	Common Scab	*Streptomyces scabies*	1
	Downy Mildew	*Peronospora* sp.	1
	Blackleg	*Phoma lingam*	1
	Physiological	Boron Deficiency	2
Tomato	Leaf Spot	*Botrytis cinerea*	1
		Alternaria solani	1
	Black Mold	*Alternaria alternata*	1
	Blossom End Rot	Calcium Deficiency	1
SMALL FRUITS:			
Strawberry	Leaf Spot	*Mycosphaerella fragariae*	1
	Powdery Mildew	*Sphaerotheca macularis*	1
Blueberry	Powdery Mildew	*Microsphaera vaccinii*	1
SPECIALITY CROPS:			
Ginseng	Root Rot	*Phytophthora* sp.	1
		Alternaria sp.	1
		Rhizoctonia solani	1
Tobacco	Stalk Rot	*Sclerotinia sclerotiorum*	3
		Botrytis cinerea	2
		Pseudomonas sp.	2
	Wilt	*Fusarium oxysporum*	3
	Brown Spot	*Alternaria* sp.	1
	Leaf Spot	*Botrytis cinerea*	1
WOODY ORNAMENTALS AND FLOWERING SHRUBS:			
Shrub	Powdery Mildew	*Erysiphe* sp.	1
Pear	Physiological	Leaf Scorch	1
Lilac	Powdery Mildew	*Microsphaera* sp.	1
	Bacterial Blight	*Pseudomonas* sp.	1
		Heterosporium sp.	1
Maple		*Alternaria* sp.	1
Dahliae	Insect Damage		1
TOTAL			339

Cereals / Céréales

CROP: Barley and Wheat

LOCATION: Alberta, Central

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TITLE: CEREAL DISEASE SURVEY IN CENTRAL ALBERTA, 1994

METHODS: Cereal crops were randomly selected approximately every 10 km in Alberta Census District 8 (north central Alberta). This area encompassed Sylvan Lake and Rimbey on the west, Bashaw on the east and was bordered north and south by Ponoka and Lacombe respectively. Fields were traversed in an inverted V, with analysis of 5 plants taking place at 3 locations. Leaf diseases were scored on a 0—9 scale where 9 = more than 50 percent leaf area diseased (PLAD) on each of the upper, middle and lower leaf canopies. Common root rot (CRR) was assessed on a 0—4 scale where 1 = trace and 4 = severe. Other diseases were rated as a percent of the field infected.

RESULTS AND COMMENTS: The results are presented in Table 1. Thirty-one fields of barley were examined, 23 of which were 6-row and 8 2-row. Net blotch (*Pyrenophora teres*) and scald (*Rhynchosporium secalis*) were present in all barley fields with net scoring higher PLAD than scald. Scald PLAD was higher in 2-row barley then 6-row, reflecting the fact that the susceptible cultivar Harrington is the main 2-row barley grown in this area. The lower levels of CRR in 2-row barley reflect Harrington's intermediate resistance to this disease. Ten fields of wheat were also examined. The incidence and severity of take-all (*Gaeumannomyces graminis*) appears to be increasing, with 7 fields having an average severity of 4.6% being noted. Leaf rust was not scored in the fields examined.

TABLE 1. Disease of barley and wheat in north central Alberta in 1994.

	Average disease rating/number of fields affected					
Crop	Scald 0-9	Net 0-9	CRR 0-4	Loose smut %	Head Scald %	Physiological spot 0-9
Barley						
6-Row	2.9/23	4.7/23	0.8/16	1/3	1/4	3/1
2-Row	4.5/8	4.9/8	0.4/5	1/1	1/1	_
Crop	Septoria 0-9	Powdery mildew	CRR 0-4	Take-all %	Kernal Blast %	Glume Blotch %
Wheat	5-/	pr/1	1.3/6	4.6/7	1/1	1/2

pr = present

CROP: Barley, *Hordeum vulgare* L.

LOCATION: Manitoba

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TITLE: FOLIAR AND HEAD DISEASES OF BARLEY IN MANITOBA IN 1994

METHODS: Fields of barley in southern Manitoba were surveyed for foliar and head disease incidence and severity between July 18 and August 11, 1994. The 76 fields (59 six-rowed, 17 two-rowed) were selected at random along the survey routes depending on crop frequency and availability. Disease incidence and severity were assessed on 10 or more plants along a diamond-shaped transect about 50 m long begun a few paces from the field edge. Disease levels were estimated in both the upper (flag and penultimate leaves) and lower crop canopies using a five category scale: 0 (no visible symptoms), trace (<5% leaf area affected), slight (5—15%), moderate (16—40%) and severe (41—100%). Samples of infected leaves were collected at all sites for subsequent pathogen isolation and identification. Leaves were stored in paper envelopes for two months prior to placing small surface-sterilized leaf sections in Petri dish moist chambers to promote sporulation. When symptoms of fusarium head blight (FHB) were present, counts of four sub-samples totalling at least 100 heads were made to determine severity.

RESULTS AND DISCUSSION: Moisture generally was plentiful throughout southern Manitoba in 1994 while temperatures were somewhat cooler than normal. These conditions were conducive to the development of both foliar and head diseases in barley. Leaf spot symptoms were evident in all fields sampled (Fig. 1). Severity levels on upper leaves were trace to slight in 66% of fields and moderate or severe in 34%. On lower leaves, these severities were found in 17% and 83% of fields, respectively. This suggests that yield losses of 10—20% could be expected in about one third of fields. As observed in 1993, disease severity levels were considerably higher in fields that had likely been re-planted to barley, in comparison to fields where barley straw and stubble were not evident. *Pyrenophora teres* was the predominant pathogen and net blotch was diagnosed in all fields sampled; *Cochliobolus sativus* (spot blotch) was found in 67%, *Rhynchosporium secalis* (scald) in 16% and *Septoria* spp. in 28%. Scald was more prevalent than usual, likely the result of the cool moist conditions; it was found primarily in western regions. However, severity of scald generally was low. Symptoms of FHB, ie, either spikelets with orange-pink coloured *Fusarium* sporodochia, or with an overall mid- to dark brown discoloration were observed in 58% of barley fields. Severity ranged as high as 41% of heads infected. Trace to 5% severity levels were found in 25% of fields, 6 to 20% in 20% and above 21% in 13%. Pathogenic species determinations have yet to be done, but in 1993 barley head samples of similar appearance yielded primarily *F. graminearum*.

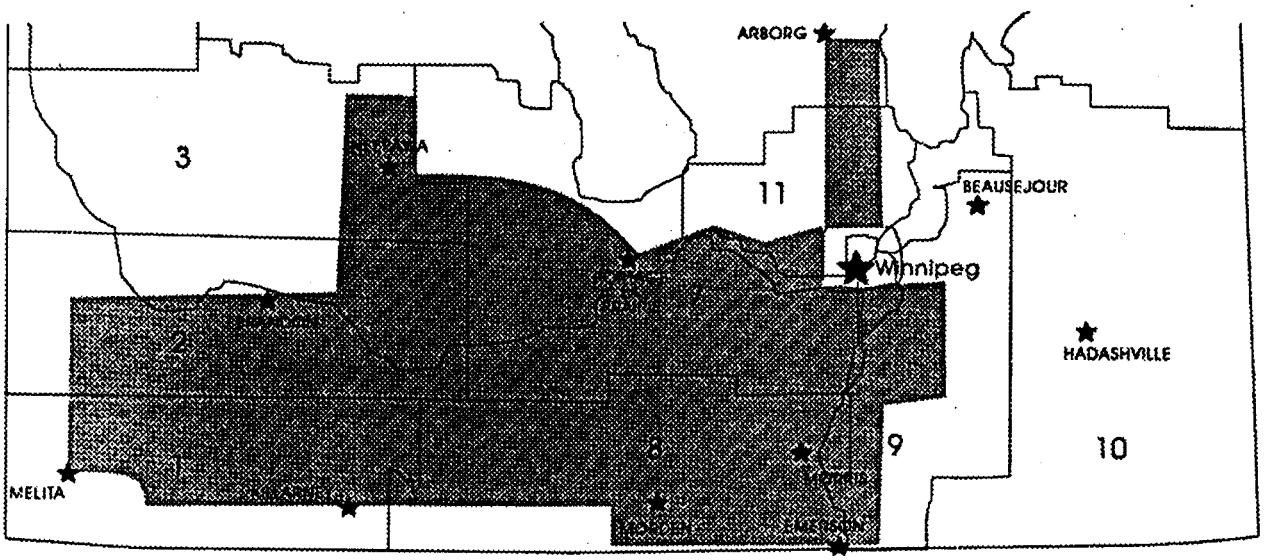

FIG. 1. Outline of the area of southern Manitoba surveyed for foliar and head diseases of barley in 1994.

CROP: Barley and Wheat

LOCATION: Manitoba

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TITLE: FLAME CHLOROSIS IN MANITOBA IN 1994

METHODS: Wheat and barley fields in regions of Manitoba that had previously been systematically surveyed for flame chlorosis (FC) were again surveyed for disease in 1994 (4).

RESULTS AND COMMENTS: Flame chlorosis, a soil-borne, virus-like disease of spring cereals has been monitored in Manitoba since it was first observed in western Manitoba in 1985 (3). In 1994, overall incidence of FC was lower than at any time since 1988. Areas near Niverville in the Red River Valley that had had relatively high disease incidences since 1988 (3,4) appeared disease-free in 1994. In western Manitoba, FC was observed in a few barley fields west of Hamiota, and the proportions of affected plants were lower than in recent years. A novel "whiteline" FC was observed in two barley fields south of Shoal Lake. Examinations of cytopathology (1) of whiteline-affected barley leaves, as well as detection of FC-RNA by hybridization to specific probes (5) confirmed that the whiteline disease was a new and distinct manifestation of infection with the FC virus-like agent (2).

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CROP: Barley, Oat and Wheat

LOCATION: Manitoba and Saskatchewan

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TITLE: CEREAL SMUT SURVEY, 1994

METHODS: In July 1994, cereal crops were surveyed for *Ustilago hordei, U. nigra, U. nuda, U. tritici, U. avenae* and *U. kolleri* in Manitoba and Saskatchewan. The area was covered by routes from Winnipeg-Swift Current-Rosetown-Yorkton-Winnipeg (thanks to N. Howes and G. Hamilton) and Winnipeg-Yorkton-Prince Albert-Swan River-Winnipeg, as well as one day trips north and south of Winnipeg. Fields were selected at random at approximately 15 km intervals, depending on the frequency of the crops in the area. An estimate of the percentage of infected plant (ie, plants with sori) was made while walking an ovoid path of approximately 100 m in each field. Levels of smut greater than trace were estimated by counting plants in a 1 m^2 area at at least two sites on the path. *U. nuda* and *U. nigra* were differentiated by observing germinating teliospores with a microscope.

RESULTS: See Table 1. Smut was found in 63% of the fields of barley, 18% of the common wheat, 45% of the durum, and 2% of the oat. The average levels were 0.5% for barley, 0.1% for durum wheat, trace for common wheat and 0.1% for oat. Two Manitoba fields of barley had high levels of smut: 10% loose in one near Minnedosa and 2% loose, 1% false loose and 7% covered in one near Brookdale.

COMMENTS: Although no data is available, increased use of seed-treatment fungicides is suspected as one cause of the relatively low levels of smut found in recent years.

TABLE 1. Incidence of smut in cereals in Manitoba and Saskatchewan in 1994.

Crop	No. Fields	Smut Species	% Fields affected		Mean % of infected plants	
			MB	SK	MB	SK
Common wheat	168	*U. tritici*	23	13	0.1	tr*
Durum wheat	55	*U. tritici*	36	49	tr	0.1
Oat	50	*U. avenae*	0	5	0	tr
		U. kolleri	0	5	0	0.3
Barley	176	*U. nada*	69	51	0.4	0.3
		U. hordei	5	6	0.1	0.1
		U. nigra	5	2	tr	tr

* tr = less than 0.1%

CROP: Barley, Oat and Wheat

LOCATION: Manitoba and eastern Saskatchewan

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TITLE: STEM RUSTS OF CEREALS IN WESTERN CANADA IN 1994

METHODS: Surveys of fields and nurseries of barley, oat and wheat for incidence and severity of stem rust (*Puccinia graminis* Pers. f.sp. *tritici* Eriks. and E. Henn. and *P. graminis* f. sp. *avenae* Eriks. and E. Henn.) were conducted in Manitoba in July and August, 1994. Samples for race identification were obtained from fields and trap nurseries in the four western provinces.

RESULTS AND COMMENTS: The incidence of stem rust on all three cereals in 1994 was one of the lightest on record in the prairie region. All oat and wheat cultivars recommended for the rust area are resistant to stem rust, and no losses were expected. Infections of susceptible lines in nurseries also were lower than normal, with maximum levels of 10% for wheat stem rust and 2% for oat stem rust. Infections of wild oat also were light. In commercial barley fields, maximum levels of infections were less than 1%, with no losses. About 20—30% infection levels developed on wild barley later in fall. An increased number of collections from cultivated and wild barley were rye stem rust (*P. graminis* f.sp. *secalis* Eriks. and E. Henn.).

For wheat stem rust, race TPM, which has been the predominant race collected from lines of susceptible wheat in nurseries, declined in prevalence. Races QFC and QCC were the main races collected from wheat, and race QCC predominated in collections from cultivated barley and wild barley. In oat stem rust, races NA27 and NA29 predominated. These races are differentiated only by virulence or avirulence to gene *Pg15*.

CROP: Barley, Oat, Wheat

LOCATION: Maritime Provinces

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TITLE: CEREAL DISEASES IN THE MARITIME PROVINCES - 1994

METHODS: This survey of cereal diseases was based on observations by the authors and discussions with cereal specialist from the Maritime Provinces. When required isolation of pathogens were made to confirm identification of disease symptoms. The summary presented describes all cereal production areas in the Maritimes, both commercial and research.

RESULTS AND COMMENTS: Weather conditions: The weather patterns in the Maritime Provinces in 1994 were diverse, between locations and over the duration of the growing season. Early weather conditions were very conducive to plantings of spring cereals, as a result of which a large portion of the acreage was planted in early May. Conditions deteriorated during the mid to late May period, with considerable periods of wet and cool weather developing. Prince Edward Island, Nova Scotia and southern parts of New Brunswick were wet through out June turning dry in early July and continuing through to mid September. The northern portions of New Brunswick did however remain relatively wet throughout the entire season. While with late planted fields moisture was a yield limiting effect, much of the early planted crop did not appear to be overly effected by the low rainfall. The low moisture may have reduced severity for some diseases resulting in off-setting yield and quality effects.

Survival of winter wheats were good in most areas, although there were some poor areas particularly on western Prince Edward Island. Where winter survival was not limiting, yields and quality of winter wheat was good.

Barley: Predominate diseases throughout the region were net blotch and scald, incited by *Pyrenophora teres* and *Rhyncosporium secalis*, respectively. While scald occurred sporadically throughout the entire region it was generally only at low levels outside of the central to northern New Brunswick area. In this latter area scald was at moderate to severe levels in some fields of six row barleys. While the severity of net blotch did not appear to be as high as in some years, use of foliar applied fungicides to research plots did have significant positive yield response benefits. This may have indicated that in a moisture stress situation low levels of disease may have greater yield reduction effects than when moisture is not limiting.

Other diseases of barley were present but there were no reports of a field being severe enough to warrant special attention. Fusarium head blight symptoms, incited by *Fusarium graminearum*, were identified but at very low levels, as was loose smut, incited by *Ustilago hordei*. Common root rot, incited by *Fusarium* spp. and *Bipolaris sorokiniana*, was observed however incidence and severity were below normal which may have been a reflection of the dry weather conditions during latter growth stages. Powdery mildew, incited by *Erysiphe gramines* f.sp. *hordei* was only observed in significant amounts at one location, on several cultivars under evaluation. Symptoms of spot blotch, incited by *B. sorokiniana*, were observed but as with many of the other diseases incidence and severity were both low.

Wheat: In general the dry conditions in the region were not conducive to the severe development of foliar disease in wheat. Leaf and glume blotch, incited by *Phaeospharia nodorum* (*Septoria nodorum*), was present throughout the region but with the exception of northern New Brunswick disease levels were not high. Similarly powdery mildew, incited by *Erysiphe graminis* f.sp. *tritici*, was not a problem in 1994. The low levels of powdery mildew

observed were in part due to the high percentage of the acreage being planted to more resistant cultivars, and the use of foliar applied fungicides on susceptible cultivars to limit disease development. Fusarium head blight, incited by *Fusarium graminearum*, was observed in most fields but weather conditions were dry enough in most areas of the region to limit the symptom development. On Prince Edward Island, the harvest of the more susceptible cultivars, such as Roblin and Max, some times required cleaning to remove tombstone kernels in order to achieve milling quality. Several fields of Roblin and Grandin in northern areas of New Brunswick did exhibit the beginnings of a moderate yield and quality limiting situation, but milling quality was achieved through combine adjustments to remove tombstone kernels.

Take-all, incited by *Gaeumannomyces graminis*, occurred most frequently in cereal-cereal rotations which are not common in the region. In general rotations used in the Maritimes do not enhance the development of take-all. Loose smut was a minor problem, as much of the cereal seed used was treated with an appropriate fungicide seed treatment or originated from a treated field.

In general yields of spring wheats ranged from poor in Nova Scotia to normal to above normal in much of Prince Edward Island and New Brunswick.

Oats: Speckled leaf blotch, incited by *Phaeospharia avenae* (*Septoria avenae*), was the only foliar disease of consequence on oats in the Maritime Provinces. This is consistent with other years. No reports of severe infection by other fungal pathogens or viruses were reported or noted in 1994.

CROP: Oat

LOCATION: Manitoba and eastern Saskatchewan

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TITLE: CROWN RUST OF OAT IN WESTERN CANADA IN 1994

METHODS: Surveys for oat crown rust (caused by *Puccinia coronata* Cda. f. sp. *avenae* Eriks.) incidence and severity were conducted in southern Manitoba from early July to mid-August, and in eastern Saskatchewan in mid-August. Crown rust collections were obtained from wild oat (*Avena fatua* L.) and commercially grown oat in field surveys, and from susceptible and resistant oat lines grown in uniform rust nurseries. Rust nurseries were composed of susceptible lines, single-gene lines with resistance gene *Pc48* or *Pc68*, lines with resistance genes *Pc38*, *Pc39* and *Pc68* combined, and common cultivars Dumont and Robert (both have resistance genes *Pc38* and *Pc39*). The nurseries were located near Arborg, Brandon, Emerson, and Morden, Manitoba, and Indian Head, Saskatchewan. Rust collections were increased on the susceptible cv. Makuru in the greenhouse. One single-pustule isolate, established from each collection, was evaluated for virulence phenotype (race), using 18 backcross oat lines, each carrying a different gene (*Pc35*, *Pc38*, *Pc39*, *Pc40*, *Pc45*, *Pc46*, *Pc48*, *Pc50*, *Pc54*, *Pc56*, *Pc58*, *Pc59*, *Pc60*, *Pc61*, *Pc62*, *Pc63*, *Pc64*, or *Pc68*) for resistance to crown rust as differential hosts.

RESULTS AND COMMENTS: Crown rust in oat was more severe and widespread in Manitoba in 1994 than 1993, making this the worst outbreak of the disease in recent years. In early July, rust severities ranged from trace amounts to 50% in wild oat and susceptible oat lines, and trace amounts to 20% in cultivars with resistance genes *Pc38* and *Pc39* in nurseries. Most of the infections were found on lower leaves. Oat crown rust increased rapidly in the following weeks, particularly in the Red River Valley, and by late July moderate to heavy infections (up to 100% severities) were found in wild oat and susceptible oat lines in the nurseries, and light to heavy infections (up to 60% severities) in cultivars with *Pc38* and *Pc39* in nurseries and farm fields in southern Manitoba. One late-sown field of Robert oat had infections up to 100% severities at the early milk stage, and likely suffered significant losses to crown rust. In 1994, crown rust also was widespread in eastern Saskatchewan. Infections in wild oat generally ranged from light in some locations to heavy in other locations in mid-August. However, in Saskatoon rust severities of up to 100% were observed (Dr. B. Rossnagel) by late July in plots of susceptible oat cultivars.

To date, 140 single-pustule isolates have been isolated from collections of susceptible oat lines and wild oat and 100 virulent phenotypes have been identified. Seventy isolates, comprising 47 virulent phenotypes, were virulent to lines having both genes *Pc38* and *Pc39*. All the currently recommended cultivars, ie, Dumont, Riel, Robert, AC Belmont, AC Marie, and AC Preakness, rely mainly on these two genes for crown rust protection. In 1994, for the first time, an isolate with virulence to the gene combination *Pc38*, *Pc39* and *Pc68* was isolated from oat in Manitoba. Cultivars with this gene combination are being developed at the Winnipeg Research Centre.

CROP: Oat, *Avena sativa* L.

LOCATION: Québec

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TITLE: OUTLINE OF DISEASES OF OATS IN QUÉBEC IN 1994

METHODS: Most experimental sites of cereals and a number of farmers fields in Québec were visited at least once in the period from mid-July to mid-August. At each visited site, diseases were identified and their severity assessed in all oat lines and cultivars grown there. Selected plant samples were also collected from field crops at various locations and were examined in the laboratory. Plant growth stage at the time of assessment or sampling ranged from medium milk to medium dough.

RESULTS AND COMMENTS: The monthly average temperatures in May, July and August were nearly normal and the one in June was about 2°C above normal. Most drastic changes to the growth season occurred in the precipitation records: they were 15% above normal in June, 95% in July and 40% in August. Hours of sunshine were down by 10% in July.

Moderate and usual levels of speckled leaf blotch (*Stagonospora avenae*) were observed and its occurrence was general. In the Eastern Townships, infections were unusually below average. On the contrary, severities recorded in the Saint-Hyacinthe region were higher than elsewhere.

As in 1993, crown rust (*Puccinia coronata*) was found more extensively than usual, as it was detected at most sites. The highest severity occurred, as, usual in the south-west part of the province and symptoms were such that it was the most important disease there and significant damage was caused. All lines and cultivars tested at Ste-Anne-de-Bellevue had severe symptoms, up to maximum leaf coverage in some instances.

Stem rust (*Puccinia graminis*) presence was not noticed at any site visited this year, as is usually the case.

Foliage symptoms of yellow dwarf (Barley Yellow Dwarf Virus) were somewhat limited in their occurrence and were more or less limited in severity. They were up to moderate levels in the Eastern Townships. Infection appeared to have come late in most areas and did not cause much damage.

Oat blast (white empty florets) was noticeable to a limited extent at a number of sites. No site in particular was showing more disease than others.

At La Pocatière, a large number of smutted panicles (*Ustilago* spp.) were found among plants that were showing yellow dwarf symptoms; very few such smutted panicles were present in plants not showing yellow dwarf symptoms. This particular phenomenon was not observed elsewhere. In farmers fields, the smut diseases are still a concern in general. It might be related partly to a limited efficacy of seed treatments currently performed in the industry.

Finally, scab or head blight (*Fusarium* spp.) was found regularly in visited sites. Its severity was low but its occurrence was widespread. This disease is seldom found in oats. Isolations on agar media confirmed the presence of *Fusarium graminearum* as the causal agent. More scab was observed in naked than in covered oat cultivars.

CROP: Wheat, *Triticum aestivum* L.

LOCATION: Saskatchewan

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TITLE: SASKATCHEWAN CEREAL ROOT DISEASE SURVEY, 1994

METHODS: Twenty-two fields of wheat and one of barley were surveyed for the presence of take-all and common root rot in the irrigated area of Outlook, Saskatchewan and the dryland area of crop production of Willowbrook, Saskatchewan. Fields were sampled between soft to hard dough growth stages. Disease was assessed on a sample of 25 random plants taken at least 20 paces from the field edge. Another sample of 15 selected plants exhibiting disease symptoms was collected from 10 fields that showed severe stunting, whiteheads, or large areas with dead plants. A root disease rating was calculated based on the percentage of severely diseased plants (at least 50% discoloration from lesions on the subcrown internode) from the total sampled in a field.

The subcrown internodes, crowns, and lower stems of the collected plants were plated for identification of *C. sativus*, red *Fusarium*, and *Gaeumannomyces graminis* var. *tritici* as root pathogens. The tissues were washed for one hour under running water, dried, disinfested with 1% silver nitrate for 1 minute, rinsed three times in sterile distilled water, drained, and then placed on a semi-selective medium for *G. gramininis* var. *tritici* modified from Juhnke et al. (1984). This was a PDA based media containing 100 mg/L streptomycin sulfate, 500 mg L-DOPA (L-B-3,4-dihydroxylphenylalanine) and 10 mg dichloran. Other inhibitory chemicals were omitted. Plates were incubated at 20°C in the dark. The presence of red *Fusaria* and *C. sativus* was recorded at 10 days and of *G. graminis* var. *tritici* at 14 days.

RESULTS AND COMMENTS: The average root disease rating in the 23 fields surveyed was 30%. The platings from random plant samples showed that, on average, 33% of the plants were infected with *G. graminis*, 23% with red *Fusaria*, and 18% with *C. sativus*. The additional samples collected from areas of the fields with severe disease symptoms indicated that 40% of these were infected with *G. graminis*, 27% with *Fusarium*, and 10% with *C. sativus*.

A comparison between the two areas suggested that Outlook had higher levels of disease and more infections caused by *G. graminis* and *C. sativus* than Willowbrook (Table 1). A mixture of take-all and prematurity blight was probably responsible for the poor wheat crops in the Willowbrook area in 1994 and the previous few years, whereas at Outlook take-all was the primary disease, followed by prematurity blight and common root rot. Both areas had high levels of take-all in 1993 (Bailey et al. 1993).

Disease ratings were correlated with isolations of *G. graminis* ($r = 0.37$) and *C. sativus* ($r = 0.38$) but less so for *Fusarium* ($r = 0.19$). There was a small negative correlation for isolations of *G. graminis* and *Fusarium* ($r = -0.11$) but a strong association of isolations of *G. graminis* and *C. sativus* ($r = 0.69$). There was no association between isolations of *Fusarium* and *C. sativus* ($r = -0.03$).

TABLE 1. Disease rating and percentage of plants infected with *G. graminis* var. *tritici*, red *Fusarium*, and *C. sativus* from the irrigated area of Outlook and the dryland area of Willowbrook in central and eastern Saskatchewan.

Location	Sample	No. fields	Disease rating %	% Plants infected ± S.E.*		
				C. graminis	Red *Fusaria*	*C. sativus*
Outlook	random	13	43 ± 1.1	39 ± 4.6	25 ± 7.0	24 ± 5.4
Willowbrook	random	10	15 ± 4.6	26 ± 3.4	20 ± 4.6	9 ± 3.3
Outlook	selected	4		49 ± 14.6	25 ± 17.1	26 ± 11.0
Willowbrook	selected	6		35 ± 9.5	28 ± 9.2	0 ± 0.0

* S.E. = standard error of mean

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CROP: Wheat, bread

LOCATION: Manitoba and eastern Saskatchewan

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TITLE: WHEAT LEAF RUST IN THE EASTERN PRAIRIES IN 1994

METHODS: Wheat fields, uniform nurseries of known cultivars and breeding lines in Manitoba and eastern Saskatchewan were surveyed for incidence and severity of leaf rust in June, July, and August.

RESULTS AND COMMENTS: In 1994 the initial observation of leaf rust was on winter wheat at Carman, Manitoba on June 19. Warm and dry weather in the eastern prairies during the latter half of June and first week of July slowed development of the leaf rust epidemic. In the second week of July leaf rust was found at trace levels on spring wheat throughout southern Manitoba. By the first week of August in the Red River Valley of Manitoba leaf rust infections levels on the moderately resistant cultivar Katepwa had reached 40%, and were up to 10% on the more resistant cultivar Roblin. Susceptible winter wheats had infection levels up to 100% in southern Manitoba. Levels of leaf rust infections on spring wheat were very light in other areas of southern Manitoba and eastern Saskatchewan. Yield losses were not expected in these areas.

CROP: Wheat

LOCATION: Manitoba

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TITLE: OCCURRENCE OF FUSARIUM HEAD BLIGHT IN MANITOBA IN 1994

METHODS: A survey for fusarium head blight (FHB) in spring wheat fields was conducted in southern Manitoba between 20 July and 11 August 1994. Heads were examined in 166 fields (113 common, 15 durum, 38 semi-dwarf) between watery-ripe and medium dough stages of development. The percentage of heads affected with FHB was estimated in each field. Kernels from sampled heads were surface sterilized and incubated on potato dextrose agar under continuous cool white light for 5-7 days to promote pathogen sporulation to confirm diagnosis and to aid in *Fusarium* species identification.

RESULTS AND COMMENTS: Southern Manitoba again experienced an epidemic of FHB second in severity only to that of 1993. Blighted heads were found in wheat fields throughout the surveyed area (Fig. 1). Severity in most fields ranged from trace to 10% of heads infected west of Portage la Prairie. The more severely infested fields (10 to 70% heads affected) were found in the Red River Valley and adjacent regions in crop districts 7 and 8 (Fig. 1). Severity levels in all wheat classes were similar (Table 1). *Fusarium graminearum* was the principal causal species accounting for >95.0% of isolations from common and semi-dwarf cultivars and 67% of isolations from durum wheats. *Fusarium avenaceum* was the second most commonly isolated species, especially from durum cultivars. The predominant species in the Red River Valley was *F. graminearum*. *F. avenaceum* and *F. poae* were more commonly isolated from wheat fields in the southwestern part of the province.

TABLE 1. *Fusarium* species isolated from spring wheat in southern Manitoba in 1994.

Wheat type	No. of Fields surveyed	*Fusarium* spp. (%)		
		F. graminearum	*F. avenaceum*	Other
Common	113	97.3	1.7	1.0
Semi-dwarf	38	98.3	1.2	0.5
Durum	15	67.0	25.8	7.3

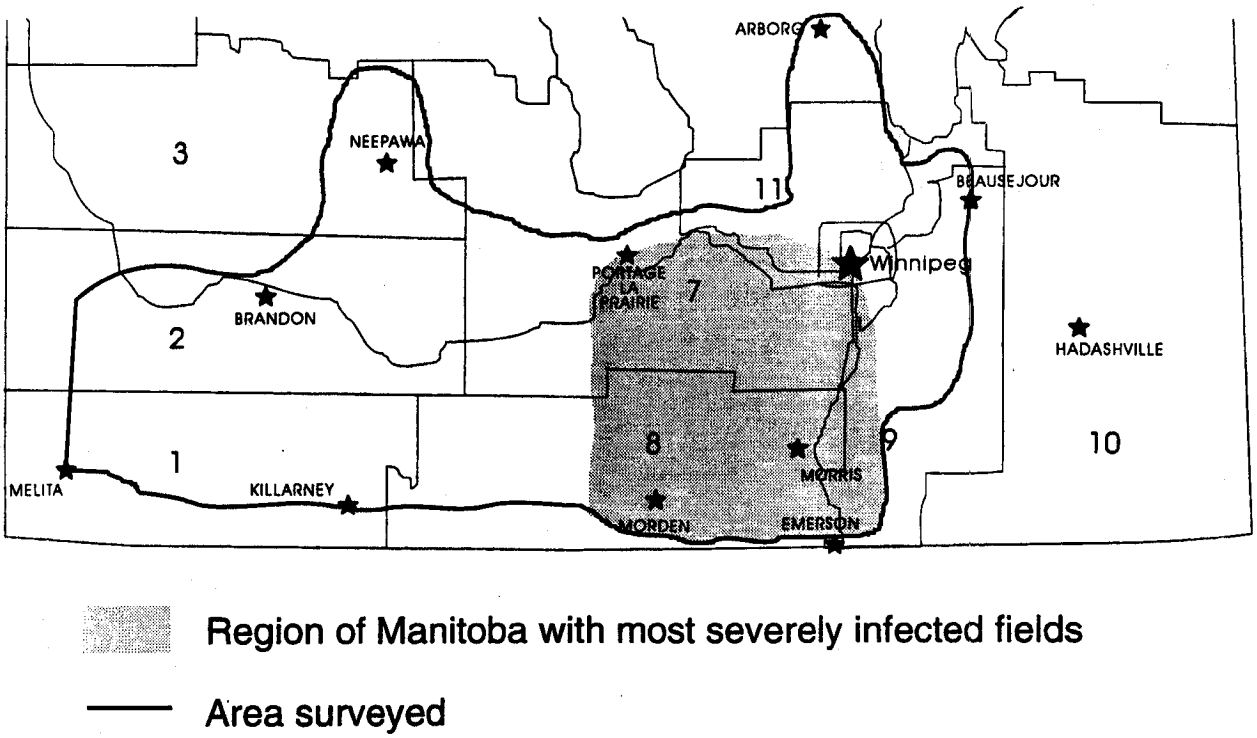

FIG. 1. Crop districts surveyed for fusarium head blight in Manitoba in 1994.

CROP: Wheat

LOCATION: Manitoba

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TITLE: LEAF SPOT DISEASES OF SPRING WHEAT IN MANITOBA IN 1994

METHODS: Surveys for foliar diseases of spring wheats were conducted in southern Manitoba between 18 July and 10 August 1994. Leaves were collected from 141 fields (102 common, 13 durum, 26 semi-dwarf) between heading and soft dough stages of development. Severity of disease on upper and lower leaves was categorized as 0, trace (TR), 1, 2, 3 or 4, with 4 describing dead leaves and 1 lightly affected. Samples of diseased leaf tissue were surface sterilized and placed in moisture chambers for 5-7 days to promote pathogen sporulation and disease identification.

RESULTS AND COMMENTS: Weather conditions in 1994 favoured leaf spot disease development. Severity levels for leaf spot diseases on the upper leaves of wheat were light in July (TR-1), and moderate (2) in August. On lower leaves levels were moderate to severe (3-4) throughout the survey period. Incidence of septoria leaf and glume blotch caused by *Septoria nodorum* was high in all wheat classes (Table 1, Fig. 1). High levels of *S. tritici*, speckled leaf blotch, were observed on common and semi-dwarf cultivars for a third consecutive year over much of the surveyed region (Fig. 1). On durum cultivars levels of *S. tritici* were low, and incidence of *Cochliobolus sativus*, spot blotch, and *Pyrenophora tritici-repentis*, tan spot, high. Tan spot was most prevalent in western Manitoba (Fig. 1). The highest incidence of *S. avenae* f. sp. *triticea* in several years was recorded in 1994, but severity was low. *Septoria* species accounted for 67% of the pathogenic fungi isolated. While incidence of tan spot and spot blotch was high, severity levels remained low as indicated by the number of isolations, 17.3% and 15.6%, respectively.

TABLE 1. Frequency of leaf spot diseases identified in 141 wheat fields in Manitoba in 1994.

Wheat type	Disease				
	Septoria spp.			Spot blotch	Tan spot
	S. nodorum	*S. tritici*	*S. avenae*		
Common	78.4	69.6	34.3	67.6	58.8
Semi-dwarf	73.0	65.3	30.7	53.8	69.2
Durum	76.9	38.4	38.4	84.6	92.3
Total Fields	109	93	48	94	90
Field (%)	77.3	65.9	34	66.6	63.8
Isolations (%)	31.8	28.8	6.4	15.6	17.3

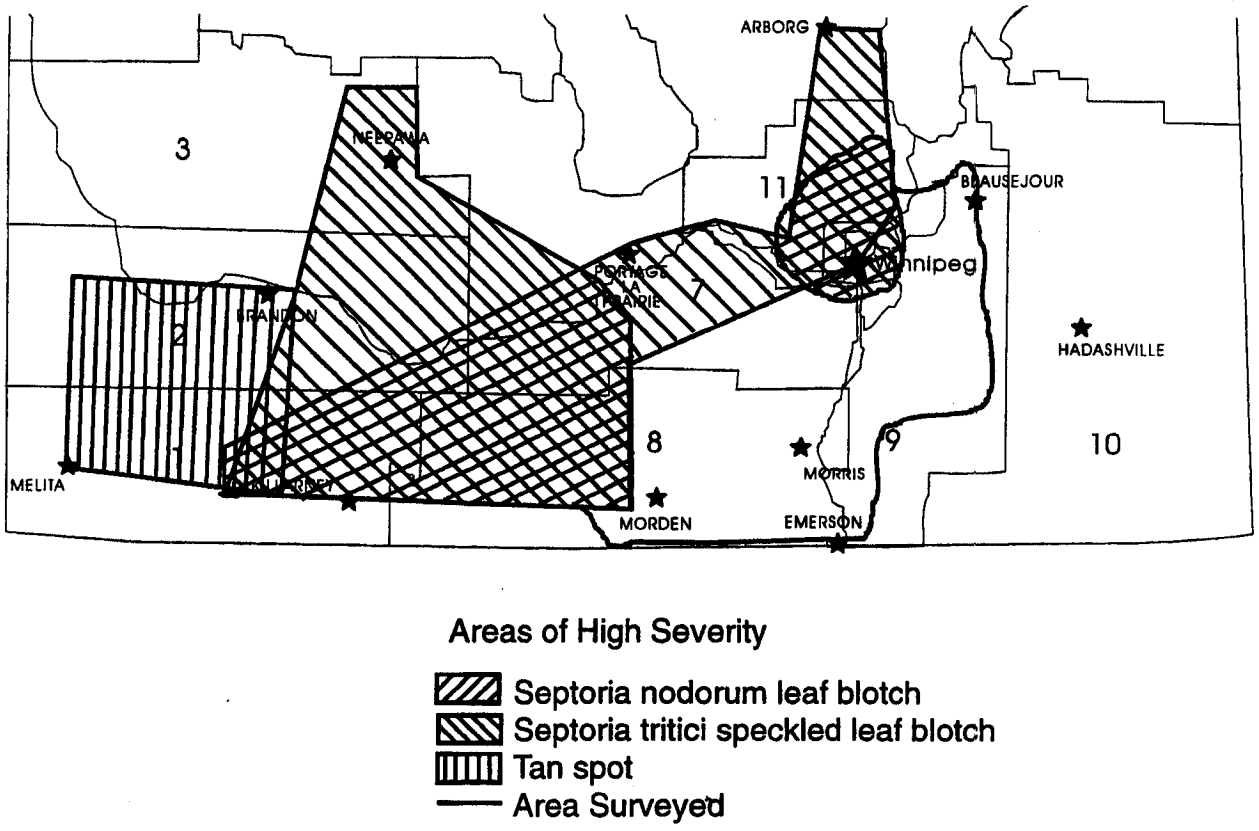

FIG. 1. Crop districts surveyed and distribution of foliar pathogens in Manitoba in 1994.

CROP: Wheat, common, *Triticum aestivum* L.

LOCATION: Québec

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TITLE: OCCURRENCE OF CONTAMINATION OF WHEAT GRAIN BY THE ORANGE WHEAT MIDGE AND SEED MICROFLORA IN QUÉBEC

METHODS: Six spring wheat fields were visited in Québec in the summer of 1994. At each visited site, a few hundred spikes were collected at random and preserved in a cooler. Plant growth stage at the time of sampling was early to mid milk. All samples were frozen until further use in the laboratory. From each lot collected, 100 spikes were dissected and examined for presence of the orange wheat midge (*Sitodiplosis mosellana*). The number of larvae and the number of spikelets were counted in each spike. The remaining spikes were dried and threshed. To determine fungal and bacterial contamination of grain, representative sub-samples of 100 seeds (mostly immature) were plated on PCNB agar (for bacteria as a group and *Fusarium* spp.) and on mannitol agar (for fungi as a group and *Fusarium graminearum*). Prior to plating out, seeds were surface-sterilized for 30 sec in 70% ethanol and 2 min in 1% sodium hypochlorite. The number of seeds with colonies of the sought after microorganisms were counted after a 13-day incubation at room temperature. Single correlations (r) were calculated between incidence of orange wheat midge and seed contamination levels.

RESULTS AND COMMENTS: Data collected are shown in Table 1. Orange wheat midge larvae were found consistently in all samples examined. High percentages of infested spikes were recorded, with a maximum of 82% at Sainte-Anne-de-Bellevue. The incidence of infested spikes appeared to be favoured in warm locations compared to cooler locations such as La Pocatière and Normandin. The number of larvae found per spike and per spikelet were higher than 4 and higher than 0.3 in half the samples.

TABLE 1. Records of incidence of orange wheat midge and seed contaminants in wheat samples collected at locations in Québec.

	Orange Wheat Midge incidence			Contamination of seeds (%)			
		Number of Larvae				*Fusarium*	
Location	Infested spikes (%)	/spike	/spikelet	Bacteria Total	Fungi Total	spp.	*graminearum*
Ste-Anne Bellevue	82	4.5	0.32	99	37	2	2
Saint-Polycarpe	50	1.1	0.07	84	37	3	1
Sainte-Rosalie	88	5.2	0.32	61	34	3	3
Lennoxville	61	5.0	0.34	49	37	3	3
La Pocatière	58	2.2	0.14	40	58	2	1
Normandin	36	1.6	0.13	15	71	8	3

Coefficients of correlation between incidence of orange wheat midge and seed contamination levels are shown in Table 2. No correlation is significant at $P \leq 0.05$. The highest correlation found is between percentage of infested spikes and fungal contamination ($r=0.721$, $P=0.1056$). The low incidence of *Fusarium* fungi is probably due to the early sampling of plant material.

TABLE 2. Correlation between incidence of orange wheat midge and contamination of seeds in wheat collected in Québec.

	Correlation (*r*) with seed contamination			
Orange Wheat Midge incidence	Bacteria	Fung	*Fusarium* spp.	*F. graminearum*
Percentage of infested spikes	0.601 *(0.2074)*	0.721 *(0.1056)*	0.668 *(0.1470)*	0.151 *(0.7754)*
Number of larvae per spike	0.270 *(0.6053)*	0.608 *(0.2005)*	0.410 *(0.4197)*	0.580 *(0.2281)*
Number of larvae per spikelet	0.260 *(0.6182)*	0.555 *(0.2531)*	0.348 *(0.4987)*	0.613 *(0.1958)*

P values in parentheses.

CROP: Wheat

LOCATION: Québec

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TITLE: DISEASES OF WHEAT IN QUÉBEC IN 1994

METHODS: The incidence of the most common diseases of wheat was recorded on the different lines and cultivars of the regional and cooperative test plot trials grown in ten localities covering the wheat growing regions of Québec. Disease severity assessments was made once during the late milk to soft dough stages. *Fusarium* head blight infection was assessed during a survey of nine farmers' fields distributed throughout the region of Saint-Hyacinthe (S.W. Québec) by calculating the percentage heads and spikelets infected by the pathogen at the soft dough stage.

RESULTS AND COMMENTS: Powdery mildew (*Erysiphe graminis*) was observed at only one locality of the Saint-Hyacinthe region (Saint-Césaire) on the two bread wheat lines: QW.550.13 and QW.546.17.

Leaf spots (*Pyrenophora tritici-repentis*) mixed with *(Phaeospharia nodorum*) were as usual widespread in all regions but was most severe at Lennoxville and Saint-Simon.

Glume blotch (*Phaeospharia nodorum*) was observed at moderate intensities at Lennoxville and the northern regions of the Province.

Leaf rust (*Puccinia recondita*) was observed late in the season and most severe infections on the susceptible cultivars Ac Baltic, Algot, Belvedere, Consens, Mondor and Opal were noted at Saint-Simon and the northerly regions (Sainte-Foy, La Pocatière and Normandin).

Fusarium head blight (*Fusarium graminearum*) was again widespread this year due to the wet conditions that occurred during the flowering periods. Intensity of infections varied greatly not only from region to region but even within the same localities. The most severe infections were noted on the very susceptible cultivars at the Saint-Hyacinthe and Sainte-Foy regions. The infections levels noted in the nine fields surveyed in the Saint-Hyacinthe region was as follows: 7.2% and 4.6% spikelets (55.0% to 26.6% heads) on Ac Mimi, 1.2% and 3.0% spikelets (14.2% and 3.2% heads) on Celtic, 0.4% spikelets (3.3% heads) on Ac Baltic, 2.8% (22.3% heads) on Casavant, 0.5% spikelets (3.9% heads) on Aquino, 1.% spikelets (7.8% heads) on Maestro and 2.8% spikelets (19.4% heads) on QW.500.9.2. In winter wheat, the two fields surveyed showed 0.8% spikelets (8.3% heads) on Karat and 0.6% spikelets (4.5% heads) on Augusta.

Chlorotic fleck (physiological leaf spot) was widespread this year for the first time on leaves of spring wheat. Severe infection occurred at Lennoxville on all cultivars, moderate to severe infections on some cultivars at Sainte-Foy, low to moderate infections in south western regions of the province and absent in the northern regions (La Pocatière and Normandin).

Other diseases observed at very low intensities were loose smut (*Ustilago tritici*), take-all (*Gaeumannomyces graminis*) and ergot (*Claviceps purpurea*).

Oilseeds and Special Crops / Oléagineux et cultures spéciales

CROP: Dry Bean

LOCATION: Southern Alberta

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TITLE: SURVEY OF DISEASES OF DRY BEAN IN SOUTHERN ALBERTA IN 1994

METHODS: Thirty-seven irrigated crops of dry bean were surveyed during late August 1994 for white mold (*Sclerotinia sclerotiorum*), gray mold (*Botrytis cinerea*) and bacterial blights (*Xanthomonas campestris* pv. *phaseoli*, *Pseudomonas syringae* pv. *phaseolicola*) in the area surrounding Bow Island, Alberta. Each crop was sampled by selecting ten sites in a U-shaped pattern, approximately 20 m apart, with each site consisting of a 3 m long section of row (Howard and Huang, 1983). The number of plants with disease symptoms, and the number of healthy plants were recorded at each site. The percentages of plants with white mold, gray mold, and bacterial blights were then calculated for each crop by averaging the incidence at the ten sites. The level of disease in each crop was then characterized according to the following scale: (1) none (0% of plants infected), (2) trace (<1%), (3) light (1—10%), (4) moderate (11—25%), (5) severe (26—50%), (6) very severe (>50%).

RESULTS: White mold was present in 33 of the bean crops surveyed (Table 1). The frequency of crops with moderate, severe, and very severe incidence of white mold was 22%, 27%, and 11%, respectively. The four crops with very severe disease incidence had 51%, 53%, 62%, and 89% of plants infected by the pathogen. The disease was distributed throughout the entire bean production area surrounding Bow Island (Figure 1).

Gray mold was present in 23 of the 37 crops surveyed (Table 1). The frequency of crops with light to moderate incidence was 8% and none of the surveyed crops had severe or very severe incidence of gray mold. The disease was found throughout the survey area. Bacterial blights were present in 19 of the crops surveyed. The frequency of crops with light to moderate incidence of bacterial blights was 8%. None of the crops surveyed had severe or very severe incidence of the disease. Bacterial blights were found throughout the survey area.

DISCUSSION: White mold, gray mold and bacterial blights were reported as major diseases of dry bean in southern Alberta (Huang and Erickson, 1993). The same diseases were widespread in southern Alberta in 1994, with white mold being the most serious disease in both years. Although gray mold and bacterial blights were widespread in southern Alberta, the incidence of these diseases was lower than white mold in 1993 and 1994.

TABLE 1. Diseases of dry bean in southern Alberta in 1994.

Disease Incidence (% plants infected)	Number of Crops		
	white mold	gray mold	bacterial blights
None (0%)	4	14	18
Trace (<1%)	1	20	16
Light (1—10%)	10	1	1
Moderate (11—25%)	8	2	2
Severe (26—50%)	10	0	0
Very Severe (>50%)	4	0	0

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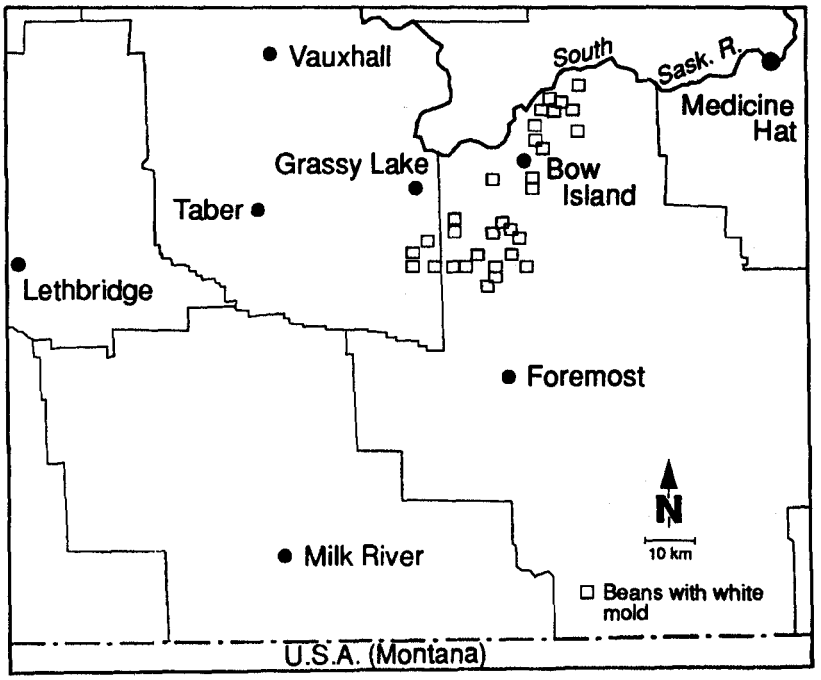

FIG. 1. White mold of dry bean in southern Alberta in 1994.

CROP: Field Bean

LOCATION: Ontario

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TITLE: STATUS OF ANTHRACNOSE DISEASE ON FIELD BEAN IN SOUTHWESTERN ONTARIO IN 1994

METHODS: Isolations were made from anthracnose-diseased bean samples collected from six trial locations (Brussels, Exeter, Kippen, Mitchell, Shetland and Woodstock) in September 1993. The isolates were characterized to the race level using a series of differentials (Dark Red Kidney, Widusa, Kaboon, Michelite, Sanilac, Prelude and Cornell 49-242). Later, all 42 lines of white bean and 39 lines of coloured beans at nine trial locations were destroyed, the machinery and instruments were decontaminated, and the trial sites abandoned.

For 1994 trials, all submitted seeds were visually inspected and treated with DCT (diazinon 6%, captan 18% and thiophanate-methyl 14% w/w) before sowing. Nine trials were conducted at new sites in the same townships as in 1993. (Ailsa Craig, Brussels, Elora, Exeter, Kippen, Mitchell, Shetland and Kemptville). Two official inspections for anthracnose disease were made in mid- and late-August.

RESULTS AND CONCLUSIONS: Ten isolates of *Colletotrichum lindemuthianum* were obtained from diseased pods of five cultivars (Centralia, Midland, Mitchell, OAC Spring and Shetland) and three breeding lines in 1993. Pure cultures of the isolates were nearly identical in morphology to that of the alpha race. Based on their pathogenicity to the series of differential hosts noted above, all isolates were determined to be not the alpha but the alpha-Brazil race of the pathogen. This is the first finding of this race in Canada.

Tests conducted in the laboratory and greenhouse showed that the currently-used seed treatment compound (DCT) was effective in eradicating the fungus from the infected seeds.

All trial sites were carefully observed for anthracnose disease during the 1994 growing season. During official field inspections which were conducted in late-August the disease was not found. Thus, the Ontario field bean has again returned to anthracnose-free status.

CROP: Canola

LOCATION: British Columbia

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TITLE: 1994 CANOLA BLACKLEG SURVEY IN THE BC PEACE RIVER REGION

METHODS: The purpose of the survey was to determine whether the virulent strain of blackleg (*Leptosphaeria maculans*) had been introduced into the Peace River region of British Columbia. The survey was conducted from September 6 to 9, 1994 by eight B.C.M.A.F.F. staff and two volunteers. All canola producing areas were surveyed, with emphasis on areas of intensive production and areas where canola commonly follows canola. Every *Brassica napus* and every second *B. campestris* crop encountered were surveyed. Crops were sampled in an inverted W pattern starting 30 metres from the field entry point. Ten plants were pulled and examined for blackleg every 30 m for a total of 50 stems per crop. Additional plants were also examined for blackleg along the edge of the field near the field access. All samples were retained and rated in the laboratory for the presence of blackleg and sclerotinia (*Sclerotinia sclerotiorum*). Stems with pycnidia were cultured at the provincial plant diagnostic lab. Blackleg cultures were forwarded to Dr. P. Ellis, Agriculture and Agri-Food Canada, Vancouver Research Centre, for ELISA testing using monoclonal antibodies.

RESULTS AND COMMENTS: Virulent blackleg was not detected in this survey. A total of 134 canola crops were surveyed, representing 8710 ha out of a total of 48,000 ha grown. Non-virulent blackleg was detected in 54.5% of crops. None of the samples had girdling lesions, and very few had basal stem cankers. The average incidence of non-virulent blackleg within infested crops was 13%. Sclerotinia stem rot was detected in 50.7% of crops surveyed at an average incidence of 7.6% within infested crops. Virulent blackleg has not yet been detected in British Columbia.

ACKNOWLEDGEMENTS: Many thanks to the following for assisting with the canola survey: A. Anderson, K. Nickel, G. Carter, J. Dobb, J. Elmhirst, J. Forbes, L. Bowd, V. Joshi, D. Bray, C. Anderson.

CROP: Canola

LOCATION: Peace River region of Alberta

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TITLE: SPREAD AND DISTRIBUTION OF VIRULENT BLACKLEG OF CANOLA IN THE PEACE RIVER REGION OF ALBERTA IN 1994

INTRODUCTION AND METHODS: In 1993, virulent blackleg was found extensively in the Peace River region in over 100 canola crops (1). In 1994, canola acreage was expected to increase to a record high of 600,000 hectares. The purpose of the survey was to monitor the spread of blackleg in municipalities where the prevalence was high in 1993 and to survey more canola crops in other municipalities in the Peace River region. The survey was conducted from June to September 1994, with the cooperation of agricultural fieldmen in all 13 municipalities. Canola crops in fields with shortened or no rotation were given priority in the survey. In two municipalities, all canola crops were checked at least once during the summer whereas in all other municipalities crops were selected at random. Crops were sampled as previously described (2). Additional samples were collected at the road access to crops and in low spots in the fields. Stems with blackleg-like lesions and stubble pieces with pycnidia were collected. These plant samples were tested to confirm virulent blackleg at the Regional Crops Laboratory, Fairview, the Pest Diagnostic Clinic, Vegreville and Brooks Diagnostics Ltd, Brooks.

RESULTS AND COMMENTS: A total of 2010 crops was surveyed in the Peace River region. There were 104 crops with confirmed virulent blackleg. Most of the canola crops had disease incidence at low or trace levels. The disease was found to have spread from four municipalities in 1993 to seven municipalities in 1994. In the two municipalities with high prevalence of virulent blackleg in 1993 (1) there were fewer infested crops in 1994, ie 14 crops in the County of Grande Prairie and 24 in the Municipal District of Smoky River. The highest number [52] of infested crops in 1994 was found in the Improvement District of Birch Hills. Many of these infested crops were in fields in which cv. Westar had been grown continuously for two or more years and some showed moderate to high incidence. The Regional Crops Laboratory in Fairview surveyed 131 of the 2010 crops, received 448 canola specimens and confirmed 78 with virulent blackleg. One hundred of the 448 specimens were sent to Brooks Diagnostics Ltd to test their new ELISA procedure using monoclonal antibodies. The Diagnostic Pest Clinic in Vegreville received 110 canola specimens and identified 26 with virulent blackleg.

ACKNOWLEDGEMENTS: Thanks to the agricultural fieldmen and inspectors involved in surveying the canola crops, to Ellen Dalke for assistance in isolating virulent blackleg from canola specimens, and to the Alberta Canola Producers' Commission for financial support.

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CROP: Canola

LOCATION: Alberta

NAME AND AGENCY:
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TITLE: BLACKLEG OF CANOLA SURVEY IN ALBERTA - 1994

INTRODUCTION AND METHODS: The provincial survey for virulent blackleg (*Leptosphaeria maculans*) of canola was continued for the seventh consecutive year. Fieldmen in each of Alberta's 67 municipalities where canola was grown were assigned crops of canola to inspect in proportion to the amount grown in their respective areas of jurisdiction ie one crop of canola for every 2000 ha grown. The 50% increase over 1993 in area sown to canola was reflected in the survey crop numbers. Fieldmen were expected to pay particular attention to short or non-existent rotations and sample as previously described (3). Agriculture and Agri-Food Canada seed inspectors reported on the presence of virulent blackleg in seed crops. Diagnostic confirmation of virulent blackleg-infected samples was provided by the Alberta Environmental Centre at Vegreville and laboratories at Fairview and Brooks.

RESULTS AND COMMENTS: In central regions of Alberta virulent blackleg infection was at trace to minor levels. The first stem and foliar lesions did not generally appear until late June. In southern regions of the province, particularly around the Vulcan area, significant losses occurred in many crops of Westar canola. Field histories typically showed that canola, usually Westar, had been grown for 3 years in a row. A similar situation existed in the Birch Hills area of the Peace region (1,2,4) again involving continuous Westar, but virulent blackleg infection levels there were generally low. Province-wide 2784 canola crops were surveyed and 202 (7.2%) were positive for virulent blackleg.

Agriculture and Agri-Food Canada inspectors found only 10 seed crops of canola with trace levels of virulent blackleg in the Vermilion region. These 10 crops totalled 384 ha out of 664 seed crops province-wide, totalling 18,402 ha.

Six private seed laboratories in Alberta and one in Saskatchewan checked 1635 lots of canola seed for virulent blackleg and 42 lots were found to be positive. Infected samples were for the most part from lots of common seed.

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CROP: Canola

LOCATION: Saskatchewan

NAME AND AGENCY:

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TITLE: SURVEY OF CANOLA DISEASES IN SASKATCHEWAN, 1994

METHODS: Between 15 and 23 August 1994, 106 canola crops (at growth stages 5.1-5.4 [1]) were surveyed in Saskatchewan crop districts 1, 2, 5, 6, 7, 8 and 9 (Fig. 1), where the majority of canola in the province was grown. The number of crops surveyed per crop district (CD) was approximately in proportion to the area of canola seeded in each district [2], and the acreage in the seven districts surveyed accounted for 94% of the estimated 1994 production for Saskatchewan. Crops were usually surveyed along preplanned routes, with a minimum distance of 40 km between survey sites. Twenty-plant samples from each of 5 locations per field, taken along a horseshoe-shaped path starting 25 m from the edge of the field, were collected and rated. A total of 74 *Brassica napus* and 32 *B. rapa* crops were assessed for the prevalence (percent of crops infested) and incidence (percent of plants infected per crop) of sclerotinia stem rot (*Sclerotinia sclerotiorum*), foot rot (*Fusarium* spp. and *Rhizoctonia* sp.), aster yellows (mycoplasma-like organism) and staghead (*Albugo candida*). Blackleg (*Leptosphaeria maculans*) lesions that occurred on any part of the canola stem were noted, as were basal stem cankers that destroyed or weakened the structural integrity of tissues [3]. The prevalence and severity (percent surface area of pod covered by lesions) of alternaria pod spot (*Alternaria* spp.) was determined.

RESULTS: The overall prevalence of sclerotinia stem rot was high in CDs 8A, 8B and 9A (86—100% of crops infested) (Table 1). Mean prevalence was slightly higher for *B. rapa* (59%) than for *B. napus* (53%), although mean disease incidence was lower in *B. rapa* (5%) than in *B. napus* (6%) (Table 2).

Blackleg lesions occurred in 76% of *B. napus* and 91% of *B. rapa* crops, with overall incidences of 11% and 25%, respectively (Table 2). Disease incidence was over 50% in 3 *B. napus* and 5 *B. rapa* crops. In CD 8B, blackleg occurred in 91% of the crops with a mean incidence of 36% (Table 1); in CDs 7B and 8A, 100% of crops were infested. Basal stem cankers were not prevalent generally; no cankers were recorded in 47% of both *B. napus* and *B. rapa* crops. However, in CD 7B and 9B, basal stem cankers were recorded in all crops, with mean incidences of 11% and 7%. Lesions caused by the weakly virulent strain of *L. maculans* were observed in many crops of *B. napus* and *B. rapa*, but incidence was low.

The incidence of foot rot was generally low, but prevalence was high (Table 2). Similarly, the overall incidence of aster yellows was low, but most crops were infested. However, appreciable disease incidences (11—20%) had developed in 5 crops of *B. rapa*.

The incidence of staghead was low (1.9%), but 69% of *B. rapa* crops were infested. Malformations similar to small stagheads, caused by *Peronospora parasitica*, were recorded in 4 crops of *B. napus*.

The severity of alternaria pod spot was low, with means ranging from 0.3—2.7% in different crop districts, but prevalence was high (Table 2). More than 50% of the crops were infested in 7 of the 12 crop districts surveyed, with the highest prevalence (83%) in CD 7B (Table 1).

COMMENT: In 1994, rainfall was above average for most of the Saskatchewan grain belt in late May and June. This trend continued for July and August, although below average rainfall was reported for these months in southeast, southwest and northwest districts. Excess moisture was a problem in northeast districts [2]. The generally low incidence of diseases was surprising given the favorable moisture levels and moderate to high disease prevalence. Growing conditions for canola, and for development of sclerotinia stem rot, were generally favorable but disease incidence was not high in any district. However, in 5 crops (2 in 8B, 2 in 9A and 1 in 5A) disease incidence was over 20%. The low prevalence of stem rot in the southeast districts may have been partly due to the lower moisture levels during July and August, and because there is less of a history of canola production in these districts. It was not possible to determine if any of the surveyed crops had been sprayed with fungicides for the control of stem rot or blackleg. The occurrence of 5 crops (2 in 8B, 2 in 9A and 1 in 5B) with 11—20% aster yellows was unusual, although the high prevalence was normal.

The prevalence of blackleg lesions was generally high except in CDs 1A and 2B. Petrie [4] also reports a high prevalence of blackleg in CDs 6, 8 and 9. The incidence of lesions was generally lower in this survey, but there was close agreement in the incidence of cankers reported in CDs 8 and 9. In this survey, the overall incidence of blackleg lesions was higher in *B. rapa* than in *B. napus*, agreeing with the reports by Petrie in 1993 [3] and 1994 [4]. However, the incidence of stem cankers was found to be higher in *B. rapa* than in *B. napus* in this survey, whereas Petrie reported a higher incidence in *B. napus* in 1994.

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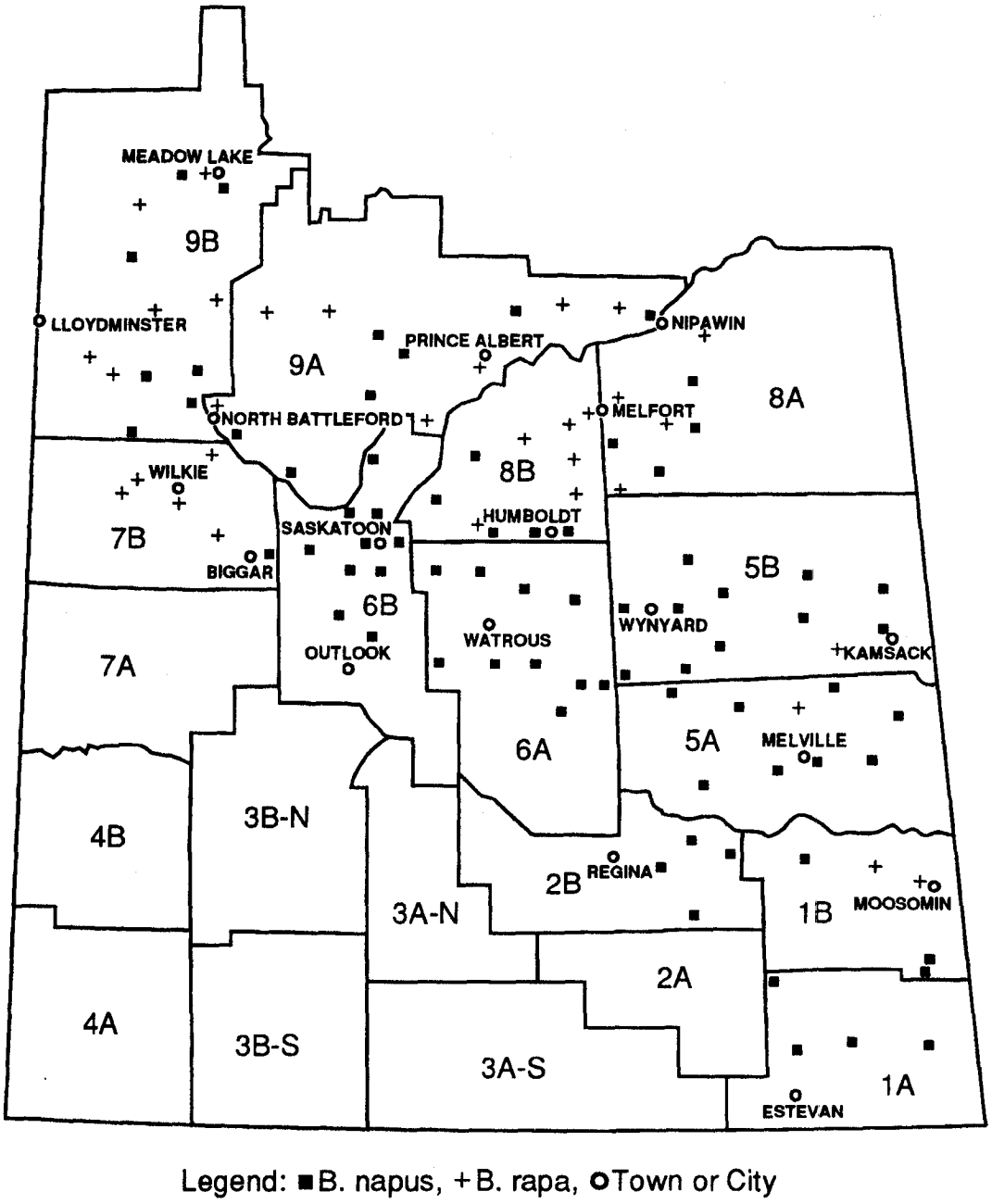

FIG. 1. Distribution of surveyed crops in Saskatchewan in relation to crop districts.

TABLE 1. Canola acreage, number of crops surveyed, disease prevalence and disease incidence or severity in Saskatchewan, 1994.

Crop district	Estimated canola acreage (x 10^3 ha)	No. of crops surveyed		Sclerotinia stem rot		Blackleg		Alternaria pod spot	
		B. napus	*B. rapa*	P*	DI**	P lesions	DI lesions /cankers	P	Mean % severity
1A	116	4	0	0		0		50	0.3
1B	154	3	2	0		60	4/1	60	1.6
2B	84	4	0	0		0		75	0.2
5A	309	8	1	67	4	44	1/0	44	0.8
5B	292	11	1	58	4	83	14/3	75	0.8
6A	264	10	0	20	<1	90	4/1	50	0.1
6B	184	10	0	50	3	90	14/1	40	0.7
7B	174	1	5	0		100	22/11	83	0.8
8A	180	4	4	100	7	100	19/2	38	2.6
8B	222	5	6	91	10	91	36/4	55	1.5
9A	313	7	7	86	11	93	19/1	64	1.2
9B	228	7	6	62	1	100	24/7	62	2.7

* Mean percent prevalence.
** Mean percent disease incidence.

TABLE 2. Mean incidence, prevalence and distribution of diseases in relation to categories of disease incidence in 74 crops of *B. napus* and 32 of *B. rapa* in Saskatchewan, 1994.

	Number of crops with						
	Stem rot	Blackleg lesion	Blackleg canker	Foot rot	Aster yellows	Staghead	Alternaria pod spot
B. rapa							
0	13	3	15	4	3	10	7
trace <1%	2				11	3	4
1- 5%	9	3	10	22	11	17	17
6-10%	2	6	2	4	2	1	2
11-20%	5	5	3	2	5	1	2
21-50%	1	10	2				
>50%		5					
Mean % DI*	5	25	5	4	3	2	3
Mean % P**	59	91	53	88	91	69	75
B. napus							
0	35	18	47	34	15		39
trace <1%	4				34		26
1- 5%	26	19	20	31	25		7
6-10%	3	11	2	9			2
11-20%	2	14	5				
21-50%	3	9					
>50%	1	3					
Mean % DI*	6	11	2	2	1	n/a	1
Mean % P**	53	76	36	54	80		47

* Disease incidence.
** Prevalence.

CROP: Canola

LOCATION: Central Saskatchewan

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TITLE: 1994 SURVEY FOR BLACKLEG AND OTHER DISEASES OF CANOLA

METHODS: Between 15 August and 30 September, 141 canola crops (111 of *Brassica napus* [BN] and 30 of *B. rapa* [BR] were surveyed in the 11 Saskatchewan rural municipalities (RM's) visited annually between 1991 and 1993 (6). The stubble from 10 plants was pulled at each of six sites per field and the mean disease incidence (DI) for each pathogen present was calculated. Both the incidence of all blackleg (*Leptosphaeria maculans*) infections and the incidence of severe basal stem cankers (6) were recorded. Swathed plants were examined for alternaria black spot (*A. brassicae* and *A. raphani*), staghead (*Albugo candida*), and aster yellows. The severity of *Alternaria* pod infection was rated as trace, slight, moderate, or severe, corresponding, respectively, to 1, 5, 10, and 20% (or more) of the surface area covered by lesions (2). Notes were taken on the extent of weed infestation, hail damage, herbicide damage, and the presence of blackleg-infested residue of earlier canola crops.

RESULTS AND DISCUSSION: Blackleg was found in 140 of the 141 crops. In most RM's DI ranged from very low to very high (Table 1). The overall DI of 64% was lower than that recorded in 1991 or 1993 (6). However, the mean DI for severe basal stem cankers, 5%, was higher than that recorded for either 1992 or 1993. Crops in fields with short rotations (typically canola-cereal-summerfallow-canola) had the highest incidences of severe basal stem cankers, ranging from 30—72%. Plants with severe stem cankers were frequently severed at the stem base, prostrate, and prematurely ripened. There was often a close association with pieces of blackleg-infested root residue from a preceding canola crop. Abundant rainfall in the latter half of May, 1994, may have been an important factor contributing to the increase in frequency of severe basal stem cankers. Frequent rain showers stimulated ascospore production and liberation, resulting in early infections.

Blackleg incidences of 70—90% occurred in some fields where canola had not been grown for 10 years or more. However, plants with severe cankers were rare in these fields. Inquiries determined that the seed sown had usually been treated with a fungicide specifically for blackleg control; thus, ascospore inoculum apparently had blown in from adjacent fields. As in 1993 (6), overall blackleg infection in BR crops was higher than in BN (Table 2). However, in 1994, the mean incidence of basal stem cankers was higher in BN. Many of the short rotations involved BN. Producers apparently were relying on the greater blackleg resistance of BN cultivars to help negate the possible adverse effects of shorter rotations.

Sclerotinia stem rot (*Sclerotinia sclerotiorum*) occurred in 104 crops (74%); infection incidences between 10 and 37% were recorded in 16 fields (11%). Stem rot was most common in the northeastern part of the surveyed area, or RM's 401, 402, and 431 (Table 1). As previously reported (5), it was more prevalent, and the DI was higher, in BN than in BR (Table 2). Foot rot (*Rhizoctonia solani* and *Fusarium roseum*) and aster yellows also were more common in BN crops (Table 2), in keeping with earlier results (3, 5, 7). Alternaria black spot was less severe in BN than in BR (Table 2), reflecting their relative susceptibility to the disease (1). Grey stem (*Pseudocercosporella capsellae*) was rarely found in BN (Table 2), but BR stubble often was extensively colonized by the pathogen. Presently grown cultivars of BN are less affected by grey stem than were those grown previously (4). Staghead (*Albugo candida*) was conspicuous in 11 BR crops (37%).

Hail damage was noteworthy in 11 crops (8%). In one field south of Asquith in RM 345, early hail left gaping wounds in the stems, many of which were broken over. Blackleg lesions were often associated with hail injury. Herbicide drift caused significant damage in only three crops (2%). Partial sterility was noted in plants near the edge of one of these fields, and proliferation of stem tissues was observed in the two others. Infestations of stinkweed (*Thlaspi arvense*), wild mustard (*Sinapis arvensis*), and volunteer cereals were a serious problem in several fields throughout the area.

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TABLE 1. Blackleg and sclerotinia stem rot infection of stubble of canola (*Brassica napus* and *B. rapa*) crops in 11 rural municipalities in central Saskatchewan, 1994.

Rural Municipality	Virulent blackleg				Sclerotinia stem rot	
	Mean incidence & range of stem infections		Mean incidence & range of severe		% fields infested stem cankers	Mean incidence
343 Blucher	60	(3 - 98)	4	(0 - 22)	42	1
344 Corman Park	57	(0.1-100)	5	(0 - 56)	69	2
345 Vanscoy	72	(10 -100)	10	(0 - 72)	65	6
372 Grant	81	(55 - 98)	7	(0 - 30)	91	4
373 Aberdeen	65	(5 - 99)	6	(0 - 59)	70	2
401 Hoodoo	53	(18 - 80)	2	(0 - 8)	100	12
402 Fish Creek	49	(12 - 90)	1	(0 - 3)	100	6
403 Rosthern	62	(10 - 95)	6	(0 - 32)	82	5
404 Laird	58	(0 - 98)	5	(0 - 33)	67	3
405 Great Bend	64	(18 - 95)	2	(0 - 10)	80	1
431 St. Louis	79	(58 - 98)	1	(0 - 7)	100	7
Overall mean and range for 141 crops	64	(0 -100)	5	(0 - 72)	74	4 (0-37)

TABLE 2. Mean prevalence, incidence or severity* of diseases of two species of canola in 1994 in central Saskatchewan.

Disease	Disease measurement	*Brassica napus*	*Brassica rapa*
Blackleg	Prevalence	99	100
	Mean incidence	62	69
	Mean % basal cankers	6	4
Sclerotinia stem rot	Prevalence	77	63
	Mean incidence		
	all crops	4	2
	infested crops	6	3
Alternaria black spot	Prevalence	100	100
	Severity	7	9
Aster yellows	Prevalence	45	17
Foot rot	Prevalence	21	7
Grey stem	Prevalence	10	100
Staghead	Prevalence	0	37

* Prevalence = percent crops infested; incidence = percent plants infected in a crop; severity = percent surface area of pods with lesions.

CROP: Canola

LOCATION: Manitoba

NAME AND AGENCY:

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TITLE: DISTRIBUTION, PREVALENCE AND INCIDENCE OF CANOLA DISEASES IN MANITOBA 1994

METHODS: Three surveys of 101 canola crops in four agricultural regions of Manitoba, Southwest (crop districts 1, 2, and 3), Northwest (crop districts 4, 5, 6, and 13), Central (crop district 7 and 8), and Eastern/Interlake (crop districts 9 and 11), were conducted in the last week of August and the first week of September. The majority of crops were *Brassica napus*. Results for the three fields of *B. rapa* were combined with those for *B. napus*. The presence of diseases was noted in each field and disease incidence was determined from a sample of 50 plants. The route taken in the surveys is shown in Figure 1.

RESULTS AND COMMENTS: Sclerotinia stem rot caused by *Sclerotinia sclerotiorum* was the most frequent disease encountered in Manitoba except in the southwest region where blackleg (caused by *Leptosphaeria maculans*) was more frequently detected. The prevalence (percentage of infested crops) ranged from 37% in crop district 1 to 100% in crop districts 4, 8, 9, 11, and 13 (Table 1). The mean disease incidence ranged from 3% in crop district 3 to 32% in crop district 11 (Table 2). On a province-wide basis the prevalence was 78% and the mean disease incidence was 15%. This level of infection would likely result in about a 7.5% yield loss (Morrall et al. 1982), which is lower than in 1993 (Mathur and Platford 1994).

Blackleg was observed in all crop districts except crop district 13 which included only one crop (Table 1). Prevalence ranged from 50% in crop districts 4, 8, 9 and 11 to 87% in crop district 1. The mean disease incidence ranged from 2% in crop district 8 to 36% in crop district 11 (Table 2). Prevalence and mean disease incidence on a province-wide basis were 67% and 16% respectively, which were higher than in 1993 (Mathur and Platford 1994).

Foot rot (Rhizoctonia sp./Fusarium spp.) was observed in 38% of the crops surveyed (Table 1). The mean disease incidence ranged from 0 in crop districts 4, 5 and 13 to 14% in crop district 8 (Table 2). The overall incidence of foot rot was higher in 1994 than in 1993 (Mathur and Platford 1994). Black spot caused by *Alternaria* spp. was found at trace to moderate level with an incidence of 100% in all crop districts surveyed. Aster yellows (mycoplasma-like organism) was found in four crop districts, 1, 2, 3 and 7 and grey stem (*Pseudocercosporella capsellae*) was observed in two crop districts, 3 and 6.

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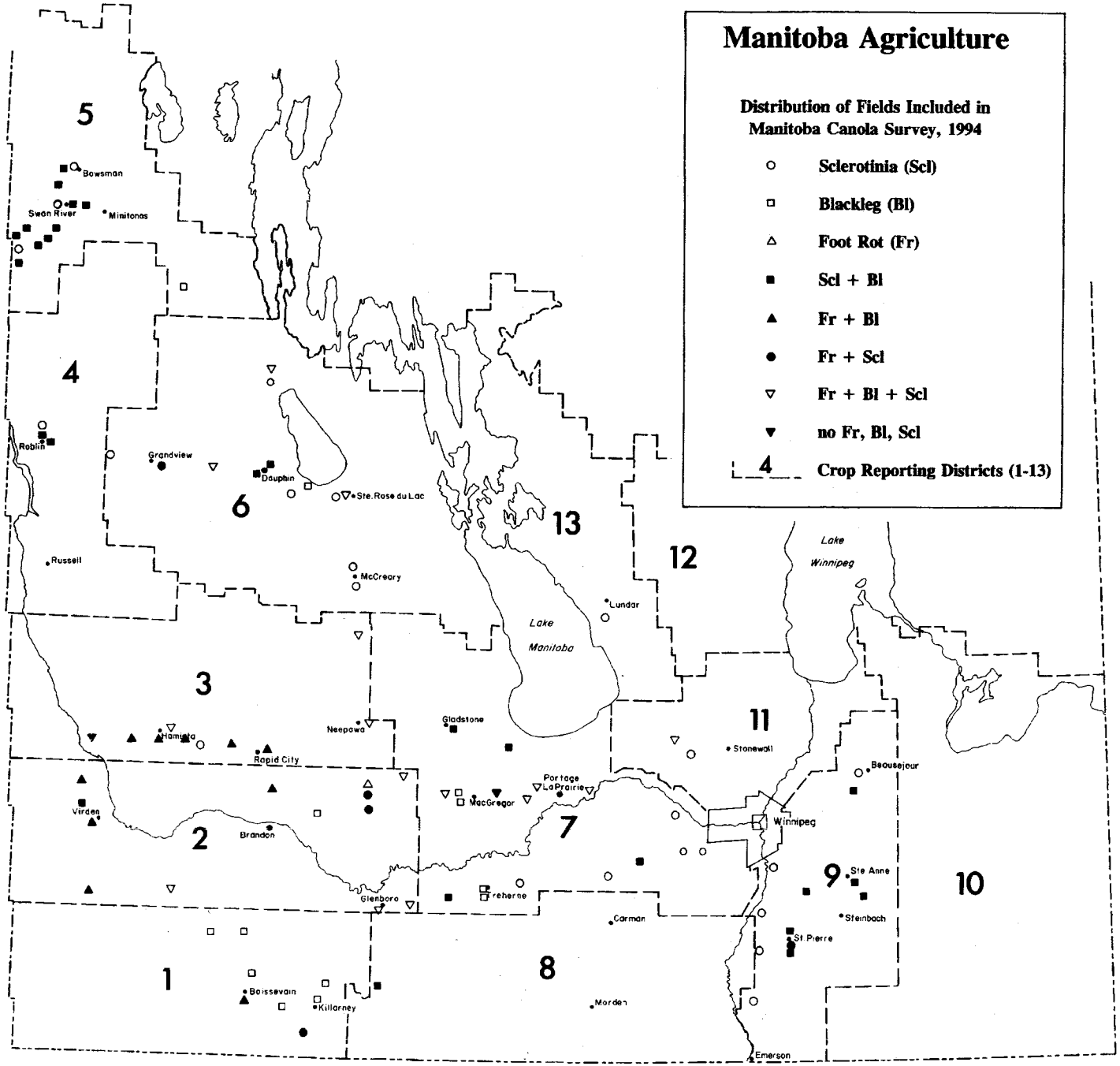
TABLE 1. Prevalence of diseases of canola in Manitoba in 1994.

Crop District	Number of Crops Surveyed	Percentage of crops infested					
		Sclerotinia	Blackleg	Foot rot	Black spot	Grey stem	Aster yellows
1	8	37	87	37	37	-	12
2	12	67	75	75	50	-	8
3	10	60	80	80	30	10	10
4	4	100	50	-	75	-	-
5	14	93	79	-	64	-	-
6	14	71	57	36	93	7	-
7	22	73	68	45	68	-	5
8	2	100	50	50	100	-	-
9	12	100	50	8	100	-	-
11	2	100	50	50	50	-	-
13	1	100	-	-	100	-	-
Manitoba Average	101	78	67	38	67	2	4

TABLE 2. Mean percentage incidence of diseases of canola in Manitoba in 1994.

Crop District	Sclerotinia	Blackleg	Foot rot	Black spot
1	6	29	13	100
2	7	18	8	100
3	3	16	8	100
4	11	12	-	100
5	20	10	-	100
6	24	18	5	100
7	17	19	7	100
8	9	2	14	100
9	11	12	4	100
11	32	36	4	100
13	18	-	-	100
Manitoba Average	15	16	6	100


Manitoba Agriculture
Distribution of Fields Included in Manitoba Canola Survey, 1994
Sclerotinia (Scl)
Blackleg (Bl)
Foot Rot (Fr)
Scl + Bl
Fr + Bl
Fr + Scl
Fr + Bl + Scl
no Fr, Bl, Scl
Crop Reporting Districts (1-13)
Bowsman
Swan River
Minitonas
Roblin
Grandview
Dauphin
Ste. Rose du Lac
Russell
McCreary
Lundar
Lake Manitoba
Lake Winnipeg
Gladstone
Neepawa
Hamiota
Rapid City
Virden
Brandon
Glenboro
MacGregor
Portage La Prairie
Stonewall
Winnipeg
Beausejour
Ste Anne
Steinbach
St. Pierre
Carman
Morden
Boissevain
Killarney
Emerson
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13

CROP: Flax

LOCATION: Manitoba

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TITLE: DISEASES OF FLAX IN MANITOBA IN 1994

METHODS: A total of 31 flax crops in southern Manitoba and 5 crops in southeastern Saskatchewan were surveyed in 1994. Sixteen crops were surveyed on August 10, 15 crops on August 18, and 5 crops on September 1. Crops were selected at random in different regions. Each crop was sampled by two persons walking 100 m in opposite directions in the field following an "M" pattern. Diseases were identified by symptoms and the incidence and severity of each disease were recorded.

In addition, 25 samples of flax were submitted for analysis to the Manitoba Agriculture Crop Diagnostic Centre by agricultural representatives and growers.

RESULTS AND COMMENTS: Moisture conditions were adequate throughout the growing season in most flax growing regions in Manitoba. Crop emergence and stand were excellent in most of the crops surveyed. Pasmo (*Septoria linicola*) was observed in 47% of crops surveyed. The incidence of pasmo ranged from 0 to 5% in crops surveyed in early August, and from trace to 40% in crops surveyed in mid-August and early September. Severity of pasmo ranged from trace to 5% of stem and leaf area infected in early August to 5 to 40% stem and leaf area infected in mid-August and early September (Table 1). Both incidence and severity of pasmo were lower in 1994 than in 1993 due perhaps to the less favourable conditions for disease development in 1994.

Traces of aster yellows (Mycoplasma-like organism) were observed only in three crops. Fusarium wilt (*Fusarium oxysporum* f.sp. *lini*) was not observed in any of the crops surveyed in 1994. Rust (*Melampsora lini*) was not observed in any of the crops surveyed nor on the 30 rust-differential flax lines planted at Morden and Portage la Prairie. Chlorosis caused by excess soil moisture was observed on heavy clay soils in the central region.

Of the 25 samples submitted to the Manitoba Agriculture Crop Diagnostic Centre, nine were affected by root rot caused by *Fusarium, Pythium,* and *Rhizoctonia*, and one was affected by pasmo. In addition to disease problems, 11 samples were affected by herbicide injury, four affected by environmental stress caused by heat canker and excess moisture, and three affected by nutrient deficiency.

ACKNOWLEDGEMENTS: The assistance of L. J. Wiebe and G. Mardli in conducting this survey is gratefully acknowledged.

TABLE 1. Incidence and severity of pasmo on flax in Manitoba and south-eastern Saskatchewan in 1994.

No. of Crops Surveyed	% of Crops Surveyed	Incidence*	Severity**
August 10			
13	81	0	0
1	6	Trace	1%
2	13	1-5%	1-5%
August 18			
5	33	0	0
3	20	Trace	1%
2	13	1-5%	1-5%
2	13	5-20%	5-10%
3	20	20-40%	10-40%
September 1			
1	20	0	0
2	40	1-5%	1-5%
2	40	20-40%	10-40%

* Incidence is the percentage of infected plants in each field.
** Severity is estimated as the percentage of stem and leaf area infected.

CROP: Lentil

LOCATION: Saskatchewan

NAME AND AGENCY:

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TITLE: SEED-BORNE LENTIL DISEASES IN SASKATCHEWAN IN 1994

METHODS: As in 1993 (1), no systematic survey of lentil crops was conducted. However, in connection with other work 13 crops were visited in early July and again in early August in Saskatchewan Crop Districts 2B, 6A, 7A and 8B and the extreme north and south ends of 6B. Most of these crops were cv. Laird. In addition, the results of agar plate testing of 400-seed samples from the 1994 crop by three commercial companies were summarized. It was not possible to determine which of these samples came from crops where the plants had been sprayed with Bravo (chlorothalonil) or the seed treated with Crown (thiabendazole and carbathiin). Bravo is registered to control ascochyta blight (*Ascochyta fabae* f. sp. *lentis*) and anthracnose (*Colletotrichum truncatum*) of lentil. Crown was registered in 1994 for the control of seed-borne ascochyta blight of lentil, but recent work (J. Carter and R.A.A. Morrall, unpublished) shows that it also reduces seedling blight caused by seed-borne *Botrytis cinerea*.

RESULTS AND COMMENTS: By early July substantial infestations of ascochyta blight were evident in all crops except one in Crop District 6A and one in Crop District 7A. By mid-August ascochyta blight was widespread in all except the crop in District 7A. Botrytis stem and pod rot were also very abundant in 7 of the 13 crops. Anthracnose was not observed in any of the crops.

The growing season was marked by above normal rainfall in May and June in most lentil-growing areas. Normal to below normal rainfall occurred in late July and August and some crops in southern and western areas were harvested by early August. After the first few days in September, warm and extremely dry harvest weather continued throughout the month.

By early December about 700 lentil seed samples had been processed by the three commercial companies. Only 5.7% of the samples showed 0% *Ascochyta* infection and levels of infection ranged up to 64.5%. The mean level of *Ascochyta* infection was 7.6%, which is substantially higher than in any of the previous seven years (1). No seed samples infested with *Colletotrichum* were detected. *Botrytis* infection was not detected in 25.9% of the seed samples, but in the others infection levels ranged as high as 17.5%. The overall mean level of *Botrytis* infection was 1.9%, lower than that reported in 1993 (1). Mean levels of *Ascochyta* and *Botrytis* infection were calculated for individual crop districts from which at least 10 samples were tested. The values for *Ascochyta* ranged from 2.8% in Crop District 2A to 10.9% in Crop District 5A. Values for *Botrytis* ranged from 0.7% in Crop District 9A to 3.1% in Crop District 6A. However, values for individual crop districts could not be easily related to weather patterns in different parts of the province.

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CROP: Field Pea

LOCATION: Northwestern and northeastern Alberta

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TITLE: ROOT ROT DISEASE SURVEY IN NORTHEASTERN AND NORTHWESTERN ALBERTA IN 1994

METHODS: Fifty-eight pea crops in northern Alberta were surveyed for root rot, caused by *Fusarium solani, Rhizoctonia solani*, and/or *Pythium* spp., in June (Fig. 1). Ten plants were dug up in one-metre lengths of rows at each of ten sites equally spaced along the arms of a 'W' pattern in each field. All plants were stored in a cooler at 5°C pending assessment. Roots were washed and the incidence and severity of root rot assessed. Severity ratings were assigned based on a scale of 0 to 4 where 0 = healthy, 1 = 1—10%, 2 = 11—25%, 3 = 26—50% and 4 = 51—100% root discoloured.

RESULTS AND COMMENTS: Root rot was found in all crops surveyed. Mean disease incidence and severity of root rot were 34% and 0.5, respectively.

TABLE 1. Incidence and severity of root rot of pea in northwestern and northeastern Alberta in 1994.

Location	No. of fields	Incidence (%)		Severity (0—4)	
		Mean	Range	Mean	Range
Athabasca	2	16	11 - 21	0.3	0.2 - 0.3
Barrhead	6	46	31 - 83	0.8	0.5 - 1.5
Fort Saskatchewan	5	28	2 - 62	0.4	0.0 - 1.2
Lamont	7	31	10 - 47	0.5	0.2 - 0.6
Morinville	3	41	17 - 56	0.8	0.3 - 1.2
Stony Plain	4	50	18 - 66	0.9	0.3 - 1.1
St. Paul	10	30	8 - 66	0.3	0.1 - 0.9
Vermilion	10	12	3 - 27	0.2	0.0 - 0.4
Westlock	11	45	7 - 91	0.7	0.4 - 1.1
Total/Average	58	34		0.5	

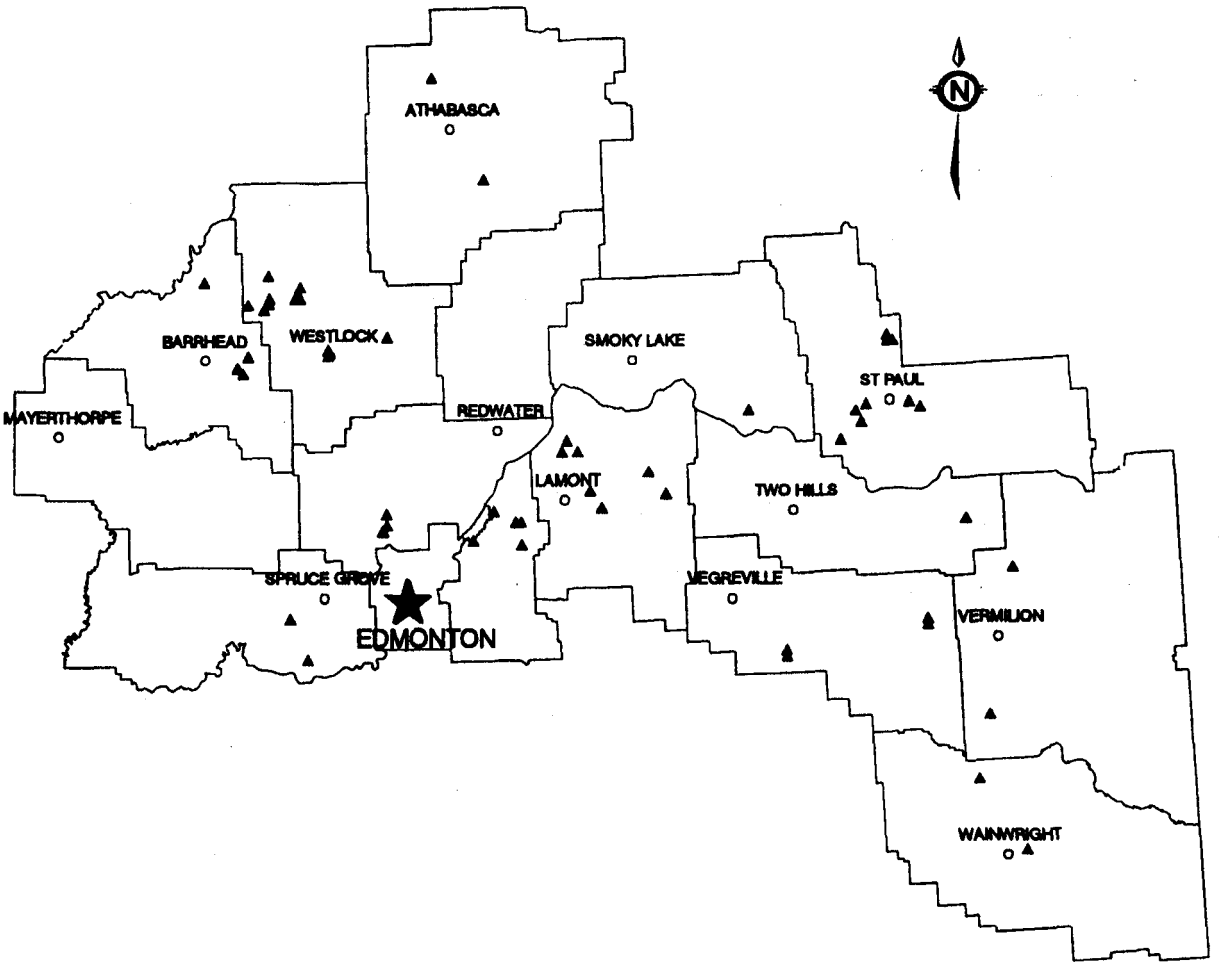

FIG. 1. Locations of pea fields in northeastern and northwestern Alberta surveyed for root rot disease in 1994.

CROP: Field pea, *Pisum sativum* L.

LOCATION: Southern Alberta

NAME AND AGENCY:
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TITLE: PEA ROOT ROT SURVEY IN SOUTHERN ALBERTA IN 1994

METHODS: Fifteen commercial pea crops (Fig. 1) were surveyed in mid-June for root rot, caused primarily by *Pythium* and *Fusarium* species. Ten plants were dug in one-meter-length rows at each of ten equally spaced sites along the arms of a 'W'-shaped pattern that was walked in each field. The plants were returned to the laboratory where the roots were washed and root rot incidence and severity were assessed. Root rot incidence was determined by counting the number of seedlings with root rot symptoms, then calculating the percentage of diseased seedlings out of the total number examined. Root rot severity was estimated visually on the same samples using a five-point scale, ie clean (0) = no root, slight (1) = 1—10% root discoloration, moderate (2) = 11—25%, severe (3) = 26—50%, and very severe (4) = >51%. Pieces of diseased root from each field were surface sterilized for one minute, rinsed in sterile distilled water, then plated onto cornmeal-rose bengal agar, cornmeal agar amended with pimaricin, vancomycin and penicillin, and acidified potato dextrose agar to determine if root rot organisms were present. The plates were examined after 3-7 days and the genera of fungi present were identified.

RESULTS: Root rot was found in all 15 crops (308.5 ha) surveyed. The average disease incidence was 61% and the average severity rating was 1.2 (slight). The major fungal organisms retrieved from the plated root pieces were *Pythium*, *Fusarium* and *Mucor* species.

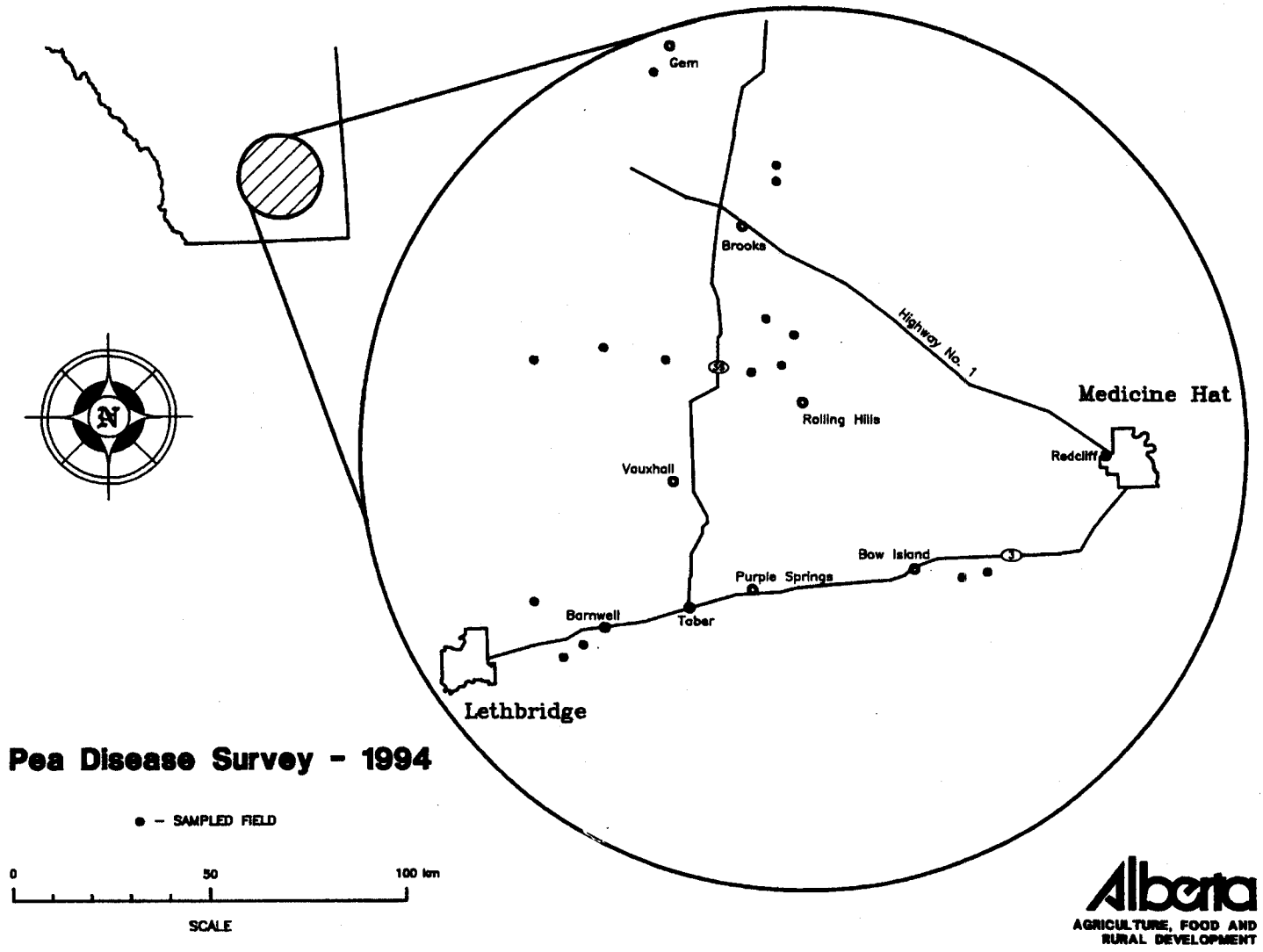
COMMENTS: Pea root rot incidence was moderate to high in most of the pea crops surveyed, but the severity of the disease was generally low.

TABLE 1. Incidence and severity of root rot from in fifteen commercial pea crops in southern Alberta in 1994.

Field No.	Field Size (ha)	Cultivar	End use	Avg. disease incidence (%)*	Avg. disease severity (0—4)**
1	12.1	Onward	Seed	64	1.1
2	12.1	Onward	Seed	65	0.9
3	12.1	Stampede	Processing	49	0.7
4	27.5	Stampede	Processing	18	0.2
5	38.7	Stampede	Processing	57	0.8
6	36.4	ICI	Seed	38	0.5
7	27.5	Lincoln	Seed	65	1.3
8	28.3	Scout	Seed	95	2.9
9	20.2	Century	Processing	27	0.3
10	16.1	Lincoln	Seed	78	1.9
11	24.2	Lincoln	Seed	88	2.2
12	25.0	Lincoln	Seed	75	1.8
13	10.9	Frosty	Seed	70	1.4
14	16.1	Lincoln	Seed	55	0.8
15	11.3	Lincoln	Seed	71	0.9

* Percentage of plants with root rot out of 100 examined per field.

** Clean (0) = no root discoloration, slight (1) = 1—10% root discoloration, moderate (2) = 11—25%, severe (3) = 26—50%, and very severe (4) = >51%.



very severe (4) = >51%.

FIG. 1. Location of pea fields surveyed for root rot in southern Alberta in 1994.

CROP: Field pea

LOCATION: Manitoba

NAME AND AGENCY:

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TITLE: DISEASES OF FIELD PEA IN MANITOBA IN 1994

METHODS: Thirty-three field pea crops were surveyed in southern Manitoba during the 1994 growing season. The crops surveyed were chosen at random in regions where most of the field peas in Manitoba are grown (Figure 1). The survey was conducted from July 21-28 when the crops were in the late flowering and pod filling stages. Ten plants were sampled at each of five random sites in each crop. Diseases were identified by symptoms and the severity of each disease was estimated using a scale of 0 (no disease) to 9 (whole plant severely diseased). In addition, diseases were diagnosed from 31 samples submitted to the Manitoba Agriculture Crop Diagnostic Centre by agricultural representatives and growers in Manitoba.

RESULTS AND COMMENTS: Eight diseases were recorded in the crops surveyed (Table 1). Of these mycosphaerella blight (*Mycosphaerella pinodes*) was prominent and occurred in all the crops examined. Severity varied from crop to crop and three crops were observed with heavy infection (severity >6). Downy mildew (*Peronospora viciae*) was observed in 30 crops but generally at trace levels (severity <2). Maximum severity was 2.5 in one crop only. The impact of this disease on yield of field pea in Manitoba is not clear. Sclerotinia rot (*Sclerotinia sclerotiorum*) was recorded in 20 crops and ranked as the third most common disease. Severe infection was observed in two crops in the Cypress and Glenboro areas, where the disease affected 100% of the plant population. Yield losses were estimated at over 70% in these crops. Powdery mildew (*Erysiphe pisi*) was observed in only 12 crops at trace to moderate levels (severity <4). However, a severe epidemic of powdery mildew occurred on pea crops in southern Manitoba late in the growing season. Crops planted late were the most severely affected. Septoria leaf blotch (*Septoria pisi*) was observed in five crops and severe infection was found in one crop near Crystal City. Bacterial blight (*Pseudomonas pisi*), gray mold (*Botrytis* sp.) and anthracnose (*Colletotrichum pisi*) were observed in seven, five, and five crops, respectively, at trace amounts. The impact of these diseases is considered insignificant.

Of the 31 diseased samples of field pea submitted to the Manitoba Agriculture Crop Diagnostic Centre, 12 showed mycosphaerella blight, 9 root rot (*Fusarium* spp. and *Rhizoctonia solani*), 1 powdery mildew, 1 downy mildew, 1 seedling blight (*Pythium* spp.), 2 bacterial blight, 6 herbicide injury, and 3 symptoms caused by excess moisture.

ACKNOWLEDGMENT: We thank I. Wolfe and G. Mardli for their assistance in this survey.

TABLE 1. Prevalence and severity of field pea diseases in Manitoba in 1994.

Disease	No. crops surveyed	No. crops affected	Severity (0—9)*	
			Mean	Range
Mycosphaerella blight	33	33	3.0	1.0-6.8
Downy mildew	33	30	1.1	0.1-2.5
Sclerotinia rot	33	20	1.2	0.1-6.9
Powdery mildew	33	12	1.6	0.5-4.0
Bacterial blight	33	11	0.8	0.1-2.6
Gray mold	33	7	0.5	0.1-1.3
Septoria leaf blotch	33	5	1.7	0.5-6.3
Anthracnose	33	5	0.5	0.2-0.6

* 0 = no disease symptoms and 9 = whole plant severely diseased.

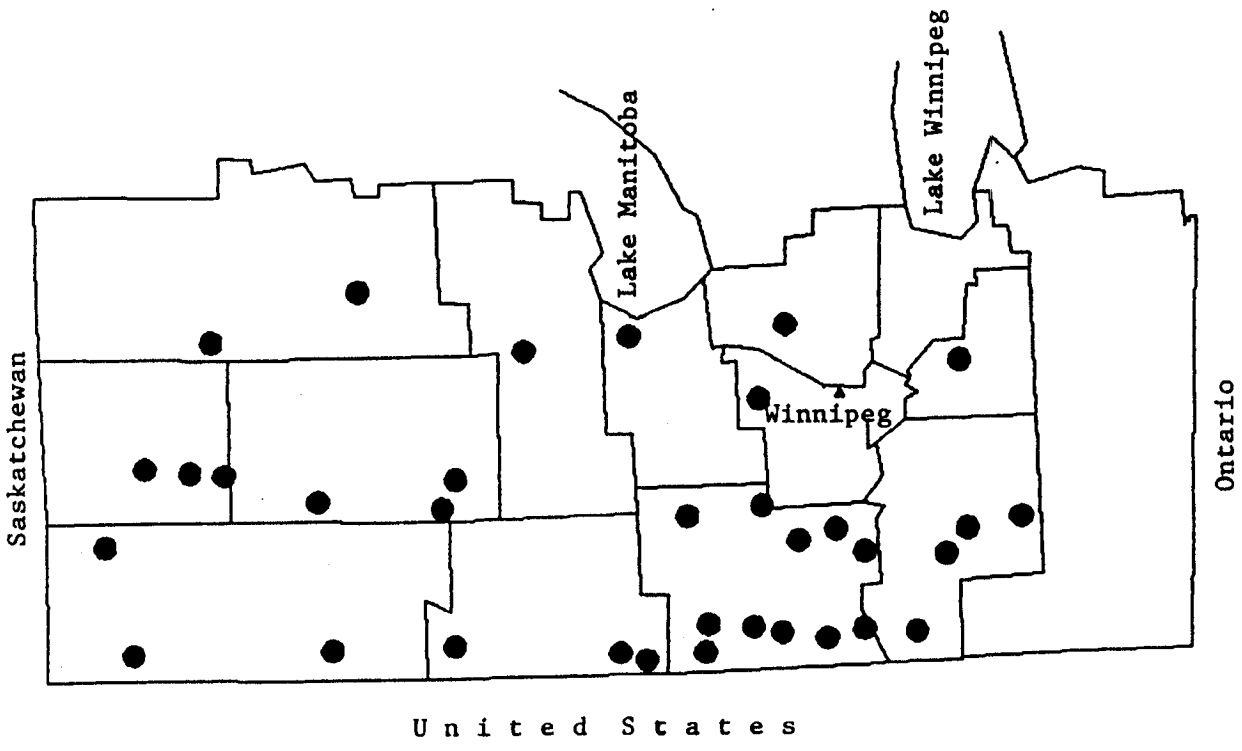

FIG. 1. Locations of 33 field pea crops surveyed for diseases in southern Manitoba in 1994.

CROP: Sunflower

LOCATION: Manitoba

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TITLE: DISEASES OF SUNFLOWER IN MANITOBA IN 1994

METHODS: A total of 56 sunflower crops in southern Manitoba and 2 crops in southeastern Saskatchewan were surveyed in 1994. Seventeen crops were surveyed in mid-July especially for downy mildew and eight of these were surveyed again in September for the other diseases. Eleven crops were surveyed on August 10, 13 crops on August 18, and 25 crops in the first week of September. Crops were selected at random, and each crop was sampled by two persons walking 100 m in opposite directions in the field following an "M" pattern. Diseases were identified by symptoms and the incidence of downy mildew (*Plasmopara halstedii*), sclerotinia wilt or head and stem infections (*Sclerotinia sclerotiorum*), and verticillium wilt (*Verticillium dahliae*) were estimated. Disease severity for rust (*Puccinia helianthi*) and leaf spots (*Septoria helianthi* and *Alternaria* spp.) were measured as percent leaf area infected. Only 49 crops were assessed for sclerotinia wilt, 38 crops for rust and verticillium wilt, 25 crops for sclerotinia head rot/stem rot, and 17 crops for downy mildew (Table 1). A disease index was calculated for each disease in every crop based on disease incidence or disease severity (Table 1).

In addition, 20 samples of sunflower were submitted for analysis to the Manitoba Agriculture Crop Diagnostic Centre by agricultural representatives and growers.

RESULTS AND COMMENTS: Crop conditions were generally good throughout the 1994 growing season. Above normal soil moisture and slightly below normal temperatures at the seedling stage were favourable for soilborne downy mildew infections in several locations in southern Manitoba. The crop was 1-2 weeks earlier than normal in most crop regions.

Sclerotinia wilt/basal stem infection was prevalent in 78% of the crops surveyed for this disease, with incidence ranging from trace to 20% infected plants. Only one field at St. Joseph had 50% sclerotinia-wilted plants. Sclerotinia headrot and mid-stem breakage from ascospore infections were prevalent in 68% of the crops surveyed in late August and September, with incidence ranging from trace to 50% infected plants. The ratio of head rot and mid-stem infections varied among fields but seemed constant within individual fields. Only two crops had 30—50% head rot/mid-stem infected plants where yield losses were estimated at 30%.

Verticillium wilt was prevalent in 45% of the crops surveyed for this disease, with incidence ranging from trace to 1% infected plants in oilseed hybrids, and from trace to 20% in confectionery hybrids. The high disease incidence in confectionery hybrids is due to the lack of resistance in these hybrids.

Downy mildew was observed in 94% of the crops surveyed for this disease, with incidence ranging from trace to 60% infected plants. Several crops with 50—60% infected seedlings were ploughed under and re-seeded to other crops.

Rust was the least prevalent disease in 1994, and was observed in 8% of the crops surveyed. This is the second consecutive year of low incidence and severity of sunflower rust in Manitoba, and the lowest in the last ten years (1,2).

Leaf spots caused by *Septoria helianthi* and *Alternaria* spp. were observed in several crops at very low levels. Stem lesions caused by *Phoma* spp. were also observed at low levels in most crops surveyed towards the end of the season

Of the 20 samples submitted to the Manitoba Agriculture Crop Diagnostic Centre, nine were infected with downy mildew, two with sclerotinia head rot, and one with fusarium root rot. In addition to diseases, 11 of the samples were found to be affected by herbicide injury and one affected by insect damage.

ACKNOWLEDGEMENTS: The assistance of L.J. Wiebe and G. Mardli in conducting this survey is gratefully acknowledged.

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TABLE 1. Prevalence and intensity of sunflower diseases in Manitoba and south-eastern Saskatchewan in 1994.

Disease	No. and % of Crops Infested*	Disease Index**	
		Mean	Range
Sclerotinia wilt	38 (78%)	1.1	T-3
Sclerotinia head rot	17 (68%)	1.1	1-3
Sclerotinia mid-stem	17 (68%)	1.1	1-3
Verticillium wilt	17 (45%)	0.9	T-2
Downy mildew	16 (94%)	2.0	T-4
Rust	3 (8%)	0.2	Traces
Stand	49	1.6	1-3
Vigour	49	1.5	1-3

* Sclerotinia wilt was assessed on 49 crops surveyed; sclerotinia head rot/mid-stem infections were assessed on 25 crops in mid- August and September; rust and verticillium wilt were assessed on 38 crops in August-September; while downy mildew was assessed on 17 crops.

** Disease index is based on a scale of 1 to 5: 1= trace to 5% disease, 2= 5% to 20% disease, 3= 20% to 40% disease, 4= 40% to 60% disease and 5= greater than 60% disease levels. Index is based on disease incidence for downy mildew, verticillium wilt, sclerotinia infections, and on disease severity measured as percent leaf area infected for rust. Indexes for stand and vigour are based on 1-5 scale (1= very good and 5= very poor).

CROP: Sunola

LOCATION: Saskatchewan

NAME AND AGENCY:
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TITLE: INCIDENCE OF SCLEROTINIA ON SUNOLA IN SASKATCHEWAN IN 1994

INTRODUCTION: Before 1992, sunflower production in Saskatchewan was limited by the short growing season and conventional farm equipment. Since the development of AC Sierra and AC Aurora, two miniature early maturing sunflower (sunola) cultivars, production has been on the rise. However, there was a decrease in production from 35,000 tonnes in 1993 to 26,000 tonnes in 1994, and a shift to southern regions of Saskatchewan [3]. These changes are due in part to the high incidence of sclerotinia diseases (*Sclerotinia sclerotiorum*) in 1993. The purpose of this survey was to examine the relationship between geography, plant density, crop history, and the incidence of aerial and basal stem rot.

MATERIALS AND METHODS: Thirty-two sunola crops were surveyed between August 30 and September 18, 1994, with three of the crops being resurveyed on October 7 to determine late season disease development. The survey was conducted as in 1993 with focus on four areas of canola production (Crop Districts 6B, 8A, 8B, and 9B) and one area of non-canola production (CD 7A) [1]. Disease incidence (DI) was calculated based on the number of diseased plants in four 100-plant samples taken at well-separated sites within each crop (Table 1). Basal stem infections and aerial infections (lesions on the head or upper stem) were recorded separately. If less than 5% plants were infected, DI was recorded as a trace. Mean plant density (number plants/m^2) was determined for each crop. Information on crop history and seeding rate was obtained from the grower.

RESULTS AND DISCUSSION: Total DI ranged from 0 to 36%, of which 55 to 100% was due to aerial infections. The high incidence of aerial infections was similar to that found in 1993 [1] and may be attributed to mid-summer precipitation which favoured the production of air-borne ascospores and disease development in flowering heads. However, some rural municipalities (RMs) in CDs 6B, 9B, and 8A received below normal precipitation in July and August [3] which may have limited disease development compared to the more favourable environment in 1993 [1].

Total DIs were greatest in CD 8A, followed by 9B, 6B, and 8B. Other susceptible crops, such as canola and pea, are commonly grown in these CDs and may have contributed sclerotia to the soil which when combined with sufficient moisture could result in high amounts of disease. For example, in CD 8A in a field which was sown to pea in 1991 and canola in 1990, a crop developed 36% total DI of which 33% was due to aerial infection. A crop in CD 9B developed a total of 23% disease, of which 10% was basal stem rot. This field had a large weed population (annual sow thistle, *Sonchus paniculata*) and had been sown to pea in 1993; both factors would contribute to the high DI. However, there was a low correlation between the number of years since the last susceptible crop and total DI ($r=0.45$).

Except for one crop in which a trace of head rot was found, disease was absent in CD 7A. This low level of disease also occurred in 1992 and 1993 and can be attributed to lack of previous host crops and lower precipitation in this area [1,2,3].

Plant density ranged from 12 plants/m^2 in CD 9B to 22 plants/m^2 in CD 7A. There was a low correlation between plant density and total disease development (r=-0.37). The mean seeding density in 1994 was 11 kg/ha which was similar to that of 1993 and twice that of 1992.

Of the three crops in CD 6B that were resurveyed, two showed an increase in total DI from 11 to 19% and from 5 to 10%, respectively. The RMs in which these two crops were located received 13 mm of precipitation in early September which would favour late disease development. The third crop, which showed no increase in disease, was located in an RM which received no late precipitation. Therefore, the values given in Table 1 may not reflect the full impact of *S. sclerotiorum* as they were recorded at least one month before harvest.

ACKNOWLEDGMENTS: The authors would like to sincerely thank the sunola growers, D. Hutcheson, M. Egert, and S. Foster for their assistance in the survey and the Agriculture Development Fund, Saskatchewan Agriculture and Food, for financial support.

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3. Saskatchewan Agriculture and Food. Final Crop Report - #27. Regina, Saskatchewan. October 20, 1994.

TABLE 1. Summary of plant density, crop rotation, and percent sclerotinia disease incidences for 32 sunola crops in Saskatchewan, 1994.

Crop District	# Crops Surveyed	Mean Plant Density (plants/m^2)	Crop* Rotation	Mean %** Aerial DI (range)	Mean %** Basal DI (range)
8A	3	15	4	12 (t-33)	1 (0-3)
9B	7	12	3	4 (t-13)	2 (0-11)
6B	10	16	6	2 (0-9)	1 (0-3)
8B	4	17	6	2 (t-6)	1 (0-2)
7A	8	22	>10	0 (0-t)	0

* Mean number of years between susceptible host crops.

** t = trace amounts of disease (<5%).
Traces were counted as 1% when calculating mean DI.

Forage legumes / Légumineuses fourragères

CROP: Alfalfa

LOCATION: Southern Alberta

NAME AND AGENCY:
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TITLE: SURVEY OF VERTICILLIUM WILT OF ALFALFA IN SOUTHERN ALBERTA IN 1994

METHODS: Twenty-eight irrigated alfalfa fields in the area south of Calgary, Alberta were surveyed for verticillium wilt (*Verticillium albo-atrum*) in September and October 1994. Fields were surveyed by entering the field at a corner, walking 200 paces toward the middle of the field, and exiting the field perpendicular to one side of the field (Huang et al., 1988). At twenty-pace intervals, plants were counted in a 2 by 2 meter square. Diseased plants were identified by generalized wilting, inward curling of leaves, and the presence of V-shaped lesions on leaf tips. Severity of disease was then estimated according to the following scale: (1) none (0% of plants infected), (2) trace (<1%), (3) light (1—10%), (4) moderate (11—25%), (5) severe (26—50%), (6) very severe (>50%).

RESULTS: Verticillium wilt was found in 18 of the 28 fields surveyed in southern Alberta (Table 1). Of the 18 diseased fields, the incidence was trace in six fields, light in two fields, moderate in seven fields, severe in two fields, and very severe in one field. Diseased fields were found in all the areas surveyed, from Pincher Creek to the Alberta-Saskatchewan border, and from High River to the Canada-United States border (Figure 1). Incidence of verticillium wilt-infected alfalfa was highest in the southwestern part of the province.

TABLE 1. Verticillium wilt of alfalfa in southern Alberta in 1994.

Severity	Incidence (%)	No. Fields
None	0	10
Trace	<1	6
Light	1-10	2
Moderate	11-25	7
Severe	26-50	2
Very Severe	>50	1

DISCUSSION: Verticillium wilt of alfalfa remains as a serious disease in all areas of southern Alberta. The disease occurs mainly in irrigated alfalfa. Two new cultivars, Barrier (Hanna and Huang, 1987) and AC Blue J (Acharya et al., 1994) are resistant to verticillium wilt, and are well adapted to the irrigated region of southern Alberta (Huang et al., 1994). Farmers are strongly encouraged to grow these verticillium wilt resistant cultivars to reduce the risk of crop losses due to this economically important disease.

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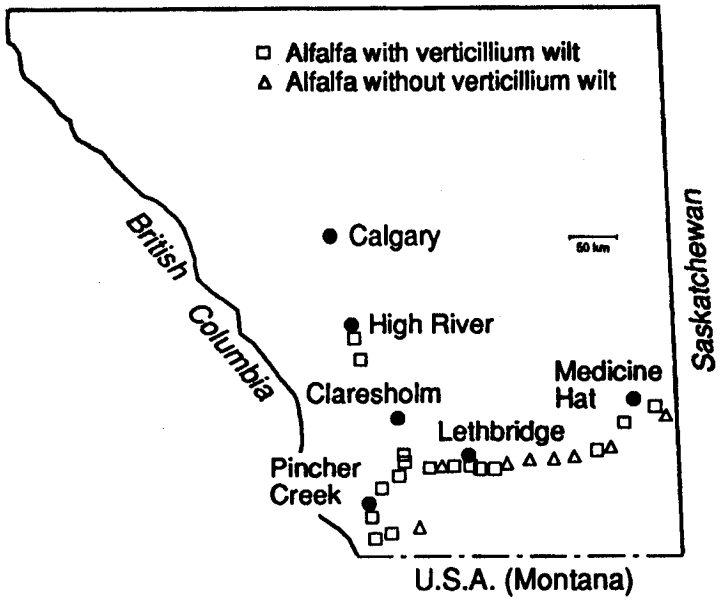

FIG. 1. Survey of verticillium wilt of alfalfa in southern Alberta in 1994.

CROP: Alfalfa

LOCATION: Saskatchewan

NAME AND AGENCY:

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TITLE: SURVEYS FOR VERTICILLIUM WILT OF ALFALFA UNDER IRRIGATION IN SASKATCHEWAN, 1991—94

METHODS: In each year, surveys for verticillium wilt in irrigated alfalfa forage production fields in Saskatchewan were conducted when the plants were at a late vegetative or early flowering stage, just prior to harvest. Each field was assessed by walking either a V-shaped or tear-drop pattern through the field. The identity of the pathogen was confirmed by isolation. In 1991, 22 fields in the westcentral region were surveyed in early to mid-August. In 1992, 20 fields were assessed in either mid-July or early September; 5 fields in the southwest and 15 fields in the westcentral region. No surveys were made in 1993. In 1994, 18 fields in the southwest and 12 fields in westcentral Saskatchewan were assessed in mid to late August.

RESULTS AND COMMENTS: From 1991 to 1994, verticillium wilt of alfalfa continued to spread into new irrigation areas in southern Saskatchewan.

In 1991, trace (<1% of plants infected) levels of verticillium wilt were found in 5 of the 8 fields examined in the Miry Creek irrigation area. Moderate (11—25%) to severe (26—50%) levels of wilt were found in 3 of 6 fields near Riverhurst. No verticillium wilt was found in six fields near Outlook or two fields near Saskatoon. At Miry Creek, wilt was nearly eradicated in the late 1980s [1], but was found at trace levels in 1990 [2]. Many of the fields with wilt in 1991 were custom-harvested in 1990, and inoculum may have been carried between fields on the harvesting equipment. This was the first report of verticillium wilt in the Riverhurst region.

In 1992, verticillium wilt was found at slight (1—10%) levels in one field near Swift Current, at trace levels in 2 of 4 fields at the Ponteix irrigation project, at trace to slight levels in 3 of 11 field in the Grainland irrigation project and at slight to moderate levels in 2 of 4 irrigated fields near Riverhurst. This was the first report of wilt in the Swift Current, Ponteix and Grainland irrigation areas.

In 1994, verticillium wilt was found at trace levels in 5 of 12 fields in the Outlook irrigation area. It occurred at trace levels in 2 of 4 fields at Miry Creek, but was not found at other sites in the southwest. Wilt had not been observed in the Outlook irrigation area since the early 1980s [1].

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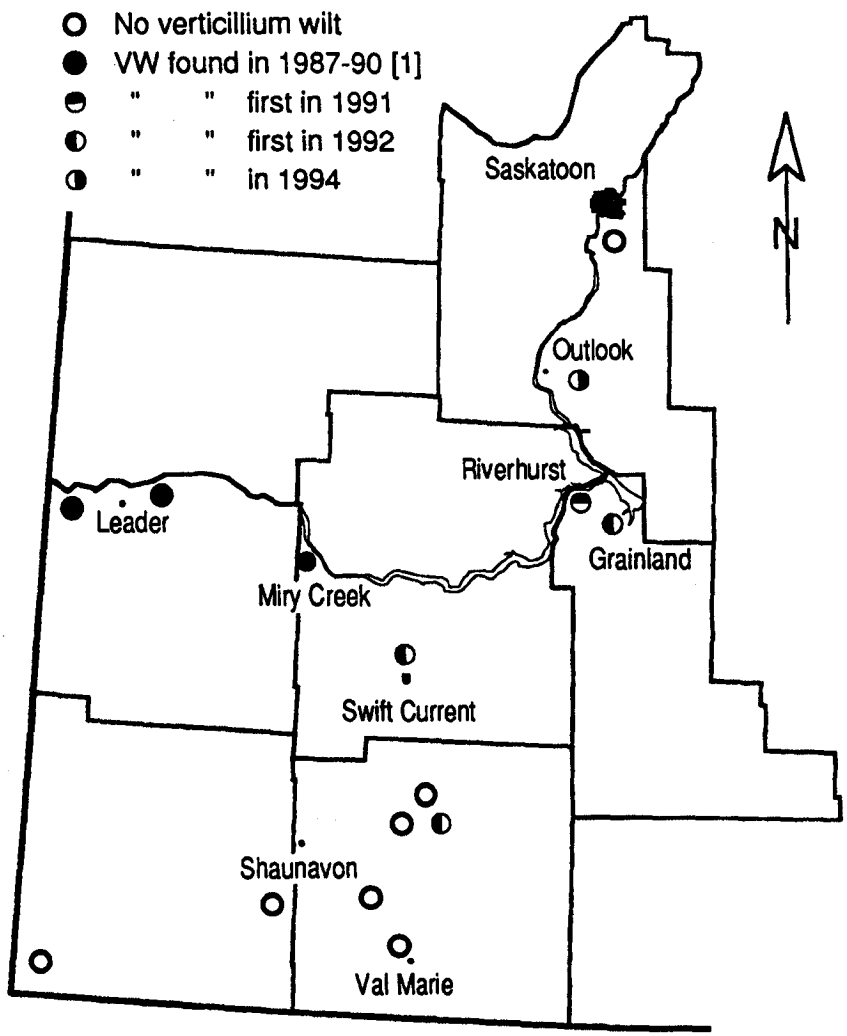

FIG. 1. Distribution of verticillium wilt of irrigated alfalfa in southern Saskatchewan, 1991—94.

CROP: Alfalfa

LOCATION: Saskatchewan and Manitoba

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TITLE: SURVEY OF *BOTRYTIS CINEREA* IN ALFALFA SEED IN SASKATCHEWAN AND MANITOBA, 1993

METHODS: Alfalfa seed (50-100 seeds per sample) harvested in 1993 from 16 fields in Saskatchewan was surface sterilized for 5 minutes in 0.6% NaOCl, plated on PDA plus streptomycin, incubated at room light and temperature for 8-10 days, and then assessed for infection with *Botrytis cinerea*. Samples from 45 fields in Manitoba were assessed using washing for disinfestation. In addition, several samples of seed harvested under dry conditions from 1988—91 were assessed to compare infection incidence with that observed in samples from 1993. The efficacy of several protocols for isolating *B. cinerea* was examined using a seedlot from a field in Manitoba where botrytis blossom blight was severe in 1993. In a four replicate trial with 100 seeds per sampling unit, disinfesting the seed by washing in running water for 30 min was compared with surface sterilization for 2, 5 or 10 min in 0.6% NaOCl.

RESULTS AND COMMENTS: The incidence of *B. cinerea* was low (generally 0%) in all of the samples and never exceeded 6% (Table 1), even in fields severely damaged by blossom blight in 1993. *Botrytis* inoculum was abundant in many of these fields right up until harvest, and the cool, wet fall conditions prevalent throughout the region should have favoured disease spread. Initially, we suspected that the surface sterilization procedure was too stringent to detect the pathogen. However, there were no differences among surface disinfection treatments for the incidence of isolation of *B.cinerea*. The pathogen was only rarely isolated, irrespective of treatment (data not shown). Also, we had no difficulty in isolating *B. cinerea* from NaOCl-treated lentil seed in another study. Surface sterilization with NaOCl greatly reduced the incidence of saprophytic fungi in the isolations from alfalfa seed. This often made estimates of pathogens such as *Phoma medicaginis* more reliable because they were not being overgrown by saprophytes. Only a small number of seeds per field were tested because our primary interest was to screen seedlots for a high incidence of *Botrytis* infection, rather than to assess small differences in infection frequency.

The samples from 1993 generally showed a high incidence of saprophytic fungi. In most fields, roughly 20% of the seed was contaminated, and incidence was close to 90% in one field (Table 1). The incidence of *P. medicaginis* ranged from 0 to 10%, with mean incidence of just over 1% In contrast, the incidence of fungi in seed produced in dry years was very low, generally 1% (data not shown).

It is likely that blossoms that escaped infection by *B.cinerea* until pod initiation became resistant to further infection by this pathogen. If pods were susceptible to infection during filling and maturation, the pathogen would penetrate through the pod wall and either contaminate the seed surface or penetrate into the seed, resulting in a high incidence of seed infection. The observation that otherwise healthy leaves, pods, and even flower buds are not susceptible to infection [1] lends credence to this hypothesis.

We conclude that *B. cinerea* is not carried at high frequency in or on alfalfa seed from fields affected by blossom blight. Other work indicates that the pathogen is not transmitted to young seedlings grown from seed from infected fields [2]. Therefore, seed from fields affected by botrytis blossom blight is unlikely to represent a significant source of inoculum in stands established from this seed.

TABLE 1. Incidence of fungal pathogens and saprophytes and percent seed germination of alfalfa seed harvested from commercial fields in Manitoba and Saskatchewan in 1993.

Location & Cultivar	No. of fields	% Germination	*Botrytis** Mean	*Botrytis** Range	*Phoma* Mean	*Phoma* Range	*Cladosporium* Mean	*Cladosporium* Range	*Alternaria* Mean	*Alternaria* Range	Other Mean	Other Range	Total Mean
Manitoba													
- Algonquin	15	60	>1	0-2	1	0-6	5	0-28	6	0-48	6	0-26	18
- Beaver	12	57	0	0	1	0-4	6	0-36	6	0-66	5	0-22	18
- Vernal	7	52	>1	0-2	3	0-10	4	0-10	4	0-10	8	0-16	20
- Angus	4	67	0	0	1	0-2	4	0-10	1	0-2	3	0-8	9
- AC Caribou	3	72	0	0	4	0-10	11	2-24	9	6-14	nd	nd	23
- Arrow	2	45	3	0-6	1	0-2	37	24-50	4	16-52	11	8-14	86
- Saranac	2	78	0	0	3	2-4	0	0	0	0	1	0-2	4
- Other	4	53	1	0-2	2	0-8	3	0-12	3	0-8	14	2-38	23
Saskatchewan													
- Other	16	nd	>1	0-2	3	0-9	1	0-7	2	0-8	10	5-42	16

* Botrytis = *Botrytis cinerea*, Phoma = *Phoma medicaginis*. *Cladosporium* and *Alternaria* spp. are saprophytes commonly associated with seed.
nd = not done

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ACKNOWLEDGEMENT: We thank the Canadian Seed Growers Association for financial support and G.Huebner, S.R.Smith, Newfield Seeds, Johnson Seeds and Brett-Young Seeds for providing seed samples used in the study.

CROP: Tall Fescue, *Festuca arundinacea*

LOCATION: Peace Region of Alberta

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TITLE: OCCURRENCE OF ENDOPHYTIC FUNGI IN TALL FESCUE CULTIVARS IN THE PEACE REGION IN 1993 AND 1994

BACKGROUND: Tall fescue is a perennial grass used for turf, erosion control and for livestock feed. Variety trials at the Northern Research Centre in Beaverlodge show that tall fescue is well adapted to this region (1). Several cultivars were seeded in the Peace Region since 1992 and many growers are interested in growing tall fescue for seed and forage production. Growers should be aware of fescue toxicosis for livestock grazing or feeding on tall fescue. In 1977, Bacon et al. (2) reported the close association of endophyte-infested tall fescue and the incidence of fescue toxicity in cattle. The objective of this survey was to determine if the endophytic fungi survives and is present in tall fescue cultivars grown in the Peace region.

METHODS: In 1993, five tall fescue crops were surveyed. In each field, 10 plants were collected from widely separated locations for subsequent laboratory analysis. A single basal leaf was selected from each plant. The epidermal surface was separated by slicing through the mesophyll tissue with a scalpel. The thinly sliced leaf was stained with 1% aqueous aniline blue and examined for the presence of dark corkscrew shaped hyphae running parallel to the mesophyll cell walls characteristic of the fescue endophyte, *Acremonium coenophialum* (3). Samples were considered positive, if any of the corkscrew mycelium was observed. In 1994, 20 plants from each of the four fields were sampled.

RESULTS AND COMMENTS: The endophytic fungi was present at high levels in all of the tall fescue fields surveyed in 1993 and 1994 (Table 1).

TABLE 1. Incidence of endophytic fungi in tall fescue cultivars, in the Peace River region in 1993 and 1994.

YEAR	CULTIVAR	LOCATION	(%) ENDOPHYTE INFECTED PLANTS
1993	Jaquar	Rycroft	90
1993	Pengrazer	Beaverlodge	100
1993	Peace	Fairview	90
1993	K31	Fairview	100
1993	K31	Hines Creek	100
1994	K31	Worsley	90
1994	K31	Fairview	95
1994	K31	Hines Creek	100
1994	Mustang	Bonanza	65

A single field of Mustang had 65% incidence of endophyte; incidence in all the other cultivars approached 100%. Livestock consuming tall fescue with high levels of endophytic fungi could suffer from fescue toxicity which causes symptoms similar to ergot poisoning. These symptoms include reduced feed intake, lower weight gains, decreased milk production, higher body temperatures, rough hair coats, abortions and birth problems and gangrene of hooves, feet and ears.

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Vegetables / Légumes

CROP: Crucifers

LOCATION: Nova Scotia

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TITLE: RACE SURVEY OF *PLASMODIOPHORA BRASSICAE* IN NOVA SCOTIA

METHODS: Samples of plants showing severe symptoms of clubroot were obtained from 10 fields of various cruciferous crops (Bok Choi, broccoli, cabbage, cauliflower and rutabaga) throughout Nova Scotia in 1993. The clubbed roots were washed and stored frozen at -20 C. Resting spores were obtained by grinding 100 g of frozen clubbed tissue in 400 mL water for 3 min in a blender (3). The macerate was filtered through cheesecloth and the filtrate centrifuged at 2,000 g for 7 min. The supernatant was discarded and the pellet containing spores was resuspended in water and recentrifuged. The final spore concentration was then adjusted to 5×10^7 spores/mL. Race designations of the various isolates were determined on two differential cultivars of cabbage (*Brassica oleracea* L. var. *capitata* L., Jersey Queen and Badger Shipper) and two cultivars of rutabaga (*B. napobrassica* Mill., Laurentian and Wilhelmsburger). Roots of 10-day old seedlings were washed, dipped into the appropriate spore suspension and then transplanted into a soil mix containing peat moss, loam soil, and sand (2:1:1, v/v) at pH 5.5. There were four seedlings/pot and four replicate pots/cultivar for each *P. brassicae* isolate. The plants were allowed to grow for six weeks on a greenhouse bench. Soil was then washed from the roots and the roots were rated for disease severity according to the scheme of Seaman et al. (2) and race designations followed those of Williams (3).

RESULTS AND COMMENTS: Of the 10 isolates, eight were designated as race 3, one was race 2 and one was race 1. Although the sample size was small, it appears that the race structure may have shifted to a predominance of race 3 in comparison to a survey reported by Ayers in 1972 (1) in which races 2 and 3 were present in similar proportions. Of concern is the fact that a field of rutabaga, cultivar York, was severely affected by race 3. This may confirm suspicions that resistance in York is beginning to breakdown.

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CROP: Potato (*Solanum tuberosum* L.)

LOCATION: Alberta, southern, central and north-central

NAME AND AGENCY:

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TITLE: LATE BLIGHT OF POTATO IN ALBERTA - 1994

METHODS: The survey was conducted in forty-two commercial potato fields (1489 hectares) in southern Alberta (11 - 14 August), six fields (172 hectares) in central Alberta (14 - 18 August) and thirty-six potato fields (654 hectares) in north-central Alberta (15 August - 2 September). The southern Alberta fields were located in the County of Newell (Co. # 4), the Municipal District of Taber (M.D. # 14) and the County of Lethbridge (Co. # 26), while fields of central Alberta were in the Counties of Ponoka (Co. # 3), Lacombe (Co. # 14), and Red Deer (Co. # 23) and in the Municipal District of Rocky View (M.D. # 44). Fields of north-central Alberta were in the City of Edmonton, the County of Parkland (Co. # 31), the Municipal District of Sturgeon (M.D. # 90) and the Improvement District of Yellowhead (I.D. # 14) (Fig. 1). Late blight incidence and severity were assessed at five randomly selected sites representative of the disease in the field. At each site, the incidence of the disease was assessed by counting the number of infected plants out of 10 along a row. The disease severity was estimated on the same plants using the 0 to 100% leaf area infection scale, as suggested by James (1971). From sites with severity levels _ 5%, fifteen to twenty tubers were dug, cut with a sharp knife and examined for symptoms of late blight tuber rot. Blight-infected leaf samples were also collected from each site and sent to Drs. H.W. Platt (Agriculture and Agri-Food Canada, Prince Edward Island) and Z.K. Punja (Simon Fraser University, British Columbia) for assessment of the metalaxyl sensitivity of the pathogen isolates and also to test for the possible occurrence of the A2 mating type in Alberta. The samples are being processed. Occurrence of other diseases and disorders was also recorded.

RESULTS AND COMMENTS: Late blight was not observed in any field in southern Alberta, and in just one field in central Alberta. In the north-central region, 100% of the fields visited had late blight (Table 1, Fig. 1). The incidence of the disease varied from a trace to 100%, while the severity ranged from a trace to >75% (Tables 1 and 2). The incidence of infected tubers, which were found in 32% of the north central Alberta fields, ranged from 0 to 40% at the time of survey. According to some growers, the percentage of infected tubers reached much higher levels at harvest. The occurrence of the late blight in Alberta appears to be correlated to precipitation (Fig. 2). There was extensive rainfall in the north-central region, but very little in the south.

The cultivars Banana, Ranger Russet and Yukon Gold showed high levels of late blight (Table 3). Cultivars showing low levels of disease may not necessarily have been resistant, but may have escaped infection. Atlantic had no disease in two separate fields where other cultivars showed high disease incidence (Table 4), suggesting that Atalantic may possess resistance to the disease.

The occurrence of late blight was negatively correlated with the application of fungicides (Table 5). Application of contact fungicides alone or in combination with a systemic fungicide, Ridomil-MZ, significantly reduced disease incidence and severity. In north-central Alberta, the contact fungicide Bravo 500 was most used; Ridomil-MZ was used in only two fields. Use of fungicides (contact as well as systemic) was quite common in southern Alberta. Extensive application of Bravo/Dithane DG and Ridomil by farmers, along with unfavourable weather conditions for late blight development may have prevented the occurrence of the disease in the south.

Other diseases and disorders recorded during the survey were: bacterial soft rot (*Erwinia carotovora* subsp. *carotovora*), blackleg (*Erwinia carotovora* subsp. *atroseptica*), early blight (*Alternaria solani*), purple top (aster yellows phytoplasma), scab (*Streptomyces scabies*), silver scurf (*Helminthosporium solani*), wilts (*Fusarium* spp. and *Verticillium* spp.), and herbicide damage.

An epidemic of late blight was reported in southern Alberta in 1992, but the disease was not recorded in central or north-central Alberta (Howard et al., 1993). Reports of some tubers obtained from storages in north-central Alberta showing late blight infection in the spring of 1994 suggest that late blight must have occurred in some fields in 1993, even though the incidence must have been low. Late blight occurred at epidemic levels in 1994 in north-central Alberta. This is the first record of the occurrence of a late blight epidemic in north-central Alberta. The presence of the primary inoculum in the region and favourable weather conditions contributed towards the development of a epidemic of the disease.

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TABLE 1. Occurence of late blight (LB) on potato in Alberta, 1994

Region/District*	Surveyed for LB			% Fields with LB	
	No.of fields	Area (hectares)	% area with LB	Foliar blight	Tuber rot
Southern Alberta					
Co. Newell (#4)	15	361.1	0	0	0
M.D. of Taber (#14)	17	701.6	0	0	0
Co. of Lethbridge (#26)	9	352.2	0	0	0
Central Alberta					
Co. of Ponoka (#3)	2	32.4	0	0	0
Co. of Lacombe (#14)	2	16.2	0	0	0
Co. of Red Deer ((#23)	1	1.3	100	100	0
M.D. of Rocky View (#44)	1	121.5	0	0	0
North-central Alberta					
City of Edmonton	9	110.9	100	100	22
Co. of Parkland (#31)	13	306.1	100	100	15
M.D. of Sturgeon (#90)	5	183.4	100	100	40
I.D. of Yellowhead (#14)	10	55.5	100	100	50

* Co. = County, M.D. = Municipal District, I.D. = Improvement District.

TABLE 2. Incidence of late blight on potato foliage and tubers in Alberta, 1994.

Regions / District *	No. of fields	Foliar infection (%)		Tuber infection (%)
		Inc. (range)**	Sev. (range)	Inc. (range)
Southern Alberta				
Co. of Newell (#4)	15	0	0	0
M.D. of Taber (#14)	24	0	0	0
Co. of Lethbridge (#26)	9	0	0	0
Central Alberta				
Co. of Ponoka (#3)	2	0	0	0
Co. of Lacombe (#14)	2	0	0	0
Co. of Red Deer (#23)	1	< 1	< 1	0
M.D. of Rocky View (#44)	1	0	0	0
North-central Alberta				
City of Edmonton	9	16 (2 - 100)	9 (<1 - 75)	5 (0 - 40)
Co. of Parkland (#31)	13	9 (<1 - 75)	6 (<1 - 75)	1 (0 - 10)
M.D. of Sturgeon (#90)	5	17 (1 - 50)	3 (<1 - 10)	3 (0 - 10)
I.D. of Yellowhead (#14)	10	25 (<1 - 100)	16 (<1 - 75)	3 (0 - 10)

* Co. = County, M.D. = Municipal District, I.D. = Improvement District.

** Inc. = incidence, % of plants with late blight infection. Sev. = severity, % of leaf surface area covered with the lesions.

TABLE 3. Late blight infection on foliage and tubers of various potato cultivars, surveyed in Alberta, 1994.

	North-central Alberta				Central Alberta				Southern Alberta			
Cultivar	Field infd/surv *	Area infd/surv *	Foliar inc (sev) **	Tuber inf (%) ***	Field infd/surv	Area infd/surv	Foliar inc (sev)	Tuber inf (%)	Field infd/surv	Area infd/surv	Foliar inc (sev)	Tuber inf (%)
All Blue	1 / 1	0.2 / 0.2	5 (<1)	0	-	-	-	-	-	-	-	-
Amisk	1 / 1	28.3 / 28.3	5 (1)	0	-	-	-	-	-	-	-	-
Atlantic	-	-	-	-	-	-	-	-	0 / 1	0 / 24.3	0	0
Banana	1 / 1	0.8 / 0.8	100 (75)	40	-	-	-	-	-	-	-	-
Bintje	1 / 1	8.1 / 8.1	5 (<1)	0	-	-	-	-	-	-	-	-
Chipita	-	-	-	-	-	-	-	-	0 / 1	0 / 0.2	0	0
Delta Gold	1 / 1	0.4 / 0.4	< 1 (<1)	0	-	-	-	-	-	-	-	-
FL 1533	-	-	-	-	-	-	-	-	0 / 2	0 / 54.7	0	0
FL 1625	-	-	-	-	-	-	-	-	0 / 1	0 / 26.3	0	0
Frontier Russet	1 / 1	2.0 / 2.0	< 1	< 1	-	-	-	-	-	-	-	-
Hi-Lite Russet	1 / 1	6.1 / 6.1	< 1 (<1)	0	-	-	-	-	-	-	-	-
Niska	-	-	-	-	-	-	-	-	0 / 3	0 / 57.5	0	0
Norchip	1 / 1	0.04 / 0.04	5 (1)	0	-	-	-	-	0 / 15	0 / 508.5	0	0
Norland	5 / 5	51.4 / 51.4	21 (9)	2	0 / 1	0 / 40.5	0	0	0 / 3	0 / 26.3	0	0
Ranger Russet	3 / 3	21.5 / 21.5	42 (34)	5	-	-	-	-	0 / 1	0 / 24.3	0	0
Russet Burbank	11 / 11	275.3 / 275.3	11 (8)	0.5	1 / 5	1.3 / 115.8	< 1 (<1)	0	0 / 11	0 / 417.0	0	0
Russet	7 / 7	246.2 / 246.2	13 (2)	2	0 / 1	0 / 8.1	0	0	0 / 2	0 / 52.6	0	0
Snowden	-	-	-	-	-	-	-	-	0 / 4	0 / 139.3	0	0
Sangre	1 / 1	10.1 / 10.1	1 (<1)	0	0 / 2	0 / 6.9	0	0	-	-	-	-
Shepody	-	-	-	-	-	-	-	-	0 / 5	0 / 109.3	0	0
W 7530	-	-	-	-	-	-	-	-	0 / 1	0 / 0.27	0	0
Yukon Gold	1 / 1	0.8 / 0.8	25 (15)	5	-	-	-	-	-	-	-	-

* Number of fields or area infected / number of fields or area surveyed.

** Foliar inc (sev) = percentage of plants showing late blight infection, and (percentage of leaf area covered with blight); values represent mean of all fields.

*** Tuber inf = percentage of tubers showing late blight infection.

TABLE 4. Incidence and severity of late blight in four cultivars in two experimental fields in the City of Edmonton and the Municipal District of Sturgeon, 1994.

Cultivar	City of Edmonton	M.D. of Sturgeon
Atlantic	0 *	0
Norchip	100 (1)	100 (3.5)
Russet Burbank	100 (< 1)	100 (1)
Yukon Gold	100 (4)	100 (3)

* Percent of plants with foliar late blight symptoms; values in parenthesis denote the severity of late blight on leaves using the scale of James, C. (1971). All values represent a mean of four replications.

TABLE 5. Effect of fungicides on foliar and tuber late blight in north-central Alberta, 1994.

		Foliar late blight (%)**		
Fungicide application *	No. of fields	Incidence (range)	Severity (range)	% Tubers infected (range)
None	19	25.4 (< 1 - 100)	16.8 (< 1 - 75)	3.9 (0 - 40)
Contact	15	7.8 (<1 - 50)	1.4 (<1 - 10)	1.1 (0 - 10)
Contact and systemic	2	< 1 (<1)	< 1 (< 1)	0

* Contact and systemic fungicides were Bravo and Ridomil-MZ, respectively.
** Foliar late blight incidence = percent of the plants with late blight symptoms, while the severity = percent of the leaf surface area covered with the lesions.

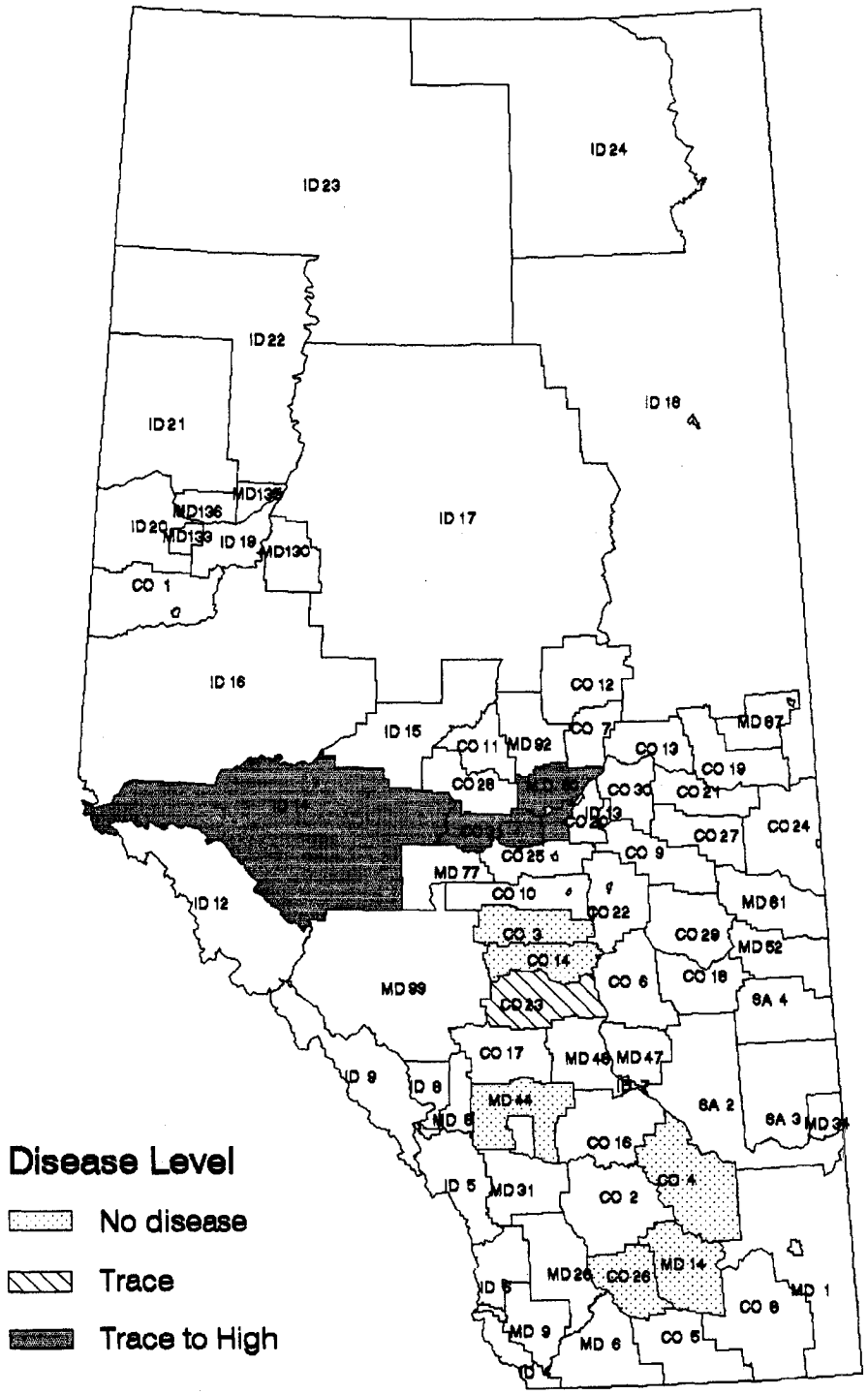

FIG. 1. Incidence of late blight on potato in Alberta, 1994.

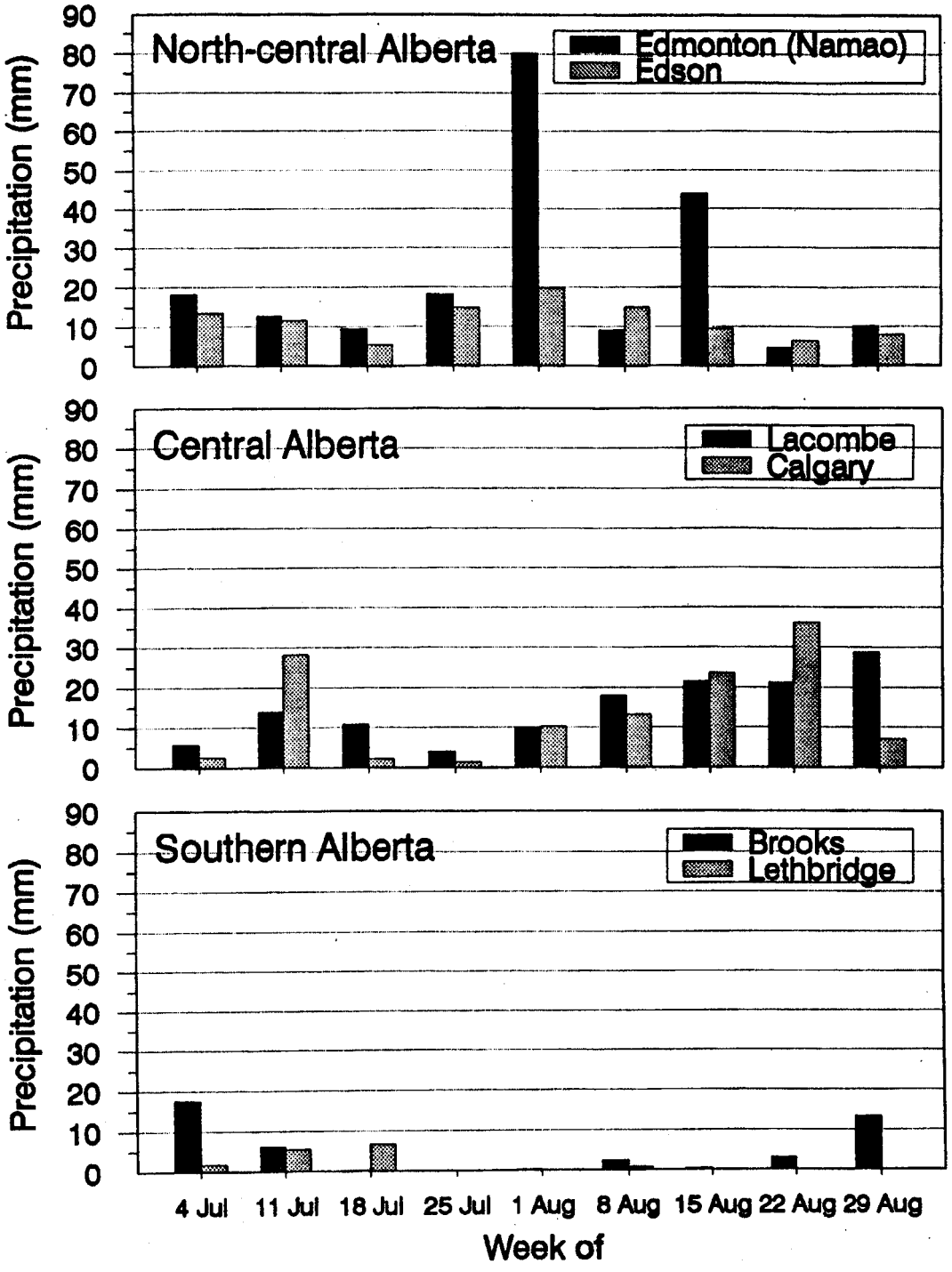

FIG. 2. Precipitation at selected sites in Alberta, 1994.

CROP: Pepper, *Capsicum annuum*
Squash, *Cucurbita pepo*

LOCATION: Ontario

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TITLE: *PHYTOPHTHORA CAPSICI* ISOLATED FROM PEPPER AND SQUASH IN ONTARIO

INTRODUCTION: *Phytophthora capsici* Leonian causes root rot, crown rot and foliar blight of pepper and other vegetables in the United States and tropical countries. Originally, the disease was identified in New Mexico but in recent years severe outbreaks of the disease have occurred in more northern areas such as New Jersey, Colorado and Michigan. Once introduced into an area the disease has become a problem annually. In August, 1994, the disease was detected in Ontario in fields planted with pepper and squash.

MATERIALS AND METHODS: Observations were made on a field of commercial peppers in the vicinity of the Harrow Research Centre. Subsequently, other fields in Essex and Kent counties were surveyed for signs and symptoms of the disease. The causal organism was isolated from diseased shoots and fruit and cultured on V8 agar. Measurements of sporangia and pedicel lengths were made from cultures on solid agar. Thirteen varieties of pepper were point inoculated with an isolate from sweet pepper. Inoculum consisted of a suspension of 10,000 zoospores/ml. Peppers were incubated at 26 C for 4 days prior to rating disease severity.

RESULTS AND DISCUSSION: The field was planted with several pepper varieties and was approximately 0.5 ha in size. All plants in the field had characteristic symptoms of phytophthora crown rot and phytophthora blight. Sporangia of the fungus were evident on mummified fruit and severely infected stems. Loss was 100%. Squash fruit in an adjacent field were infected and losses exceeded 50%.

Results of a random survey of other pepper fields in Essex and Kent counties were negative.

The fungus isolated from pepper and squash was identified as *P. capsici* based on recent descriptions (Alizadeh and Tsao, 1985; Tsao and Alizadeh, 1988). All 13 varieties of pepper developed symptoms of phytophthora blight following inoculation. Lesions were larger in size on chili peppers but this may be due to differences in shape, size and texture compared to sweet peppers.

The presence of *P. capsici* in Ontario could be a major threat to domestic pepper production. This is especially true in the absence of suitable resistant varieties or chemical controls. Pepper and squash crops in Essex county will be monitored in 1995 for further outbreaks of the disease.

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Small Fruits / Petits fruits

CROP: Saskatoon, *Amelanchier alnifolia* (Nutt.)

LOCATION: North-central Alberta

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Alberta Tree Nursery and Horticulture Centre, Edmonton, Alberta

TITLE: SURVEY OF ENTOMOSPORIUM LEAF AND BERRY SPOT OF SASKATOON IN 1994

METHODS: Six commercial orchards and one wild stand of saskatoon in north-central Alberta were surveyed for entomosporium leaf and berry spot caused by *Entomosporium mespili* (DC ex Duby). Randomly selected samples consisting of a minimum of four leaves were taken from 10% or 20% of the bushes at each location, depending on the size of the orchard. The leaves were taken from the middle and lower portions of each bush sampled, and rated for the percentage of surface area affected by the pathogen: 0 = 0%, 1 = 1—25%, 2 = 26—50%, 3 = 51—75% and 4 = 76—100%.

RESULTS AND COMMENTS: Saskatoons were heavily affected by *E. mespili* at most orchards included in this survey (Table 1). In general, disease severity was greater than that seen in previous surveys (1, 3), probably due to the high humidity caused by heavy rainfall experienced in north-central Alberta in 1994. The importance of humidity was most apparent when fields A and B at site 2 were compared. Disease development was light in Field A, which is situated on the top of a small hill, and has widely spaced plants, good weed control and no shelter belt. Severe levels of disease were seen in Field B, which is more sheltered, both by topography and vegetation. Weed control in this field was poor. Decis (deltamethrin, Hoechst Canada Inc, Regina SK) was applied in field A; otherwise, cultural practices, cultivar and plant age were the same. It appears, therefore, that relative humidity was the most important determinant of disease level at this site. Disease severity and incidence of leaf spotting caused by *E. mespili* at the wild stand examined in 1993 (1) was again low.

No consistent differences were found between upper and lower leaves concerning disease severity or disease incidence. The higher disease severity normally observed on lower leaves (2) may have been masked by heavy disease pressure due to favourable environmental conditions and inoculum build-up.

Triforine (Funginex 190 EC, DuPont Canada Inc., Mississauga, Ontario) has recently been registered for use on saskatoon; the sites to which this fungicide was applied are noted in Table 1. Fungicide application does not appear to have been an effective control measure for entomosporium leaf and berry spot of saskatoon in 1994.

TABLE 1. Incidence and severity of entomosporium leaf spot and berry spot of saskatoon in north-central Alberta in 1994.

Site No.	Field	No. bushes surveyed	Fungicide applied**	Upper or lower†	Average rating on leaves††	
					Disease severity††	Disease incidence†††
1	A	20	N	U	2.7	100.0
				L	2.7	100.0
2	A	48	N	U	0.9	65.4
				L	1.1	84.3
2	B	18	N	U	2.3	100.0
				L	2.8	100.0
3	A	35	N	U	2.7	100.0
				L	2.7	100.0
4	A	9	N	U	2.4	100.0
				L	2.0	100.0
5*	A	19	N	U	0.7	62.0
				L	1.1	77.1
6	A	26	Y	U	1.2	77.6
				L	1.8	91.0
6	B	35	Y	U	1.1	94.3
				L	1.2	80.5
7	A	44	Y	U	2.6	100.0
				L	2.5	99.5

* Wild stand.
** Y = Funginex 190 EC, applied at a rate of 3 L of product/ha, N = no fungicide.
† Sample from upper (U) or lower (L) half of plant.
†† Average severity rating (0-4) of all leaves examined.
††† Average percentage of leaves affected (severity classes 1-4).

REFERENCES:

1. Lange, R.M. and Bains, P.S. 1994. Survey of entomosporium leaf and berry spot of saskatoon in 1993. Can. Plant Dis. Surv. 74(1):123—124.
2. Howard, R.J., Briant, M.A. and Sims, S.M. 1994. Saskatoon leaf and berry spot in south-central Alberta in 1993. Can. Plant Dis. Surv. 74(1):120—122.
3. Pesic-van Esbroeck, Z., Bains, P.S. and Motta, J.A. 1991. Survey for common leaf spot, blight and berry spot of saskatoon in central Alberta. Can. Plant Dis. Surv. 71(1):125.

CROP: Saskatoon, *Amelanchier alnifolia* Nutt.

LOCATION: South-central Alberta

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TITLE: SASKATOON LEAF AND BERRY SPOT SURVEY IN SOUTH-CENTRAL ALBERTA IN 1994

METHODS: Five commercial saskatoon orchards (Fig. 1) were sampled in early August for leaf and berry spot caused by *Entomosporium mespili.* The total area surveyed was 33.5 ha. Depending on the size of the orchard, either every row (for small plantings) or every 2nd or 4th row (for large plantings) was sampled. The sampling procedure consisted of picking leaves and berries from every 20th shrub in each row examined. Single leaves were collected from the upper and lower portion of individual shrubs and, where available, a cluster of berries was picked from the upper and lower portions of the same trees. Disease incidence and severity were assessed on all leaves and berries. Disease incidence was determined by counting the number of leaves and berries with symptoms of entomosporium leaf and berry spot, then calculating the percentage of diseased leaves and berries out of the total number examined. Disease severity was estimated visually on the same samples using the following five-point scale: clean (0) = no lesions on leaves/berries, slight (1) = 1—25% leaf/berry surface lesioned, moderate (2) = 26—50%, severe (3) = 51—75%, and very severe (4) = >75%.

RESULTS: Overall, the average disease incidence was 58% for leaves and 44% for berries (Table 1). Leaves from the lower half of the shrubs generally had a higher incidence of disease than those from upper portions because *E. mespili* usually infects suckers and lower leaves first, then spreads upward. The average disease severity on the leaves and berries of most of the bushes examined was rated as slight (<25% of leaf/berry surface lesioned). All eight of the saskatoon cultivars examined were affected by leaf and berry spot.

COMMENTS: Entomosporium leaf and berry spot incidence was moderate to high in most of the saskatoon orchards surveyed, but the severity of the disease was relatively low. In the opinion of most of the growers whose crops were surveyed, 1994 was a good year for saskatoon production in southern Alberta, but leaf and berry spot would reduce the quality and marketability of harvested fruit.

TABLE 1. Area, age and composition of saskatoon plantings and average incidence and severity of entomosporium leaf and berry spot in five commercial saskatoon orchards in south-central Alberta surveyed in August, 1994.

Orchard No.	Size (ha)	Cultivar	Avg. age of orchard (yrs)	Avg. disease incidence (%)*		Avg. disease severity (0-4)**	
				Leaves	Berries	Leaves	Berries
1	2.8	(A) Smoky, Pembina, Thiessen (mixed)	2-7	84.5	64.3	1.1	0.8
		(B) Smoky, Pembina, Thiessen (mixed)		42.8	44.8	0.5	0.5
		(C) Smoky		70.7	0	0.8	0
2	16.8	Northline (field #1)	4-7	76.0	40.8	0.8	0.4
		Smoky (field #1)		97.6	48.8	1.0	0.5
		Northline (field #2)		94.0	51.4	1.1	0.5
		Smoky (field #2)		93.4	52.5	1.1	0.6
3	1.1	Smoky	3-11	75.1	63.0	1.0	0.8
		Thiessen		51.2	70.9	0.6	0.7
		Pearson II		53.6	47.7	0.7	0.5
		Northline		80.0	50.0	1.3	0.5
		Parkhill		14.1	64.8	0.2	0.7
		Mixture		36.1	34.7	0.5	0.4
4	0.8	Smoky	13-18	36.1	34.7	0.5	0.4
5	12.0	Northline	2-23	33.7	22.9	0.4	0.3
		Honeywood		34.0	35.2	0.4	0.4
		Smoky		24.8	22.3	0.3	0.2
		Forestburg/ Pembina		42.1	46.0	0.4	0.5

* Percentage of leaves or berries with entomosporium leaf and berry spot out of the total number examined.

** Clean (0) = No lesions on leaves/berries; slight (1) = 1—25% leaf/berry surface lesioned, moderate (2) = 26—50%, severe (3) = 51—75%, and very severe (4) = >75%.

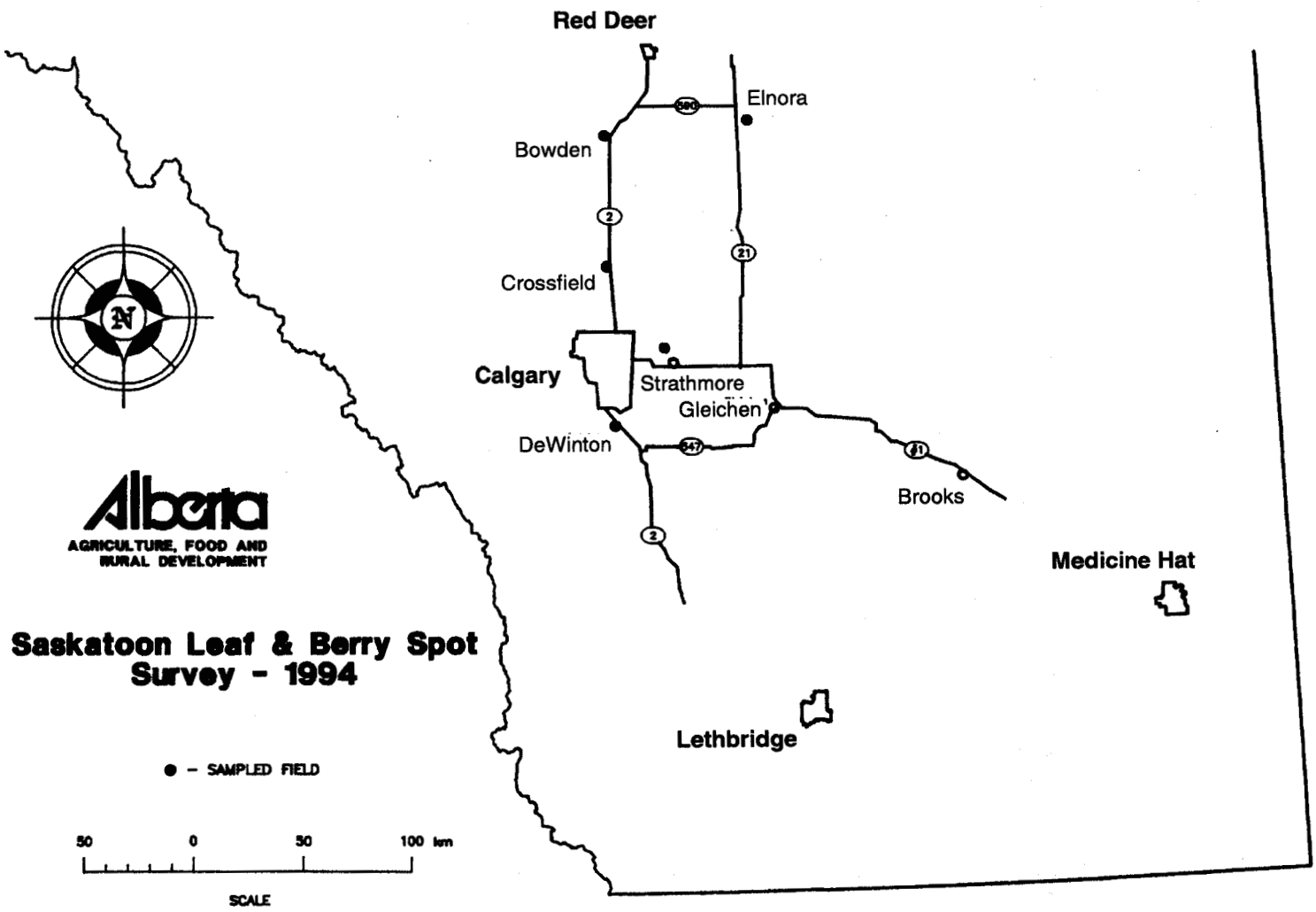

FIG. 1. Location of saskatoon orchards surveyed for entomosporium leaf and berry spot in south-central Alberta in 1994.

Instructions to authors

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