Canadian Plant Disease Survey

Inventaire des maladies des plantes au Canada

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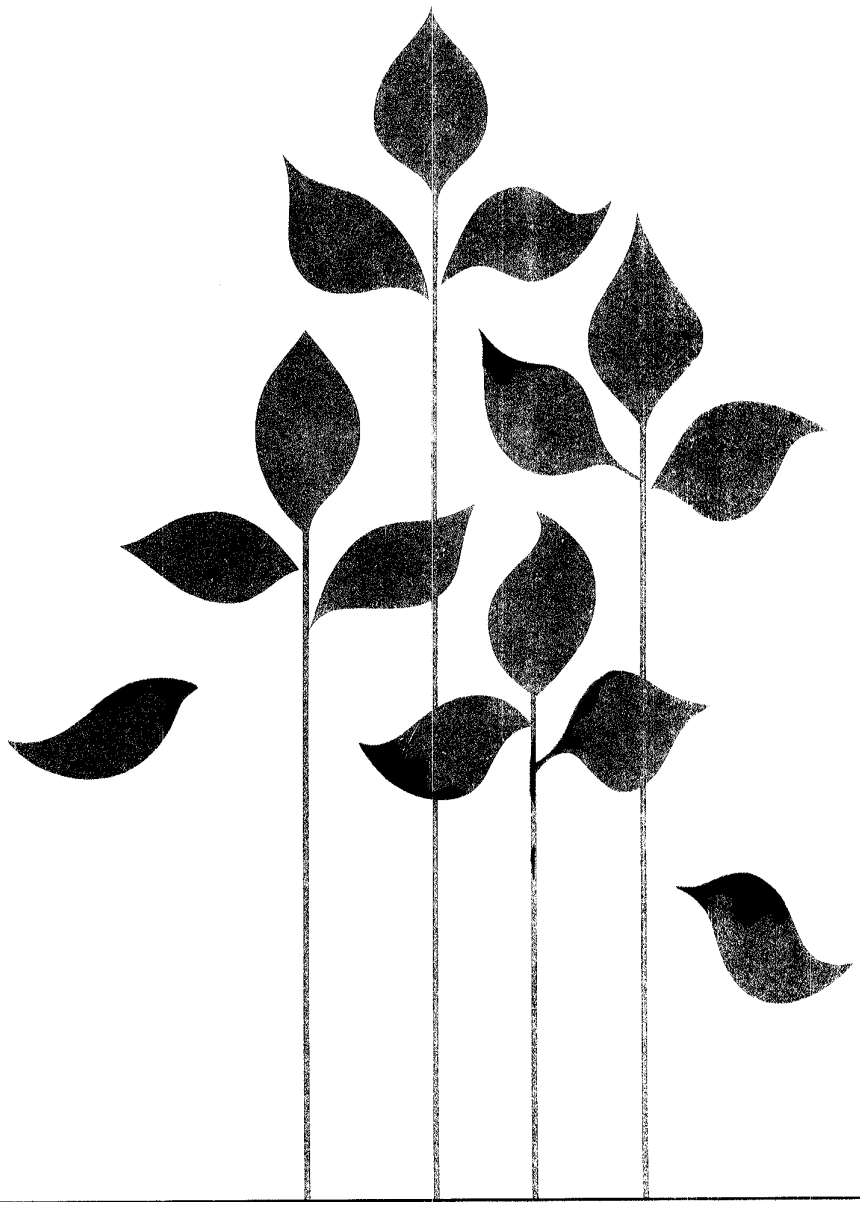

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The *Canadian Plant Disease Survey* is a periodical of information and record on the occurrence and severity of plant diseases in Canada and on the assessment of losses from disease. Other original information such as the development of methods of 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.

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

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Occurrence of a highly virulent strain of blackleg (Leptosphaeria maculans) on rape in Saskatchewan (1975-77)[1]

G.A. Petrie

A highly virulent form of the blackleg fungus, *Leptosphaeria maculans*, was found in 10 rapeseed fields in east-central Saskatchewan in 1976 and in 16 fields in 1977. These represented 10% and 17% of fields surveyed, respectively. A number of heavy infections occurred in the Melfort-Star City area. The estimated yield loss in one field as a result of basal stem canker alone was 20%. Severe blackleg occurred only where rape residues from the previous year bearing ascocarps of *L. maculans* were present in an adjacent field or in the same field. The virulent strain was isolated more frequently from dark-colored lesions on stubble than from those light in color.

Can. Plant Dis. Surv. 58: 21-25, 1978

Une forme très virulente du champignon de la jambe noire, *Leptosphaeria maculans*, a été constatée dans dix champs de colza du centre-est de la Saskatchewan en 1976 et dans seize champs en 1977, soit respectivement 10 et 17% des champs visités. Plusieurs fortes infestations se sont produites dans la région de Melfort-Star City. Dans un champ, les pertes de rendement dues au seul chancre de la tige ont été évaluées à 20%. Des symptômes graves de jambe noire n'ont été observés que lorsqu'il y avait des résidus de culture de *Brassica* dans le même champ ou dans un champ voisin. La souche virulente a été isolée plus fréquemment sur les lésions de couleur foncée que sur celles de couleur pâle.

Two strains of *Leptosphaeria maculans* (Desm.) Ces. & de Not. [imperfect state, *Phoma lingam* (Tode ex Fr.) Desm.] occur widely on *Brassica* spp., one considerably more virulent than the other. Recently, severe outbreaks of the virulent type have occurred in Australia on rape (*Brassica napus* L.) and turnip rape (*B. campestris* L.) cultivars of Canadian origin (1, 4) and in the United States on cabbage (2). In Western Canada blackleg has been of minor importance for many years, as strains of relatively low virulence occurred sporadically on cruciferous weeds, rape and mustards (6, 7). However, in 1975 a virulent strain identical to that occurring in parts of the United States and similar to the one found in Australia was isolated from rape stubble from two fields in east-central Saskatchewan (5). In light of the Australian experience, its discovery in the heart of the rape-growing area is viewed as a potentially serious threat to Canadian rape production. This paper describes the results of blackleg surveys made in 1976 and 1977, and discusses possible control measures.

Methods

Stubble fields of rape and mustard were sampled in the fall or early spring. The spring, 1976, survey took in areas not covered the preceding fall (5). In 1977, the survey of that year s crop was begun in mid-July. On the basis of the extensive survey conducted in the fall of 1975 (5) and earlier surveys, the area receiving closest attention consisted of Saskatchewan crop districts 8 and 6. The incidence of blackleg in each field was rated "nil", "slight", "moderate" or "heavy" and notes were taken on severity of infection. The incidence ratings corresponded to 0, trace-9%, 10-39%, and 40% or more of the plants infected, respectively. In many instances, samples consisting of 20-25 plants each were pulled at intervals of 25 paces along a diagonal across the field. Material collected at several sites per field was retained for purposes of isolation, for the virulent and avirulent strains cannot be distinguished in the field on the basis of symptom type.

A 0.5 × 1 cm piece was excised from the lesioned part of each stem; pieces were plated after surface sterilization as previously described (6). Preliminary experiments had shown that two types of lesion consistently yielded *L. maculans*, whitish lesions bearing numerous pycnidia and slate-grey to black areas bearing relatively few inconspicuous pycnidia. Where both lesion types were abundant in a field, they were segregated and plated separately. In 1977, the sources of several heavy infections noted around Star City were sought by examining surrounding fields for evidence of rape residues. Samples of residues were removed to the laboratory and checked periodically for sporulation in ascospore liberation tunnels using a method similar to that of McGee (3).

Whenever isolations were made, identity as to strain was determined by cultural studies (5) and pathogenicity tests. In the latter, seeds of *B. napus* cv. Midas were

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Table 1. Results of blackleg surveys conducted in northeastern Saskatchewan, 1976-77

Time surveys conducted	No. of fields entered	Total blackleg incidence				Virulent strain*	
		% of fields with infections rated				% of fields infected	% of fields rated Mod-Heavy
		Nil	Slight	Moderate	Heavy		
Spring 1976	35	8.6	51.4	28.6	11.4	2.9	0.0
Fall, 1976 and Spring, 1977	76	4.0	61.9	26.3	7.9	11.8	1.3
Midsummer, 1977	92	71.7	17.4	4.4	6.5	17.4	6.5

*Presence confirmed following isolation.

Table 2. Amount of blackleg infection in representative fields rated "slight" "moderate" and "heavy"

Field no.	Field rating	% of stems infected by *L. maculans*	%of sampling* sites having *L. maculans*	Range of infected stems at different sites (%)
61	slight	1.3	20.0	0.0 - 10.0
69	moderate	21.0	80.0	0.0 - 50.0
74	heavy	55.6	100.0	33.3 - 73.1

*As a rule, 20 to 25 stems were pulled at each of 10 sampling sites.

inoculated with a conidial suspension and sown in vermiculite. Ten to 14 days following seedling emergence, isolates were classified on the basis of virulence and symptom type (8). For convenience, the virulent strain will hereafter be referred to as the "Wisconsin" (W) strain and the weakly virulent type, as the "Puget Sound" (PS) strain (8).

Results

A total of 203 fields were surveyed; blackleg occurred in 94.5% of the 1975-76 fields and in 28.3% of the 1977 fields (Table 1). However there was an increase in percentage of fields having the virulent strain. Forty percent of the 1975 fields rated "moderate" or "heavy", as did 34% of the 1976 fields and 11% of 1977 fields. Examples of levels of infection typified by the ratings "slight", "moderate" and "heavy" may be seen in Table 2, as may an indication of disease distribution within fields. In 1975 and 1976, the most heavily infected fields occurred near Humboldt, Lake Lenore, Cudworth, Vonda, St. Benedict, Waldheim, and Saskatoon. Most of the symptoms resulted from late season infection by the PS strain. In midsummer, 1977, several severely diseased fields were located around Star City in northeastern Saskatchewan. These had obviously been infected considerably earlier by a much more virulent strain.

The virulent W strain was detected in 11 of the 111 1975-76 fields (10%) when isolations were made (Table 3). It was present in from 1.0% to 94.5% of the stems from which *L. maculans* was isolated. In the field near Star City from which over 94% of the blackleg infections consisted of the virulent strain, the incidence rating was "moderate". This strain, although well distributed throughout some fields, was only found in others at a single sampling site, as in field 81 (Table 3). In 1977, the W strain occurred in 16, or 17.4%, of the fields and accounted for six of the 10 in which the blackleg incidence was "moderate" or higher (Table 1). All of the fields having high levels of the W type were located in the Melfort-Star City area (Table 4). These were the only fields entered during the two-year period in which ratings for severity in addition to incidence were high. In field 138 near Naisberry, 100% of the plants were infected in the portion of the field sampled. All infections had been caused by the W strain. A field 1 km south of no. 138 had only a trace of infection. Another, no. 148, located close to 1976 field 109, had been seeded on stubble infected by the W strain. In this field severe basal cankers were common and often accompanied by severing of the upper taproot. When the method of McGee and Emmett (4) was used to calculate loss in yield, a minimum loss figure of 20% was obtained for field 148. In no other field was basal cankering this severe.

Table 3. Results of isolations of *L. maculans* from *Brassica* stubble from Saskatchewan rape fields (1976) in which the virulent strain was found

Field no.	Location	No. stems yielding *L. maculans*	% of blackleg-infected stems yielding W strain*	% of blackleg-infected stems yielding PS strain**
23	Rosthern	50	2.0	98.0
78	Humboldt	101	1.0	99.0
81	Marysburg site 1	102	0.0	100.0
	Marysburg site 2	31	0.0	100.0
	Marysburg site 3	233	34.8	65.0
81E	Marysburg	59	27.1	74.6
87	Lake Lenore	241	12.9	87.1
104	Melfort	11	18.2	81.8
105	Melfort	46	6.5	93.5
107	Star City	47	23.4	78.7
108	Star City	80	2.5	97.5
109	Star City	91	94.5	8.8
112	Tarnopol	3	33.3	66.7

*The virulent "Wisconsin" strain.
**The weakly virulent "Puget Sound" strain.

Table 4. Occurrence of the virulent W strain of *L. maculans* in Saskatchewan rape fields sampled in 1977

Field	Location	Incidence	Severity
138	Naisberry	heavy (100%)	moderate-severe
139	Naisberry	slight	slight
141	Star City	slight	slight
142	Star City	slight	slight
145	Star City	moderate	moderate
146	Star City	heavy	moderate
147	Star City	slight	slight
148	Star City 5W	heavy	severe
176	Star City	heavy	severe
177	Star City	heavy	severe
151	Wakaw 12E	slight	mod-severe premature ripening
154	Tarnopol	slight	mod-severe premature ripening
155	Tarnopol 10N	slight	slight
158	Meskanaw	moderate	moderate
169	Brooksby 12N	slight	slight-moderate
204	Vonda	moderate	slight-moderate

In almost every instance in which 1977 fields had ratings of "moderate" or higher, rape residues bearing ascocarps of the W strain were found in an adjacent field, or in the same field in the case of no 148. Although the material was often partially covered by soil as a result of frequent rains, ascospore discharge occurred when samples were tested in the laboratory. Discharge was particularly abundant in the case of the material collected adjacent to field 138. Invariably barley was the 1977 crop under which the rape residues were located. Infection in many of the rape fields was uniform and heavy close to the source of inoculum, with frequently a rather sharp line of demarcation setting off the less heavily diseased remainder of the field. One example was field 177 which lay north of the inoculum source, a large barley field. A large, yellowed, semicircular zone several meters across, in which the loss was estimated at 50%, lay adjacent to the barley; other large yellow patches could be seen throughout the field. In field 176, 2 km north of no. 177, infection occurred in small patches up to 1 m across, in which 50% or more of the plants were severely diseased or dead. It appeared that the primary inoculum source was again the barley field south of field 177. The patches apparently resulted from secondary infection by rain-splashed conidia. Another heavily infected field (146) lay across the road to the east of the same barley field. Spores from residues in the latter were therefore responsible for severe infection in at least three 1977 fields.

Table 5. Recovery of the virulent "W" strain and weakly virulent "PS" strain of *Leptosphaeria maculans* from light- and dark-colored stem lesions from four rape fields

Field no.	Rep. no.	Stem lesion color	No. of stems yielding *L. maculans*	% of stems yielding W strain	% of stems yielding PS strain
81E		"Dark"	16	81.3	25.0
		"Light"	16	6.3	93.8
		mixed*	27	7.4	92.6
87	1	"Dark"	22	31.8	68.2
	2	"Dark"	21	38.1	61.9
	1	"Light"	15	6.7	93.3
	2	"Light"	25	8.0	92.0
	1	mixed*	23	43.5	56.5
2	2	mixed*	135	3.0	97.0
86		"Dark"	85	0.0	100.0
		"Light"	46	0.0	100.0
130		"Dark"	54	0.0	100.0
		"Light"	49	0.0	100.0

*Isolations from bulk sample without regard to lesion color.

Fields lightly infected by the W strain were scattered between Saskatoon and the Melfort area (Table 4). In the Wakaw and Meskanaw fields, blackleg-infected and footrot-infected* plants had completely ripened off well in advance of the remainder of the crop. Premature ripening to this degree was much less common in the Star City area, probably due to more moist conditions in the northeast. The well-developed center of virulent blackleg infection observed in the Lake Lenore-Marysbury area in 1976 had all but disappeared in 1977. Indeed, there was very little blackleg in this area in August, probably due once again to conditions being relatively dry.

In 1977, rape had been seeded adjacent to both of the 1975 fields in which the virulent strain was found initially (5). In both instances, however, no blackleg was detected in 1977. Both of the original fields were cropped to cereals in 1976; one was fallowed in 1977 and the other was again in cereal.

In June and July, lesions caused by the W strain were invariably light in color and bore conspicuous pycnidia. By fall, both light and dark-colored lesions occurred on stubble. When isolations were made from both lesion types from stubble collected in late 1976 and early 1977 it was found that the W strain was associated much more frequently with dark-colored lesions (Table 5). The PS strain, in the absence of the other, occurred in both types of lesion. Almost without exception, the two strains did not occur at the same site on a stem (Tables 3 and 5). Samples yielding the W strain almost never yielded the PS strain as well. By late 1977, all the 1976 material incubated out-of-doors had become dark in color and bore ascocarps of *L. maculans*.

* *Footrot is caused by Rhizoctonia sp. and Fusarium spp.*

Discussion

In recent years, blackleg has been prevalent on rape by late fall throughout central Saskatchewan. In a considerable proportion of infected stubble fields incidence has also been high. Most of this reflects late development of the weakly virulent strain. Incidence of this strain recorded in late fall has increased sharply since the 1963-67 period (7). The lower values reported for 1977 are no doubt due to the survey having been largely completed by late August, rather than late October as was previously the case. The 1977 data may be compared to those from the 1970-72 period (6). An increase in prevalence and incidence is indicated here as well, due in part to the recent appearance of the virulent strain.

Plentiful blackleg infections of a severity not seen in Western Canada prior to 1976 were consistently associated with the occurrence nearby of abundant rape residues bearing ascocarps of the virulent strain. McGee and Emmett (4) reported that crop failures due to blackleg in Australia were directly associated with the occurrence of infected residues in adjacent fields or in the same fields. In northeastern Saskatchewan incidence of infection often decreased markedly when one travelled a short distance from an inoculum source. In a few cases this decrease appeared to be influenced by the occurrence of shelter belts between an inoculum source and a field.

Dry conditions in areas in which an abundance of inoculum should have been present appeared to be the factor responsible for the virtual disappearance of a few well-established pockets of infection. Original sources of

inoculum also appeared ineffective after 2 years of non-host crops.

By late fall the virulent strain was much more frequently associated with dark-colored than with light-colored stem lesions. This was not true of the PS strain. Ascocarps of *L. maculans* form following blackening of stem tissues. As the perfect state of the W strain develops much earlier in the season than does that of the PS strain (unpublished data) blackening of tissues would be expected to proceed more rapidly in the case of the W strain.

Until other control measures are available, management practices will be the key to holding the disease in check. Fields only a relatively short distance from infected trash of the preceding crop had considerably less blackleg than those adjacent to source of ascospore inoculum. Burial of infected residues is an effective means of reducing this inoculum (unpublished data). Seed treatment with an appropriate fungicide can reduce spread into uninfected areas. The extent of the occurrence of the W strain in seed is under investigation. Sources of resistance have been identified (5); it remains to incorporate these into agronomically suitable cultivars. Vigilance and attention to control measures on the part of the growers and a major research effort on the part of scientists will be required to contain the potential destructiveness of the virulent strain of blackleg.

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Seed potato improvement in Canada

James Munro[1]

Techniques and procedures required for an effective certification program to provide disease-free seed potatoes are described. Canada's Elite Seed Potato Program, originally developed to control bacterial ring rot, now includes to some degree tuber indexing, tuber uniting, and testing for viruses and the spindle tuber viroid. Clone selection procedures and virus-tested stem cuttings are also used in Prince Edward Island and New Brunswick. Contributions made by some of the provinces to the national program include the operation of Elite Seed Potato Farms in Prince Edward Island, New Brunswick, Quebec, and Manitoba. It is also shown that there is a need for full development of the national program to make Canadian Certified seed potatoes acceptable to all countries.

Can. Plant Dis. Surv. 58: 26-28, 1978

L'étude décrit les techniques et les méthodes nécessaires à la conduite d'un bon programme de contrôle sanitaire de la production des pommes de terre de semence. Le plan de production de semences d'Elite qui, à l'origine ne visait que la flétrissure bactérienne, s'est depuis étendu à l'indexage, à la plantation en tubercules individualisés et au contrôle pour les virus et pour le viroïde de la filosité. L'Île-du-Prince-Édouard et le Nouveau-Brunswick utilisent la sélection clonale et le bouturage de tiges indemnes de virus et, en outre, le programme national est bien épaulé par les fermes de production de semence d'Elite exploitées par quelques-unes des provinces, Île-du-Prince-Édouard, Nouveau-Brunswick, Québec et Manitoba. L'étude fait ressortir le besoin d'un programme national complet qui puisse ouvrir à nos semences l'accès de tous les pays.

The potato plant is characterized by an extreme sensitivity to disease, and in the various countries where it is grown it may be affected by any one of more than 300 pests and diseases. As commercial potato crops are produced by vegetative reproduction, many of the diseases transmitted by the seed tubers cause qualitative and quantitative depreciation in yield. That is why the potato, more than any other crop plant, depends upon quality of seed for a high production potential. The practise of seed potato improvement is that of changing and adapting to new techniques and procedures as they are developed to improve both certified seed potato crops and certification methods. Experience in countries most advanced in seed potato improvement has shown that high production levels can be maintained only by continued use of the technical procedures practised in countries where the potato is of prime economic importance.

Seed potato improvement

Of the countries that grow high acreages of seed potatoes the United States and Canada alone do not have clone-selecting, virus-testing, and disease-freeing procedures as part of a total official program throughout the respective countries. But we in Canada do have tuber indexing and tuber uniting; several provinces have a developing virus-testing program and have shown interest in clone selecting; three provinces carry out southern tests for their seed potato growers. Greater control of bacterial ring rot is also being obtained in an Elite Seed Potato Certification Program that is based upon tested freedom of all nuclear stocks of seed potatoes from the causal pathogen, *Corynebacterium sepedonicum* (Spieck. & Kotth.) Skapt. & Burkh.

European countries have been changing and adjusting their inspection methods over the past 30 years to obtain more reliance on routine laboratory and greenhouse tests, and much more concentration on seed plots to produce a steady flow from virus-free clone selections down to commercial classes. This has been made possible because the traditional method of planting whole seed has prevented the cutting knife from becoming a major cause of virus spread in basic seed stocks.

Virus-testing and virus-free programs are not new; they have been growing and developing continuously, though at times slowly, over the past 45 years. In fact virus-free seed potato programs had their origin in 1925 immediately after Johnson announced (2) that all healthy looking plants of North America's established potato varieties were infected with a virus, which was later to be called potato virus X. After that report by Johnson several countries, including Great Britain, the Netherlands, and Germany, began a search through their respective stocks of commercial varieties for virus-X-free tubers. Some were found in most of the popular varieties in Europe, including the variety Up-to-date, formerly grown in Canada and known to have been in

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commercial production since 1894. By 1933 virus-X-free stocks of 25 of the most popular varieties in the United Kingdom alone had already been found. Today most countries in Europe that grow seed potatoes, either to be self-sufficient or for export, produce their commercial seed from nuclear stocks of virus-free material. Seed potato growers in most of these countries have been encouraged to accept and participate in this kind of seed potato improvement with the help of price controls and supporting legislation. But the growers pay for this stability with substantial acreage, testing, and other fees.

North America has been rather slow to adopt some of the methods used in Europe because a serious disease problem peculiar to this part of the world transcends those solved by the refined procedures practised in Europe. By cutting whole tubers to use as seed pieces we in North America have spread bacterial ring rot across the continent to make it the most important problem in seed potato certification. Although this disease is present in Europe and is known to have been there for many years before it was reported in North America, it is of little consequence in Europe because it is controlled by planting whole seed. When potato seedlings are selected to become varieties in Europe, breeders make their selections with this planting practise in view.

Methods of certification with laboratory and greenhouse facilities have of course been introduced into certain North American seed potato certification programs, and in Canada valuable stocks of virus-free material of all common varieties are available from the Agriculture Canada Research Station, Vancouver, B.C. and from the Plant Quarantine Division, Agriculture Canada, La Pocatière, Quebec. So, unofficially, a very active virus-free program has been developing in Canada for some years. But as our prime concern at the moment is to maintain sufficient amounts of bacterial ring rot tested Elite seed to produce Foundation Class seed for our markets, and to find more effective ways to control this disease, preoccupation with bacterial ring rot will remain with us until we have much stronger legislation to control this disease, and potato breeders find immunity to the pathogen.

In the development of a complete seed potato certification program we are preparing to go even further. The potato plant is subject to many diseases which spread readily and in some cases become latent in or on the tubers. Thus it is common for the foliage from planted virus-free tubers to be free from causal organisms of fungal and bacterial diseases even though the seed tuber itself is carrying a latent infection of blackleg or some other non-virus pathogenic disease. Therefore it is possible to propagate disease-free stocks from stem cuttings taken from healthy potato foliage (1). Some of Canada's basic virus-free stocks have been propagated this way in the Maritimes.

Elite seed potato program

Canada's Elite Seed Potato Program has been officially in effect since 1970 and was brought about initially as a planned attempt to obtain more effective control of the bacterial ring rot disease. This disease was first reported in Germany in 1906, but not in Canada until 1931. Although bacterial ring rot is readily controlled in Europe by planting whole seed, this custom has not progressed to any extent in North America. Because the pathogen which causes this disease spreads readily from infected to healthy tubers when they are cut into seed pieces, no tolerance is permitted for the disease in Canadian certified seed. But despite this strong control measure the disease is still prevalent, and the Elite Seed Program was introduced as a further and more effective way to control the disease.

In this Elite Seed Program single plants or tubers are tested in the laboratory for the presence of the bacterial ring rot pathogen and those found to be free are multiplied in bulk to produce Elite I class seed. From this class of seed, Elite II and Elite III classes respectively are produced in successive years, followed by the commercial classes known as Foundation and Certified. The movement down in class from Elite I to Certified is automatic and is known as a "flushing out" procedure.

The stability of the Elite Seed Potato Program is partially dependent upon the continuous selecting and multiplying of bacterial ring rot tested seed stocks by Elite Seed Growers in each province and the provincial Elite Seed Farms. Testing is carried out by staff of the Agriculture Canada Plant Quarantine Division, and clone selecting jointly by staff of that Division and the growers. Substantial support to the program is also given by most provinces to help their growers. The provincial governments of New Brunswick, Quebec, and Manitoba each provides an Elite Seed Farm with all of the staff and facilities required to produce Elite seed stocks. A similar farm has been established on Prince Edward Island by the Prince Edward Island Potato Marketing Board. Three other provinces select and multiply tested seed stocks for the Elite classes in carefully chosen areas.

The current regulations under which seed potato certification is carried out in Canada are therefore based upon a program of continuous selecting, reselecting, testing, and retesting of single plants or tubers to and from the Elite I classes. The future development will be one of concentration on freedom from bacterial ring rot jointly with a complementing and rapidly developing virus-free program.

Virus freeing

It is now possible to have virus-free seed potato certification programs throughout North America because of the ease with which all potato varieties may be freed from virus infections. Procedures to free potatoes from viruses by the use of heat and biological therapies began in the U.S.A. with potato witches

broom in 1943 (5) and in England with leaf roll in 1950 (3). Similar procedures were developed later in France for the potato mosaic viruses X, S, M, Y, and A in 1955 (7) and in England in 1957 (4). These practices have been adopted rapidly in other countries in successive years.

Virus-freeing work for commercial development in Canada was first reported as being done at the Agriculture Canada Research Station at Vancouver in 1967 (6), and since that time has had a good deal of publicity. Material from that source has been distributed across the country, largely to the Provincial Elite Seed farms and to locations selected by the other provinces. Basic stocks on two of these provincial seed farms are virus-free, and since 1973 all plantings on the Prince Edward Island and New Brunswick Elite Seed farms have been with tubers derived from virus-free material.

Virus-free program

New regulations are being written to modify the present Canadian Elite Seed Potato Program and permit that bacterial ring rot testing procedures complement virus-testing requirements. It will take some time to replace the existing Elite stock so carefully nurtured by the many outstanding Elite Seed growers with virus-free or their own virus-freed material, but at the appropriate time the virus-free Elite program will be made complete by an amendment to the regulations.

Each province is contributing to the development of this complete Elite Seed Potato Program largely through assistance in producing the respective provincial basic seed requirements. The most valuable help that a province can give to this end is in providing an Elite Seed Farm with all of the staff and facilities required for such a venture. It is expected that this help will eventually extend to include a provincial seed farm or its equivalent, bacterial ring rot testing, clone selecting, maintenance of nuclear stocks, testing for viruses and spindle tuber viroid, trial plots for virus spread assessments, legislation for bacterial ring rot control, and intensive extension work with seed growers.

Virus-tested stem cuttings

Seed potatoes free from virus infections have been produced commercially in Europe for many years, but it is only now that seed stocks are becoming available substantially free from certain fungal and bacterial diseases. This has been made possible by a new technique whereby virus-free seed stocks are raised from tested stem cuttings instead of tubers (1). At least one country, the United Kingdom, has introduced a Virus-Tested-Stem-Cuttings Class as the highest class of certified seed, which is produced in Scotland. Regulations in that country now require that all basic stocks of certified seed potatoes be derived from stem cuttings, and this procedure is spreading to other countries.

The technique to produce rooted cuttings is similar to that used by horticulturists. Virus-free tubers are planted in pots in a greenhouse, using tubers obtained from stem cuttings in the previous year. When plants are about 15 cm high they are tested for virus freedom, allowed to grow about another 15 cm, and then topped to encourage the rapid growth of side shoots. When the shoots are about 8 cm long they are cut from positions on the stems at least 15 cm above the soil level. From the lowest cutting on each stem a small portion is removed and tested in the laboratory for the blackleg bacterium. If the test is negative the other rooted cuttings from the same stem are transplanted into 8-cm pots, then eventually to the field for normal growth and tuber development. This work is done entirely by the certification agency, and the harvested tubers are given to selected growers to multiply as basic stocks. As elimination of disease in this way does not give immunity from further infection it is recommended that growers take care to prevent reinfections in a way somewhat similar to bacterial ring rot control methods.

Conclusion

Seed potato certification in Canada is carried out as a national program to produce seed that will be accepted by any country. The demands and requirements in certain valuable markets are growing to an insistence that all imported seed potatoes be derived from virus-free stocks. Exporters and importers in other countries have found that the strong measures required for seed potato improvement have been well justified. The demand for good seed remains, or is greater than ever, but in all prominent seed potato growing countries, the seed acreage is going down because the harvested tonnage per acre is going up. Some states in the U.S.A. have already introduced propagation of virus-X-free potato stocks as part of their certification programs.

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Barley stripe mosaic in Saskatchewan in 1977[1]

Arthur W. Chiko

In 1977, barley stripe mosaic (BSM) was detected in 7.5% of the fields of two-row barley (*Hordeum distichum*) surveyed in southwestern Saskatchewan. The incidence of plants with BSM in these fields varied from a trace to 13%. The disease was not encountered in any fields of six-row barley (*H. vulgare*) surveyed in this region.

At Regina, about 800 plots of foundation, registered and certified barley, consisting of all cultivars commonly grown in the Canadian prairies, were examined for BSM. The disease was detected only in one plot, which was derived from certified seed of the two-row cultivar Fergus.

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En 1977, la mosaïque striée de l'orge a été constatée dans 7.5% des champs d'orge à deux rangs (*Hordeum distichum*) visités dans le sud-ouest de la Saskatchewan. La proportion de plants atteints dans ces champs fluctuait de traces à 13%. La maladie n'a été observée dans aucun champ d'orge à six rangs.

A Regina, quelque 800 parcelles d'orge de classes fondation, enregistrée et certifiée recouvrant tous les cultivars d'usage courant dans les Prairies canadiennes ont été inspectées à l'égard de la mosaïque. On n'a pu constater de symptômes que sur une seule parcelle, provenant de semence certifiée du cultivar à deux rangs Fergus.

In a survey conducted in 1975, barley stripe mosaic (BSM) was detected in 45%, 30% and 25% of the fields of two-row barley (*Hordeum distichum* L. emend. Lam.) examined in southern Alberta, southwestern Saskatchewan and southeastern Manitoba, respectively; in each of these regions the disease had been encountered in a similar proportion of two-row barley fields in 1974 (2). In both years, relatively large numbers of two-row barley fields were examined in southern Alberta and southeastern Manitoba but only a few fields were examined in southwestern Saskatchewan. The accuracy of surveys conducted in the latter region was thus questionable. Consequently, an intensive survey for BSM was conducted in southwestern Saskatchewan in 1977. To evaluate the current status of barley stripe mosaic virus (BSMV) in pedigreed seed, barley cultivar verification plots located at the Regina Research Station were also examined for BSM.

The 1977 survey for BSM in southwestern Saskatchewan was conducted from July 5 to 8 along a route of about 800 miles passing through Crop Districts 3, 4, 6 and 7. Fields of two-row barley and six-row barley (*H. vulgare* L. emend. Lam.) in the late tillering to soft dough stage were examined at intervals of about 5 and 15 miles, respectively. Barley cultivar verification plots were examined July 4, when plants in most plots were at the jointing stage. In each field or plot where BSM was detected, a sample of leaves was collected from plants with symptoms and the presence of BSMV was confirmed by infectivity and serological tests (1). Data on the acreage occupied by different barley cultivars in southwestern Saskatchewan were obtained from reports prepared by the Saskatchewan Wheat Pool.

In 1977, BSM was detected in 4 of 53 (7.5%) fields of two-row barley and in none of 13 fields of six-row barley surveyed in southwestern Saskatchewan. In the four fields where BSM was detected, the incidence of affected plants was a trace, 4%, 7% and 13%.

Changes in the cultivar composition of two-row barley grown in southwestern Saskatchewan from 1974 to 1977 were relatively minor; during this period the proportion of two-row barley acreage occupied by the most common cultivar, Betzes, remained essentially constant (77-78%). Therefore, it is unlikely that changes in cultivars were responsible for differences in the proportions of two-row barley fields in which BSM was detected in this region in 1977 and in two preceding years (1974 and 1975). In 1974 and 1975 surveys, estimates of the frequency of occurrence of BSM in fields of two-row barley in southwestern Saskatchewan were probably subject to considerable error because of the small numbers of fields examined. A more accurate estimate of the frequency of occurrence of BSM in fields of two-row barley in this region was probably obtained in the 1977 survey. This survey indicated that BSM is presently of little significance to barley production in southwestern Saskatchewan.

Results of previous surveys suggested that BSM occurred commonly in fields of Betzes barley in southern Alberta (2). Information obtained in the present survey, however, indicated that the disease was not common in

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this cultivar in southwestern Saskatchewan. The reason for this apparent difference is unknown.

At Regina, barley cultivar verification trials consisted of varying numbers of plots of 18 of the most common cultivars grown in the Canadian prairies. Each plot consisted of about 3000 plants. Of a total of 792 verification plots examined, 17%, 20% and 63% were derived from samples of foundation, registered and certified seed, respectively, 11%, 26% and 63% were derived from seed samples obtained from pedigreed growers in Alberta, Manitoba and Saskatchewan, respectively, and 33% and 67% were two- and six-row cultivars, respectively. BSM was detected in only one verification plot (0.1% of the plants affected) of Fergus, a two-row cultivar. A total of 81 verification plots of this cultivar was examined. The plot containing diseased plants was grown from certified seed obtained from a grower in Tisdale, Saskatchewan.

In southern Alberta and southeastern Manitoba combined, BSM in two-row barley accounted for losses of about $0.8 million in both 1974 and 1975 (3). Observations made at Regina strongly indicate that growers could avert or minimize losses due to this disease by planting pedigreed seed.

Acknowledgement

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Natural infection of two new hosts by hemlock dwarf mistletoe in British Columbia

R.S. Hunt and R.B. Smith[1]

The dwarf mistletoe, *Arceuthobium tsugense*, exists as two pathotypes in British Columbia: one primarily infects western hemlock (*Tsuga heterophylla*), the other shore pine (*Pinus contorta* var. *contorta*). This is the first report of natural occurrence of either pathotypes on Douglas-fir (*Pseudotsuga menziesii*) and the first of the hemlock dwarf mistletoe pathotype on western white pine (*Pinus monticola*) north of Oregon.

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Il existe deux pathotypes d'arceuthobie, *Arceuthobium tsugense*, en Colombie-Britannique; le premier s'attaque à la pruche de l'Ouest (*Tsuga heterophylla*) et le second au pin à feuilles tordues (*Pinus contorta*, var. *contorta*). Il s'agit ici du premier cas naturel de l'existence d'un des pathotypes sur le sapin de Douglas (*Pseudotsuga menziesii*) jamais rapporté. C'est également la première fois qu'on signale l'arceuthobie de la pruche sur le pin blanc de l'Ouest au nord de l'Oregon.

Dwarf mistletoe (*Arceuthobium*) infections were observed on a Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) tree in a Douglas-fir and western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) stand on West Redonda Island (50°10′ N, 125°W). The tree had one large stem swelling and numerous fusiform branch swellings, while adjacent Douglas-fir lacked similar infection. Witches' brooms were not observed. Basal cups of dwarf mistletoe shoots were present on two infections, but the plants were missing. Cross-sections through several of the swellings lacking basal cups revealed typical *Arceuthobium* sinkers in the host xylem. The large diameter of the basal cups, 1.5-2 mm, identifies the dwarf mistletoe as *A. tsugense* (Rosendahl) G.N. Jones, the only dwarf mistletoe species in these coastal areas, rather than the interior Douglas-fir dwarf mistletoe, *A. douglasii* Engelm. *A. tsugense* has two ecological races (or pathotypes (Fed. Br. Pl. Path. 1973)): hemlock dwarf mistletoe, attacking primarily western hemlock, and shore pine dwarf mistletoe, attacking primarily shore pine (*Pinus contorta* Dougl. var. *contorta*) (Smith and Wass 1976). Since there were many infected western hemlock at the site, but no infected shore pine, we assume that the Douglas-fir was infected by the western hemlock pathotype of *A. tsugense*.

Western white pine (*Pinus monticola* Dougl.) is reported as a natural host for *A. tsugense* in association with hemlock in California and Oregon (Hawksworth and Wiens 1972), but in British Columbia, infections are reported only as associated with infected shore pine (Kuijt 1956). We assume these infections are by the hemlock and shore pine dwarf mistletoe pathotypes, respectively. Recently, a single infected western white pine tree was observed in each of three areas: Nanaimo River and Caycuse on Vancouver Island, and West Redonda Island. Also, two infected trees, about 1000m apart, were located after examining 128 western white pine in the Robertson River area on Vancouver Island. All infections were fusiform cankers and witches' brooms were not produced. Two trees had several infections, whereas adjacent western white pines which could have been inoculated from the same inoculum source were free of infection. One of these infections bore typical *A. tsugense* aerial shoots. Cross-sections of some of the other fusiform infections revealed typical *Arceuthobium* sinkers in the host xylem. All four of these stands lacked shore pine, but contained infected western hemlock; hence, we assume that the western white pines were infected by the hemlock pathotype of *A. tsugense*.

Inoculation with both pathotypes of *A. tsugense* produced infection on Interior, but not Coastal Douglas-fir (Smith 1974). This is the first report of natural infection of Douglas-fir by *A. tsugense*. In the same inoculation studies, only the shore pine dwarf mistletoe successfully infected western white pine. The natural infection reported above shows that some individuals of western white pine are also susceptible to the hemlock dwarf mistletoe pathotype in British Columbia. The trees used in the inoculation studies probably are less genetically diverse than could be found in nature (von Rudloff 1973; Hunt and von Rudloff 1977), which could account for dwarf mistletoe host-pathogen combinations occurring in nature that are difficult to produce artificially. Also, several infections in individual trees and the lack of infections in many adjacent trees suggest that infected individuals were genetically susceptible to dwarf mistletoe rather than that a new dwarf mistletoe race was involved. Therefore, these newly reported host-pathogen combinations are probably rare occurrences

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only and would not normally affect management practices relating to dwarf mistletoe control. For example, Douglas-fir should still be considered resistant to hemlock dwarf mistletoe and highly favored for reforestation adjacent to infected hemlock stands (Baranyay and Smith 1972). Even though such host-pathogen possibilities are rare, they should be borne in mind before planting large areas with selected, limited gene pools, as may occur with blister rust resistant trees.

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Distribution and severity of root and leaf diseases and cereal leaf beetle damage of barley in western Ontario

R.V. Clark[1]

Barley fields in western Ontario were surveyed for incidence of root rot and foliage pests from 1972 to 1975. Estimates of the effect of common root rot caused by *Cochliobolus sativus* on barley yields using discoloration of the subcrown internode as a measure of the amount of disease indicated that 4.3 and 0.8% of the crop was lost in 1972 and 1974, respectively. In 1973, an 8.3% increase in yield occurred in plants discolored by root rot. Because of the wide variation in yields and lack of adequate subcrown internodes it would appear that this method of determining root rot damage to barley may not be usable in Ontario. An early season survey in 1975 showed that pathogenic *Pythium* spp. were present in soils but there was no definite evidence of root rot damage from these species. Spot blotch (*C. sativus*) was the most severe and prevalent foliage disease of barley from 1973 to 1975. Scald (*Rhynchosporium secalis*), leaf rust (*Puccinii hordei*) and powdery mildew (*Erysiphe graminis*) occurred irregularly in trace amounts. Damage to the foliage caused by the cereal leaf beetle (*Oulema melanopus*) was minor and decreased each year of the foliage survey.

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De 1972 à 1975, des champs d'orge de l'ouest de l'Ontario ont été examinés sur la fréquence d'apparition des maladies des racines et des feuilles. Les pertes de récolte dues au piétin causé par *Cochliobolus sativus* et mesurées d'après la décoloration de l'entre-noeud situé sous la couronne sont estimées à 4.2 et 0.8% pour les campagnes de 1972 et 1974, respectivement. En 1973, on a noté un accroissement de 8.3% chez les plantes décolorées par le piétin ce qui tient au fait que malgré la présence de souches pathogènes de *Pythium* spp. dans le sol au printemps 1975, elles n'ont pas provoqué de symptômes convaincants de piétin. De 1973 à 1975, c'est l'helminthosporiose (*C. sativus*) qui a été la maladie foliaire la plus répandue et la plus grave de l'orge, la tache pâle (*Rhynchosporium secalis*), la rouille des feuilles (*Puccinia hordei*) et le blanc (*Erysiphe graminis*) se manifestant de façon isolée et sans aucune gravité. Les dégâts occasionnés au feuillage par le criocère des céréales (*Oulema melanopus*) ont été bénins et ont diminué au cours de chacune des années de la période d'observation.

Root rot of cereals caused by the fungus *Cochliobolus sativus* (Ito and Kurib.) Drechsl. ex Dastur, conidial state *Bipolaris sorokiniana* (Sacc. in Sorok.) Shoem., Syn *Helminthosporium sativum* Pamm., King. and Bakke has been investigated for many years in Canada. Recent surveys in western Canada have estimated that 5.7% or 30 million bushels of wheat (4) and 10.3% or 54 million bushels of barley (8) are lost annually in that area because of root rot. These surveys employed discoloration of the subcrown internode as a measure of the root rot present.

Barley grown in pure and in mixed stands with oats is an important crop in Ontario and no surveys to estimate root rot or foliage damage have been made. For this reason, root rot surveys were carried out in western Ontario for 4 years starting in 1972. In 1973-75, surveys were conducted to determine the prevalence and severity of damage to barley foliage caused by diseases and by the cereal leaf beetle. The following report summarizes the data obtained over these 4 years.

Methods

Approximately 60% of Ontario's barley crop (0.3 M ha) is grown in 10 counties in western Ontario (Fig. 1) as pure and mixed stands with oats and almost 50% is concentrated in five counties [Huron, Perth, Wellington, Bruce and Grey (6)] within the larger area. In 1972 and 1973 the surveys covered the 10 counties but were restricted to the five main counties in 1974 and 1975. One field was sampled for approximately every 10,000 ha of barley grown per county (6) with 5 being done for the counties producing the most barley and fewer for those producing less barley. Townships within counties were chosen at random and one field was sampled per township. The root rot discoloration method requires barley plants that are reasonably ripe (mealy ripe) at the time of sampling. In 1972 only one survey was made in a selected field with the crop at the correct stage of growth. In subsequent years an effort was made to do the foliage disease survey and the root rot survey on the same fields. In a few cases this was not possible because of maturity problems and the root rot samples had to be obtained from the most suitable nearby field. Root rot sampling procedures in the field and assessment of plants in the laboratory were similar to those described by Ledingham *et al.* (4) with the exception that all sampling was done on a diagonal line rather than in quadrats and the effect on barley yield was calculated for the surveyed area rather than for individual fields. The formula for determining the effect of root rot on yield was applied as follows:

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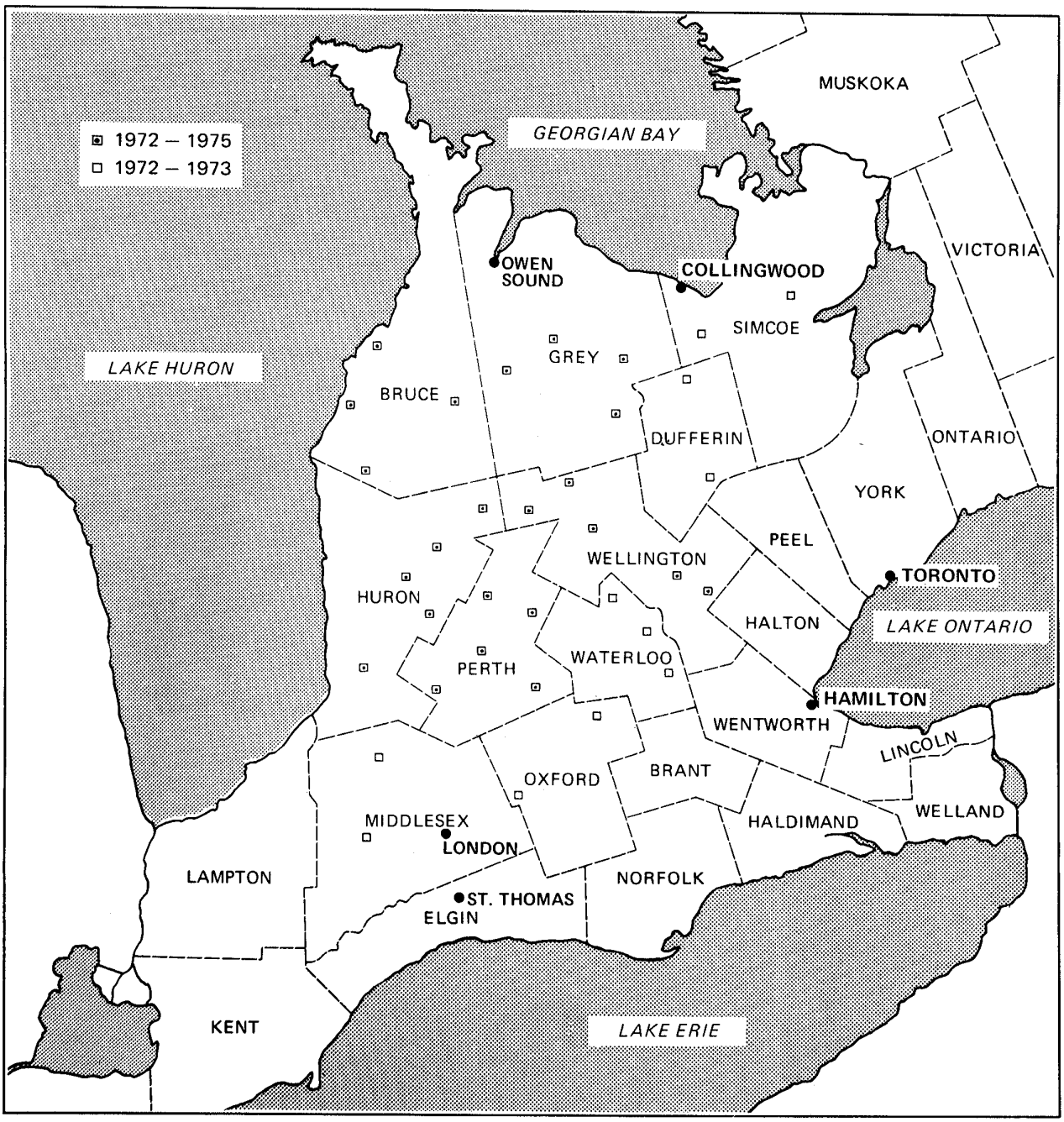

Figure 1. Approximate location of barley fields in western Ontario sampled for root rot and foliage pests from 1972-1975.

$$\text{Effect of yield in \%} = 100 - \left(\frac{\Sigma W}{\Sigma W_1 \times N} \times 100\right)$$

where W is the total weight of grain of all plants rated; W_1, the average weight of grain per plant of all clean plants rated; and N, the total number of plants rated.

In 1975, fields were surveyed in mid-June at the 3-5 leaf growth stage (3) for the presence of disease symptoms that might be caused *Pythium* spp. Sampling was done on a diagonal path starting 25 paces from the edge of each field and an examination of plants was made at 5-pace intervals for 25 times using the plants at the toe of the right foot in each case. Some root

Table 1. The effect of root rot on the yield of barley and barley-oat mixtures grown in western Ontario during 1972 to 1974 using discoloration of the subcrown internode to rate root rot severity

Year	No. of Counties	No. of Fields	No. of Plants examined	% unclassified subcrowns	Yield	
					% Loss	% increase
1972	10	31	5139	45.6	4.3	
1973	10	34	6263	36.7		8.3
1974	5	25	5166	61.8	0.8	

Table 2. The effect of root rot severity on number of heads and yield per plant (g) of barley in the subcrown internode disease categories employed in a survey in western Ontario 1972 to 1974.

Year	Clean		Slight		Moderate		Severe		Unclassified [1]	
	heads	yield	heads	yield	heads	yield	heads	yield	heads	yield
1972	2.5	1.9	2.2	1.7	2.2	1.8	2.3	1.5	2.4	1.8
1973	2.7	1.8	2.7	2.1	2.7	2.3	2.8	2.4	2.4	2.1
1974	2.6	1.7	2.6	1.7	2.6	1.7	2.5	1.5	2.4	1.4
Mean	2.6	1.8	2.5	1.9	2.5	1.9	2.5	1.8	2.4	1.8

[1]Subcrown internode too short to classify.

samples from diseased plants were plated on agar (1) in the field while some yellowed plants and soil were transplated to flats and plated later in the laboratory. A composite soil sample from each field was assessed in the laboratory for the presence of *Pythium* spp. by a bait-plant technique (1).

The foliage disease and cereal leaf beetle surveys were carried out on barley plants from fields that ranged from approximately late-flowering to the milky-ripe stages of growth on the Feekes' scale (3). The fields were sampled as described for the 1975 Pythium survey with one main tiller collected at each 5-pace stop. The top 3 leaves of the 25 tillers per field were examined and the percent leaf area covered by diseases was recorded using the septoria leaf blotch disease key (2) as a guide for estimating the amount of infection.

Results and discussion

Common root rot

The subcrown internode technique was unsuitable for determining damage caused by common root rot in Ontario because the results ranged from a 4.3% yield loss in 1972 to an 8.3% yield increase in 1973 (Table 1). The individual variation in effect of root rot on yield as determined by the yield loss formulae from field to field each year ranged from approximately a 30% decrease to a 30% increase. The yearly figure for effect of root rot on yield had to be determined on bulked samples from all fields because a number of fields each year had no plants in the clean category. The number of plants that had no subcrown internode or one too short to classify was extremely high each year ranging from 37% in 1973 to 62% in 1974 (Table 1). Much of the success of the subcrown internode method for rating root rot depends on the presence of a high percentage of plants from each field having internodes that can be rated. Deep seeding, which is necessary in western Canada, results in the development of long subcrown internodes.

The damage by root rot on the barley plants that could be classified was minimal (Table 2). Only in 1972 was there any measurable decrease in the number of heads and yield per plant due to root rot. In 1973 there was a sizable increase in yield per plant in the diseased categories and those rated as severely diseased had the greatest yield increase. Furthermore, in that year, 63% of the plants had classifiable subcrown internodes so most samples were of a reasonable size. Every year several surveyed fields had no plants with subcrown internodes long enough to classify, probably as a result of shallow seeding.

The above results indicate, that in Ontario, there is a wide variation between barley fields with respect to development of subcrown internodes and response to root rot as determined by the discoloration of internodes. Recent surveys of wheat (4) and barley (8) have been

Table 3. Kinds and frequency of isolation of *Pythium* spp. from plant and soil samples collected in western Ontario in 1975 using both barley and oats as host receptors (1)

Barley		*Oats*	
P. arrhenomanes	(7) [1]	*P. aristosporum*	(5)
P. aristosporum	(7)	*P. volutum*	(2)
P. tardicrescens	(1)	*P. arrhenomanes*	(1)
Pythium spp.	(3)	*P. irregulare*	(1)
		P. torulosum	(1)
		P. tardicrescens	(1)
		Pythium spp.	(2)

[1]Comparative frequency of isolation.

done in western Canada using the same method for rating root rot and a similar wide variation was present in the results from Manitoba, especially with barley. There, the calculated effects on yield based on an average 2-3 fields per crop district also ranged from a 35% decrease to a 26% increase (8). However, their results were determined on individual field samples whereas the Ontario samples had to be bulked, as noted previously. Because of the wide variation in yields within and between surveys, the reliability of the root rot data and the use of the subcrown internode method for rating disease in barley in Ontario and probably Manitoba is questionable. Furthermore, it is quite possible that the principal fungus causing root rot of barley in Ontario may be different to that causing it in Saskatchewan and Alberta.

A sizeable portion of the barley crop in Ontario is grown as mixtures with oats and in a few cases a small percentage of wheat also is included. Only two mixed fields were surveyed in 1972 but 20 and 35% of the fields surveyed in 1973 and 1974 contained mixtures. The estimated effects of root rot on yield of barley from these fields were yield increases of 15.1 and 3.8% respectively, indicating that root rot behaviour in mixed stands of grain may differ from that in pure stands of barley. This may be an added complicating factor in the use of the subcrown internode method for determining root rot damage and yield loss of barley in Ontario.

Pythium root rot

In 1975, twenty-four fields were surveyed for Pythium root rot and particular attention was paid to symptoms such as yellowing and stunting. Yellowing of leaves was observed in 11 fields, principally in trace amounts on the bottom leaf. However, it was general on all leaves in 3 late-seeded fields where the plants were in the 3rd leaf stage when surveyed. Transplants of these yellowed plants did not produce *Phythium* spp. It was concluded that the symptoms produced in these 3 fields were caused by a corn herbicide applied to the fields the previous year. *Pythium* spp. were isolated from plant and root material obtained from 5 of the remaining 8 fields having plants with yellow leaf symptoms. These plants were found mostly in a few low areas in the fields; in one case the crop was growing next to a swamp with an obviously high water table.

The leaf yellowing was at times associated with dark brown spotting of the leaves and dark brown lesioning of the crown areas of the barley plants. These symptoms were largely due to *C. sativus*. Plants with such symptoms were collected from 8 fields and 5 of them were infected with the above fungus when samples were placed in a humidity chamber. In general, it was concluded that Pythium-like symptoms were not prevalent in the field and where they were present they were associated with high moisture levels.

The soil sample collected from each of the above fields was assayed for pathogens using both barley and oat test plants (1). A number of *Pythium* spp. were isolated from 14 of the samples and *P. aristosporum* Vanterpool and *P. arrhenomanes* Drechsler occurred most frequently (Table 3). Obviously *Pythium* spp. are plentiful in the soil in these fields and possibly could have caused damage during extended periods of excessive moisture in poorly drained soil. McKeen (5) has suggested that Pythium root rot damage may be of major importance in barley in southwestern Ontario. Our results do not support this suggestion. However, additional surveys are needed, especially during a wet season, to determine whether *Pythium* root rot is an important disease of barley in this area.

Foliage diseases

The foliage disease surveys of barley were done on the same fields as the root rot surveys wherever possible. Spot blotch caused by *C. sativus* was consistently the most prevalent disease occurring in all fields sampled each year (Table 4). There were wide annual variations in severity with 26.2, 2.8 and 5.6% of leaf area infected from 1973 to 1975 respectively. There was also a wide variation in severity from field to field (Table 5) partly influenced by the age of the plants and partly by environmental conditions. Spot blotch developed very quickly toward maturity when wet weather prevailed (Table 5) and fields with slightly older plants had considerably more disease present as recorded in 1973. Variable weather also affected the severity of disease development as frequent heavy rainstorms occurred

Table 4. The number of fields with infected plants and % severity of damage to foliage of barley caused by diseases and insects in western Ontario 1973-75 [1]

Diseases	1973		1974		1975	
	No. of Fields	% severity	No. of Fields	% severity	No. of Fields	% severity
Spot blotch (*Cochliobolus sativus*)	34	26.2	25	2.8	25	5.6
Scald (*Rhynchosporium secalis*)	6	Tr	11	2.3	7	Tr
Septoria (*Septoria passerinii*)	2	Tr	5	Tr	7	Tr
Leaf rust (*Puccinia hordei*)	15	1.3	7	Tr		
Mildew (*Erysiphe graminis*)	4	Tr				
Leaf Beetle (*Oulema melanopus*)	34	2.1	20	1.4	10	Tr

[1]Number of fields surveyed 1973 - 34, 1974 - 25, and 1975 - 25.

Table 5. The range and average spot blotch (*C. sativus*) infection in percent between individual fields and age of barley surveyed in western Ontario 1973-75

Year	No. of Fields	Range of infection %	Average infection %	Host maturity [1]
1973	34	2.1 - 68.8	26.2	11.0
1974	25	0.3 - 11.1	2.8	10.8
1975	25	0.2 - 23.7	5.6	10.9

[1]Feekes' host maturity scale (3).

throughout the survey area during July each year. Their occurrence was quite intermittent and very localized resulting in wide differences in the duration of leaf wetness which caused wide differences in spot blotch severity regardless of age or host.

Plant samples having dark brown crowns and lower leaf tissues were collected occasionally during the foliage surveys. Subsequent isolation and sporulation tests on agar showed that the spot blotch fungus was present on most tissues indicating an abundance of secondary inoculum.

Pure and mixed barley and oat stands and different barley cultivars also appeared to affect the severity of spot blotch (Table 6). The reduced development of spot blotch in barley grown in mixed stands with oats is possibly one reason why much of the barley in western Ontario is grown in mixed stands. Mixed barley and oats outyielded both pure barley and pure oats in western Ontario each year over the five year period 1971-75 by an average 13% and 10%, respectively (7).

Other leaf diseases were observed only in trace amounts. In 1973, leaf rust (*Puccinia hordei* Otth) was widespread while in 1974 scald [*Rhynchosporium secalis*, (Oud.) Davis] was found in half of the fields surveyed (Table 4). The minor diseases occurred regionally to some extent with scald and septoria (*S. passerinii* Sacc.) being found in cooler areas close to Lake Huron and in the northern counties of Bruce and Grey. Leaf rust was found more frequently in southern fields which accounted for its apparent prevalence in 1973 as more southern fields were sampled that year. Powdery mildew (*Erysiphe graminis* DC ex Merat.) was restricted to a

Table 6. The range and average spot blotch (*C. sativus*) infection in percent in fields of mixed barley and oats and of 3 cultivars of pure barley in western Ontario in 1975

Cultivar	No. of Fields	Range of infection %	Average infection %
Herta (mixed)	11	1.1 - 11.0	4.5
Herta (pure)	6	6.2 - 23.7	11.3
Conquest (pure)	4	0.2 - 1.3	0.7
Trent (pure)	2	1.2 - 11.5	6.3

small area in eastern Wellington county around Guelph. Damage by the cereal leaf beetle (*Oulema melanopus* L.) was widespread each year but it never occurred in more than trace amounts and the damage decreased in prevalence each year of the survey (Table 4).

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