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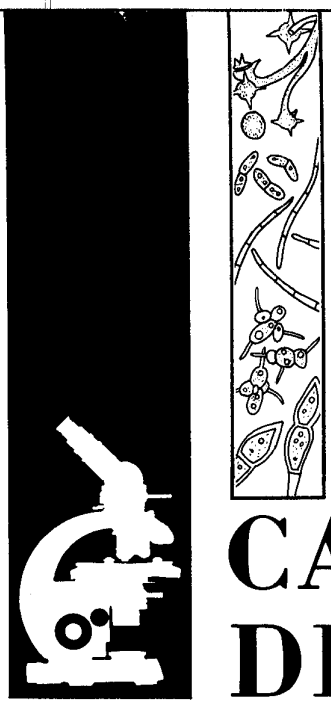

CANADIAN PLANT DISEASE SURVEY

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CANADIAN PLANT DISEASE SURVEY

RESEARCH BRANCH CANADA DEPARTMENT OF AGRICULTURE

CONTENTS

"The Canadian Plant Disease Survey is a periodical of information and record on the occurrence and severity of plant diseases in Canada. It will also accept other original information such as the development of methods of investigation and control, including the evaluation of new materials. Review papers and compilations of practical value to phytopathologists will be included from time to time."

VOL. 53, NO. 1, CAN. PLANT DIS. SURV. MARCH, 1973

CROWN ROT OF APPLE TREES IN NOVA SCOTIA[1]

R.G. Ross and C.O. Gourley

Abstract

Crown rot of apple trees caused by Phytophthora cactorum is reported for the first time in Nova Scotia. The extent of the disease is not known but the fungus is widespread in orchard soils. In attempts to isolate P. cactorum by inserting diseased bark into pear fruit a diversity of fungi was obtained. P. cactorum was isolated from the bark of apple trees exhibiting the symptoms of crown rot and was pathogenic to apple bark. Pencillium expansum produced cankers on apple seedlings and detached twigs. Fusarium oxysporum caused cankers on the latter.

Introduction

In Nova Scotia there have been serious losses in recent years of young apple trees from crown or root troubles which did not appear to be due to unfavorable soil or climatic conditions. No extensive survey of losses was done but in some orchards up to 25% of the trees had died. Most losses occurred in orchards just coming into bearing and included trees on both seedling rootstocks and the Malling series of clonal rootstocks. The syndrome of affected trees was similar to collar or crown rot caused by Phytophthora cactorum (Leb. and Cohn.) Schroet, which has not heretofore been reported on apple trees in Nova Scotia. Many fungi were encountered when attempts were made to isolate P. cactorum from soil and from dying trees.

The fungi isolated and some studies on their pathological characteristics are reported in this paper.

Isolation of fungi

Attempts to isolate P. cactorum from diseased areas of roots and crowns of apple trees by inserting strips of bark into the flesh of apple or pear fruits were unsuccessful. Numerous rots developed in the fruits and isolations onto potato-dextrose agar (PDA) yielded a diversity of fungi. Bark from 4- to 5-year-old Wayne apple trees on seedling rootstock collected in September 1969 and irrigated in running tap water for 2 days before being inserted into pear fruits yielded Monilinia fructicola (Wint.) Honey (IMI 164415), Botryospheria obtusa (Schw.) Shoem., Fusarium roseum Lk., Botrytis sp., and Monilinia laxa (Alderh. and Ruhl.) Honey. However, bark from these trees collected in October but not irrigated before insertion into pear fruits yielded Alternaria alternata (Fr.) Keissler, Botrytis cinerea Pers., Fusarium oxysporum Schlecht., Trichoderma sp., Fusarium solani (Mart.) App. and Wr. and Cytospora ambiens Sacc. Similarly bark collected in October from 8-to 9-year-old McIntosh trees on MM104 rootstock yielded Phomopsis sp. (stat. perf. Diaporthe eres Nit.), Penicillium expansum Link ex S. F. Gray (IMI 158108), A. alternata, and a bacterium. In June and July 1970, bark from the Wayne and McIntosh trees, which were located in widely separated orchards, and from Spartan apple trees on seedling rootstock in another orchard yielded only P. expansum when inserted into apple fruit.

Inoculation experiments

In 1969, Phytophthora cactorum was isolated from decayed apples collected from the ground and from apples on lower limbs and in contact with the ground in the Wayne and McIntosh orchards and in several other orchards in which the trees had no apparent crown or root troubles. Subsequently in 1970 soil samples from the infected root and crown zones of the Wayne and McIntosh trees were puddled in shallow pans and apple fruit from the previous year's crop were placed on the surface. P. cactorum was isolated from the soil from the McIntosh orchard but not from the Wayne orchard.

In September 1970, a selective medium (2) was used to isolate P. cactorum from diseased bark. It contained cornmeal agar (Difco, 17 g/liter) supplemented with pimaricin, penicillin "G"-potassium and polymixin B sulphate at 100, 50, and 50 ppm, respectively. Strips of diseased bark were

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irrigated in running tap water for at least 2 days, and sections plated on the medium. Isolations were attempted from 19 trees of various cultivars on a variety of rootstocks. P. cactorum was isolated from 4 trees. One was a McIntosh on MM104 rootstock in the orchard referred to above, and the other 3 were Greening on MVII rootstock from another orchard. The Wayne trees did not yield P. cactorum.

Seedlings

On March 31, 1971, dormant 1-year-old Beautiful Arcade apple seedlings were removed from storage, their roots washed free of soil, and a longitudinal incision about 10 mm long and 2 mm deep was made with a flamed scalpel in the stem just above the roots. Groups of these seedlings were inoculated with P. cactorum from cornmeal agar or with P. expansum or F. oxysporum from PDA by inserting a 3 mm agar plug containing fungus mycelium under the flap of bark which was pressed down and held in place with a single layer of masking tape. Controls consisted of seedlings with a plug of sterile agar medium inserted under the flap and seedlings in which no incision was made. Excess roots were cut off and the seedlings pruned back to about 30 cm of stem. They were then potted in a mixture of soil, peat and sand (1:2:1) plus nutrients in 15 cm clay pots so that the incisions were below the surface of the mixture. The potted seedlings were placed in the greenhouse and watered twice daily.

One month after the initial inoculation, inoculum consisting of agar plugs of P. cactorum was placed over the incision flap of four seedlings that had been inoculated with P. expansum and four that had been inoculated with F. oxysporum. The soil was withdrawn from around the original point of inoculation, the tape removed, a plug of inoculum placed over the incised area, retaped, and the soil replaced. Similarly inoculum of P. expansum and F. oxysporum was placed over the flaps of seedlings initially inoculated with P. cactorum. This procedure was repeated on a different group of four seedlings 2 months after the initial inoculation. Four inoculated seedlings for each fungus were left undisturbed.

Two seedlings initially inoculated with P. expansum and two inoculated with P. cactorum did not leaf out. They were removed and examined 35 days after inoculation. Suckers were coming up from the roots of the P. expansum seedlings but not from the roots of those inoculated with P. cactorum. The inoculated area of one P. expansum inoculated seedling was surrounded by a sunken canker 28 mm in length which almost encircled the stem. Underneath the canker was a concave area of brown decayed tissue extending almost through the stem. The other seedling had a canker 45 mm long which encircled the stem but was not sunken. The two P. cactorum inoculated seedlings had decayed areas about 40 mm long girdling the stems.

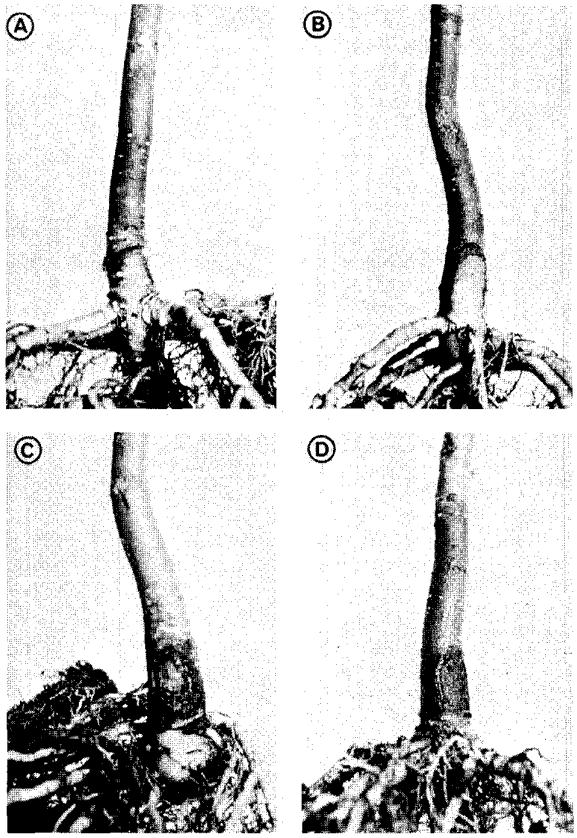

Figure 1. Beautiful Arcade apple seedlings 1 month after inoculation: A) agar plug; B) *Fusarium oxysporum;* C) *Penicillium expansum;* D) *Phytophthora cactorum.*

One month after the initial inoculations, damage from P. expansum was more severe than from P. cactorum (Figure 1). P. cactorum cankers were not sunken and usually not extensive, although cankers on a few of these seedlings half encircled the stems. P. expansum cankers were sunken with definite margins and were about 13 mm wide and up to 25 mm long. Incisions on the seedlings inoculated with F. oxysporum appeared to be completely healed.

Five months after the initial inoculations all seedlings were removed from the pots and examined. Except for some slight callousing where P. expansum had been placed over P. cactorum inoculations there were no obvious differences between seedlings that had been inoculated with P. cactorum alone and seedlings where at 1 and 2 months inoculum of P. expansum or F. oxysporum had been placed on P. cactorum cankers. Likewise placing P. cactorum on wood inoculated with P. expansum or F. oxysporum had no obvious effect. Most seedlings inoculated with P. cactorum alone appeared healthy except for a

brown film of dead tissue over previously cankered areas, which readily sloughed off revealing healthy tissue. Where complete girdling had occurred the roots below the canker were usually dead and new roots had developed above the canker. Considerable callus tissue had formed around the deep sunken P. expansum cankers which resembled those already described. Dead wood extended through 2/3 of the stem and the core was brown or discolored for 2 or 3 cm above and below the cankers. Seedlings inoculated with F. oxysporum appeared to be completely healed but on dissection there was often a shallow area of discoloration below the areas of inoculation.

Isolations for P. expansum and F. oxysporum were made on PDA and for P. cactorum on the selective medium (2). Only 3 of the 36 seedlings inoculated with P. cactorum yielded P. cactorum on reisolation. Two were seedlings where P. expansum had been placed over P. cactorum cankers at 1 month and the other was a seedling where P. expansum had been added at 2 months. P. expansum was readily reisolated from the edges of surface cankers and from the internal decayed or discolored areas of all seedlings in which it had been placed. F. oxysporum was recovered from the discolored areas below the inoculation point from about 2/3 of the seedlings inoculated with this organism.

Detached twigs

On January 27, 1971, terminal shoots from dormant apple trees were cut into 14 cm lengths and inoculated by replacing a 3 mm bark disc with a disc of fungus mycelium in the agar medium used in inoculating seedlings (4). Four shoots of each cultivar were inoculated with P. cactorum and one with P. expansum and F. oxysporum. The experiment was repeated on twigs collected April 1, 1971, except that two shoots of each cultivar were used for each of the latter two fungi. Each inoculated twig was placed in a metal capped test tube containing 4 cm of water and incubated at room temperature. Controls consisted of twigs with sterile agar plugs. Four weeks after inoculation the lesion lengths (Figure 2) were recorded and the twigs that had been inoculated with P. cactorum were laid on the surface of the Phytophthora-selective medium. After 4 days the distance along the shoot from which P. cactorum emerged to form a colony was measured. Isolations from P. expansum- and F. oxysporum-inoculated shoots were made on PDA and since sunken cankers with definite margins were formed by these fungi it was possible to measure their length.

On the Phytophthora-selective medium P. cactorum grew from all shoots except two of MM104 inoculated in January. Uninoculated and inoculated shoots of MM104 standing in water became heavily colonized by a variety of fungi whereas shoots of the other cultivars were relatively free of these

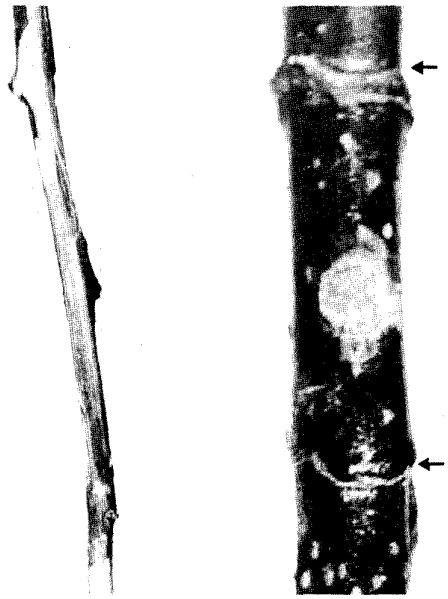

Figure 2. *Left* – Lesion produced by *Phytophthora cactorum* on Beautiful Arcade apple shoot. The bark has been removed to show internal discoloration. *Right* – Canker produced by *Penicillium expansum* on McIntosh apple shoot (arrows delimit edges of canker).

colonizers. With a few shoots it took longer than 4 days for P. cactorum to emerge and their measurements were not included in the average length of colonies given in Table 1. P. expansum and F. oxysporum were also readily reisolated from the edges of the cankers produced by these organisms and isolations from the lesioned areas which extended in the wood at various distances from the definite sunken cankers were usually positive for the appropriate fungus.

Discussion

These investigations show that crown rot of apple trees caused by P. cactorum is present in Nova Scotia. As in British Columbia (5) it appears to be confined to the near ground level portion of the tree. In some areas P. cactorum causes trunk cankers to above ground parts of apple trees (1) but this type of canker has not been identified in Nova Scotia. This preliminary work does not give any indication of the extent of the disease or what proportion of tree losses might be due to P. cactorum. It does, however, show that the fungus is widespread and points out the danger of using rootstocks susceptible to P. cactorum (3).

In attempts to isolate P. cactorum by placing bark samples in pear or apple fruit a number of fungi was obtained. This method obviously isolates only the organisms most aggressive in the fruit. It is interesting that in pear fruits an entirely different

Table 1. Length (mm) of lesions and cankers on apple shoots 4 weeks after inoculation with fungi associated with crown rot

Cultivar	*Phytophthora cactorum*		*Penicillium expansum*		*Fusarium oxysporum*	
	Lesion	Colony emergence*	Canker	Lesion	Canker	Lesion
		January 27 inoculations				
McIntosh	81	84	11	10	9	12
Cortland	15	23	6	7	11	16
Red Spy	48	43	6	8	7	8
Gravenstein	79	73	6	8	14	10
Beautiful Arcade	100	84	9	9	4	10
MM 104**	108	30	30	138	13	90
		April 1 inoculations				
McIntosh	125	103	21	111	6	45
Cortland	81	119	20	81	7	8
Red Spy	123	104	18	76	4	9
Gravenstein	44	114	17	140	10	24
Beautiful Arcade	67	88	10	76	4	5
MM 104**	126	110	15	120	7	126

* Distance along shoot that *P. cactorum* emerged on culture medium.

** Shoots of MM 104 were heavily colonized by other fungi.

group of fungi was recovered from irrigated Wayne bark in September than from non-irrigated bark in October 1969. In 1970 when apple fruits were used, P. expansum was the only organism recovered from diseased trees in three different orchards.

When P. expansum was inoculated into Beautiful Arcade apple seedlings, it was an aggressive wood invader, suggesting that it may be a primary or secondary parasite which decays the wood following or prior to initial infection by P. cactorum. F. oxysporum caused some discoloration of the crowns but did not cause a definite canker. The Nova Scotia isolate of P. cactorum was pathogenic on the seedlings but after 5 months most cankers had healed. Welsh (5) found that high soil moisture is necessary for crown rot development. With increasing temperatures in the greenhouse during the spring months, alternate wetting and drying of the upper layers of the soil in the pots may have arrested disease development. This may have also arrested the penetration of P. expansum.

The data on the detached twig inoculations (Table 1) suggest that wood taken in April is more susceptible to invasion by P. cactorum and P. expansum than wood collected in January. With this technique F. oxysporum and P. expansum produced definite sunken cankers and invaded the wood beyond the edges of these cankers. The high susceptibility of MM104 to P. cactorum (3) may in some way be correlated with its susceptibility to secondary invaders.

Acknowledgments

The assistance and advice of Dr. D. L. McIntosh in isolating P. cactorum from apple trees is gratefully acknowledged.

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EFFECT OF 2-(THIOCYANOMETHYLTHIO) BENZOTHIAZOLE (TCMTB) ON EMERGENCE AND GERMINATION OF CEREALS, FLAX, AND RAPE[1]

J.T. Mills[2] and W.H. Silversides[3]

Abstract

Three formulations of 2-(thiocyanomethylthio) benzothiazole (TCMTB) liquid, including Busan (Buckman Laboratories) liquid, were tested for effects on germination and emergence at varying dosages on each of seven seed crops of differing bushel weights. Tests were made under laboratory and greenhouse conditions and in the field at Winnipeg, Morden, and Brandon, Manitoba. TCMTB used on wheat, oats, and barley at the recommended field rate of 0.75 oz/bu, resulted in increased abnormal germination on moist filter paper and reduced seedling emergence in sterile soil. Emergence of rye, rape, flax, and corn was variable in sterile soil. Use of TCMTB 30EC (Busan 30EC) and 30IP at 0.75 and 1.00 oz/bu resulted in decreased emergence in the field of two lots of Manitou wheat and one lot each of Betzes and Conquest barley, Cougar rye, and Redwood 65 flax compared to the respective controls. A slight reduction in emergence may not seriously affect the amount of grain harvested as it is compensated for by increased tillering. However, further work does appear warranted on dosage rates and alternative formulations.

Introduction

In Canada seed- and soil-borne diseases can cause serious losses which may be reduced through the use of chemical seed treatments. Treatment chemicals containing mercury are presently being phased out in Canadian agriculture and are being replaced by treatments of lesser toxicity. Many of these compounds are formulated either as slurries or as liquids so that they can be used in seed treatment plants that formerly utilized liquid mercurial treatments. This is particularly true in Alberta. One of the replacement compounds is Busan 30EC liquid (P.C.P. No. 11,261), also known as TCMTB 30EC, manufactured by Interprovincial Cooperatives Ltd. of Winnipeg from technical material supplied by Buckman Laboratories, Memphis, Tennessee. TCMTB has been included in cereal seed treatment trials previously carried out in Canada (5,6,7), but no extensive laboratory or field trials with a variety of crops have been made. It was considered important to obtain data on this new product as it could be used extensively throughout the Prairie region. Busan 30EC is claimed to control bunt of wheat, false loose smut and covered smut of barley, loose and covered smuts of oats, and seed- and soil-borne seedling blights (seed-borne root rots) of wheat, barley, and oats. This paper describes the results of germination and emergence trials using several formulations of TCMTB at varying dosages on seed crops of differing bushel weights under greenhouse and field conditions. The effectiveness of TCMTB for control of disease is described elsewhere (3).

Materials and methods

Most of the greenhouse and laboratory tests were with TCMTB 30EC (Busan 30EC), an emulsifiable concentrate formulation containing 30% 2-(thiocyanomethylthio) benzothiazole, an emulsifier (X 193 Rohm & Haas), cyclohexanone, plus 0.2% rhodamine B concentrate dye. The field tests with all crops and the laboratory and greenhouse tests with winter wheat (Triticum aestivum L.) were with either TCMTB 30EC plus 1% rhodamine B dye or TCMTB 30IP plus 1% rhodamine B dye, a formulation containing 30% 2-(thiocyanomethylthio) benzothiazole with 10% isopropyl alcohol.

The bushel weight and source of cultivars used are given in Table 1. Barley (Hordeum vulgare L.), wheat, and oat (Avena sativa L.) seed was generally screened before use. Peeling was most severe in Conquest lot F,

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Table 1. Source and bushel weights of seed lots used to test the effects of TCMTB on emergence and germination

Seed lot code*	Crop	Cultivar	Source	Weight (lb/bu)
A	Barley	Betzes	Saskatoon, Sask.	44.0
B	Barley	Betzes	Saskatoon, Sask.	48.0
C**	Barley	Betzes	Saskatoon, Sask.	54.0
D	Barley	Conquest	Saskatoon, Sask.	46.5
E	Barley	Conquest	Saskatoon, Sask.	48.0
F**	Barley	Conquest	Saskatoon, Sask.	54.0
G**	Spring wheat	Manitou	Saskatoon, Sask.	61.0
H	Spring wheat	Manitou	Saskatoon, Sask.	63.0
I**	Spring wheat	Manitou	Saskatoon, Sask.	65.5
J	Spring wheat	Neepawa	Saskatoon, Sask.	65.0
K**	Oats	Harmon	Winnipeg, Man.	42.5
L	Oats	Harmon	Saskatoon, Sask.	42.0
M	Oats	Harmon	Saskatoon, Sask.	43.5
N**	Oats	Kelsey	Winnipeg, Man.	40.5
O	Rape	Target	Strathclair, Man.	54.0
P**	Rape	Arlo	Strathclair, Man.	54.0
Q**	Rape	Span	Strathclair, Man.	55.0
R	Corn	Unknown	Toronto, Ont.	64.0
S	Corn	Unknown	Toronto, Ont.	63.0
T	Corn	Unknown	Toronto, Ont.	63.5
U	Corn	Unknown	Toronto, Ont.	63.0
V**	Rye	Frontier	Winnipeg, Man.	58.0
W**	Rye	Cougar	Winnipeg, Man.	59.0
X**	Flax	Noralta	Winnipeg, Man.	54.0
Y	Flax	Raja	Winnipeg, Man.	52.0
Z**	Flax	Redwood 65	Winnipeg, Man.	53.0
AA	Winter wheat	Winalta	Lethbridge, Alta.	67.5
BB***	Corn	Morden CM7	Morden, Man.	63.0
CC***	Corn	Morden W219	Morden, Man.	63.5

* A to Z and AA used in laboratory and greenhouse tests.

** Also used in field tests.

*** Used in field tests only.

Table 2. Dosages of TCMTB in fluid ounces per bushel used in laboratory, greenhouse, and field tests

*Laboratory & greenhouse tests**	
Spring wheat, barley:	0.50, 0.75, 1.00, 1.25, 1.50, 3.00, 6.00
Winter wheat :	0.50, 0.75, 1.00, 1.25, 1.50, 3.00
Oats :	0.50, 0.75, 1.00, 1.25, 1.50
Rye :	0.50, 0.75, 1.00, 1.25, 1.50, 3.00
Rape :	0.50, 0.75, 1.00, 1.50, 2.00, 2.50
Flax :	0.42, 0.56, 0.84, 1.12, 1.68
Corn :	1.12, 1.40, 1.68, 2.24, 2.80
*Field tests***	
Spring wheat, barley, oats, flax:	0.75, 1.00
Rye :	0.50, 0.75
Rape :	1.50, 2.50
Corn :	1.12, 1.40

* In laboratory and greenhouse tests, the formulation used for all crops except winter wheat was TCMTB 30EC containing 0.2% rhodamine B dye; for winter wheat the formulations were TCMTB 30EC containing 1.0% rhodamine B dye, and TCMTB 30IP containing 1.0% rhodamine B dye and 10% isopropyl alcohol.

** In the field tests the formulations were TCMTB 30EC containing 1.0% rhodamine B dye, and TCMTB 30IP containing 1.0% rhodamine B dye and 10% isopropyl alcohol.

less severe in Betzes lot C and only slight in the other barley lots. For treatment, the appropriate quantity of TCMTB was pipetted onto the inside wall of a 1-liter glass jar, which was then rotated to spread the fungicide as evenly as possible. Two hundred grams of seed were added, and after sealing the jar was thoroughly shaken to ensure even coverage of the seed. The dosages used for all tests are given in Table 2. The treated seeds were left in the jars for at least 24 hours at 15C before removal.

Germination tests were carried out in the laboratory on filter paper and in greenhouse and field soil. On filter paper 100 treated or untreated seeds were used, 25 seeds in each of four petri dishes; for corn (Zea mays L.) there were 10 seeds per dish. Each 100-mm diameter dish contained a 90-mm no. 3 Whatman filter paper disc moistened with 5 ml distilled water for wheat, 6 ml for oats, 5 or 6 ml for barley, 5 ml for corn, and 4 or 5 ml for rye (Secale cereale L.), flax (Linum usitatissimum L.), and rape (Brassica campestris L.). Germination was assessed after 7 days at 25 C and was considered abnormal if the seedling did not have a shoot and three roots.

In greenhouse soil, 100 seeds of each treatment were used, 10 seeds per 7.6 cm (3 inch) diameter peat pot. The soil was a 3:1 mix of soil and sand sterilized moist at 116 C (240 F) for 48 hr and left to cool for 24 hr before use. Seeds were sown 3.75 cm (1.5 inches) deep. Pots were randomized in a growth cabinet at 16 C or on a greenhouse bench at 18-25 C. Fluorescent lights on a 15-hr photoperiod were placed 50 cm (20 inches) above the tallest leaves. Emergence and germination were assessed 21 days after seeding.

In the field tests, there were four treatments and a control for each of two seed lots of spring wheat, barley, oats, rye, rape, flax and corn. The four treatments for each seed lot were two formulations at each of two dosages. Treatments were sown in 12-ft randomized rows in four replicates at Brandon, Morden, and Winnipeg on May 1, 11, and 16, 1972, respectively. Emergence was rated 3 weeks after sowing.

Table 3. Total and abnormal germination of different seed lots of screened, untreated and TCMTB-treated spring wheat, barley, and oats after 7 days on filter paper in the laboratory

Dosage**	Barley						Wheat				Oats			
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
	*Total germination**													
Control	100	99	91	98	100	88	96	98	99	91	100	99	95	98
0.50	98	95	87	92	97	88	95	98	98	93	98	96	96	95
0.75	98	90	86	97	97	79	97	97	99	93	95	98	89	91
1.00							98	73	96	90	94	95	82	91
1.25							100	98	91	88	93	93	89	83
1.50	59	66	71	83	89	56	91	94	91	90	93	77	67	71
	*Abnormal germination**													
Control	3	3	6	2	1	6	1	1	0	0	0	0	2	3
0.50	7	10	13	3	2	10	0	1	0	2	1	5	1	7
0.75	8	7	14	7	8	9	2	0	0	2	3	9	7	14
1.00							1	0	0	0	5	6	7	12
1.25							0	0	2	1	4	9	6	13
1.50	17	29	28	19	11	17	5	0	2	1	10	10	16	12

* Total and abnormal germination based on four replicates each of 25 seeds.

** Note: Tables 3-7, dosages in fluid oz/bu; see Table 2.

Results and discussion

Wheat, oats, barley, and rye

On filter paper, germination of seed treated with TCMTB 30EC + 0.2% dye at dosages of up to 0.75 oz/bu for barley, 1.50 oz/bu for spring wheat, and 1.25 oz/bu for oats and rye was generally similar to the untreated controls (Tables 3,4). However the percent abnormal germination at the recommended dosage rate of 0.75 oz/bu was higher than in the control in 12 out of 14 tests (Table 3). At and above 1.50 oz/bu there was evidence for reduced germination and increased abnormal germination in barley and oat samples. Germination of winter wheat seed treated with up to and including 1.25 oz/bu of the TCMTB 30EC + 1% of dye or 30IP + 1% dye was generally similar to that of the untreated controls; at 3.00 oz/bu, germination was sharply reduced (data on winter wheat are not given in the tables).

In sterilized soil in the greenhouse, there was slightly reduced emergence in spring wheat, barley, and oats treated with TCMTB 30EC + 0.2% dye at 0.75 oz/bu. Compared to the control, emergence was lower in 11 out of 23 tests, higher in 7 out of 23, and the same in 5 tests at this dosage. At the 3.00 and 6.00 oz/bu rates there was a large decrease in emergence of barley and spring wheat in a growth cabinet (Table 5). Rye treated above 0.50 oz/bu showed evidence of reduced emergence (Table 6). Data on emergence of treated winter wheat seed in sterilized soil were generally similar to those of the controls up to and including

Table 4. Total and abnormal germination of different seed lots of untreated and TCMTB-treated rape, flax, corn, and rye seed after 7 days on filter paper in the laboratory

*Total germination**

Rape				Flax			
Dosage	O	P	Q	Dosage	X	Y	Z
Control	99	88	100	Control	100	98	98
0.50	96	78	100	0.42	100	99	95
0.75	97	85	100	0.56	98	94	98
1.00	94	85	100	0.84	99	97	98
1.50	96	83	98	1.12	98	97	98
2.00	98	78	98	1.68	98	98	91
2.50	97	68	99				

*Total germination**

Corn					Rye		
Dosage	R	S	T	U	Dosage	V	W
Control	93	99	93	99	Control	34	95
1.12	94	82	91	100	0.50	34	94
1.40	80	96	93	97	0.75	51	94
1.68	92	93	94	98	1.00	30	91
2.24	94	94	91	97	1.25	31	92
2.80	87	84	83	88	1.50	24	87
					3.00	18	86

*Abnormal germination**

Corn					Rye		
Dosage	R	S	T	U	Dosage	V	W
Control	33	31	11	18	Control	1	3
1.12	35	33	14	16	0.50	3	2
1.40	22	44	10	11	0.75	10	1
1.68	24	30	16	13	1.00	6	6
2.24	30	34	16	20	1.25	3	4
2.80	38	39	15	26	1.50	8	3
					3.00	1	2

* Total and abnormal germination based on four replicates each of 25 seeds (corn 10 replicates each of 10 seeds).

Table 5. Emergence of different seed lots of untreated and TCMTB-treated wheat, barley, and oats after 21 days in soil in greenhouse or growth cabinet

Unscreened seed (growth cabinet)

	Barley						Wheat		
Dosage	A	B	C	D	E	F	G	H	I
	*Total emergence**								
Control	95	100	88	98	99	98	94	99	93
0.50	99	96	91	99	98	98	94	99	92
0.75	98	95	94	98	99	96	93	96	92
1.50	96	97	91	93	93	95	92	86	89
3.00	74	75	76	75	62	82	72	69	31
6.00	29	29	29	42	33	54	44	30	5

Screened seed (greenhouse)

	Barley						Wheat				Oats			
Dosage	A	B	C	D	E	F	G	H	I	J	K	L	M	N
	*Total emergence**													
Control	98	99	84	99	99	99	96	98	95	85	99	100	100	100
0.50	100	97	92	96	97	96	95	98	97	90	100	100	96	99
0.75	97	100	91	99	95	97	93	100	98	87	99	100	98	99
1.00	95	97	92	95	95	93	91	96	98	87	100	99	99	99
1.25	91	97	89	94	96	92	98	96	92	91	100	100	98	100
1.50	97	93	92	97	95	94	97	97	85	86	99	97	99	100

* Total of 10 replicates each of 10 seeds.

dosages of 1.00 oz/bu TCMTB 30EC + 1% dye or 30IP + 1% dye; at 3.00 oz/bu emergence was sharply reduced.

In field soil (Table 7) emergence of spring wheat, barley, and rye (seed lot V) was significantly reduced at all stations after treatment with TCMTB 30EC or 30IP + 1% dye at 0.75 (the recommended dosage) and 1.00 oz/bu. There were no sigificant differences between treatments and respective controls in rye (seed lot W) and oats. The poor emergence of both rye samples in field soil was probably due to badly shrivelled seed. In particular, seed of Frontier rye (seed lot V, Table 1) had considerable embryo exposure due to cracks in the pericarp that could have allowed invasion by soil microorganisms and thus reduced germination. A reduction in emergence of wheat treated with TCMTB was also noted by Hansing et al. (1), who found reduced emergence in field soils from bunt-infested wheat seed treated with 2.00 oz/bu TCMTB 30EC + 0.2% dye, when compared to untreated infested seed. Recent work at Lacombe (2) and at Swift Current (4) with barley and wheat respectively have shown that highest yields were obtained with low seeding rates. At Swift Current (4) it was found that the plant population differences resulting from variations in seeding rate were largely eliminated by plant survival and tillering.

Table 6. Emergence of different seed lots of untreated and TCMTB-treated rape, flax, corn, and rye after 21 days in greenhouse soil

	Rape				Rye	
Dosage	O	P	Q	Dosage	V	W
	*Total emergence**					
Control	82	65	77	Control	37	94
0.50	88	58	84	0.50	27	92
0.75	85	40	85	0.75	28	79
1.00	93	38	67	1.00	18	75
1.50	70	63	79	1.25	23	70
2.00	92	38	64	1.50	17	72
2.50	76	41	59	3.00	8	46

	Corn				Flax		
Dosage	R	S	T	U	Dosage	X	Y	Z
	*Total emergence**							
Control	94	100	89	92	Control	88	69	68
1.12	91	98	83	96	0.42	68	78	57
1.40	95	99	86	95	0.56	58	75	71
1.68	89	97	87	93	0.84	64	69	49
2.24	84	97	77	94	1.12	52	78	64
2.80	88	97	71	75	1.68	64	64	54

* Total of 10 replicates each of 10 seeds.

Table 7. Mean percentage emergence at three locations* of different seed lots of untreated and TCMTB-treated cereals and flax, rape, and corn after 21 days in field soil

CROP:		WHEAT		BARLEY		OATS					
Variety:		(G) Manitou (I)		Betzes (C)	Conquest (F)	Harmon (K)			Kelsey (N)		
Location:		WMB	WMB	WMB	WMB	W	M	B	W	M	B
LSD:		1.4	1.8	1.6	2.0	all NS			all NS		
Treatment and percentage emergence	A	90.2	83.5	84.5	89.0	90.5	92.3	98.0	96.3	95.0	94.3
	B	86.8	76.6	79.8	83.7	94.0	91.0	93.3	92.5	95.5	89.5
	C	85.0	72.9	78.4	80.8	91.8	88.8	91.0	86.0	92.3	95.5
	D	84.7	77.2	81.7	81.7	92.3	90.3	92.8	94.5	96.0	95.8
	E	87.5	72.8	78.3	80.7	90.8	91.3	86.8	92.5	92.3	95.8

CROP:		RYE				FLAX			
Variety:		Frontier (V)			Cougar (W)	Noralta (X)			Redwood 65 (Z)
Location:		W	M	B	WMB	W	M	B	WMB
LSD:		all NS			4.1	all NS			2.2
Treatment and percentage emergence	A	7.8	2.0	17.8	50.1	69.0	55.3	68.3	58.7
	B	12.8	3.0	11.3	37.8	55.8	55.0	73.8	53.3
	C	12.5	4.0	18.5	42.3	62.8	56.5	59.0	54.3
	D	10.5	2.5	18.8	48.0	61.0	53.8	64.8	51.4
	E	11.3	3.0	13.8	39.2	63.0	58.8	70.0	50.3

CROP:		RAPE						CORN					
Variety:		Arlo (P)			Span (Q)			CM 7 (BB)			W 219 (CC)		
Location:		W	M	B	W	M	B	W	M	B	W	M	B
LSD:		all NS			all NS			all NS			all NS		
Treatment and percentage emergence	A	3.8	3.8	6.5	35.5	54.3	31.8	50.5	14.0	12.8	44.5	13.8	9.8
	B	4.3	4.3	5.0	32.5	49.3	32.5	52.0	14.8	17.8	44.0	20.8	15.5
	C	6.8	1.3	9.0	47.3	44.0	32.3	48.8	9.0	11.5	42.3	18.5	11.3
	D	6.3	4.8	4.0	33.8	52.5	32.5	57.3	14.3	13.5	48.3	17.8	15.5
	E	10.8	1.5	7.3	32.0	47.3	25.0	53.8	15.8	9.5	43.8	12.0	8.8

* Location: W = Winnipeg, M = Morden, B = Brandon, WMB = Winnipeg & Morden & Brandon combined.
Treatment: A = control, B = 0.75 oz/bu TCMTB 30EC, C = 1.0 oz/bu TCMTB 30EC, D = 0.75 oz/bu TCMTB 30IP, E = 1.0 oz/bu TCMTB 30IP.
LSD = least significant difference 5.0% level.
NS = not significant.

Flax, rape, and corn

Germination on filter paper of flax, rape lots O and Q, and corn seed treated with 1.68, 2.50, and 2.24 oz/bu TCMTB 30EC + 0.2% dye, respectively, was similar to the untreated controls (Table 4). Rape lot P, whether untreated or treated had lower germination than lots O and Q. All lots of corn, whether untreated or treated, had much abnormal germination, possibly a reflection of insufficient moisture.

In sterilized soil in the greenhouse, emergence of rape and flax was variable (Table 6), and emergence of corn was reduced with treatment rates above 1.68 oz/bu TCMTB 30EC + 0.2% dye.

In field soil (Table 7) emergence of flax lot Z was significantly reduced at all three stations after treatment with TCMTB 30EC + 1% dye or 30IP + 1% dye at 0.75 and 1.00 oz/bu. Emergence of flax lot X and of rape and corn did not differ significantly from the respective controls. Flax lot Z had much more cracking and embryo exposure than lot X. Emergence of rape lot P was extremely low in field soil and in sterilized soil (Table 6). Some of the reduced emergence in rape lots P

and Q can be explained by infestations of flea beetles [Phyllotreta cruciferae (Goeze)], which often ate the plants to ground level. Corn lots BB and CC (Table 7) had much higher emergence at Winnipeg than at Morden and Brandon because the soil at Winnipeg was much warmer at and just after sowing. Despite the lack of response of corn to treatment in these tests, later sowings of corn seed lot BB treated with TCMTB 30IP in warmer soils at Morden and Brandon showed significantly improved emergence due to control of soil-borne fungi (3).

Conclusions

TCMTB used at the recommended dosage of 0.75 oz/bu was associated with increased abnormal germination of spring wheat, oats, and barley on moist filter paper and with reduced emergence in sterile soil. These effects were more pronounced at and above 1.50 oz/bu. Emergence of rye, rape, flax, and corn was variable in sterile soil. Use of TCMTB in the field at rates of 0.75 and 1.00 oz/bu resulted in decreased emergence in two lots of Manitou spring wheat and one lot each of Betzes and Conquest barley, Cougar rye, and Redwood 65 flax compared to the respective controls. Mercurial seed treatments were also often associated with slightly decreased seedling emergence. A slight reduction in emergence may not seriously affect the amount of grain harvested as there is often increased tillering. However, further work does appear warranted on dosage rates and alternative formulations.

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DISEASE ASSESSMENT AND LOSSES IN FORAGE CROPS IN CENTRAL AND NORTHERN ALBERTA, 1972

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Abstract

In 1972, for the third successive year, forage crops in central and northern Alberta were surveyed for foliar diseases. A total of thirty diseases on alfalfa (Medicago sativa), clover (red, alsike, sweet, and white), brome, timothy, and fescue were observed. The estimated loss due to disease was 6.2% or $5.5 million as compared with 6.8% or $5.9 million in 1971 and 5.6% or $4.6 million in 1970.

Methods

The third annual forage disease survey in central and northern Alberta was carried out between June 30 and August 23, 1972. Samples were collected in census divisions (C.D.) 8 through 15 (excluding C.D. 9 because of limited cultivation). Methods of sampling, estimation of disease severity, and estimation of losses have been described in detail (1). The Disease Index was based on percent area of the leaves or stems affected and was multiplied by 0.25 to give percent loss (3). One percent of the farms reporting forage were sampled in each C.D. This totalled 312 fields. The percentage of each species in each field was estimated, and 10 shoots of each were sampled for detailed examination.

Results and discussion

The index for each disease of each forage species, the number of acres grown, and the number of fields affected out of the total number sampled in each census division are shown in Table 1. The total acreage of each species indicates its relative contribution to forage production.

Percent loss of each forage species caused by individual diseases in 1970 (1), 1971 (2) and 1972 for the entire district surveyed is shown in Table 2. Variations in the severity of diseases from year to year are shown as well as the average level over the 3-year period. In 1972, only a trace of downy mildew was found on alfalfa, and sweet clover was free of downy mildew (Peronospora trifoliorum de Bary) and gray stem canker (Ascochyta caulicola Laub.). A trace of pepper spot on red clover was seen only in 1971. The figures in Table 2 for the percentage of each species in the surveyed area were derived from the average percent of the species in all fields.

Acreage, yield, and production figures in Table 3, as well as the estimated value of $17 per ton of hay in Alberta in 1972 were supplied by the Statistics Branch, Alberta Department of Agriculture. The percent loss was calculated for each C.D. and these figures used to determine loss in tons and value. In 1972, the loss was 6.24%, a decrease from 1971 (6.80%) and an increase over 1970 (5.65%), resulting in a 3-year average of 6.23%. The average yield over the three years was 1.81 tons/acre and loss in value was 5.4 million dollars.

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Table 1. Incidence and severity of foliage diseases of forage crops in central and northern Alberta, 1972

1. ALFALFA (*Medicago sativa* L.)

Census Division	Acres grown ('000)	No. fields sampled	Diseases* assessed**					
			Yellow leaf blotch	Black stem	Stagon-ospora	Pepper spot	Downy mildew	Common leaf spot
8	184.4	35	35/15.69	34/4.53	17/0.28	5/0.75	2/0.04	35/ 3.59
10	100.0	49	47/ 9.60	48/2.72	21/0.22	9/1.15	0/0	49/ 7.59
11	208.0	43	43/14.78	42/3.21	29/0.50	7/2.37	0/0	42/ 6.76
12	98.6	23	22/ 9.79	21/1.29	3/0.19	5/1.05	0/0	23/ 8.20
13	177.7	22	22/32.25	22/4.22	9/0.25	13/6.18	0/0	22/13.90
14	28.6	3	3/13.20	3/2.83	1/0.27	2/4.00	0/0	3/ 5.03
15	309.9	22	22/26.14	20/6.81	7/0.08	1/0.27	0/0	21/10.38
Total	1107.2	197	194/16.27	190/3.61	86/0.28	42/1.84	2/0.01	195/ 7.75

* Causal fungi: Yellow leaf blotch, *Leptotrochila medicaginis* (Fckl.) Schuepp; black stem, *Ascochyta imperfecta* Pk.; stagonospora, *Leptosphaeria pratensis* Sacc. and Briard; pepper spot, *Pseudoplea trifolii* (Rostr.) Petr.; downy mildew, *Peronospora trifoliorum* de Bary; common leaf spot, *Pseudopeziza trifolii* f. sp. *medicaginis-sativae* Schmiedeknecht.

** Number of fields affected/disease index.

2. RED CLOVER (*Trifolium pratense* L.)

Census Division	Acres grown ('000)	No. fields sampled	Diseases* assessed**				
			Powdery mildew	Northern anthracnose	Black stem	Black-stem leaf spot	Stagon-ospora
8	48.1	7	0/ 0	3/10.19	5/1.06	2/ 9.14	4/15.51
10	26.1	0	0/ 0	0/ 0	0/0	0/ 0	0/ 0
11	54.3	7	0/ 0	4/ 8.47	5/2.80	4/18.69	7/32.36
12	25.7	4	3/15.70	0/ 0	1/0.03	0/ 0	3/11.02
13	46.4	16	5/ 5.15	8/ 5.22	15/3.77	0/ 0	15/62.15
14	7.5	3	0/ 0	2/29.33	3/1.53	2/32.77	0/ 0
15	80.9	15	3/ 0.73	3/ 3.29	7/1.29	0/ 0	14/37.11
Total	289.0	52	11/ 3.00	20/ 6.76	36/2.14	8/ 5.64	43/37.12

* Causal fungi: Powdery mildew, *Erysiphe polygoni* DC. ex Mérat; northern anthracnose, *Kabatiella caulivora* (Kirchn.) Karak.; black stem, *Ascochyta meliloti* (Trel.) Davis; stagonospora, *Stagonospora recedens* (O. Massal.) Jones and Weimer.

3. ALSIKE CLOVER (*Trifolium hybridum* L.)

Census Division	Acres grown ('000)	No. fields sampled	Disease* assessed**					
			Powdery mildew	Black stem	Stagon-ospora	Pepper spot	Rust	Sooty blotch
8	33.0	12	1/ 1.52	4/0.22	11/29.01	1/ 0.68	2/1.83	2/ 2.98
10	17.9	2	1/15.30	0/0	1/ 2.05	0/ 0	0/0	1/14.30
11	37.3	5	0/ 0	3/0.36	5/15.96	1/ 1.10	0/0	1/ 0.17
12	17.7	0	0/ 0	0/0	0/ 0	0/ 0	0/0	0/ 0
13	31.8	16	5/ 4.84	7/0.30	16/41.65	10/16.18	0/0	2/ 3.50
14	5.1	1	0/ 0	0/0	1/34.30	0/ 0	0/0	0/ 0
15	55.5	9	2/10.26	0/0	9/25.00	0/ 0	0/0	0/ 0
Total	198.3	45	9/ 4.86	14/0.20	43/30.17	12/ 6.06	2/0.49	6/ 2.69

* Causal fungi: Powdery mildew, *Erysiphe polygoni* DC. ex Mérat; black stem, *Ascochyta meliloti* (Trel.) Davis; stagonospora, *Leptosphaeria pratensis* Sacc. and Briard; pepper spot, *Pseudoplea trifolii* (Rostr.) Petr.; rust, *Uromyces trifolii* (Hedw. f. ex DC.) Lév.; sooty blotch, *Cymadothea trifolii* (Pers. ex Fr.) Wolf.

Table 1 (ctd.)

4. SWEET CLOVER (*Melilotus alba* and *M. officinalis* L.)

C.D.	Acres grown ('000)	No. fields sampled	Diseases* assessed** Black stem	Stagonospora
8	2.9	0	0/0	0/0
10	1.5	1	1/0.20	1/0.10
11	3.2	0	0/0	0/0
12	1.5	2	0/0	1/0.25
13	2.8	0	0/0	0/0
14	0.4	0	0/0	0/0
15	4.8	1	0/0	0/0
Total	17.1	4	1/0.05	2/0.15

* Causal fungi: Black stem, *Ascochyta meliloti* (Trel.) Davis; stagonospora, *Leptosphaeria pratensis* Sacc. and Briard.

5. WHITE CLOVER (*Trifolium repens* L.)

C.D.	Acres grown ('000)	No. fields sampled	Diseased* assessed** Pepper spot	Stagonospora	Rust	Sooty blotch
8	2.4	0	0/ 0	0/ 0	0/ 0	0/0
10	1.3	0	0/ 0	0/ 0	0/ 0	0/0
11	2.8	2	1/12.50	2/12.00	1/33	0/0
12	1.3	0	0/ 0	0/ 0	0/ 0	0/0
13	2.4	0	0/ 0	0/ 0	0/ 0	0/0
14	0.4	1	0/ 0	1/44.00	0/ 0	1/2.00
15	4.1	0	0/ 0	0/ 0	0/ 0	0/0
Total	14.7	3	1/ 8.33	3/22.67	1/22	1/0.67

* Causal fungi: Pepper spot, *Pseudoplea trifolii* (Rostr.) Petr.; stagonospora, *Leptosphaeria pratensis* Sacc. and Briard; rust, *Uromyces trifolii* (Hedw. f. ex. DC.) Lév.; sooty blotch, *Cymadothea trifolii* (Pers. ex Fr.) Wolf.

6. BROME (*Bromus inermis* Leyss.)

C.D.	Acres grown ('000)	No. fields sampled	Diseases* assessed** Brown leaf spot	Selenophoma	Scald	Whitehead
8	73.8	25	24/3.49	19/0.37	2/0.02	1/0.40
10	40.0	24	24/5.42	14/0.23	4/0.36	4/2.08
11	83.3	17	16/3.62	5/0.12	0/0	0/0
12	39.5	16	16/6.16	2/0.01	2/0.02	0/0
13	71.2	18	18/4.08	5/0.05	1/0.01	1/0.56
14	11.5	2	2/3.50	0/0	0/0	0/0
15	124.1	11	11/6.03	4/0.07	0/0	1/1.82
Total	443.4	113	111/4.64	49/0.16	9/0.08	7/0.80

* Causal fungi: Brown leaf blotch, *Drechslera bromi* (Died.) Shoem.; selenophoma, *Selenophoma bromigena* (Sacc.) Sprague and Johnson; scald, *Rhynchosporium secalis* (Oud.) J.J. Davis.; whitehead, *Fusarium poae* (Pk.) Wr.

7. TIMOTHY (*Phleum pratense* L.)

C.D.	Acres grown ('000)	No. fields sampled	Diseases* assessed** Eyespot	Leaf streak
8	40.4	25	19/0.31	25/3.38
10	21.9	3	3/0.17	3/1.53
11	45.5	15	14/0.58	14/6.89
12	21.6	5	3/0.10	5/2.46
13	38.9	19	19/0.48	18/2.98
14	6.3	6	6/0.13	4/1.03
15	67.9	6	3/0.08	6/4.22
Total	242.5	79	67/0.36	75/3.71

* Causal fungi: Purple spot, *Heterosporium phlei* Gregory; leaf streak, *Drechslera phlei* (Graham) Shoem.

8. FESCUE (*Festuca rubra* L.)

Census Division	Acres grown ('000)	No. fields sampled	Diseases* assessed** Brown stripe	Stem eyespot
8	13.9	0	0/ 0	0/0
10	7.5	0	0/ 0	0/0
11	15.6	0	0/ 0	0/0
12	7.4	0	0/ 0	0/0
13	13.4	0	0/ 0	0/0
14	2.2	0	0/ 0	0/0
15	23.3	11	9/23.01	7/5.65
Total	83.3	11	9/23.01	7/5.65

* Causal fungi: Brown stripe, *Passalora graminis* (Fckl.) Höhn; stem eyespot, *Phleospora idahoensis* Sprague.

Table 2. Percent losses from diseases of forage crops in central and northern Alberta, 1970, 1971 and 1972

Forage species	% of forage crops grown 1970	1971	1972	Avg	Disease	Loss (%) 1970	1971	1972	Avg
Alfalfa *(Medicago sativa)*	45.5	38.3	45.2	43.0	Yellow leaf blotch	2.87	2.81	4.07	3.25
					Black stem	1.45	0.83	0.90	1.06
					Stagonospora	0.11	0.10	0.07	0.09
					Pepper spot	0.06	0.09	0.46	0.20
					Downy mildew	0.02	0.01		0.01
					Common leaf spot	1.30	2.13	1.94	1.79
					TOTAL	5.81	5.97	7.41	6.40
Red clover *(Trifolium pratense)*	16.5	14.5	11.8	14.3	Powdery mildew	3.04	1.00	0.75	1.59
					Northern anthracnose	1.11	2.63	1.69	1.81
					Black stem	0.64	0.65	0.53	0.60
					Stagonospora	2.17	8.23	9.12	6.50
					Black stem leaf spot	0.32	0.61	1.41	0.78
					Pepper spot		0.10		0.03
					TOTAL	7.28	13.22	13.50	11.31
Alsike clover *(Trifolium hybridum)*	8.7	13.1	8.1	10.0	Powdery mildew	3.54	3.24	1.21	2.66
					Black stem	0.18	0.10	0.05	0.11
					Stagonospora	2.83	7.82	7.54	6.06
					Pepper spot	0.06	0.39	1.51	0.65
					Rust	0.24	0.02	0.12	0.13
					Sooty blotch	0.18	0.67	0.67	0.51
					TOTAL	7.03	12.24	11.11	10.12
Sweet Clover *(Melilotus alba* and *M. officinalis)*	3.0	2.4	0.7	2.0	Black stem	0.28	0.05	0.01	0.11
					Downy mildew	0.01			
					Stagonospora	0.06	0.41	0.04	0.17
					Gray stem canker		0.01		
					TOTAL	0.35	0.47	0.05	0.28
White clover *(Trifolium repens)*	0.2	0.5	0.6	0.4	Pepper spot		4.12	2.08	3.10
					Stagonospora	0.01	1.25	5.67	2.31
					Rust	0.01	4.50	5.50	3.33
					Sooty blotch		4.00	0.17	2.08
					TOTAL	0.02	13.87	13.42	10.82

Table 2 (Cont'd)

Forage species	% of forage crops grown 1970	1971	1972	Avg	Disease	Loss (%) 1970	1971	1972	19
Brome *(Bromus inermis)*	11.0	14.5	18.1	14.5	Brown leaf blotch	2.56	2.07	1.16	1.93
					Selenophoma leaf spot	0.02	0.12	0.04	0.06
					Scald	0.02	0.02	0.02	0.02
					Whitehead		0.13	0.20	0.16
					TOTAL	2.60	2.34	1.42	2.17
Timothy *(Phleum pratense)*	9.5	12.0	9.9	10.5	Purple spot	0.11	0.10	0.09	0.10
					Leaf streak	1.46	1.55	0.93	1.31
					TOTAL	1.57	1.65	1.02	1.41
Fescue *(Festuca rubra)*	3.2	3.4	3.4	3.3	Brown stripe	0.24	6.03	5.75	4.00
					Stem eyespot	0.91	7.42	1.41	3.24
					TOTAL	1.15	13.45	7.16	7.24
Other	2.3	1.1	2.1	1.8					

Table 3. Losses from foliage diseases of forage crops in Alberta Census Divisions 8 to 15, 1972

Census Division	No. of fields sampled	Acreage of forage crops ('000)	Yield (tons/acre)	Loss (%)	Actual production ('000 tons)	Potential production ('000 tons)	Loss ('000 tons)	Loss* ($'000)
8	47	408	1.95	4.42	795.6	832.4	36.8	625.6
10	56	221	1.66	4.59	367.2	384.9	17.7	300.9
11	61	460	1.95	5.74	897.2	951.8	54.6	928.2
12	29	218	1.74	4.13	379.7	396.0	16.3	277.1
13	49	393	1.74	11.27	684.0	770.8	86.8	1475.6
14	8	63	1.74	5.15	110.3	116.3	6.0	102.0
15	62	686	1.71	8.38	1169.3	1276.2	106.9	1817.3
Total	312	2449	1.78	6.24	4403.3	4728.4	325.1	5526.7

* Based on a farm value of $17 per ton of forage.

EVALUATION OF SEVERAL INSECTICIDES FOR CONTROL OF STRAWBERRY GREEN PETAL DISEASE[1]

L.S. Thompson, J.A. Cutcliffe[2], C.O. Gourley[3] and R.A. Murray[4]

Abstract

Field experiments were conducted in 1969-70 and 1970-71 at Oxford, Nova Scotia and Charlottetown, Prince Edward Island, to determine the efficacy of several insecticides in reducing the incidence of green petal disease in strawberries. In 1970, the least number of green petal infected plants occurred in plots treated by incorporating disulfoton into the soil prior to planting. In 1971, best control resulted from three foliar spray applications with either DPX-1410, endosulfan, or oxydemeton-methyl. Fruit yields were recorded only at Charlottetown and were not increased by any of the treatments.

Introduction

Green petal, a leafhopper transmitted disease of strawberries, has been reported to be of major economic importance in strawberry production in the Maritime Provinces (1, 3, 5). The infectious agent of green petal appears to be a mycoplasma-like organism (2). Since the disease was first reported in Nova Scotia in 1955 (3), moderate to severe infections have occurred in some commercial fields in Nova Scotia and Prince Edward Island, with light infections occurring annually in most fields and in plant nurseries. Increasing concern by strawberry growers and those involved in disease-free stock programs during the 1960's prompted investigations into means of controlling the green petal disease with the use of insecticides, primarily systemic insecticides.

The results of field experiments to determine the protective capabilities of some insecticides when incorporated into the soil prior to planting or when sprayed on growing plants for control of leafhopper vectors of green petal are reported in this paper.

Materials and methods

In each of the years 1969-70 and 1970-71 an experiment of the same design was conducted at each of two locations, Oxford, Nova Scotia and Charlottetown, Prince Edward Island. The vegetation surrounding the experimental plots contained weeds which are known hosts of the green petal entity and its leafhopper vectors as well as older strawberry plants. The six treatments in 1969-70 and the seven treatments in 1970-71 were randomized within each of four blocks on 10-plant plots, with plants spaced 2 ft apart within rows and with 4.5 ft between rows. The plants were allowed to form matted rows. Disease-free strawberry plants, cv. Sparkle, from the Research Station, Charlottetown, were used as test plants. In the Atlantic Region, Sparkle is apparently more susceptible to green petal or its insect vectors than most other commonly grown cultivars (1, 4, 6). In 1970, in Nova Scotia the test area was fumigated for nematode control about 3 weeks prior to planting. Subsequent plant injury required that this test be reduced to 3 replications.

Granular soil insecticides were placed in a 4-5 inch band in the row and incorporated into the soil to a depth of 1 inch prior to planting. Spray treatments were applied with a hand-operated knapsack or upright garden sprayer.

Assessment of green-petal infected plants was made during the harvest period of the first fruiting year for both years of the test. Fruit yield data were recorded only at Charlottetown, as the fruit matured.

Results and discussion

The number of green-petal infected plants

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Table 1. Effect of insecticides incorporated into the soil prior to planting in 1969 on the incidence of green petal in Sparkle strawberries in 1970

Insecticide	Rate (lb a.i./acre)	No. of plants infected*			
		Oxford		Charlottetown	
		Mother plants	Total	Mother plants	Total
Carbofuran	3.0	4	11ab†	7	31ab
Disulfoton	6.0	3	8a	4	12 b
Nemacur	3.0	7	16ab	5	15 b
Phorate	1.5	3	9ab	12	52a
Propoxur	1.5	6	9ab	7	20ab
Untreated check		17	38 b	6	23ab

* Total number of plants infected in 4 replicates.

† Numbers within a column followed by same letter are not significantly different at P = 0.05.

Table 2. Effect of insecticides applied during 1970 on the incidence of green petal in Sparkle strawberries in 1971

Insecticide	Rate (lb a.i./acre)	Site of application*	Plants infected†			
			Oxford		Charlottetown	
			No.**	%	No.	%
Carbofuran	3.0	soil	9a	2.0	6ab	0.5
DPX-1410††	3.0	foliage	6a	1.3	3 b	0.2
Endosulfan***	2.0	foliage	2a	0.5	4 b	0.3
Oxydemeton-methyl	0.375	foliage	2a	0.5	2 b	0.1
Phorate	1.5	soil	11a	2.5	30a	2.0
Propoxur	1.5	soil	1a	0.2	8ab	0.8
Untreated check			11a	2.6	25a	1.7

* Soil treatments were applied just prior to planting. Sprays were applied to the foliage three times at monthly intervals beginning approximately July 15 of the planting year.

† Number of plants infected in 3 replicates at Oxford and 4 replicates at Charlottetown; percent infection based on total of all plants in 3 and 4 replicates, respectively.

** Numbers within a column followed by the same letter are not significantly different at P = 0.05.

†† DPX-1410, S - methyl 1-(dimethylcarbamoyl)-N-[(methylcarbamoyl)oxy] thioformidate, DuPont of Canada Ltd.

*** Miller Nu-Film-P sticking agent was added to endosulfan sprays at 4 oz/acre.

in the test plots at Charlottetown and Oxford was low in both years, making it difficult to satisfactorily evaluate the efficacy of the treatments. In 1971, the percentage of plants infected in the untreated check was 2.6% at Oxford and 1.7% at Charlottetown; incidence of green petal was only slightly higher in the checks in 1970. In both provinces, plots treated with granular disulfoton prior to planting in 1969 had the

Table 3. Effect of insecticides applied during the planting year on strawberry yields at Charlottetown

Insecticide	Site of application*	Yield (lb/20-ft plot) 1970	1970
Carbofuran	soil	20.75a**	12.4 b
Disulfoton	soil	19.97a	
DPX-1410	foliage		16.5a
Endosulfan	foliage		13.9ab
Nemacur	soil	18.95a	
Oxydemeton-methyl	foliage		13.5ab
Phorate	soil	14.97a	13.0ab
Propoxur	soil	18.22a	13.7ab
Untreated check		19.52a	13.8ab

* Rates as in Tables 1 & 2.

** Numbers within a column followed by the same letter are not significantly different at P = 0.05.

least number of green-petal infected plants in 1970 (Table 1); however the incidence of the disease was significantly lower than in the untreated check only at Oxford (Table 1). Results with the other granular soil treatments were inconsistent between provinces in 1970, particularly with phorate. In Prince Edward Island, plots treated with phorate had the greatest number of infected plants and also yielded the least amount of fruit (Tables 1 and 3). Fruit yields were not increased significantly by any of the treatments.

In 1971, the best control resulted from the three foliar spray treatments with DPX-1410, endosulfan, or oxydemeton-methyl although differences were significant only at Charlottetown (Table 2). Less green petal occurred in plots treated with propoxur and carbofuran than in the phorate treated plots. Fruit yields in Prince Edward Island were neither reduced by the amount of green petal present in the check plots, nor increased as a result of the insecticide treatment (Table 3).

In 1958, in New Brunswick, Collins and Morgan (1) reported fewer green petal infected clones in strawberry plots that received weekly applications of malathion during the growing season than in untreated plots. However, the reduction in the number of infected clones was not as great as expected and they assumed that considerable transmission of the disease must have occurred before the insecticide inactivated the vectors on the plants.

Further test plots were established at Charlottetown and Oxford in the spring of 1971 involving insecticidal spray treatments only. The Charlottetown plots were almost completely winterkilled so that records could not be taken in 1972. At Oxford, plots survived the winter well, but by July 1972 not a single infected plant was found.

Because of the low rate of infection during the period of these tests, and because of poor or inconsistent results in attempting to control green petal with insecticides, work on the screening of insecticides has been discontinued. However, the results may be useful in selecting chemicals for future tests or in other areas where green petal is a problem. Also, the possibility that there is varietal resistance to this disease or its insect vector cannot be ignored (2, 4), and plant breeding for resistance to green petal or its insect vectors may be the most promising approach to the control of this disease in strawberries.

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DISEASES OF BRASSICA SPECIES IN SASKATCHEWAN, 1970-72. I. STAGHEAD AND ASTER YELLOWS[1]

G. Allan Petrie[2]

Abstract

No infection by the fungus (Albugo cruciferarum) responsible for staghead was observed in commercial fields of Brassica napus in the period from 1970 to 1972, but a steady increase in incidence and severity of all phases of the disease occurred in fields of B. campestris. In Saskatchewan, estimated losses resulting from hypertrophies of the inflorescence in B. campestris in 1970, 1971, and 1972 were 0.747, 1.836, and 1.080 million bu worth 1.68, 4.13, and 2.43 million dollars, respectively. Losses due to aster yellows were negligible in each of the 3 years.

Introduction

This paper reports the results of 3 years' surveys of Brassica crops for the staghead and stem blister phases of white rust caused by Albugo cruciferarum S. F. Gray, and for the aster yellows disease. In 1971, Berkenkamp (1) and Harper (F. R. Harper, personal communication) conducted surveys involving staghead in Alberta. Berkenkamp's survey was carried out in central and northern areas and Harper's in the south. Average yield loss figures reported were 1.2% and 3.6%, respectively. Also in 1971, Bernier (2) examined fields in southern and northwestern Manitoba and estimated yield reductions from severe staghead infections of 30 to 60%.

The acreage sown to rape and the total production in Saskatchewan in each of the years 1970-72 appear in Table 6 (3, 4, 5). In recent years, a very high percentage of the acreage has been in the crop districts 5, 8 and 9.

Methods

Annually routes were mapped out through the principal areas of production and the approximate locations of fields to be sampled were marked along them at random. The surveys were conducted in August; the locations of fields entered are shown in Figures 1 and 2. Fields were sampled by pulling plants at equally spaced sampling sites following an "M" pattern within the crop. Further detail is provided in Table 1. Samples were examined in the laboratory and each symptom given a severity rating between 0 and 3. Disease severity classes employed for the staghead phase of white rust and for aster yellows have been converted to those used for staghead by Harper and Pittman; severity classes 1, 2, and 3 represented, respectively, 1-25, 26-50, and over 50% of a plant's branches systemically infected (F. R. Harper, personal communication). Ratings for stem blisters caused by Albugo were related to percentage of stem area damaged (Table 2). A disease severity index (DSI) was calculated for each symptom rated at each sampling site according to the following formula:

$$DSI = \frac{a + 2b + 3c}{3d} \times 100$$

In the equation, a, b, and c represent the number of plants in severity classes 1, 2, and 3 respectively, and d the total of diseased plus healthy plants. Plants rated "trace" were considered healthy when calculating the rating for stem blisters.

Estimates of reductions in yield caused by systemic Albugo infections were based on the linear relationship between severity class and reduction in yield per terminal stem found by Harper and Pittman (F. R. Harper, personal communication) and were very similar to the DSI values. Only the latter, therefore, have been reported in the tables. The relationship between severity of Albugo stem blisters or aster yellows and loss in yield has not been determined.

Results

Albugo infections were never observed on Brassica napus L. during the three disease surveys, nor were they noted in the two

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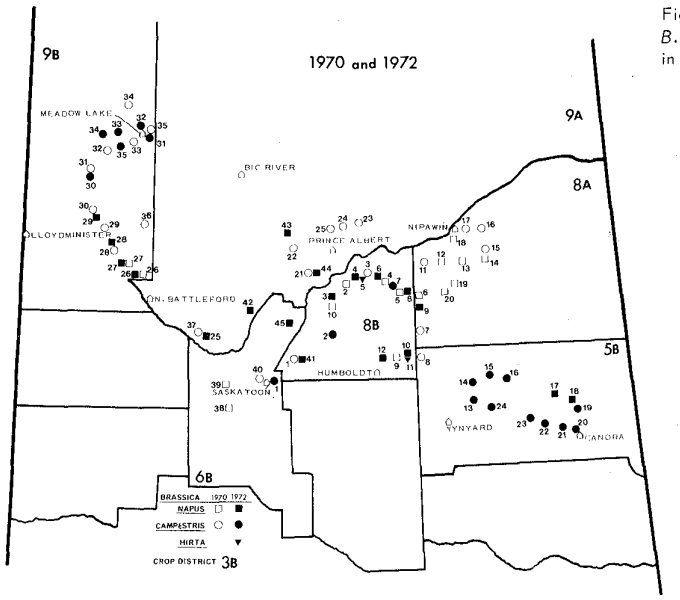

Figure 1. Commercial fields of *Brassica napus*, *B. campestris*, and *B. hirta* sampled during disease surveys conducted in Saskatchewan in 1970 and 1972.

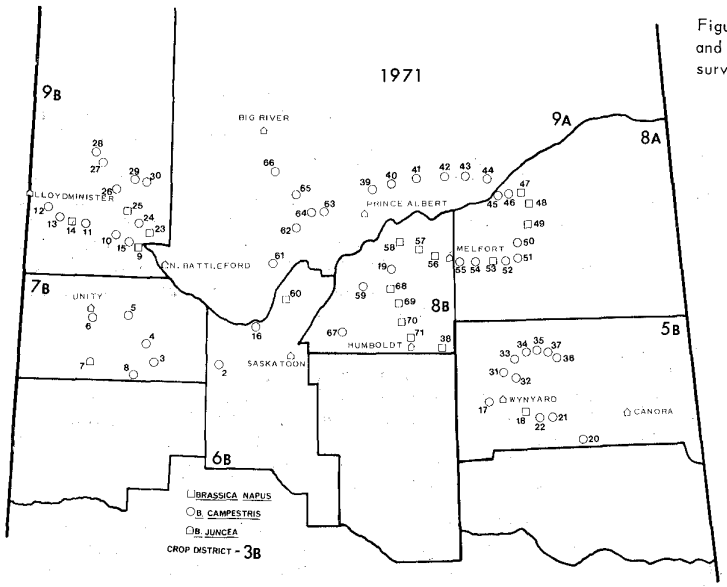

Figure 2. Commercial fields of *Brassica napus*, *B. campestris*, and *B. juncea* sampled in Saskatchewan during the 1971 disease survey.

Table 1. Details of *Brassica* disease surveys conducted in Saskatchewan from 1970-1972

Year	Number of sampling sites per field	Minimum number of plants pulled per sampling site	Species and number of fields entered				
			B. napus	*B. campestris*	*B. hirta*	*B. juncea*	Total
1970	5	25	16	24	0	0	40
1971	10	10	18	51	0	1	70
1972	10	10	19	19	2	0	40

fields of B. hirta Moench sampled in 1972. In the only field of B. juncea (L.) Coss examined (field 7,1971), 1% of the plants had stagheads and 3% had stem blisters. Percent infection levels and severity indices for all fields of B. campestris L. are recorded in Tables 3-5. Other data are included to indicate the degree of uniformity of distribution of the particular disease symptom within fields. By reference to Figures 1 and 2 and the tables, an indication of the geographical distribution of infection may be obtained.

Table 6 contains the data used in calculations of yield reductions in bushels and monetary losses due to staghead. In

Table 2. Disease severity classes used in rating stem blisters caused by *Albugo*

Disease class	Percentage of stem area damaged
0	0
TR	< 1%
1	1 to 10%
2	10 to 30%
3	>30%

Table 3. Prevalence and severity of stagheads and stem blisters on *Brassica campestris* in Saskatchewan, 1970

	Stagheads				Stem blisters		
Field no.	% plants infected	Mean DSI*	% sites having infected plants	Range in severity indices among sampling sites	% plants infected	Mean DSI*	Range in severity indices among sites**
1	2	1	40	0- 3	75	17	10-20
3	11	4	100	1- 7	89	13	8-14
7	18	6	100	6- 8	22	1	0- 2
8	24	10	100	5-19	75	7	5- 9
11	4	2	60	0- 4	69	5	3- 6
15	24	11	100	8-14	53	2	0- 5
16	11	6	100	2- 9	32	0	0- 1
17	2	0	40	0- 1	32	1	0- 4
21	6	2	100	1- 4	68	5	0-10
22	2	1	50	0- 1	52	3	0- 8
23	2	0	40	0- 1	61	4	1- 9
24	3	1	33	0- 7	45	4	1- 6
25	6	2	60	0- 5	31	1	0- 6
28	13	6	100	3- 9	32	1	0- 3
29	8	3	80	0- 6	38	2	0- 5
30	4	1	80	0- 2	81	12	9-16
31	6	2	100	1- 5	49	3	1- 5
32	14	6	100	1-13	55	2	0- 5
33	16	6	100	3-12	39	1	0- 3
34	11	5	100	2- 7	61	5	2- 9
35	7	3	80	0- 6	69	9	4-16
36	9	3	80	0- 7	54	1	0- 2
37	3	1	40	0- 5	71	2	1- 4
40	1	0	20	0- 2	75	5	2- 8
Average	9	3	75	1- 7	55	4	2- 7

* DSI values for stagheads and stem blisters are not comparable. Only those for stagheads are known to approximate reductions in yield.

** All sampling sites had plants with stem blisters.

Table 4. Prevalence and severity of stagheads and stem blisters on *Brassica campestris* in Saskatchewan, 1971

Field no.	Stagheads				Stem blisters		
	% plants infected	Mean DSI	% sites having infected plants	Range in severity indices among sites	% plants infected	Mean DSI	Range in severity indices among sites*
2	5	2	20	10	50	10	13
3	0	0	0	0	53	4	7
4	2	1	20	7	91	18	10-27
5	14	8	70	20	71	6	13
6	3	1	20	7	81	12	3-17
8	9	4	50	10	51	3	7
10	36	20	100	10-33	66	7	12
11	10	6	60	17	88	21	10-30
12	10	5	60	20	91	41	27-50
13	4	2	40	7	91	42	23-53
15	46	23	100	50	56	7	3-13
16	12	5	70	17	78	14	3-27
17	2	1	20	6	50	8	20
19	6	3	20	17	74	10	27
20	3	2	20	13	58	7	10
21	18	10	80	27	72	8	17
22	1	0	10	3	48	5	13
24	10	5	70	13	94	26	20-33
26	4	2	40	7	66	10	20
27	6	2	40	10	90	27	10-37
28	4	2	20	13	73	27	13-37
29	3	1	30	3	87	20	7-30
30	32	18	100	3-42	53	5	9
31	6	3	30	15	80	23	7-33
32	0	0	0	0	83	16	3-30
33	7	3	50	13	81	26	20-33
34	12	5	80	17	69	14	33
35	13	8	70	20	72	9	3-13
36	4	2	30	10	82	17	3-30
37	11	7	56	20	63	5	13
39	8	4	50	13	86	16	10-23
40	17	10	90	20	38	6	17
41	14	7	80	20	91	33	27-53
42	20	12	80	27	56	15	7-27
43	33	13	88	30	95	21	10-33
44	15	8	75	13	88	18	7-23
45	5	4	40	17	40	6	3-13
46	12	6	90	13	38	4	10
50	9	6	60	17	23	4	10
51	15	10	70	37	27	5	10
52	7	5	50	17	76	17	7-27
54	18	9	80	20	35	6	17

Table 4 (ctd.)

Field no.	Stagheads				Stem blisters		
	% plants infected	Mean DSI	% sites Having infected plants	Range in severity indices among sites	% plants infected	Mean DSI	Range in severity indices among sites*
55	7	3	40	13	88	18	10-20
59	0	0	0	0	86	20	13-23
61	9	4	63	10	78	28	20-33
62	2	2	20	10	13	3	10
63	0	0	0	0	80	18	37
64	7	4	70	7	39	7	13
65	6	4	50	17	76	20	10-28
66	8	4	50	10	88	15	3-20
67	9	3	50	13	94	23	17-30
Average	10	6	50	1-15	69	15	6-23

* Considering all fields, 99% of the sampling sites had plants with stem blisters.

Table 5. Prevalence and severity of stagheads and stem blisters on *Brassica campestris* in Saskatchewan, 1972

Field no.	Stagheads				Stem blisters		
	% plants infected	Mean DSI	% sites having infected plants	Range in severity indices among sites	% plants infected	Mean DSI	Range in severity indices among sites*
1	4	4	40	0-18			
2	30	17	90	0-43	96	30	20-40
7	28	13	100	6-30	89	23	13-39
13	12	9	60	0-22	88	29	19-37
14	13	7	90	0-14	84	20	10-31
15	17	13	80	0-31	93	28	10-39
16	15	9	80	0-26	81	23	13-35
19	26	8	90	0-17	97	24	18-31
20	15	9	90	0-18	81	20	7-29
21	16	10	90	0-19	96	24	14-40
22	6	3	60	0- 9	96	31	24-40
23	29	11	100	3-19	91	25	14-37
24	19	12	100	7-24	93	37	31-45
30	17	8	100	3-11	84	37	24-52
31	7	4	60	0-14	96	24	7-39
32	24	13	100	4-21	98	33	27-42
33	3	1	50	0- 4	100	38	27-53
34	19	9	100	2-19	100	34	26-45
35	30	15	100	3-24	98	34	21-47
Average	17	9	83	2-20	92	29	18-40

* All sampling sites had plants with stem blisters.

Table 6. Rapeseed acreage, production in bushels, and reduction in yield caused by the staghead phase of white rust in Saskatchewan, 1970-1972*

Year	Acreage (millions)	Total production (millions of bu)	% of acreage in varieties of *Brassica campestris*	Total production of *B. campestris* varieties (millions of bu)	Avg loss in yield due to staghead (%)**	Avg loss in yield due to staghead (millions of bu)	Avg loss in millions of dollars***
1970	2.20	39.5	63.0	24.9	3.0	0.747	1.68
1971	2.74	51.0	60.0	30.6	6.0	1.836	4.13
1972	1.50	25.5	47.0	12.0	9.0	1.080	2.43

* Sources of information regarding acreage and production were literature citations 3, 4, and 5.

** The disease severity index (DSI) equals loss in yield.

*** Calculated using a price per bushel of $2.25.

Table 7. Incidence of aster yellows on *Brassica* species in Saskatchewan, 1970-1972

Species	% of fields in which symptoms recorded			% of plants per field diseased (avg)		
	1970	1971	1972	1970	1971	1972
Brassica napus	37.5	22.2	35.0	0.3	0.2	0.2
B. campestris	62.5	13.7	0.0	1.0	0.2	0.0
All fields	52.5	15.7	17.5	0.8	0.2	0.1

Saskatchewan, losses in B. campestris were approximately 3%, 6%, and 9%, respectively, for 1970, 1971 and 1972. In millions of bushels, this would amount to 0.75, 1.84 and 1.08 and, at $2.25 per bushel, 1.68, 4.13, and 2.43 million dollars lost in 1970, 1971, and 1972. Considering the total Saskatchewan production of rape (including (B. napus), losses from staghead averaged 1.9%, 3.6%, and 4.2% in the 3 years.

The data for aster yellows are in Tables 7 and 8. From the figures for percentages of plants infected (Table 7), it is apparent that reductions in yield due to this disease were much less than 1% in each of the 3 years.

Discussion

Immunity to staghead continues to be maintained in commercial varieties of Brassica napus in spite of their continued cultivation in certain areas of high disease intensity. On B. campestris a steady rise in severity of hypertrophies of the inflorescence has been evident over the 3 years. Disease indices for the stem blister stage have shown a more spectacular increase. White rust is now so uniformly established that at least one of its symptoms can be readily observed at every sampling site in every B. campestris field. The severity of the problem is emphasized by the extent of monetary loss which has resulted from just one phase of the disease.

Acknowledgments

The author wishes to express his gratitude to F. R. Harper and U. J. Pittman, Research Station, Agriculture Canada, Lethbridge, for permitting citation of a number of their experimental findings as personal communications. He also gratefully acknowledges the technical assistance of Marjorie M. Smith and George Cornwell, and is indebted to A. J. Rugg, Saskatchewan Wheat Pool, Regina, for supplying statistical data.

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Table 8. Levels of aster yellows infection in individual fields of *Brassica napus* and *B. campestris*, 1970-1972

1970			1971			1972		
Field no.	% of plants infected	% of sites having infected plants	Field no.	% of plants infected	% of sites having infected plants	Field no.	% of plants infected	% of sites having infected plants
				Brassica napus				
2	1.3	20	23	1.0	10	3	<1.0	10
4	1.3	17	60	1.0	10	4	<1.0	10
5	0.6	17	70	1.0	10	8	<1.0	<10*
10	0.7	20	71	1.0	10	9	<1.0	<10
27	0.7	20				12	<1.0	<10
39	0.9	20				43	<1.0	<10
						44	<1.0	<10
				Brassica campestris				
1	3.5	80	2	1.0	10			
7	0.9	25	15	2.0	20			
8	0.8	20	17	1.0	10			
11	3.8	20	33	1.0	10			
21	0.6	17	46	1.0	10			
22	0.7	17	51	1.0	10			
23	0.8	20	64	1.0	10			
24	0.7	17						
25	2.3	40						
28	1.5	40						
29	0.8	20						
30	3.7	80						
32	0.8	20						
35	0.7	20						
40	2.7	60						

* Occasional infected plant observed in field.

HERBICIDE DAMAGE AND INFECTION OF RAPE BY THE BLACKLEG FUNGUS, LEPTOSPHAERIA MACULANS[1]

G. Allan Petrie[2]

On three occasions in August 1972 an association of herbicide damage and blackleg infection was observed on Brassica napus L. The herbicide injury consisted of cauliflower-like proliferations of tissue below the epidermis and cortex which frequently extended for several inches upwards from ground level. Pronounced stem twisting often accompanied this symptom. Splitting and sloughing off of cortical tissue covering the proliferations was also common (Figure 1). Grayish to pale brown fungal lesions, on which pycnidia were sometimes observed, occurred on the loosened tissue.

Material surface-disinfected in 10% commercial Javex (sodium hypochlorite) for 1-2 minutes and plated on V8 juice agar containing 40 ppm rose bengal and 100 ppm streptomycin sulfate consistently yielded the "brassica" strain of Leptosphaeria maculans (Desm.) Ces. & De Not. (1). The fungus was readily isolated from both cortical tissues and hypertrophied inner tissue.

The locations where these observations were made were: a field 6 miles east of Aberdeen, Saskatchewan; a field 10 miles north of Shellbrook, Saskatchewan; and experimental plots belonging to the Crop Science Department, University of Saskatchewan, Saskatoon, in which a study of the effects of herbicides on rape was being conducted.

Table 1. Association of herbicide injury and blackleg infection in a field of *Brassica napus* near Aberdeen, Saskatchewan

Site no.	No. of plants	Percentage* of plants with: Herbicide injury and blackleg	Herbicide injury only	Blackleg only	Neither symptom
1	10	90	0	0	10
2	10	20	0	20	60
3	10	80	0	0	20
4	10	70	0	30	0
5	10	50	0	0	50
6	10	0	20	0	80
7	10	0	0	0	100
8	10	50	0	20	30
9	8	88	0	0	12
10	9	22	11	22	45
11	10	80	0	0	20
12	10	100	0	0	0
13	10	100	0	0	0
Total	127	Avg: 58%	2%	7%	33%

* 65% of all plants examined showed symptoms of blackleg; 60% showed damage from herbicide.

Herbicide damage and blackleg symptoms were quite uniformly distributed throughout the Aberdeen field. The plants were in swath at the time the field was visited. Stubble

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[2] Plant Pathologist, Saskatoon.

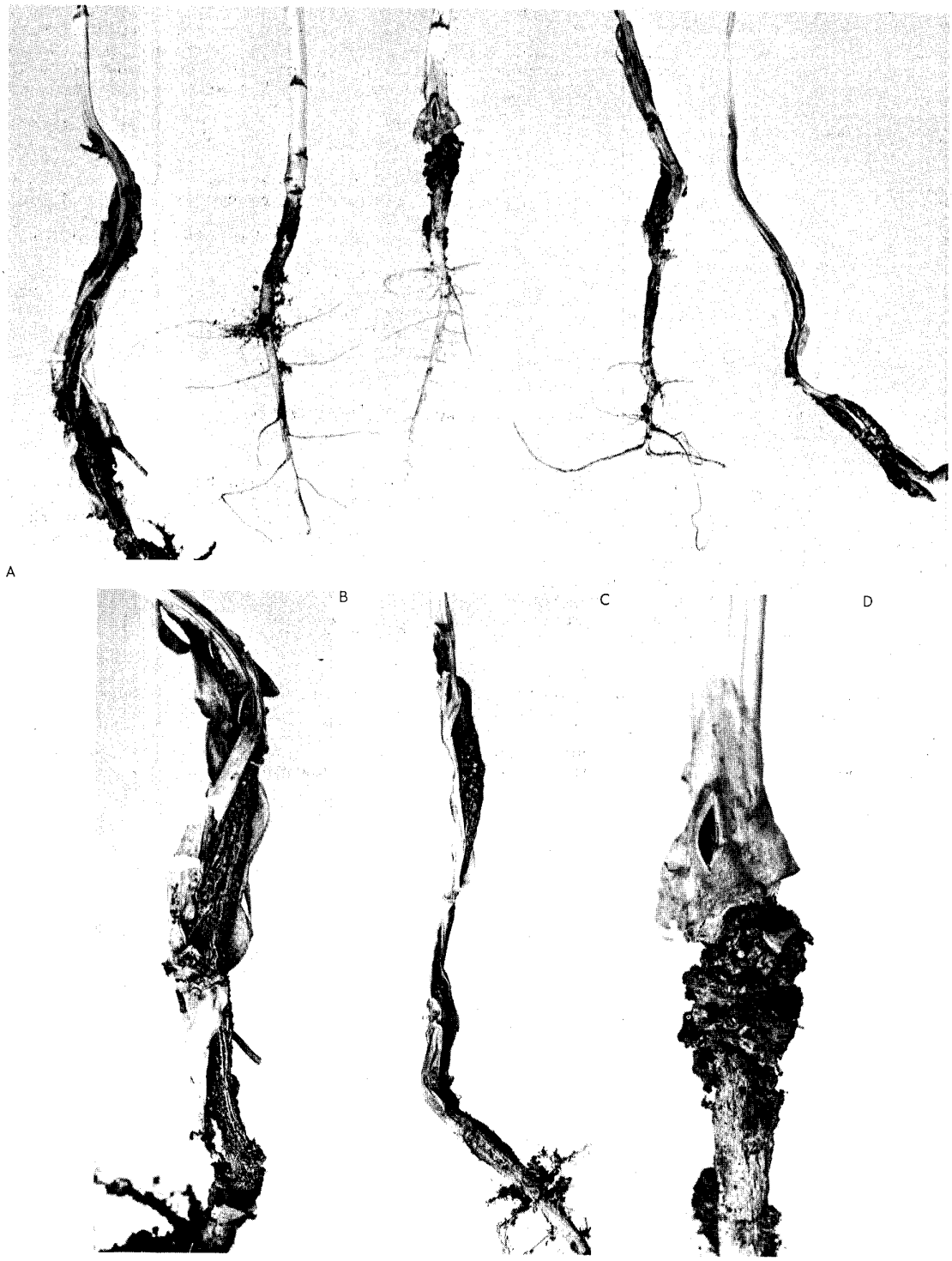

Figure 1. Herbicide damage and blackleg symptoms on stems of *Brassica napus*. A) Peeling of cortical tissues and twisting and discoloration of the stems, normal stem second from left. B, C, D) Herbicide damaged stems (enlarged) from which *Leptosphaeria maculans* was isolated; note cauliflower-like gall on upper portion of root (D), and above it a dark blackleg lesion.

Table 2. Extent of blackleg infection in fields of *Brassica napus* and *B. campestris* in Saskatchewan from 1970 to 1972*

	Brassica napus			*B. campestris*		
	1970	1971	1972	1970	1971	1972
No. of fields examined	16	19	19	24	51	19
% of fields having blackleg	19	11	21	13	18	17
% of plants infected per field (avg)	0.1	0.8	<1.0**	0.1	1.0	<1.0
Highest % of plants in a field infected	0.7	11.0	<1.0**	0.8	30.0	<1.0

* Other crops examined included one field of brown mustard [*B. juncea* (L.) Coss] in 1971 and two fields of yellow mustard [*B. hirta* Moench] in 1972. In none of these three fields was blackleg detected.

** Does not include the Aberdeen field in which 65% of the plants had blackleg infections.

samples were pulled at equal intervals on a line running diagonally across the field. The results of an examination of these samples are recorded in Table 1. The vast majority of the plants (91%) either had blackleg in conjunction with herbicide injury or were free of any symptoms. Approximately 65% of the stems had blackleg infections, the highest percentage ever found by the author in a commercial rape field. In contrast, the highest level of infection recorded in any field in the 1972 rape disease survey was less than 1% and the highest during the last 3 years, 30% (Table 2).

An obvious relationship between chemical injury and blackleg also was apparent in the Shellbrook field. In an area at one corner of the field almost all of the plants had been damaged by herbicide and also had blackleg infections. About half of the field had been swathed, with the area of interest lying in the swathed portion. No blackleg or herbicide injury whatever was seen in the field apart from the area described.

The experimental plots at Saskatoon had been sprayed with 2,4-D amine at various concentrations (R. Ashford and M. Betts, personal communication). Plants damaged by the treatment frequently exhibited blackleg whereas normal plants in adjacent plots rarely had detectable blackleg symptoms.

These observations represent the only clear example found by the author to date of greater susceptibility of herbicide-damaged rape plants to colonization by a pathogenic fungus.

Acknowledgments

The author wishes to express appreciation to Majorie M. Smith for technical assistance and to M. Betts and Ross Ashford of the Crop Science Department of the University of Saskatchewan for their cooperation.

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PLANT-PARASITIC NEMATODES IN IRRIGATED SOILS OF ALBERTA

E.J. Hawn[1]

In 1971, a survey program was begun for the purpose of compiling an inventory of the plant parasitic nematodes in irrigated soils of southern Alberta.

Materials, methods, and results

The top 4-inch layer of soil in each of 72 irrigated alfalfa fields was sampled in the following manner. Five samples, each weighing roughly 100 g, were taken at approximately equal intervals along each leg of a figure ⩙ covering an entire field. These samples were bulked, passed through a 4-mesh-per-inch sieve, and thoroughly mixed. A 250-g portion was then processed by the centrifugation-flotation method used by Jenkins (1) to recover soil-borne nematodes. Stylet-bearing forms were identified to genus except where their numbers warranted more complete identification (Table 1).

The 1972 survey was extended to include fields where specialty crops were grown on irrigated fields (Table 2).

Table 1. Stylet-bearing nematodes in irrigated soils planted to alfalfa (*Medicago sativa* L.), 1971

Identification	Percentage of fields infested
Paratylenchus projectus	56
Ditylenchus dipsaci	75
Tylenchorhynchus acutus	75
Aphelenchoides	40
Aphelenchus	89
Tylenchus	100
Xiphinema	21
Pratylenchus	8

Surveys will be continued in 1973 and 1974 with special attention being given to fields where peas, beans, sugar beets, corn, and carrots are grown.

Table 2. Stylet-bearing nematodes in irrigated soils planted to different crops†, 1972

Identification	Percentage of fields infested						
	Alfalfa 11*	Pea 28	Green bean 2	Sugar beet 27	Potato 3	Field corn 2	Carrot 1
Paratylenchus projectus	38	57	100	67	67	100	0
Ditylenchus dipsaci	85	93	100	100	100	100	100
Tylenchorhynchus acutus	86	68	100	33	33	0	0
Aphelenchoides	70	61	50	85	67	50	100
Aphelenchus	95	89	100	89	67	100	100
Tylenchus	90	61	50	56	33	100	100
Pratylenchus	9	4	0	15	0	0	0

* Number of fields sampled.

† Alfalfa - *Medicago sativa* L., pea - *Pisum sativum* L., green bean - *Phaseolus vulgaris* L., sugar beet - *Beta vulgaris* L., potato - *Solanum tuberosum* L., field corn - *Zea mays* L., carrot - *Daucus carota* L. var. *sativa* DC.

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Acknowledgments

The efforts of Mr. B. E. Mauza (C.O.S.E.P.) and of the Nematology Section, Entomology Research Institute, are gratefully acknowledged.

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DISTRIBUTION OF PRATYLENCHUS SPP. AND OTHER STYLET-BEARING NEMATODE GENERA IN SOILS IN THE FLUE-CURED TOBACCO AREA OF SOUTHERN ONTARIO

Th.H.A. Olthof[1] *and B.E. Hopper*[2]

Abstract

In a survey for nematodes associated with flue-cured tobacco, a total of 86 soil and root samples was collected at regularly spaced intervals within a 1,100-square-mile area covering Norfolk county and parts of surrounding counties. Three species of the root-lesion nematode (Pratylenchus) appeared to be randomly distributed throughout the main tobacco area. P. penetrans occurred in 40% of the samples; P. neglectus in 36%, and P. crenatus in 9%. Representatives of eight other stylet-bearing nematode genera also were found, with relative frequencies of occurrence as follows: Tylenchorhynchus, 33%; Paratylenchus, 29%; Tylenchus, 12%; Meloidogyne, 7%; Xiphinema and Hoplolaimus, each 4%; and Heterodera and Aphelenchus, each 1%.

Introduction

Five species of Pratylenchus Filipjev [viz. P. neglectus (Rensch.) Filipjev and Schuurmans Stekhoven (Hopper, 1971), P. penetrans (Cobb) Sher and Allen, P. crenatus Loof, P. pratensis (deMan) Filipjev and P. thornei Sher and Allen] have been found in southern Ontario (Potter & Townshend 1973). With the possible exception of P. thornei, routine procedures used by the Ontario Nematode Diagnostic and Advisory Service are insufficient to distinguish among species. Pratylenchus penetrans is generally recognized as the principal cause of brown root rot of tobacco in southern Ontario (Elliot & Marks, 1972; Olthof et. al., 1973). Mountain (1954, 1955) has shown that P. neglectus also is capable of causing lesions and stunting growth. There is no information on the pathogenicity of the other three Pratylenchus species in Ontario, nor on the relative pathogenicity of the five Pratylenchus species on flue-cured tobacco.

Mountain (1954) found large numbers of Pratylenchus spp. and small numbers of 12 other stylet-bearing nematode genera within and around the roots of diseased tobacco plants from southern Ontario. The relative frequency of occurrence of the three Pratylenchus spp. on tobacco were not indicated; however, 75% of a Pratylenchus population in soil cropped to rye consisted of P. neglectus and the remainder of P. penetrans. Townshend (1966) found that almost all soil samples with a suspected brown root rot problem contained P. penetrans. A survey in 1968 (Potter & Townshend 1973) showed that P. neglectus was the most widespread species in southern Ontario, except for Norfolk county and the Niagara Peninsula, where P. penetrans occurred more commonly. This latter observation confirmed previous findings in peach (Mountain & Boyce, 1958), in celery (Townshend, 1962a), and in strawberry (Townshend, 1962b)

This paper presents the results of a survey of the flue-cured tobacco area in southern Ontario to determine the distribution of different Pratylenchus species and genera of other stylet-bearing nematode associated with tobacco soil and roots. A brief summary of the results has been reported earlier (Olthof et al., 1968).

Methods

To ensure uniform distances between sampling sites and to avoid bias, the flue-cured tobacco area was covered with a grid system that resulted in 86 sampling sites on 4-mile centers. Samples were collected during June, July, and August, 1968, from tobacco fields on or close to the predetermined sites within the 1,100-square-mile area. Soil samples were taken to a

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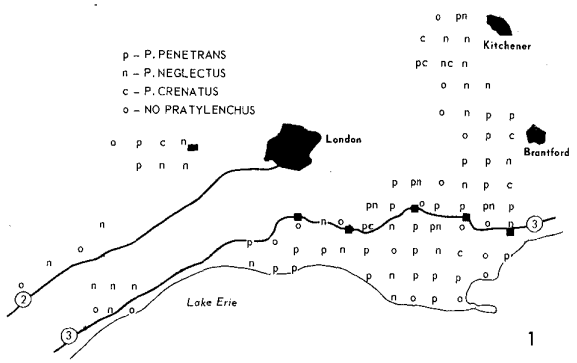

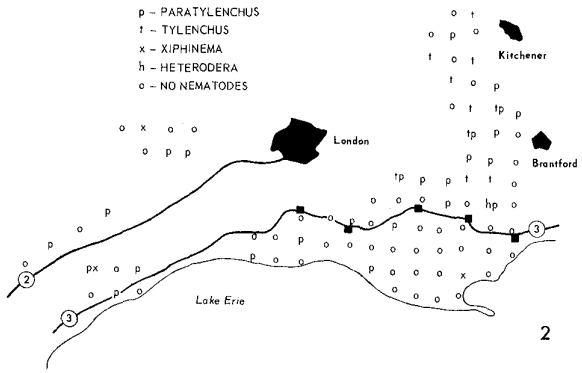

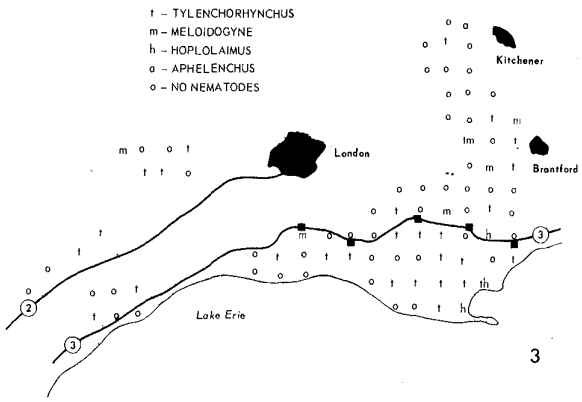

Figures 1–3. Maps of flue-cured tobacco growing areas in Southern Ontario showing distribution of 1) *Pratylenchus* spp.; 2) *Paratylenchus, Tylenchus, Xiphinema,* and *Heterodera;* 3) *Tylenchorhynchus, Meloidogyne, Hoplolaimus* and *Aphelenchus.* Names of towns (black squares) along Highway 3 are, left to right; St. Thomas, Aylmer, Tillsonburg, Delhi, and Simcoe.

depth of 8–10 inches from the root zone of stunted tobacco plants, each sample being composed of 10–20 probes taken with a 1-inch-diameter sampling tube. Two or more root systems of stunted tobacco plants also were collected from each site. The nematodes were extracted from soil or roots for 1 week with the Baermann pan method described by Townshend (1963). After generic identification and counting, the nematodes were killed and fixed in formalin and, when possible, 10–20 specimens of Pratylenchus were mounted in lactophenol on microscope slides (Goodey, 1957) for specific determination.

Observations and discussion

The distribution of the three Pratylenchus spp. found in this study is shown in Fig. 1. Of the 86 samples, 32% had a pure population of P. penetrans; 29% contained a pure population of P. neglectus; 6% consisted of pure P. crenatus, and in 24% no Pratylenchus spp. were detectable. Mixtures of penetrans and neglectus; penetrans and crenatus; and neglectus and crenatus comprised, respectively, 6%, 2% and 1% of the total number of samples. All three species appear to be randomly distributed throughout the main area except for two small tobacco growing areas southwest of London, where only P. neglectus was found. Potter & Townshend (1973) also noted the absence of P. penetrans and P. crenatus in these areas and the presence of P. penetrans and P. neglectus in the main tobacco growing area.

In addition to Pratylenchus, eight other genera were found (Figs. 2 & 3). The stunt nematode, Tylenchorhynchus Cobb, occurred in 33% of the samples but never in large numbers. The pin nematode, Paratylenchus Micoletzky, was found in 29% of the samples. Whether either nematode parasitizes tobacco is not known. Tylenchus Bastian occurred in 12% of the samples, indicating that it is more common than Mountain (1954) suggested. The root-knot nematode, Meloidogyne Goeldi, and the cyst nematode, Heterodera Schmidt, occurred in, respectively, 7% and 1% of the samples. The presence of Meloidogyne in tobacco soils is well known (Elliot & Marks, 1972) and, although parasitic on tobacco, it is not considered to be a great threat to tobacco production. The Heterodera was probably the clover cyst nematode, H. trifolii Goffart, which has survived from a previous rotation crop.

The dagger nematode, Xiphinema Cobb, and the lance nematode, Hoplolaimus Daday, both occurred in 4% of the samples. The former

probably occurs more commonly, but the extraction procedure used discriminates against recovery of the larger nematodes. Although Xiphinema is a known vector of plant viruses, its role, if any, in Ontario tobacco production is not known. The lance nematode, also reported by Mountain (1954), appears to be confined to a small area near Simcoe, Ontario. No damage to tobacco has been attributed to this nematode, but as yet only small populations have been found. Only one sample was infested with Aphelenchus Bastian, although Mountain (1954) reported that this was the most common stylet-bearing nematode apart from the root-lesion nematode.

Acknowledgment

The authors are grateful to Mr. M.C. Watson, Tobacco Extension Specialist, Ontario Ministry of Food and Agriculture, Delhi, Ontario, for delineating the flue-cured tobacco areas and for advice.

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PLANT-PARASITIC NEMATODES FROM CANADA AND ABROAD, 1971

Robert Sewell[1]

During 1971 soil samples, plants, and other material were submitted to the Nematology Section, Entomology Research Institute, for extraction and identification of nematodes. Samples were submitted by the Plant Protection Divsion, Canada Department of Agriculture, mostly of material intercepted at airports and ports, and by agricultural agencies, scientists, farmers, greenhouse operators, and florists from across Canada.

ROOT-KNOT NEMATODES (Genus Meloidogyne)

The northern root-knot nematode Meloidogyne hapla Chitwood, 1949 was extracted from soil samples from the roots of roses from Charlottetown, Prince Edward Island. Meloidogyne incognita (Kofoid & White, 1919) Chitwood, 1949 was found on roses from the United States intercepted at Montreal and Windsor.

CYST FORMING NEMATODES (Genus Heterodera)

The cyst-forming nematode Heterodera trifolii Goffart, 1932 was found in samples taken from potato fields from Charlottetown, Prince Edward Island; Toronto, Ontario; St. John, New Brunswick; and Marytown, Newfoundland. Heterodera avenae Wollenweber, 1924 was intercepted in soil associated with heather plants from England and in samples from potato fields near Toronto, Ontario. Heterodera humuli Filipjev, 1934 and Heterodera fici Kirjanova, 1954 was found in soil supporting herbaceous plants and ornamentals from Italy and greenhouse plants from Greece. Heterodera schachtii Schmidt, 1871 was found in soil associated with tulip bulbs from Portugal. Heavy infestations of Heterodera punctata Thorne, 1928 were found on native grasses on uncultivated land from the Matador Ranch, Saskatchewan. Heterodera latipons Franklin, 1967 was found for the first time in Canada, in a potato field in Prince Edward Island. This species was also intercepted in soil imported from Poland, Greece, and Italy. Soil collected from a jeep imported from Belgium was screened and found to contain Heterodera bifenestra Cooper, 1955. Heterodera weissi Steiner, 1949 was associated with ornamentals imported from Pennsylvania. Heterodera estonica Kirjanova & Krall, 1963 was recovered in soil on passenger baggage from Turkey. Heterodera gottingiana Liebscher, 1892 was intercepted on house plants from England. The Golden nematode, Heterodera rostochiensis Wollenweber, 1923 was extracted from soil samples from potato fields in Newfoundland and at Sidney, British Columbia.

ROOT-LESION NEMATODES (Pratylenchus)

Pratylenchus crenatus Loof, 1960 was identified in soil samples from potato fields in Charlottetown, Prince Edward Island; in forage crops and blueberry from New Brunswick; peach orchards from Harrow, Ontario; and on Astible sp. from Holland. Pratylenchus penetrans (Cobb, 1917) Chitwood & Oteifa, 1952 was found in samples from potato fields from Charlottetown, Prince Edward Island, and New Brunswick; forage crops, strawberry and corn from Harrow, Ontario; in several beds of phlox from the Central Experimental Farm, Ottawa, Ontario; and on Astible sp. and Trollius sp. roots from Holland.

SPIRAL NEMATODES (Genus Helicotylenchus and Rotylenchus)

Helicotylenchus digonicus Perry, in Perry, Darling and Thorne, 1959 and Rotylenchus fallorobustus Sher, 1965 occurred frequently in samples of forage crops from Eastern Canada. Helicotylenchus pseudorobustus (Steiner, 1914) Golden, 1956 was extracted from soil containing Astible sp. imported from Holland. Rotylenchus robustus (deMan, 1876) Filipjev, 1936 was found in beds of phlox at the Central Experimental Farm, Ottawa.

APHELENCHOIDES

Aphelenchoides limberi Steiner, 1936 was isolated from tulip bulbs growing in beds at the Central Experimental Farm, Ottawa. Aphelenchoides composticola Franklin, 1957 was associated with roots of shallot imported from Europe and Aphelenchoides blastophorus Franklin, 1952 was found with roots of Trollius sp. intercepted from Holland.

STEM AND BULB NEMATODES (Genus Ditylenchus)

Ditylenchus destructor Thorne, 1945 was intercepted on Trollius sp. roots from Holland.

STUNT NEMATODES (Genus Tylenchorhynchus)

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Several soil samples from forage crops in Prince Edward Island and New Brunswick had large populations of Tylenchorhynchus parvus Allen, 1955. Merlinius brevidens (Allen, 1955) Siddiqi, 1970 was found infesting beds of phlox at the Central Experimental Farm, Ottawa, Ontario.

PIN NEMATODE (Genus Paratylenchus)

Paratylenchus projectus Jenkins, 1956 was found in samples taken from fields of forage crops in areas from Prince Edward Island and Guelph, Ontario.

DORYLAIMIDS

Trichodorus pachydermus Seinhorst, 1954 was recovered from soil samples containing phlox on the Central Experimental Farm, Ottawa.

MISCELLANEOUS

Aphelenchus avenae Bastian, 1865 was present in most soil samples collected in surveys of forage crops in Prince Edward Island and New Brunswick and was associated with tulip bulbs and phlox from the Central Experimental Farm, Ottawa, and with alfalfa from Edmonton, Alberta.

DISEASES OF ELYMUS AND OTHER GRASSES IN ALBERTA, 1972

B. Berkenkamp, L.P. Folkins, and Joan Meeres[1]

Abstract

The intensity of powdery mildew, spot blotch, and leaf rust on various lines and species of Elymus was assayed in the field and resistance determined. Previously unreported diseases of Elymus and other forage grasses in Alberta or Canada are listed along with diseases occurring commonly in 1972.

Introduction

Grasses under test in the forage crops program at Lacombe were examined for the presence of diseases as part of the 1972 disease survey in Central Alberta. The severity of powdery mildew, spot blotch, and rust were assessed in a test of Elymus species and lines.

Some of the species included in this study are not grown commercially but were established in nurseries or tests to evaluate their potential as forage crops. Roegneria fibrosa (Schrenk) Nevski is a Russian introduction. Hordeum brevisubulatum (Trin.)Lk. has been reported as dominant in pasture associations in Siberia (3). Of the Elymus species, only E. junceus Fisch. is extensively used at present. E. piperi Bowden and E. sibiricus L. are native to Canada (1), while E. angustus Trin. and E. junceus are introductions from Russia.

Materials and methods

Observations on diseases of grasses were carried out on various experimental plantings and single nursery rows. Diseases were identified by symptoms or by examination of the fungi on leaf material directly or after incubation in moist chambers; in some cases isolations were made on agar media.

A test of Elymus species (Table 1) was seeded in May 1972. Arranged in a randomized block design, the plots were 20 ft (6.1 m) long with four rows spaced 1 ft (30.5 cm) apart. Disease intensity was estimated on four replications by a 0 to 5 visual rating (0 = disease-free, 5 = severe) in September 1972.

Results and discussion

Higher than normal moisture levels in the fall of 1972 probably increased the severity of the diseases, since they were not observed to this extent previously. Some of the diseases have not been reported previously in Alberta or Canada (1). These are included with new and common diseases on other species in 1972 as follows:

Agropyron cristatum (L). Gaertn., crested wheat grass
- Bipolaris sorokiniana (Sacc. in Sorok.) Shoem., [stat. perf. Cochliobolus sativus (Ito & Kurib) Drechs. ex Dast.], spot blotch
- Claviceps purpurea (Fr.) Tul., ergot

Agropyron trichophorum (Lk.) Richt., pubescent wheat grass
- Septoria sp. (a)

Bromus inermis Leyss., brome grass
- Drechslera bromi (Died.) Shoem. [stat perf. Pyrenophora bromi Died.], leaf blotch, brown leaf spot; common
- Selenophoma bromigena (Saac.) Sprague & Johnson, leaf spot

Dactylis glomerata (L.), orchard grass
- Claviceps purpurea, ergot (b)

Elymus angustus Trin., Altai wild rye
- Bipolaris sorokiniana, spot blotch (a)
- Erysiphe graminis DC. ex Merat, powdery mildew (a)

Elymus junceus Fisch., Russian wild rye
- Ascochyta sp. (a)
- Bipolaris sorokiniana, spot blotch (a)
- Erysiphe graminis, powdery mildew
- Puccinia recondita Rob. ex Desm., leaf rust
- Undetermined causal agent, whitehead (a)

Elymus piperi Bowden
- Bipolaris sorokiniana, spot blotch (a)
- Erysiphe graminis, powdery mildew
- Puccinia recondita, leaf rust

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Table 1. Reactions of lines of *Elymus* to three diseases

Species and lines	Description or source	Avg disease intensity* (0 - 5 scale) Powdery mildew	Spot blotch	Leaf rust
Elymus junceus (Russian wild rye)				
Mayak		2.12 e	1.25 a	0.50 c
Sawki		2.00 e	2.00 b	0 a
Vinall		2.00 e	1.37 a	0 a
NRG 711	Mile 1019	2.00 e	1.50 a	0.25 b
4N 721	Tetraploid	2.00 e	1.25 a	0.25 b
4N 722	Tetraploid	2.12 e	1.62 a	0 a
SC 3711		1.50 d	1.62 a	0.25 b
SC 3712		2.37 e	1.62 a	0 a
SC 17040	USSR	1.37 cd	1.37 a	0.25 b
LRS 6757	Shatter resistant	1.45 cd	1.25 a	0.25 b
SC 17125	Idaho 100	2.25 e	1.25 a	0.25 b
Elymus angustus (Altai wild rye)				
SC 3716	Blue	1.00 bc	2.62 b	0 a
SC 3717	Blue-green	0.75 b	2.50 b	0 a
Elymus sibiricus (Siberian wild rye)				
SC 17039	USSR	0.75 b	1.00 a	2.25 e
SC 1701	Alaska	0 a	1.25 a	0 a
Elymus piperi				
SC 17171	Kamloops	0.75 b	1.75 a	0.75 d

* Disease intensity values followed by different letters indicate significant differences by Duncan's Multiple Range Test. Disease intensity varied from 0, no disease symptoms, to 5, maximum disease.

Elymus sibiricus (L.), Siberian wild rye
- Bipolaris sorokiniana, spot blotch (a)
- Claviceps purpurea, ergot (b)
- Erysiphe graminis, powdery mildew (a)
- Pseudoplea sp. (a)
- Puccinia recondita, leaf rust (a)
- Septoria sp. (a)

Festuca rubra L., red fescue
- Didymella festucae (Weg.) Holm. (Phleospora idahoensis Sprague), stem eyespot
- Passalora graminis (Fckl.) Hohn. (Scolecotrichum graminis Fckl.), brown stripe

Hordeum brevisubulatum (Trin.) Lk.
- Bipolaris sorokiniana, spot blotch (a)
- Puccinia graminis Pers., stem rust (b)
- Puccinia recondita, leaf rust (a)
- Septoria sp. (a)

Phalaris arundinacea (L.), reed canary grass
- Claviceps purpurea, ergot

Phleum pratense (L.), timothy
- Drechslera phlei (Graham) Shoem., leaf streak; common
- Heterosporium phlei Gregory, purple spot; common

Poa pratensis L., Kentucky blue grass
- Undetermined causal agent, whitehead (silvertop) (b) [often associated with Fusarium poae (Pk.) Wr.]

Roegneria fibrosa (Schrenk) Nevski
- Claviceps purpurea, ergot (a)

The reactions of lines of Elymus species to powdery mildew [Erysiphe graminis DC. ex Merat], spot blotch [Bipolaris sorokiniana (Sacc. in Sorok.) Shoem], and leaf rust (Puccinia recondita Rob. ex Desm.), are shown in Table 1. Disease reaction varied both between and within species. One line was found to be free of powdery mildew. Leaf rust was less severe than powdery mildew and several lines were found to be rust-free. All lines were infected with spot blotch, with some variation in resistence which may be considered a general feature of "non-obligate" diseases. Hordeum brevisubulatum was also examined in this test and found to be more severely affected with rust than the Elymus lines (avg. disease intensity 2.50); it was free of powdery mildew and was rated 1.0 for spot blotch.

(a) unreported in Canada (2)

(b) unreported in Alberta (2)

Acknowledgment

The authors thank Dr. T. Lawrence, Research Station, Agriculture Canada, Saskatchewan, for the supply of Elymus species.

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DISTRIBUTION OF PLANT-PARASITIC NEMATODES IN FIELD CROP SOILS OF SOUTHWESTERN AND CENTRAL ONTARIO

J.W. Potter and J.L. Townshend [1]

Abstract

Pratylenchus, Paratylenchus, Helicotylenchus, Tylenchorhynchus, Meloidogyne and Heterodera are widely distributed throughout Southwestern and Central Ontario. The first three genera occur more frequently than the last three. Xiphinema and Criconemoides also occur infrequently in field crop soils. Pratylenchus neglectus is a cereal and forage parasite whereas P. penetrans is a fruit and tobacco parasite. Meloidogyne hapla, Heterodera trifolii, Helicotylenchus digonicus, and Helicotylenchus canadiensis are chiefly forage parasites. Heterodera avenae, H. schachtii, and P. penetrans were probably introduced into the province. The distribution of H. avenae and H. trifolii is related to watersheds.

Introduction

Previous studies of the distribution of plant parasitic nematodes in Ontario were usually part of a research program concentrating on a single crop grown in a relatively limited area. Celery, strawberry, tobacco, wheat, and peach are grown primarily in a few southern counties near Lake Erie and Lake Ontario. The root-rot and replant problems of these crops (3, 9, 10, 16, 17) are caused by only two congeneric species of nematodes. Consequently, research emphasized the distribution of these nematodes in the locales where the host crops were grown. Likewise a number of other surveys (7, 12, 13, 14, 19, 22) were similarly oriented toward single nematode species or involved intensive sampling for nematodes on a specific host in a fairly restricted area. While such distribution studies were essential to the research program of which they were a part, still the helminth fauna of much of the agricultural land of Ontario remained unknown. This paper complements our present knowledge of the general distribution of genera and species of plant-parasitic nematodes in Ontario and demonstrates some influences of host crop on the frequency of occurrence and abundance of certain species.

Methods

Using highway and soil association maps, a sampling route was established which permitted the uniform sampling of the major agricultural areas of Southwestern and Central Ontario. Southwestern Ontario refers to Southern and Western Ontario as designated by the Ontario Agricultural Statistics Publication 20 (1). In Central Ontario (1) the sampling route included only Durham, Ontario, Victoria, and York counties. Automobile odometer readings relative to selected reference points, usually towns, were used to locate sampling sites every 5 miles along the route. Minor deviations from the 5-mile interval occurred only for the lack of a crop or the presence of non-arable land. The sampling was accomplished with field trips in June, July, and August, 1967.

Ten cores of soil 2.5 x 20 cm were taken with a probe through the root systems of randomly selected plants in a field at each sampling site. These cores were bulked in a 1-kg sample. The samples were stored immediately in portable styrofoam coolers with refrigerant packs and later stored in the laboratory at 4.5 C until processed, usually within a week. Location, crop, condition of crop, soil type, soil moisture, and soil temperature were noted at each sampling site.

In the laboratory, two 50-g soil portions were removed from each 1-kg sample after thorough mixing. From one 50-g portion, migratory nematodes were extracted for 1 week by the Oostenbrink direct cotton-wool filter method (18). The other 50-g portion was air-dried and cysts were extracted by the Fenwick can method (4).

Migratory plant-parasitic nematodes were identified to genus and counted at 50X magnification in a water suspension. These nematodes were then killed by adding an equal

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volume of boiling water and preserved in 4% formalin. To prepare slides for species identification, the fixed nematodes were transferred to lactophenol for 2 weeks and mounted in the same medium. Cysts were preserved in 2% formalin and later identified at the Entomology Research Institute, Agriculture Canada, Ottawa.

The locations at which the various genera and species of the major plant-parasitic nematodes occurred on the authors' field trips were plotted on maps of Southwestern Ontario. Points off the highways were from the authors' unpublished records and were plotted only to clarify the pattern of distribution of certain species. Where sufficient nematodes were present to permit species identification, the species were named on the maps; otherwise, "sp." was used to indicate the presence of the genus at a sampling location. At some locations two or more species of a genus were found. Also at some locations several crops or mixtures of crops were sampled. For example, barley and oats occurred as mono-specific stands at some locations and as mixed grain crops at others. Where such a mixed grain crop occurred, it was designated "b,o" on the maps. Thus, a sample designated "m, pe/b, o,w" would indicate species "m" and "pe" on a mixed grain crop (barley "b" and oats "o") in one field and on wheat "w" in another field.

Results and discussion

Plant-parasitic nematodes were extracted from 291 survey soil samples, mostly from corn (Zea mays L.) (76 samples), forage [usually alfalfa (Medicago sativa L.) or red clover (Trifolium pratense L.) plus timothy (Phleum pratense L.), bromegrass (Bromus inermis Leyss.), or orchardgrass (Dactylis glomerata L.)] (39), winter wheat (Triticum aestivum L.) (37), barley (Hordeum vulgare L.) (5), oats (Avena sativa L.) (60), and mixed grains (barley & oats, 48). The remaining 26 survey samples (9% of the total number) were from beets (Beta vulgaris L.), carrots (Daucus carota L.), celery (Apium graveolens L.), potatoes (Solanum tuberosum L.), peas (Pisum sativum L.), rutabagas (Brassica napobrassica [L.] Mill.), rye (Secale cereale L.), soybeans (Glycine max. [L.] Mers.), tobacco (Nicotiana tabacum L.), and tree- and small-fruits. Eight genera of plant-parasitic nematodes were commonly encountered in the samples.

In assessing prevalence of plant-parasitic nematodes, we used two different measures of occurrence: frequency, i.e. the percentage of samples containing a given genus or species of nematode regardless of the number of nematodes in each sample; and abundance, i.e. the numbers of a given genus or species in an infested sample.

Lesion nematodes, Pratylenchus spp., were present in 95% of the samples; spiral nematodes, Helicotylenchus spp., in 72%; pin nematodes, Paratylenchus spp., in 65%; stunt nematodes, Tylenchorhynchus spp., in 32%; root-knot nematodes, Meloidogyne spp., in 16%; cyst nematodes, Heterodera spp., in 16%; dagger nematodes, Xiphinema spp., in 11%; and ring nematodes, Criconemoides spp., in 4%.

Five species of Pratylenchus were identified from the survey samples. Of these, P. thornei Sher & Allen was found twice and P. pratensis (de Man) Filipjev once, both species on corn; consequently these species are considered to be infrequent or rare in Ontario (Fig. 1). P. crenatus Loof and P. penetrans (Cobb) Chitwood & Oteifa were more frequently encountered, occurring sporadically on cereal grains and forage, and in the case of P. penetrans, on tree- and small-fruits and tobacco. P. neglectus (Rensch) Chitwood & Oteifa was the most frequent lesion nematode species in corn, forage, wheat, barley, oats, and mixed grains soils, representing 55-60% of the lesion nematodes identified from these crops. Lesion nematodes were more abundant on corn (average 2400/kg of soil), forage (1900/kg), wheat (1500/kg), oats (1500/kg), mixed grains (1300/kg) and barley (1200/kg) and less so on the other crops (800/kg). As P. neglectus was the lesion nematode most frequently found, it is apparently a cereal and forage parasite, and probably indigenous to Ontario. It is rarely found in fruit-growing areas (10, 17, 19), where P. penetrans seems to occur more frequently; also P. penetrans is more prevalent in tobacco areas (9, 12).

The only species of the pin nematode, Paratylenchus, identified was P. projectus Jenkins. This nematode was also wide-spread in Ontario (Fig. 2) although it was less frequent in our survey samples than the lesion nematodes. The pin nematode occurred in 88% of mixed grain, 85% of forage, 82% of oats, and 80% of barley samples, but in only 49% of wheat and 36% of corn samples. It was most abundant in forage samples (760/kg of soil), less abundant in wheat (640/kg), mixed grain (600/kg), oats (520/kg), and barley (500/kg), and least abundant in corn (320/kg). The frequent occurrence and abundance of the pin nematode in forage samples and those of cereal grains (mixed grains, oats, barley) often underseeded to forage may be a reflection of host preference; Townshend (20) has observed that timothy, a common forage component, is a favorable host for this nematode.

The spiral nematodes, Helicotylenchus spp., had a wide distribution (Fig. 3), mostly in the Western and Central regions from Sarnia to Hamilton north to Georgian Bay and Lake Simco. Three species of spiral

nematodes, H. digonicus Perry, H. canadensis Waseem and H. pseudorobustus (Steiner) Golden, were identified. Spiral nematodes occurred frequently in barley samples (100%), mixed grains (94%), oats (87%), forage (80%), and corn (65%) samples and least often in wheat (38%). They were most abundant in forage (1900/kg of soil), followed by mixed grains (1400/kg), corn (1300/kg), oats (820/kg), wheat (780/kg), and barley (480/kg). As with the pin nematode, the number of spiral nematodes in forage soil may be a reflection of host preference, as Townshend (20) also found alfalfa to be a favorable host for H. digonicus.

Stunt nematodes, Tylenchorhynchus spp., were widely distributed in the province (Fig. 4) in geographic terms. However, this genus was not found frequently as only 32% of samples contained it, nor was it especially abundant. The highest average number was under wheat (540/kg) and the least under oats (160/kg). Two species, T. claytoni Steiner and T. nudus Allen were identified.

The northern root-knot nematode, Meloidogyne hapla Chitwood, was broadly distributed (Fig. 5) but infrequently encountered; the highest frequency of occurrence was in forage (33%), and slightly less in mixed grains (21%) and oats (18%). The frequency of occurrence in forage might have been higher than 33% had a bioassay been used in conjunction with the other detection methods. In a subsequent survey, the authors found that use of celery as the host in a bioassay doubled the number of fields identified as containing root-knot nematode (Townshend, Willis, Potter, and Santerre, Can. Plant Dis Surv., in press). As grasses and cereals are not known to be hosts (5), the occurrence of this nematode in oat and mixed grain samples probably is a result of parasitizing the underseeded forage legumes. In corn and wheat, the root-knot nematode may be parasitizing weeds (21).

The cyst nematodes, Heterodera spp., were found throughout the sampled area (Fig. 6). Three species, H. avenae Wollenweber, H. schachtii Schmidt and H. trifolii Goffart were identified. The oat-cyst nematode, H. avenae, and clover-cyst nematode, H. trifolii, were mainly found in the Trent, Grand, Maitland, Thames, and Welland River watersheds, often within a half-mile of a creek or river. H. avenae was probably introduced into Ontario, as it has not been found in the northeastern (8), north central (11) or northern great plains (15) regions of the United States, while H. trifolii is widespread in these areas. H. avenae was present in 25% of oats, 23% of mixed grains, and 20% of barley soil samples but only 8% of wheat samples. The nematode was most abundant in oats (520 larvae/kg of soil) and least in wheat (100/kg). Although this nematode can not reproduce on corn (6), 7% of corn soil samples contained the nematode. Because of the limited host range of H. avenae, these infestations were probably the result of previous cropping to a host cereal grain.

H. trifolii was found in 21% of forage soil samples, at an average of 220 larvae/kg of soil. The sugarbeet-cyst nematode, H. schachtii, was distributed in the province with a high correlation to host crop distribution (Fig. 6), as it was found mainly on rhubarb (Rheum rhaponticum L.) north and west of Toronto. This nematode may well have been introduced into former sugarbeet-growing areas (2) and later spread on rhubarb roots to the Toronto area as the winter rhubarb forcing industry expanded (22).

The dagger nematode, Xiphinema americanum Cobb, was most frequent in wheat (19%) and corn (18%) soil samples, less frequent in oats (10%) and forage (10%) and infrequent in mixed grains. The greatest abundance of this nematode was in forage, with an average of 140/kg of soil.

The ring nematodes, Criconemoides spp., occurred sporadically in 4% of the cereal and forage soil samples. Numbers of these nematodes were insufficient to permit species identification.

Our observations have shown that, in general, those species having a broad host range, such as the lesion nematodes, were widespread and frequently encountered, showing little relation to host distribution. Conversely, species having a fairly narrow host range, such as Heterodera avenae, were restricted to fields where the host crops were being grown and consequently were less frequently found. One exception to this generalization might be the spiral nematodes, Helicotylenchus spp., which have a fairly broad host range, yet were infrequent in wheat soils in Southern Ontario but frequent in forage and cereals underseeded to forage in Western and Central Ontario. Another exception could be the pin nematode, Paratylenchus projectus, where host preference again seemed to influence the distribution of a nematode having a fairly broad host range. It can also be noted from the maps that several genera and species of nematodes might occur at a single sampling site. Consequently the interactions of these genera and species with one another and with their respective preferred hosts become an important aspect of research into crop loss assessment and cultural control of nematodes by crop rotation or host resistance.

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Mulvey, Entomology Research Institute, Agriculture Canada, Ottawa, for Paratylenchus and Heterodera species, respectively.

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Figures 1-6. Distribution in Southwestern and Central Ontario of 1) *Pratylenchus*, 2) *Paratylenchus*, 3) *Helicotylenchus*, 4) *Tylenchorhynchus*, 5) *Meloidogyne*, and 6) *Heterodera*.
Note: On all maps sampling sites are designated as: nematode species/host crop(s).

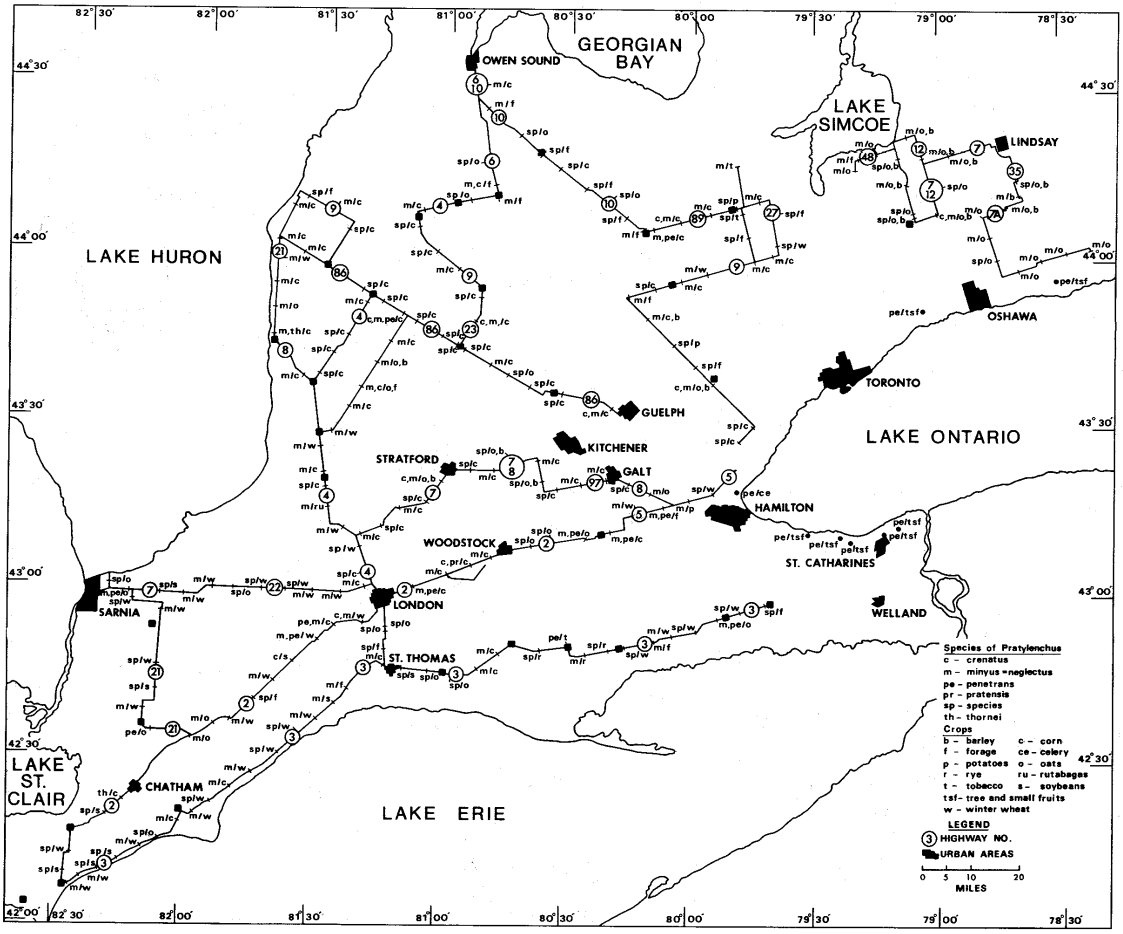

Figure 1 – *Pratylenchus*

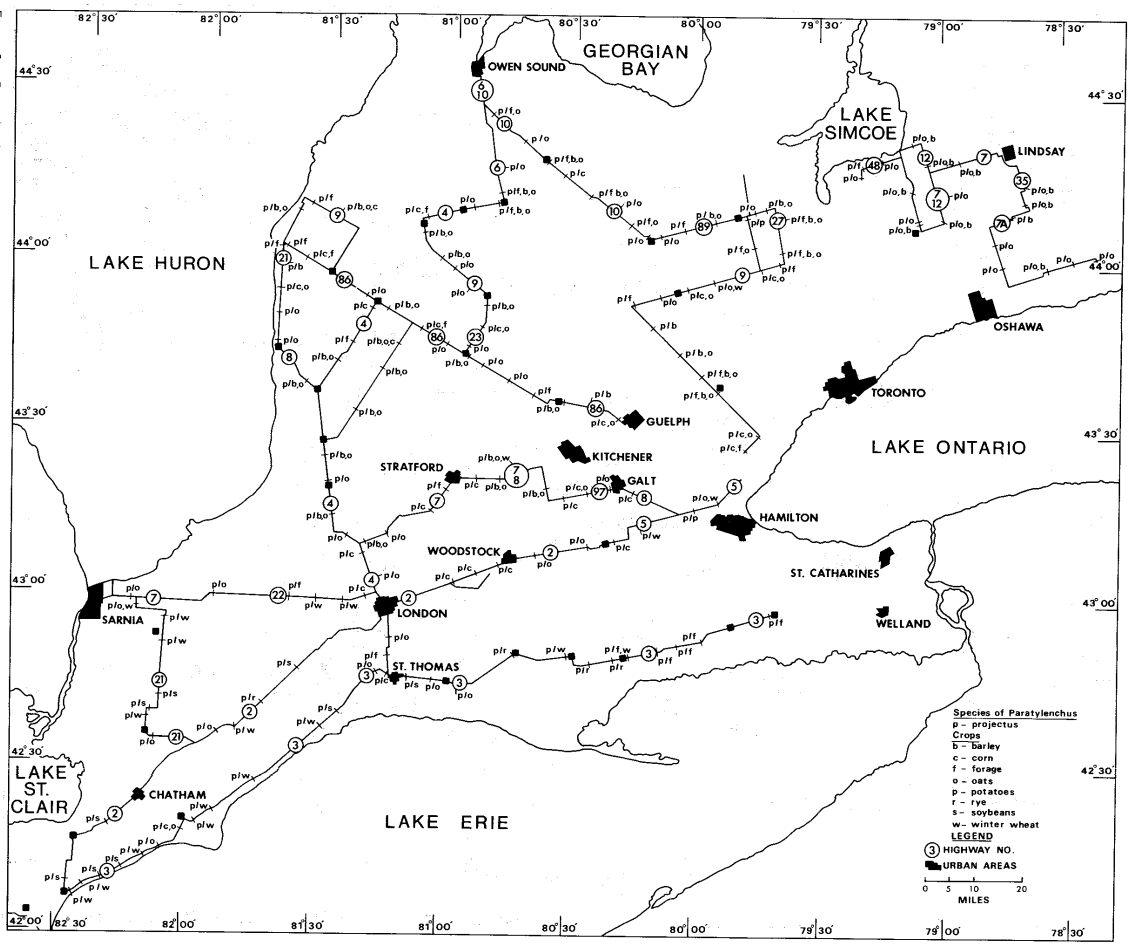

Figure 2 – *Paratylenchus*

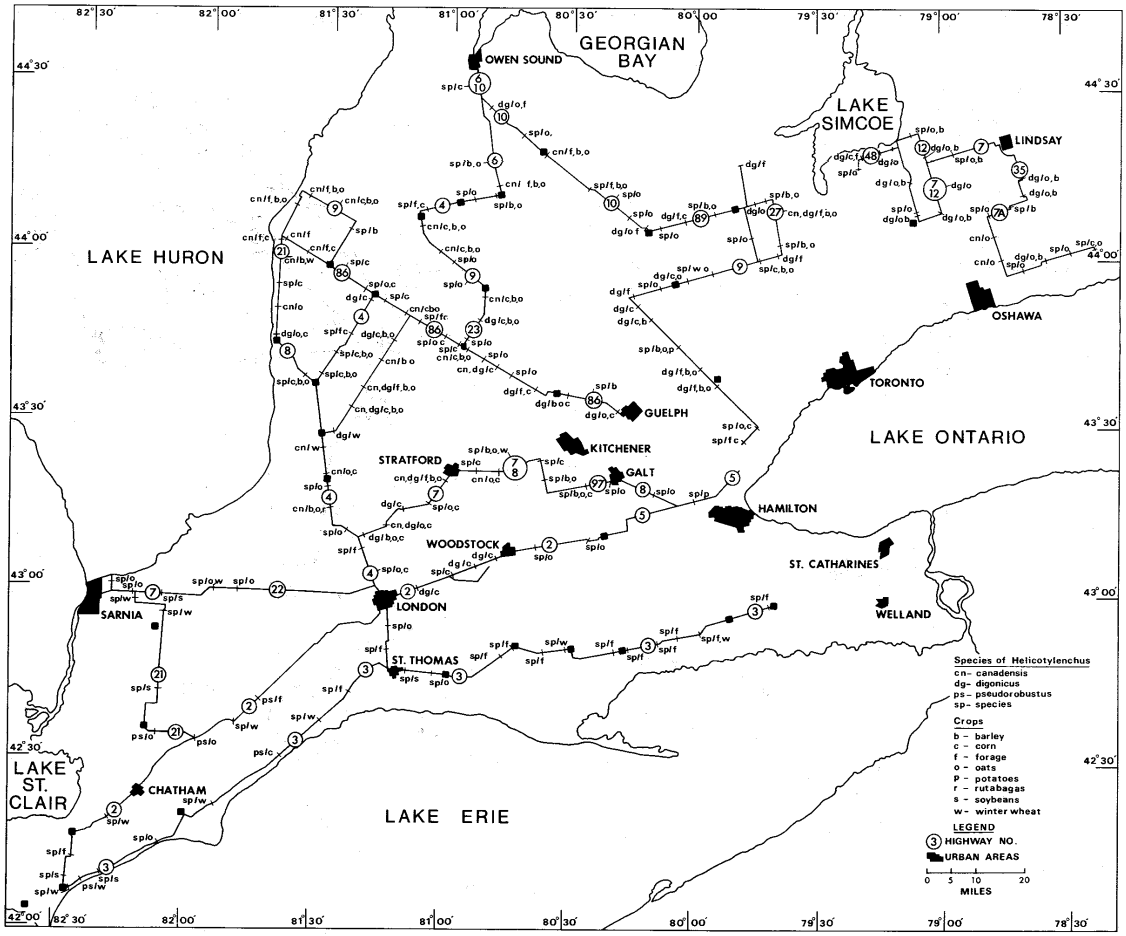

Figure 3 — *Helicotylenchus*

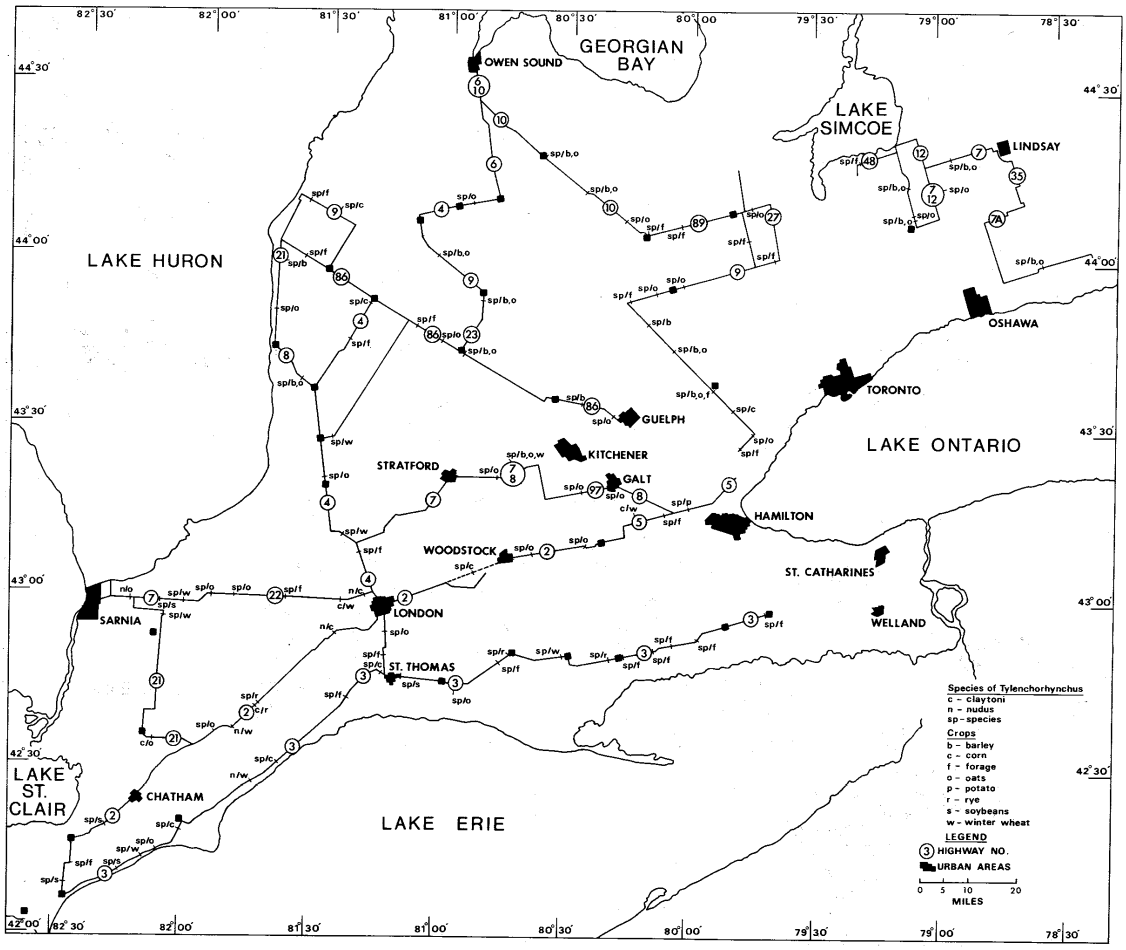

Figure 4 – *Tylenchorhynchus*

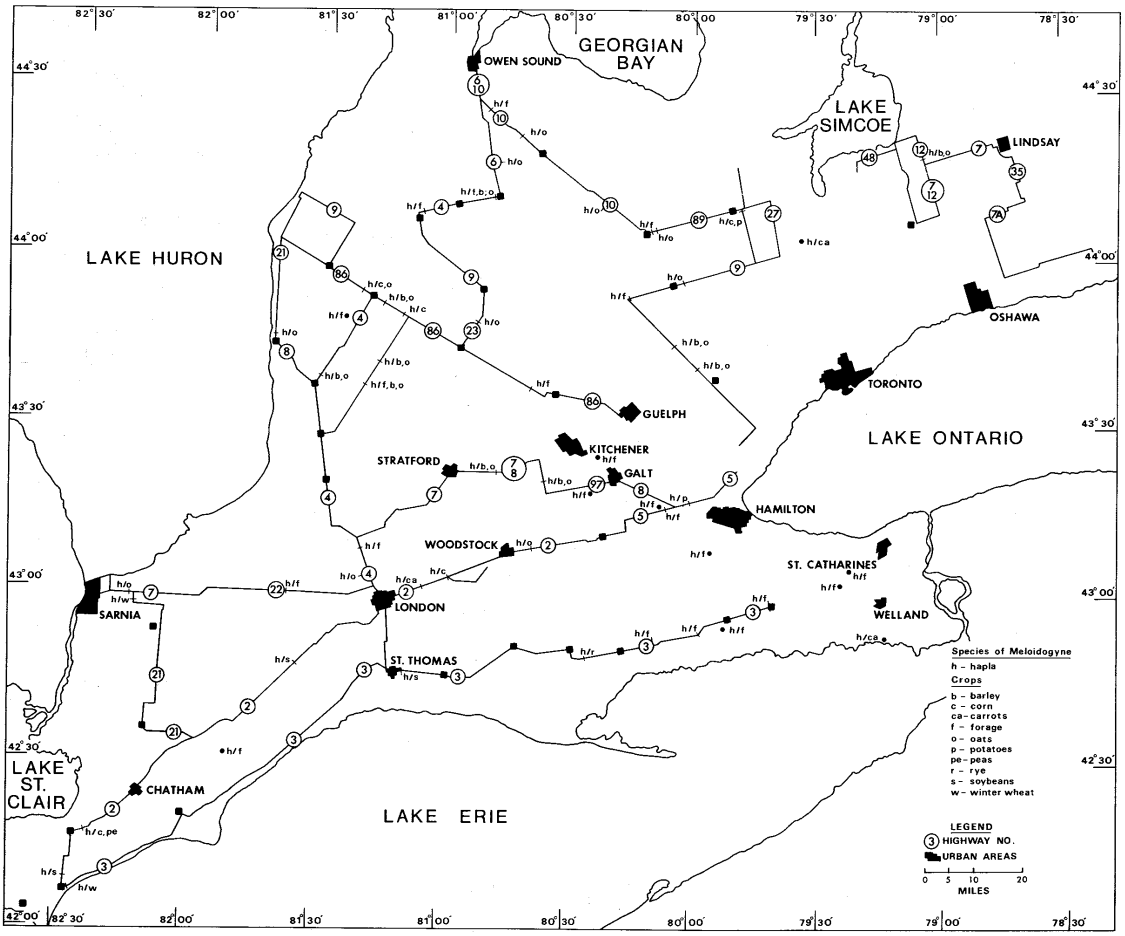

Figure 5 – *Meloidogyne*

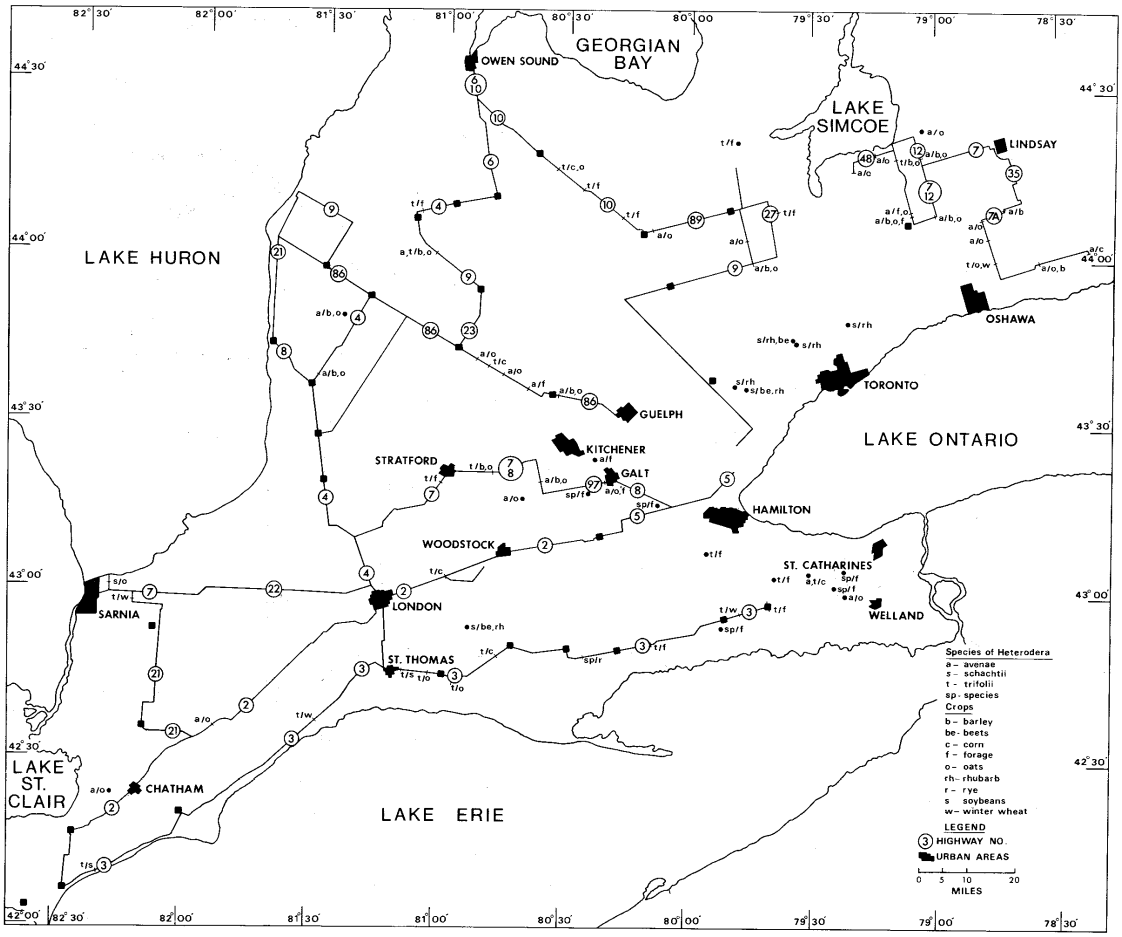

Figure 6 – *Heterodera*

PREVALENCE AND SEVERITY OF DISEASES OF PROCESSING PEAS IN CANADA, 1970-71[1]

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Abstract

The prevalence and severity of diseases of commercially grown processing peas were assessed in a cooperative survey in seven provinces in 1970 and 1971. Uniform methods of sampling and assessing disease severity were used to survey approximately 10% of the acreage of green peas, Pisum sativum, grown for canning and freezing in British Columbia, Alberta, Ontario, Quebec, New Brunswick, Nova Scotia, and Prince Edward Island each year. In most provinces fusarium root rot was the predominant disease in green peas, affecting, overall, 83% and 86% of the fields examined in the two years. Ascochyta diseases (blight, foot rot, and leaf spot), gray mold, rust, and downy mildew followed in decreasing order of prevalence. Powdery mildew, fusarium wilt, septoria blight, anthracnose, cladosporium spot, rhizoctonia stem rot, bacterial blight, virus diseases, nutritional disorders and insect damage were found infrequently. Diseases of field peas, P. sativum var. arvense, were assessed in 1971 in Manitoba, where bacterial blight and mycosphaerella blight were the most important diseases.

Introduction

Green peas, Pisum sativum L., grown for canning and freezing are an important cash crop in many areas of Canada. In 1970 and 1971 green peas were grown on approximately 50 thousand acres and had an annual farm value of more than $6 million (Table 1). In the same years field peas, P. sativum var. arvense (L.) Poir., were grown on approximately 86.0 and 75.5 thousand acres, respectively. About two thirds of the Canadian production of fields peas are grown in Manitoba (G.O. Code, Statistics Canada, personal communication).

A number of pea diseases have been reported from time to time in various regions of Canada (3, 7, 9, 11, 17), but their importance in limiting production is largely unknown. To assess the need for studies on yield-loss relationships and on control a coordinated program was undertaken to determine initially the prevalence and severity of various diseases in the chief pea-growing areas of Canada. This paper reports the results of a cooperative 2-year survey of green peas in seven provinces and a 1-year survey of field peas in Manitoba.

Materials and methods

Uniform methods of sampling, identifying, and rating the severity of diseases were used, and in each province the survey was carried out on consecutive days during the main harvest period.

The number of fields examined was determined from the total acreage contracted by each pea processor. Because of limitations of time and personnel, fields were chosen on the basis of two fields for every 500 acres, with a minimum of two fields per processor. Using a table of random numbers (12), two groups of equal numbers of fields per processor were selected independently from among those to be harvested during the week of the survey. One of the two groups of fields was designated as replication 1 and the other as replication 2.

In each field, 10 sampling sites were chosen along the arms of a W pattern, covering the whole field except for a 15- to 20-ft-wide margin. The location of the first sampling site was determined by walking a number of paces from one corner of the field

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Table 1. Acreage, production, and farm value of green peas grown for processing in Canada, 1970 and 1971*

Province or region	Acres planted under contract 1970	1971	Acres harvested 1970	1971	Tons processed 1970	1971	Total amount paid to producers 1970	1971	Avg yield 1970	1971
	('000 acres)		('000 acres)		('000 tons)		($ million)		(tons/acre)	
Maritimes	9.6	6.1	8.6	5.7	10.9	8.0	0.89	0.69	1.3	1.4
Quebec	15.6	17.0	15.1	16.8	13.5	16.4	1.23	1.32	0.9	1.0
Ontario	18.6	19.0	18.0	18.3	28.6	25.1	3.08	2.71	1.6	1.4
Prairies	3.5	3.0	3.2	2.8	4.7	4.7	0.36	0.37	1.5	1.7
British Columbia	4.6	5.2	4.6	4.8	8.7	9.8	1.01	1.08	1.9	2.0
Canada	51.9	50.2	49.5	48.4	66.4	64.1	6.58	6.17	1.3	1.3

* Data compiled by Statistics Canada (4,13).

Table 2. Number of fields and acreage of green peas surveyed in seven provinces of Canada, 1970 and 1971

Province	1970 No. fields	1970 Acreage	1971 No. fields	1971 Acreage
Prince Edward Island	20	760	14	475
Nova Scotia	6	107	6	131
New Brunswick	31	511	12	350
Quebec	42	1,346	43	1,398
Ontario	70	1,400	74	1,771
Alberta	10	234	8	241
British Columbia	44	984	19	414
Total	223	5,342*	176	4,780**

* Represents 10.3% of the total acreage planted in 1970.

** Represents 9.5% of the total acreage planted in 1971.

as dictated by a random number drawn from 5 to 30. The remaining nine sites were spaced approximately equally along the sampling path. At each site, five consecutive plants in a row were removed carefully from the soil and examined for symptoms of disease.

Illustrated descriptions of most known pea diseases (2, 5, 8, 14, 15, 16, 19) were provided for field diagnosis. These included fusarium root rot [Fusarium solani (Mart.) Sacc. f. sp. pisi (F.R. Jones) Snyd. & Hans.], fusarium wilt [Fusarium oxysporum Schl. f. sp. pisi (van Hall) Snyd & Hans.], aphanomyces root rot [Aphanomyces euteiches Drechsl.], rhizoctonia stem rot [Rhizoctonia solani (Kühn)], ascochyta leaf spot [Ascochyta pisi Lib.], mycosphaerella or ascochyta blight [Mycosphaerella pinodes (Berk. & Blox.) Vestergr., syn. Didymella pinodes (Berk. & Blox.) Petr., stat imperf. Ascochyta pinodes (Berk. & Blox.) L.K. Jones], ascochyta foot rot [Phoma medicaginis var. pinodella (L.K. Jones) Boerema, syn. Ascochyta pinodella L. K. Jones.], gray mold [Botrytis cinerea Pers.], cladosporium spot [Cladosporium cladosporioides (Fres.) De Vries f. sp. pisicola (Snyd.) De Vries], anthracnose [Colletotrichum pisi Pat.], downy mildew [Peronospora viciae (Berk.) Casp.], powdery mildew [Erysiphe polygoni DC], rust [Uromyces viciae-fabae (Pers.) Schroet.],

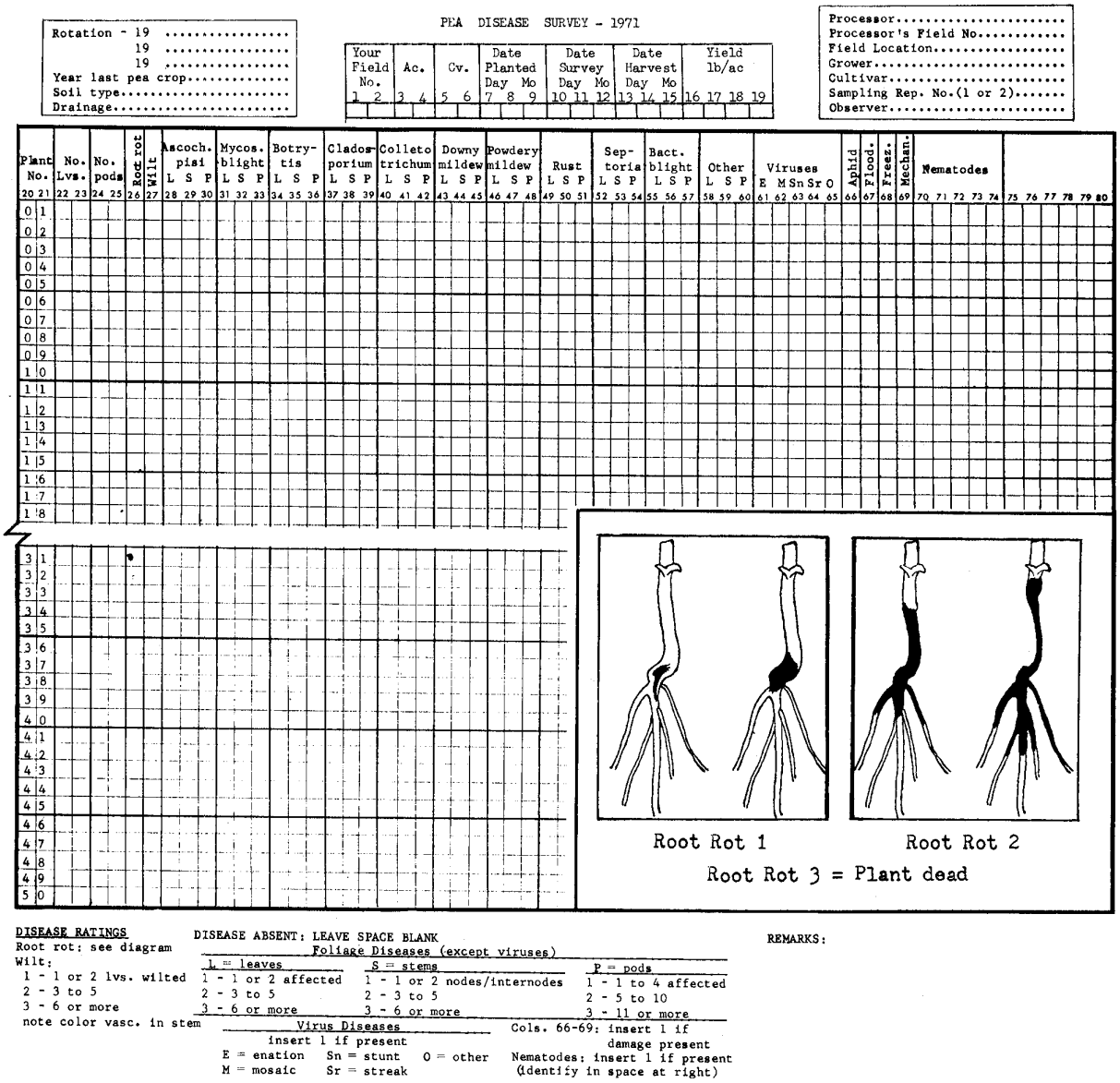

Figure 1. Data sheet used to record disease ratings in each field; insert: diagramatic key for rating root rot.

septoria blight [Septoria pisi West.], bacterial blight [Pseudomonas pisi Sackett], and the virus diseases mosaic, streak, stunt, and enation. Except for suspected virus diseases, the identification of most diseases was confirmed by isolating the casual organism.

Symptoms on roots, stems, leaves, and pods of individual plants were rated separately using a numerical scale to express severity. For root rot, plants with a trace to 2 cm brown-to-black discoloration of the tap root and below-ground portion of the stem were rated 1, those with more than 2 cm discoloration were rated 2, and dead plants were rated 3 (Fig. 1). For foliage and wilt diseases, ratings of 1, 2, and 3 were given when the symptoms appeared on 1-2, 3-5, and more than 5 leaves, respectively. Stem infections were rated similarly on the basis of number of internodes (1-2, 3-5, or more than 5) affected. For pods, the ratings 1, 2, and 3 represented symptoms on 1-4, 5-10, and more than 10 pods. Virus diseases, insect damage, and other injuries were noted without reference to severity.

Disease severity in a field or province was expressed as the average of the numerical ratings of the infected plants. The severity values for roots, stems, leaves, and pods were averaged separately because they were not considered additive. The percentage of plants showing symptoms on each of these organs was also calculated, based on the total number of infected plants.

For each field the percentage of plants diseased was estimated on the basis of 50 plants from the 10 sites. For each province a weighted mean % was then calculated for the fields in each of the two groups (replications), as follows:

$$\text{Mean} = \frac{\Sigma(\%\text{ diseased plants per field} \times \text{field acreage})}{\text{Total acreage of fields}}$$

From these data, the combined mean [(mean rep. 1 + mean rep. 2)/2] and its variance, $s^2 = 1/4$ (mean rep. 1 - mean rep. 2)^2, were estimated. By extracting the square root of the variance (s^2) an estimate of standard deviation of the combined mean (standard error) was obtained. As a relative measure of variability, the standard error was expressed as a percentage of the mean.

A data sheet (Fig. 1) for recording disease incidence, severity, and other relevant information was prepared for each field.

Results and discussion

Fourteen pea diseases and disorders reported previously in Canada (3) were detected during the 1970 and 1971 surveys (Table 4). Since the fields examined (Table 2) were selected at random and sampling sites were predetermined, no apparent bias existed with respect to any of the diseases or to the 63 cultivars and lines of green pea that were encountered.

Disease prevalence

The percentage of affected fields and plants in seven provinces (Table 3) clearly shows the dominance in green peas of fusarium root rot, followed by ascochyta diseases, gray mold, rust, and downy mildew. The high error values (>10%) associated with the means indicated considerable variation, and consequently a lack of uniformity, in the distribution of the diseases. From the provincial data (Table 3), it appears that only the most prevalent diseases can be expected to be more or less uniformly distributed; for example, the occurrence of fusarium root rot in Quebec, Ontario, Alberta, and British Columbia. While the fixed sample of 50 plants per field was not proportional to field size, which varied from 8 to 96 acres, the problem of estimating accurately % diseased plants in an area having fields of different sizes was partially resolved by the weighting method described.

Disease severity on affected plant parts

The percentage of plants showing symptoms on root, stem, leaf, and pod (Table 3) indicated that the ascochyta diseases, gray mold, and bacterial blight caused more pod infection than the other diseases. Except for fusarium root rot and rhizoctonia stem rot, most diseases affected the foliage. The results suggest that, with the exception of ascochyta diseases, most foliage diseases could be assessed on the basis of leaf symptoms alone. Fusarium root rot was rated on root symptoms, although in severe cases wilting of leaves occurred. The mean severity ratings on root, stem, leaf, and pod (Table 3) for most of the diseases rarely exceeded 2 on a 1-3 scale, indicating moderate infection. In certain fields, however, damage from fusarium and ascochyta diseases was severe. It should be pointed out that an overall severity value for a disease could be given only when the severity on stem, leaf, and pod were of the same value (e.g. ascochyta blight in Quebec, 1970) or when a disease was mainly observed on one part of a plant (e.g. fusarium rot on roots, downy mildew on leaves).

Fusarium solani (1, 7, 15) and *F. oxysporum* (9) have been isolated consistently from plants showing root rot symptoms; occasionally *Rhizoctonia solani* (3) and *Ascochyta pinodella* have been isolated from such plants. The symptoms of ascochyta foot rot [*A. pinodella*] and ascochyta blight [*A. pinodes*] are similar (11) and no attempt was made to distinguish them by field diagnosis; this complex is referred to here as ascochyta blight.

Regional observations

Prince Edward Island - The two most important diseases observed in P.E.I. fields were ascochyta blight (11) and fusarium root rot (9). Both diseases are endemic in fields that have been cropped repeatedly to peas and each may cause severe losses, depending upon weather conditions and rotation. The incidence of ascochyta blight was very high both years (Table 3,A), while the incidence of fields affected by fusarium root rot varied from zero in 1970 to 50% in 1971. The absence of fusarium root rot in the samples in 1970 followed a severe outbreak in one area of the province the previous year (9) and was attributable in large part to efforts by processors in avoiding fields used in 1969. The return of peas to some of these fields in 1971 is reflected in the higher incidence of fusarium root that year (Table 3,A). In two pea fields affected by root rot in 1969 and planted to potatoes in 1970, root rot was so severe in 1971 that the pea crops were plowed under before harvest; neither field was included in the sample reported in Table 3.

Marginal necrosis of the leaves symptomatic of boron toxicity was noted in peas in 1970. Each affected field had been

planted the previous year to a cole crop, and each had received an application of fertilizer containing boron in the spring of 1969. In two fields in 1970, a few plants of Perfection-type peas showed severe rosetting, prolonged vegetative growth, and poor seed set similar to symptoms of infection by the seed-borne pea fizzletop virus (6).

In both years a chlorotic condition, occurring typically in parallel strips one to several rows wide, was noted in a number of fields. Plants in the affected areas were a lighter green color than those in "normal" areas. This chlorotic condition was most evident when fields were viewed from a distance but its cause was not identified; in each case the previous crop in the affected fields was potatoes. Similar symptoms have been noted in New Brunswick (q.v.).

Although not indicated in the survey (Table 3), gray mold caused serious losses in several fields following a week of rainy weather just before harvest in 1970. Yield reductions estimated at up to 50% were experienced in fields that showed less than 4% of the plants affected when surveyed a week earlier; the losses were caused by rotting of pods and seeds and by plugging of the combines with partially rotted vines. (W.L.S.)

Nova Scotia - In Nova Scotia pea fields the diseases most commonly associated with a poor plant stand were fusarium root rot and fusarium wilt (Table 3,B). The frequency of F. solani and F. oxysporum recorded when isolations were made from over 100 plants from two fields with poor stands was 14% and 48%, respectively. A 10-acre field cropped successively to peas was completely destroyed in the fifth year by the fusarium wilt and root rot fungi. These fields were not part of the sample reported in Table 3.

During the survey, ascochyta blight was most prevalent in fields successively cropped to peas, and generally this disease was most severe in fields that also had a high incidence of fusarium wilt and root rot. Botrytis gray mold was most prevalent in seasons of heavy rainfall, and it occurred most frequently on the foliage.

Ascochyta leaf spot, downy mildew, and rust were often observed but the overall severity of these diseases was light. Numerous small lesions ("pepper spot") on the upper surface of the leaves were often present late in the season. A. pisi was the predominant organism isolated from these small lesions. Powdery mildew was not recorded on peas in this survey. (C.O.G.)

New Brunswick - The ascochyta blight complex and fusarium root rot were the most important diseases in New Brunswick, followed by ascochyta leaf spot, ascochyta blight, and gray mold (Table 3,C). The latter was more of a problem on the lower leaves in fields where plant growth was excessive.

Losses due to nutritional disorders were also a problem in some fields. Most of the pea crops examined were grown on potato land where the pH of the soil ranged from 4.8 to 5.4. At seeding time lime was applied in the drill at the rate of 400-700 lb per acre. This amount had little or no effect on soil pH but did have a pronounced effect on the health and vigor of the pea plants. Where lime was missed due to plugging or mechanical failure of the machinery, plants became chlorotic and nodulation was absent or sparse. Yields from these areas were poor and often the peas had hardened-off before the remainder of the crop was ready for harvesting. (C.H.L.)

Quebec - Fusarium root rot was the disease observed most frequently in Quebec (Table 3,D). When weather conditions are favorable for its development, this disease causes severe losses in affected fields. Ascochyta leaf spot and ascochyta blight occurred in more than 50% of the fields in 1970 but the severity of these diseases was only slight. Rust was also noticed in many fields but it caused very little damage. In general disease occurrence was greater in 1970 than in 1971. The low yields in Quebec (Table 1) are considered to be due chiefly to the lack of proper management. Poor drainage and lack of rotation, particularly, seem to favor the development of root rot diseases even though no correlation was found between the incidence of fusarium root rot and yield (Table 5). (R.C.)

Ontario - The general distribution of pea diseases (Table 3,E) in three regions of Ontario was as follows:

In eastern Ontario, fusarium root rot, ascochyta leaf spot, downy mildew, and rust were found consistently but the overall severity of these diseases was slight to moderate. Powdery mildew occurred only late in the season.

In central Ontario, fusarium root rot and fusarium wilt were found in most fields surveyed. However, these two diseases were difficult to distinguish under field conditions. Ascochyta blight and virus diseases were occasionally observed.

In southern Ontario, fusarium root rot predominated. Gray mold and bacterial blight were found only in this region of Ontario. Ascochyta leaf spot, ascochyta blight, and septoria blight were rarely encountered. (P.K.B., J.H.H.)

Alberta - Fusarium root rot continued to be the most important disease of green peas in Alberta (Table 3,F) (7). Some farm land is lost for pea production almost every year because of severe yield losses from root rot.

Table 3. Prevalence and severity of pea diseases in seven provinces of Canada, 1970 and 1971

Province and disease	% fields and plants affected				% diseases plants showing symptoms on root, stem, leaf, and pod, and mean severity (sev.)*													
	1970		1971		1970								1971					
					Root		Stem		Leaf		Pod		Root		Stem		Leaf		Pod	
	Fields	Plants (mean)**	Fields	Plants (mean)**	%	Sev.	%	Sev	%	Sev.	%	Sev.	%	Sev.	%	Sev.	%	Sev.	%	Sev.
A. Prince Edward Island																		
Fusarium root rot	0.0		50.0	12.2(23.1)									100.0	1.2				
Ascochyta leaf spot	10.0	0.3(100.0)	7.1	0.4(100.0)					100.0	1.0							100.0	1.0
Ascochyta blight	80.0	44.4(11.1)	78.6	18.1(9.4)			73.0	1.3	35.0	1.3	0.2	1.0	16.2	1.1	61.5	1.0		
Gray mold	15.0	1.9(28.3)	57.1	11.9(15.8)					100.0	1.1	3.3	1.0			2.2	1.4	99.1	1.2
Rust	65.0	17.9(1.6)	64.3	7.8(36.5)			4.6	1.0	98.5	1.0							100.0	1.0
Downy mildew	20.0	1.2(5.4)	92.9	26.4(4.9)					100.0	1.0							100.0	1.0
Powdery mildew	0.0		7.1	0.2(100.0)													100.0	1.0
Virus diseases	5.0	0.3(100.0)	0.0															
Boron toxicity	10.0	2.8(42.0)	0.0															
B. Nova Scotia																		
Fusarium root rot	16.6	2.9(100.0)	100.0	10.6(38.5)	100.0	1.0							100.0	1.4				
Ascochyta leaf spot	100.0	53.7(34.6)	83.3	46.8(6.9)			56.3	1.0	64.7	1.0	11.0	1.0			30.3	1.1	87.6	1.0
Ascochyta blight			66.6	36.4(45.6)											39.7	1.0	65.7	1.0
Gray mold	100.0	75.5(29.9)	100.0	88.8(11.3)			24.5	1.4	100.0	2.0	4.7	1.0			20.8	1.3	93.7	1.6
Rust	66.6	36.4(97.4)	66.6	23.5(65.9)			1.0	1.0	98.9	1.1							100.0	1.0
Downy mildew	83.3	28.0(20.5)	50.0	1.3(6.1)					100.0	1.0							100.0	1.0
Fusarium wilt	50.0	18.7(86.3)	50.0	6.1(100.0)					100.0	1.4							100.0	1.4
Bacterial blight	83.3	14.4(73.7)	0.0						100.0	1.0								
Virus Diseases	16.6	0.3(100.0)	16.6	0.8(100.0)														
C. New Brunswick																		
Fusarium root rot	83.9	48.7(44.6)	91.7	34.8(9.8)	100.0	1.2							100.0	1.2				
Ascochyta leaf spot	51.6	22.6(56.9)	100.0	84.5(2.0)			20.0	1.0	86.1	1.0	18.6	1.0			98.5	1.6	68.9	1.7
Ascochyta blight	90.3	69.3(16.9)	33.3	0.6(2.7)			71.5	1.4	81.9	1.6	36.1	1.0			25.0	1.0	75.0	1.0
Gray mold	58.1	23.6(34.8)	66.6	24.7(22.6)			9.2	1.3	100.0	1.5	1.5	1.0					100.0	1.1
Rust	19.4	15.2(0.9)	0.0				6.8	1.0	100.0	1.2								
Downy mildew	16.1	5.0(54.1)	0.0						100.0	1.1								
Fusarium wilt	16.1	3.5(84.8)	0.0						100.0	1.8								
Bacterial blight	12.9	2.6(84.6)	0.0						100.0	1.0								
Virus diseases	0.0		16.6	1.0(36.4)														
D. Quebec																		
Fusarium root rot	97.6	54.3(9.8)	95.3	25.8(9.3)	100.0	1.3							100.0	1.3				
Ascochyta leaf spot	69.0	13.4(19.8)	39.5	4.6(14.7)			33.4	1.0	64.3	1.1	23.0	1.0			2.0	1.0	91.5	1.0
Ascochyta blight	50.0	4.2(27.4)	27.9	2.1(63.5)			2.9	1.0	97.0	1.0	3.1	1.0			3.3	1.0	96.6	1.0
Gray mold	9.5	0.3(25.9)	7.0	5.1(51.1)					100.0	1.0	12.5	1.0					100.0	1.0
Rust	88.1	10.3(9.5)	53.5	19.5(4.9)			0.6	1.1	100.0	1.0							100.0	1.0
Powdery mildew	21.4	7.0(22.7)	4.7	3.7(83.3)					100.0	1.1							100.0	1.0
Fusarium wilt	9.5	0.3(7.1)	4.7	0.1(100.0)					100.0	2.3							100.0	1.5
Septoria blight	31.0	3.4(10.8)	9.3	1.0(25.8)			8.3	1.0	92.3	1.0							100.0	1.0
Anthracnose	31.0	5.0(33.2)	0.0				83.3	1.0	34.4	1.0								
Cladosporium spot	2.3	0.2(100.0)	0.0						100.0	1.0								
Bacterial blight	2.3	<0.1(100.0)	0.0				100.0	3.0	100.0	2.0	100.0	1.0						
Virus diseases	59.5	21.2(5.1)	48.8	6.6(9.5)														
E. Ontario																		
Fusarium root rot	90.0	55.1(8.8)	79.7	71.6(1.7)	100.0	1.4							100.0	1.3				
Ascochyta leaf spot	12.9	1.8(19.4)	13.5	0.9(9.3)			48.7	1.0	75.6	1.0					76.8	1.0	26.4	1.0
Ascochyta blight	7.1	1.0(50.0)	5.4	0.4(45.4)			30.4	1.0	81.3	1.7	0.9	1.0			8.3	1.0	91.5	1.0
Gray mold	30.0	5.3(29.3)	16.2	1.8(11.4)			71.4	1.0	100.0	1.1					19.6	1.2	83.2	1.0
Rust	4.8	0.3(100.0)	0.0						100.0	1.0								
Downy mildew	18.6	2.3(17.6)	20.3	6.8(25.8)					100.0	1.0							100.0	1.0
Powdery mildew	5.7	3.6(75.6)	0.0				50.0	2.2	100.0	1.6	50.0	1.8						
Fusarium wilt	28.7	5.3(32.5)	36.5	9.9(15.1)					100.0	1.0							100.0	1.0
Septoria blight	0.0		2.7	0.1(42.9)													100.0	1.0
Bacterial blight	10.0	3.8(21.1)					71.4	1.0	100.0	1.1								
Virus diseases	0.0		2.7	0.1(60.0)														
F. Alberta																		
Fusarium root rot	100.0	70.7(18.3)	100.0	59.6(38.6)	100.0	1.4							100.0	1.2				
Ascochyta leaf spot	50.0	3.6(37.3)	87.5	17.6(61.9)			20.0	1.0	80.0	1.0					74.0	1.0	30.3	1.0
Ascochyta blight	60.0	24.7(66.9)	87.5	40.5(23.7)			82.1	1.1	90.5	1.3	13.1	1.0			87.1	1.0	4.4	1.2
Gray mold	50.0	8.4(18.9)	100.0	7.9(24.4)					100.0	1.0	1.3	1.0						

Table 3 (cont'd.)

Province and disease	% fields and plants affected				% diseases plants showing symptoms on root, stem, leaf, and pod, and mean severity (sev.)*													
	1970		1971		1970								1971					
					Root		Stem		Leaf		Pod		Root		Stem		Leaf		Pod	
	Fields	Plants** (mean)	Fields	Plants** (mean)	%	Sev.	%	Sev.	%	Sev.	%	Sev.	%	Sev.	%	Sev.	%	Sev.	%	Sev.
F. Alberta (cont'd.)																		
Downy mildew	50.0	5.6(56.4)	62.5	3.3(33.3)					100.0	1.0					97.5	1.0	2.5	1.0		
Powdery mildew	90.0	26.9(68.3)	100.0	59.5(17.2)			13.3	1.4	100.0	1.2					2.5	1.0	99.3	1.1	0.6	1.0
Septoria blight	100.0	24.2(33.1)	100.0	21.5(1.1)					100.0	1.0							100.0	1.0		
Fusarium wilt	0.0		12.5	0.2(100.0)													100.0	1.0		
Rhizoctonia stem rot	0.0		37.5	2.7(36.3)																
Bacterial blight	30.0	13.4(94.0)	0.0				34.6	1.3	72.3	1.1	5.6	1.0								
Virus diseases	0.0		37.5	0.5(60.0)																
G. British Columbia																		
Fusarium root rot	100.0	96.1(2.7)	100.0	50.6(19.5)	100.0	1.8							100.0	1.6						
Ascochyta leaf spot	4.5	0.2(62.5)	0.0				75.0	1.5	75.0	1.0	50.0	1.0								
Ascochyta blight	4.5	0.3(75.0)	0.0				75.0	2.0	50.0	2.0	25.0	1.0								
Gray mold	11.4	1.1(50.9)	0.0				38.2	1.0	76.2	1.0	27.0	1.0								
Rust	11.4	1.0(49.4)	0.0						100.0	1.0										
Downy mildew	45.5	12.6(15.9)	0.0				0.5	1.0	100.0	1.1										
Fusarium wilt	4.5	0.5(100.0)	0.0						100.0	1.8										
Virus diseases	9.1	0.9(75.0)	0.0																	

* The mean severity rating is based on diseased plants only and is expressed on a 1-3 scale where 3 = maximum severity.

** Mean = combined mean of two weighted means obtained from two independent sets of fields per province; figures in parentheses are standard errors expressed as % of the combined means.

Ascochyta blight and ascochyta leaf spot appear to be increasing in importance in Alberta. This may be due to more frequent periods of high humidity in the plant canopy resulting from increased use of sprinklers to irrigate the pea crop. Powdery mildew was frequently found in pea crops; this disease is rarely important on crops grown for processing but occasional fields of late-maturing cultivars grown for seed are severely affected. (F.R.H.)

British Columbia - Processing peas are grown only in the lower Fraser Valley in the coastal strip of B.C. The most prevalent disease noted in both years was fusarium root rot, which was present in 100% of the fields surveyed (Table 3,G). In spite of this and even when affected fields had supported peas for several recent years, the average yield was higher than that of other areas (Table 1). In 1970 downy mildew occurred in 45% of the fields but no other disease was of any importance. (H.N.W.T.)

Other diseases and pests

In Ontario and Prince Edward Island, a "pepper spot" symptom on pea leaves was noted in several fields; attempts to isolate a pathogen from affected leaves were unsuccessful, and damage appeared to be minor.

In 1970, soil samples from the fields surveyed in eastern Ontario were examined for the presence of plant-parasitic nematodes, and the results have been reported by Sanwal (10).

Aphids were noted in pea crops in all provinces but, in general, little damage was observed. Pod development was affected in only a few fields where insecticides had not been used or where the control program had not been effective. The range of aphid infestation, expressed as the percentage of plants infested, was as follows: Prince Edward Island 3-7%, Nova Scotia 2-8%, New Brunswick 1%, Quebec 6-21%, Ontario 0.3%-0.5%, Alberta 2-4%, and British Columbia 0-2%.

In Prince Edward Island in 1970 and 1971, injury caused by leaf miners (Liriomyza spp.) was found in 55% and 43% of the fields, affecting 4.7% and 1.6% of the plants, respectively; however, on each affected plant only one or two leaves were attacked and damage was regarded as negligible. The two species of Liriomyza that were collected in P.E.I. fields and reared at the Charlottetown Research Station apparently have not been reported on peas in Canada. Liriomyza fricki Spencer was identified by G.E. Shewell, Entomology Research Institute, Ottawa; this species has been found previously in Canada and the USA on other legumes. An as yet unnamed species of Liriomyza, samples of which were examined by K.A. Spencer, is apparently identical to forms found by him in the USA on Trifolium sp. and alfalfa (L.S. Thompson, personal communication).

Table 4. Percentage of green pea fields and plants affected by disease in seven provinces of Canada, 1970 and 1971

Disease	1970		1971	
	Fields	Plants	Fields	Plants
Fusarium root rot	83.0	46.8	85.8	37.9
Ascochyta leaf spot	31.0	13.7	29.5	22.1
Ascochyta blight	35.0	20.5	23.9	14.0
Gray mold	27.8	16.6	25.6	20.0
Rust	30.5	11.6	20.5	7.4
Downy mildew	23.3	7.8	20.5	5.4
Powdery mildew	8.0	5.4	6.3	9.1
Fusarium wilt	15.2	4.0	18.8	2.3
Septoria blight	10.3	3.9	7.9	3.2
Anthracnose	5.8	0.7	0.0	0.0
Cladosporium spot	0.4	<0.1	0.0	0.0
Rhizoctonia stem rot	0.0	0.0	1.7	0.4
Bacterial blight	9.0	4.9	0.0	0.0
Virus diseases	3.5	0.3	5.7	0.2

Diseases of field peas in Manitoba, 1971

All nine fields sampled in Manitoba were affected by bacterial blight and ascochyta blight. These diseases affected 89% and 99%, respectively, of the plants examined, and each had a mean severity rating of 2.4. In one of the nine fields downy mildew was found on 12% of the plants, with a mean severity of 1.0. The range of diseases affecting field peas is similar to that affecting green peas, except that the cultivar Century, which is the predominant field pea grown in Canada, is resistant to Ascochyta pisi (18). In most years blight incited by Mycosphaerella pinodes is the most prevalent and damaging disease in Manitoba, where peas are frequently planted within range of wind-blown ascospores produced on debris of a previous year's crop; in this area the fungus is known to survive in refuse for at least 3 years. (R.C.Z.)

Pea yield and fusarium root rot

In 1970, an effort was made to correlate the yield of shelled green peas reported by the processors with the incidence of fusarium root rot in 145 fields selected at random in five provinces. The average yield (1.32 tons/acre) reported from these fields agreed with the national average (Tables 1, 5). However, the yield data reported did not reflect the differences in incidence of root rot observed (Table 5). In the fields surveyed, factors other than root rot apparently had a much more profound influence on yield.

Table 5. Yield of shelled green peas from 145 fields* with different percentages of plants affected by fusarium root rot

% affected plants	No. of fields	Avg yield** (lb/acre)
0	13	2489
1-10	11	2605
11-20	10	2880
21-30	8	2841
31-40	4	2852
41-50	4	2226
51-60	8	2196
61-70	10	3008
71-80	8	2041
81-90	15	2601
91-100	54	3366

* Fields surveyed in British Columbia, Ontario, Quebec, New Brunswick, and Nova Scotia for which yield data were available in 1970.

** Yield data were supplied by processors; the average yield of all the fields was 2645 lb (1.32 tons) per acre.

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INCIDENCE OF WHEAT SPINDLE STREAK MOSAIC IN ESSEX, KENT, AND LAMBTON COUNTIES, ONTARIO, 1969-72

L.F. Gates[1]

Abstract

The annual incidence of wheat spindle streak mosaic virus in winter wheat in 1969-72 averaged usually between 30% and 51% infected shoots in Essex and Kent counties and between 22% and 37% in Lambton County. Overall annual yield losses were 3-5% in Essex and Kent and 2-4% in Lambton, based on previous disease incidence - yield loss data. Disease incidence was often higher around field entrances and near roadsides and farm paths, suggesting that slow spread of the disease is occurring.

Wheat spindle streak mosaic of winter wheat is caused by a soil-borne virus. In the spring, spindle-shaped dashes and short streaks develop on new leaves as plant growth resumes. The streaks change from light green to bright yellow and develop necrotic centers as the leaf matures. The disease occurs in all areas of southern Ontario where winter wheat is grown frequently (3); in 1967-68 it attracted particular attention in Essex and Kent counties because the streaks and necrosis caused an overall brownish discoloration in many fields. The average percentage of shoots with symptoms in Essex and Kent counties in those two seasons was 49.6%, and this was estimated to cause an overall loss in grain yield of 5% in each season (1). In surveys in southern Ontario in 1969, Slykhuis and Polak (4) estimated the mean percentage of diseased plants as 38%, and James (2) as 33%. The results of annual surveys in Essex, Kent, and Lambton counties in 1969-72 are presented here.

Table 1. Incidence of wheat spindle streak mosaic in Essex, Kent and Lambton Counties in 1969-1972

County	Year	Number of fields examined	Number of fields with: No disease	Trace of disease (none in counts)[a]	Up to 50% diseased plants	51-99% diseased plants	All plants infected	Average infection for all fields (%)
Essex	1969	40	7	4	10	5	14	50.7
	1970	30	5	9	11	3	2	22.7
	1971	57	3	7	31	10	6	30.1
	1972	60	5	12	15	17	11	43.4
Kent	1969	22	3	2	8	7	2	42.5
	1970	19	3	3	9	1	3	23.2
	1971	40	4	7	14	7	8	38.5
	1972	52	12	6	15	14	5	35.2
Lambton	1969	22	6	3	7	6	0	21.9
	1970	22	16	1	5	0	0	1.3
	1971	22	4	4	8	6	0	24.9
	1972	25	3	4	8	9	1	37.2

[a] Disease observed in field, but not occurring within random sample lengths.

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Disease surveys

Fields were selected at random, usually by examining every 5th-8th wheat field encountered. In each field, counts were made

on enough 1-yard (91 cm) or 1-foot (30 cm) lengths of row to arrive at a consistent estimate of the proportion of infected shoots.

In 1969, 1971, and 1972 disease incidence averaged between 30% and 51% infected shoots in Essex and Kent counties, and between 22% and 37% in Lambton County (Table 1). Estimates of the disease were lower in 1970, especially in Lambton County. In each season, symptoms were brightest in April and early May, fading when temperatures rose in late May and early June, as described by Slykhuis (3). In 1970 especially, rapid growth occurred in May, and symptoms were mainly confined to the lower parts of the plants. This may have been responsible in part for the lower counts, especially in Lambton County. Except in fields close to Lake Erie, only occasional fields showed the overall discoloration that occurred so widely in 1967 and 1968.

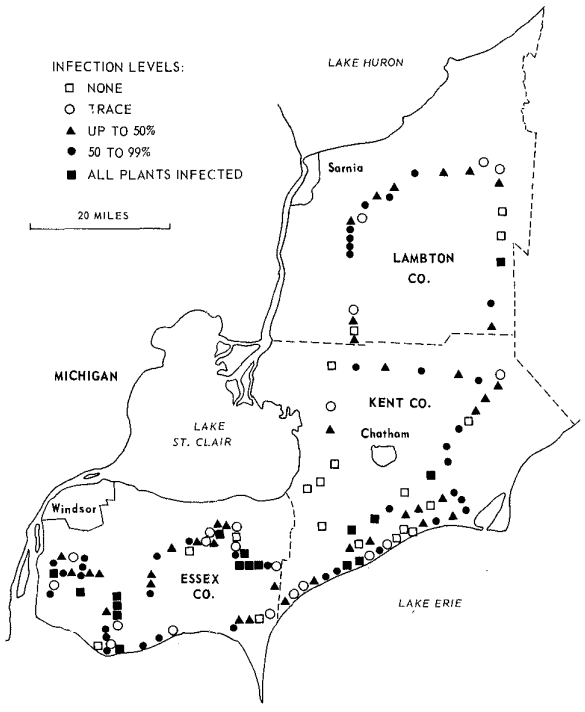

Figure 1. Wheat spindle streak mosaic survey, 1972.

In 1967 and 1968, infection of all plants in a field was estimated to cause a yield loss of 10% (1). The general levels of infection in 1969-72 indicate overall yield losses in each year of 3-5% in Essex and Kent counties and 2-4% in Lambton County. Because disease symptoms were less persistent in 1969-72 than in 1967 and 1968, these figures may be on the high side. A 4% loss would represent about 2 bushels per acre (135 kg/ha) on 130,000 acres (52,650 ha) in each year.

Disease estimates for 1967-72 reveal no tendency for the disease to increase, and fields with no disease or only a trace of infection occur in all areas together with heavily infected fields (Fig. 1). Yet the disease incidence was often noted to be higher around field entrances and near roadsides and farm paths, suggesting that slow spread is occurring, possibly either by traffic and farm machinery, or along water drainage channels.

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FIRST RECORD OF GYMNOSPORANGIUM CLAVIPES ON MALUS SP. IN WESTERN CANADA[1]

Howard Harding[2] and R.A.A. Morrall[3]

In July 1972 a single apple tree, variety unknown, in a private garden in Saskatoon was noted to be heavily infected with rust. Approximately 15% of the fruit and 5-10% of the terminal buds showed abundant bright orange aecia (Figure 1). The material was subsequently identified by Dr. J. A. Parmelee, Plant Research Institute, Ottawa, as Gymnosporangium clavipes (Cke. & Pk.) Cke. & Pk. As this is the first record of this species on Malus sp. in western Canada and as the symptoms do not agree with the description of the disease given in Anderson's text (1), we believe that a short note is warranted.

The aecial stage of G. clavipes has been recorded in western Canada on Amelanchier alnifolia Nutt., Cotoneaster lucida Schlecht., Crataegus chrysocarpa Ashe, and C. douglasii Linde., while the telial stage has been recorded on Juniperus communis L. var. depressa Pursh (4). G. clavipes is well known on Malus sp. in eastern Canada (2) where some damage to apples has been reported from the Maritimes and eastern Quebec. The Saskatoon tree had approximately 15% of its fruit badly infected and the owner has estimated the fruit yield to be about half that of 1971. There are several other apple trees in the immediate vicinity but no rust was apparent on these. However, most were clearly varieties other than the one that was infected.

Using Anderson's text (1) to key out the rust species involved, two anomalies were found. In his description of the symptoms of G. clavipes on apple fruit he states "there is little evidence of pycnial or aecial development". Also he states "the flesh below the lesion shows a dead area often extending to the calyx tube". In the Saskatoon material there were abundant aecia surrounded by very obvious "green island" tissue (Figure 1) and there were no signs of necrosis beneath the infected area.

From the extent of the infection and the fact that apparently only one tree in the area was infected one might assume that the alternate host was nearby. Juniperus spp. (primarily J. horizontalis Moench) are common in the immediate vicinity but telia of Gymnosporangium were not found there in late September 1972. However, Parmelee (3) has reported a situation where Crataegus spp. were heavily infected by G. globosum, the aerial inoculum apparently originating 24 km away. The fact that only one tree was affected may indicate a specific "race"-variety interaction but this is just speculation. Whatever the source of inoculum it is to be hoped that this is an isolated case as such severe infection could cause serious losses.

Figure 1. Aecia of *Gymnosporangium clavipes* on fruit and terminal bud of apple.

Acknowledgments

We are grateful to Dr. J. A. Parmelee for confirming the identification and to Dr. D.F. Acton for drawing our attention to the diseased tree.

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DISEASES OF RAPESEED IN MANITOBA IN 1972[1]

R.G. Platford[2] and C.C. Bernier[3]

A survey of rapeseed fields in the northern part of the rapeseed growing area of the province was made during the third week of August, 1972. Forty-two fields between Gladstone and Swan River were surveyed, 19 fields of turnip rape (Brassica campestris L.) and 23 of rape (B. napus L.). The prevalence and severity of disease in the fields surveyed was rated. The disease ratings for the staghead phase of white rust [Albugo cruciferarum S. F. Gray], black spot [Alternaria brassicicola (Schw.) Wilts.], ringspot [Mycosphaerella brassicicola (Duby) Oud.] and stem blight [Sclerotinia sclerotiorum (Lib.) De Bary] were as follows:

Table 1. Disease ratings[a] in 42 fields of turnip rape and rape surveyed in Manitoba, 1972

Severity category	Turnip rape[b] (19 fields)				Rape[c] (23 fields)	
	Staghead	Black spot	Ringspot	Stem blight	Black spot	Stem blight
Trace	26	26	32	0	57	9
Slight	47	37	5	11	13	0
Moderate	16	16	16	0	4	0
Severe	11	16	0	0	4	0
% of total fields infected	100	95	53	11	78	9

[a] Ratings indicate % of fields in each severity category.

[b] *Brassica campestris.*

[c] *Brassica napus.*

Staghead and pustules of white rust on the leaves were found in varying amounts in all the fields of turnip rape surveyed but were not found in any fields of rape. Staghead was most severe in the Dauphin area. Blackspot was found in all but one field of turnip rape and in 18 out of 23 fields of rape. The disease appeared to be most severe in the Swan River area.

Ringspot was found in 53% of the turnip rape fields, ranging in severity from trace (32%) to moderate (16%). Ringspot was not found in any of the rape fields surveyed.

Other diseases found occasionally in turnip rape were downy mildew [Peronospora parasitica (Pers. ex Fr.) Fr.] 11%, stem blight [Sclerotinia sclerotiorum] 11%, and aster yellows 11%. Downy mildew infections were associated with severe staghead in the Dauphin area. Downy mildew was not found in any of the rape fields surveyed. Aster yellows and stem blight were encountered in 30% and 9% of the rape fields respectively, but never in more than trace severity. The low incidence of stem blight reported may in part be due to the fact that prevalence and severity of stem blight are much easier to assess in stubble fields. None of the fields surveyed were stubble fields. Stem blight is probably more prevalent than this survey indicates.

In general, disease was more severe on turnip rape than rape. Staghead is becoming a serious disease problem in turnip rape. Blackspot appears to be quite prevalent in both turnip rape and rape. Ringspot was found in over half the fields of turnip rape surveyed but little is known about the damage caused by this disease. Stem blight must be regarded as a serious disease in view of its wide host range. Crop rotation is presently the only control recommended for diseases attacking rape.

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