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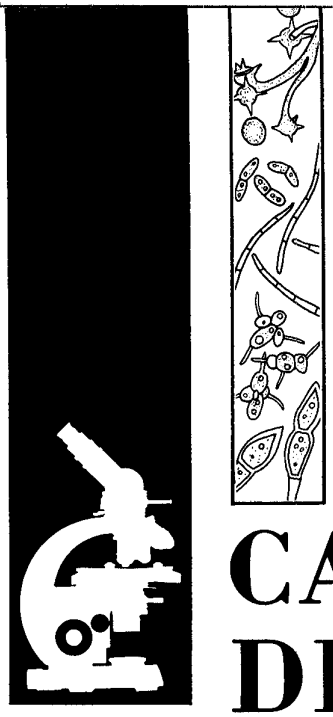
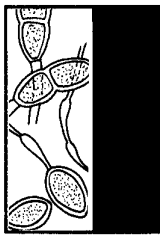


CANADIAN PLANT DISEASE SURVEY



EDITOR W.L. SEAMAN

RESEARCH BRANCH CANADA DEPARTMENT OF AGRICULTURE

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CANADIAN PLANT DISEASE SURVEY

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CONTENTS

"The Canadian Plant Disease Survey is a periodical of information and record on the occurrence and severity of plant diseases in Canada. 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."

RACES OF PLASMODIOPHORA BRASSICAE INFECTING CRUCIFER CROPS IN CANADA[1]

G.W. Ayers[2]

Abstract

The screening of isolates of Plasmodiophora brassicae Wor. has indicated that at least six races of the organism are present in the soils of Canada. Differential distinction of clubroot inocula showed that races 2 and 3 were the most common variants in isolates from the Maritime Provinces and that race 2 was the most prevalent biotype in diseased tissue samples from Quebec. Race 6 was the only pathogen variant in two spore samples from British Columbia and in one sample from Ontario. Localized infestations of races 1, 6, and 6A were established for Quebec. Scattered infestations of race 1 were demonstrated for the Maritime Provinces while race 4 was found in two clubroot tissue samples from Prince Edward Island. The sole distinction of race 7 was in a spore sample from Wisconsin, U. S. A. The rutabaga variety York proved resistant to races 2, 3, 6, 6A, and 7 and for this reason is considered relatively secure from clubroot infection when planted in most crucifer growing areas of Canada. The prevalence of race 2 in Quebec and the Maritime Provinces presents a challenge to cole crop breeders as no genes for resistance to this race have been found in cole crop lines bred for resistance to other races of P. brassicae.

Introduction

Evidence of physiologic specialization in the clubroot organism Plasmodiophora brassicae Wor. was advanced by Honig (2) in 1931, and since that time other workers throughout the world have demonstrated variation in this pathogen by means of reactions obtained on various stocks of differential crucifers. Walker (6) found that two turnip varieties had different clubroot reactions in England than when grown in Wisconsin, U.S.A. Lammerink (3) distinguished six races of the organism occurring in New Zealand, and Seaman, Walker, and Larson (5) contributed to knowledge on pathogen variation in Wisconsin, U.S.A. In studies reported in this paper a more exact method of identifying races of the clubroot organism has been developed than that described earlier (1). This has been achieved largely by careful selection and propagation of differential seed stocks for homozygosity in disease reaction when exposed to what are considered to be specific races of the organism. The method used to assess variation in the pathogen is essentially similar to that described by Williams (7), who used four differentials and classified 16 possible host reactions. The author has added an additional differential host to facilitate distinction of certain differences in inocula obtained in the Maritime Provinces of Canada. Data assembled by the author were based on an assessment of variation in inocula gathered over the period 1959-71. More than 160 spore samples were screened for variation, and the reactions of 68 representative samples are reported in this paper.

Materials and methods

Clubroot tissue samples for studies on pathogen variation were obtained from various crucifer growing areas throughout Canada with the major portion of samples collected in the Maritime Provinces and Quebec. Spores were water extracted from infected root tissues using a Waring Blendor. This procedure was followed by coarse filtering and centrifuging to remove host tissues and soil particles to the extent that spores could be readily detected upon microscopic examination. Spore counts were made with a bright line haemocytometer, and inoculum was introduced and thoroughly mixed with sandy loam clubroot-free soil at the rate of 6.1×10^7 spores per cm^3 of soil medium. These artificially infested soil samples were stored at 38°F(3.3°C), until screened for pathogen variation. Differentials used in race studies were cabbage (Brassica oleracea L. var. capitata L. 'Danish Ballhead' and 'Badger Shipper') and rutabaga (Brassica napobrassica Mill. 'Laurentian', 'Wilhelmsburger', and 'Ditmars S2'). Pathogen variation studies were conducted in the greenhouse using 2-inch earthenware pots partially filled with infested soil. For

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each infested soil sample, differentials were planted at the rate of 12 to 16 seeds per pot with four pots per crucifer. Pots were sunk in sphagnum moss, regulated in moisture content to allow sufficient penetration of capillary water for germination of seed. At the two-leaf stage of seedling development soil moisture was raised to above saturation levels for a period of 48 hr, following which the contents of each 2-inch pot were embedded in clubroot-free soil in a 4-inch pot. Temperatures were maintained at 70°F(21°C) during the course of the experiments and plants were scored for clubbing 30 days after seeding. Forty plants of each differential from each inoculum series were assessed as follows: (1) no symptoms, (2) nodulation, (3) restricted sphaeroid clubbing, (4) unrestricted clubbing. The first two categories were rated zero for disease index since nodulation caused little or no plant damage. Plants showing no restriction in the development of typical clubroot distortion were given a rating of 100, irrespective of whether symptoms were slight, moderate, or severe. This latter classification was based on the author's experience that all such plants lack genes for resistance.

The system of classification of races shown in Table 1 is at variance with that of Williams (7) in that an additional differential, Ditmars S2 rutabaga, was used to distinguish reactions of mixtures of races 2 and 3 from those of race 2 alone. Seven main differential reactions are shown out of a possible 16 listed by Williams. Race 5 and races 8 to 16 were not encountered by the author in the course of studies on pathogen variation.

Table 1. Differential reactions to infection by races of *Plasmodiophora brassicae*

Differential	Reaction* to race** 1	2	3	4	5	6†	7
Cabbage							
Danish Ballhead	+	+	+	+	-	+	+
Badger Shipper	-	+	-	+	-	-	+
Rutabaga							
Laurentian	+	+	+	+	-	-	-
Wilhelmsburger	+	-	-	+	-	-	-
Ditmars S2	+	-	+	+	-	-	-

* + indicates susceptibility, - indicates resistance.

** Races 4 and 5 according to Ayers (1) have been redesignated according to Williams (7). Races 1, 2, 3, and 6 were classified similarly by both authors. Race 7 was designated by Seaman et al. (5).

† Race 6A is distinguished from races 6 and 7 by a restricted sphaeroid clubbing of roots of Badger Shipper. This cultivar is resistant to race 6 and fully susceptible to race 7.

Table 2. Race classification of isolates of *Plasmodiophora brassicae* on five differential crucifers

Isolate No.	Source of isolates: Province and district	Crucifer	Variety (where known)	Percentage infection† on differential hosts: Cabbage: Danish Ballhead	Cabbage: Badger Shipper	Rutabaga: Laurentian	Rutabaga: Wilhelmsburger	Rutabaga: Ditmars S2	Race
	Prince Edward Island								
1	Winsloe	Rutabaga	Wilhelmsburger	98	100	100	100	100	4
2	Greenfield	Rutabaga	Laurentian		84	100	0	100	2+3
3	Mermaid	Rutabaga	Laurentian	72	100	90	0	0	2
4	South Melville	Rutabaga	Laurentian	86	88	88	0	0	2
5	Pownal	Rutabaga	Laurentian	98	98	100	0	0	2
6	Murray Harbor	Rutabaga	Laurentian	100	100	100	0	100	2+3
7	Waterside	Rutabaga	Laurentian	100	100	100	0	2	2
8	Kingston	Rutabaga	Laurentian	100	100	100	0	0	2
9	Summerside	Rutabaga	Laurentian	100	100	100	0	0	2
10	Montague	Turnip	Greystone	100	100	100	0	100	2+3
11	Upton	Rutabaga	Ditmars S2	100	0	100	0	100	3
12	Souris	Cabbage		100	14	100	0	100	3+2*
13	Riverdale	Rutabaga	Laurentian	98	100	100	2	0	2
14	Argyle Shore	Rutabaga	Laurentian	100	100	100	0	0	2
15	Uigg	Rutabaga	Laurentian	100	100	100	0	0	2
16	Morell	Rutabaga	Laurentian	100	88	100	0	100	3+2
17	Tracadie	Rutabaga	Laurentian	100	80	100	0	0	2
18	Rollo Bay	Rutabaga	Laurentian	100	100	100	0	0	2
19	Vernon River	Rutabaga	Laurentian	100	100	100	0	100	2+3
20	York	Rutabaga	Laurentian	100	100	70	0	0	2
21	Loyalist	Rutabaga	Wilhelmsburger	100	91	100	100	100	4
22	Fredericton	Rutabaga	Laurentian	95	83	100	0	0	2
23	Clyde River	Rutabaga	Laurentian	100	94	100	0	90	2+3
24	Souris	Rutabaga	York	100	0	100	58	100	1
25	Cornwall	Cabbage		95	0	100	90	100	1
	Nova Scotia								
26	Nappan	Cabbage	Badger Shipper	93	88	100	0	0	2
27	Nappan	Rutabaga	Wilhelmsburger	100	0	100	100	100	1
28	Nappan	Rutabaga	Laurentian	100	22	100	100	100	1+2*
29	Port Howe	Rutabaga	Laurentian	100	65	100	100	100	1+2*
30	Linden	Cabbage		100	96	100	0	75	2+3

Table 2 (ctd.)

Isolate No.	Source of isolates: Province and district	Crucifer	Variety (where known)	Percentage infection† on differential hosts: Cabbage: Danish Ballhead	Cabbage: Badger Shipper	Rutabaga: Laurentian	Rutabaga: Wilhelmsburger	Rutabaga: Ditmars S2	Race
31	Marshville	Rutabaga	Laurentian	100	48	100	2	100	3+2*
32	Truro	Rutabaga	Laurentian	80	58	100	0	0	2
33	Parrsboro	Rutabaga	Laurentian	100	10	100	100	100	1
34	Cole Harbor	Cabbage		82	0	100	0	100	3
35	Wallace	Rutabaga	Laurentian	100	0	100	0	100	3
36	Hastings	Rutabaga	Laurentian	100	100	100	0	0	2
37	Brentwood	Rutabaga	Laurentian	100	98	100	0	0	2
38	Bras D'Or	Rutabaga	Laurentian	100	80	100	0	100	3+2
39	Leicester	Rutabaga	Laurentian	100	100	100	0	42	2+3*
40	Berwick	Rutabaga	Laurentian	100	8	100	0	100	3
41	Heatherton	Cabbage		100	100	100	0	2	2
42	St. Joseph	Cabbage		100	100	100	0	2	2
	New Brunswick								
43	Upper Burton	Rutabaga	Laurentian	59	40	70	0	22	2+3
44	Naskwaaksis	Cabbage		100	100	100	0	0	2
45	Moncton	Brussels sprouts		100	20	100	0	100	3+2*
46	Moncton	Cabbage		100	42	100	0	100	3+2*
47	Sussex	Rutabaga	Laurentian	100	21	100	70	82	1+2*
48	Marysville	Rutabaga	Laurentian	100	78	100	0	6	2
	Quebec								
49	St. Martin	Cabbage		100	6	0	0	0	6
50	Ste. Clotilde	Cabbage		96	50-r**	0	0	0	6A
51	St. Rémi	Cauliflower		96	40-r**	0	0	0	6A
52	Plessisville	Cabbage		100	92	100	0	0	2
53	Beauport	Cabbage		86	100	100	0	0	2
54	Neuville	Cabbage		100	100	100	0	0	2
55	Ste. Edwidge	Rutabaga	Laurentian	100	100	100	52		2+1*
56	Ile O'Orleans	Cabbage		100	100	95	0	0	2
57	Baie St. Paul	Cabbage		100	100	100	0	0	2
58	Levis	Cabbage		100	65	100	0	0	2
59	Duvernay	Rutabaga	Laurentian	100	98	100	0	0	2
60	Mascouche	Rutabaga	Laurentian	92	62	100	2	6	2
61	Rivière Ouelle	Rutabaga	Laurentian	100	100	100	0	0	2
62	Ste-Foy	Cabbage		98	95	100	30	8	2+1*
63	St. Nicolas	Cabbage		100	65	100	0	0	2
	Ontario								
64	Bradford	Cabbage		100	10	0	0	0	6
	British Columbia								
65	Keating	Cabbage		98	2	0	0	0	6
66	Cordova Bay	Cabbage		98	4	0	0	0	6
	U.S.A.								
67	Wisconsin	Cabbage		100	90-r**	0	0	0	6A
68	Wisconsin	Cabbage	Badger Shipper	100	100	0	0	0	7

† Infections of 10% and under were not classified.

* Indicates lower spore load of component in racial mixture.

** r indicates restricted sphaeroid type of clubbing.

Results

Clubroot differential reactions obtained with 68 representative isolates of the organism are presented in Table 2. Race 2 proved to be the most prevalent pathogen variant in isolates from the Maritime Provinces while race 3 was also shown to be common to this area of Canada. In Quebec race 2 was also the most common variant, while races 1, 6, and 6A were present to a lesser extent. Race 6 was the only variant identified in spores samples from British Columbia and Ontario. Scattered infestations of race 1 were indicated for the Maritime Provinces. Race 4 was found in two isolates from Prince Edward Island, while race 7 was identified in a spore sample from Wisconsin, U. S. A. Difference in identity between races 6A and 7 was based on symptom expression on Badger Shipper cabbage. Race 7 caused unrestricted clubbing while race 6A caused a restricted sphaeroid distortion of roots at ground level.

Without the use of Ditmars S2 as a differential, mixtures of races 2 and 3 would probably have been classified as race 2. The author was able to isolate race 2 from representative mixtures of races 2 and 3 using Badger Shipper cabbage; similarly, race 3 was isolated from race 2 using Ditmars S2 rutabaga. Further evidence that mixtures of races 2 and 3 are so constituted is apparent in reactions obtained with York, a rutabaga variety selected at Charlottetown in 1964 for resistance to races 2 and 3. This variety was exposed to all inocula under test between 1964 and 1971 and complete resistance to clubbing was shown where inocula were classified as races 2 or 3 or as mixtures of these races (Table 3).

In tests with samples designated as mixtures of races 2 and 3, moderate to low infection percentages were encountered frequently in either the Badger Shipper or Ditmars S2 differentials, thus indicating that two races were present and that the spore load of one was insufficient to cause

Table 3. Clubroot susceptibility in York rutabaga exposed to classified representative isolates listed in Table 2

Race	Reaction*
1	+
1 + 2	+
2	-
2 + 3	-
3	-
4	+
6	-
6A	-
7	-

* + indicates susceptibility, - indicates resistance.

full infection in one or other of these crucifers. A parallel situation was encountered with mixtures of races 1 and 2 in a small plot area at the Experimental Farm, Nappan, N.S. Badger Shipper cabbage grown in this land segregated race 2 (Isolate 26, Table 2), while Wilhelmsburger rutabaga grown in close proximity segregated race 1 (Isolate 27), and Laurentian rutabaga became infected with both races (Isolate 28). However, isolate reactions indicated that race 2 spore load was minimal in comparison with that of race 1.

Attempts to segregate possible components in Isolates 1 and 21 were not successful. Inoculum from Badger Shipper and Wilhelmsburger grown under exposure to these spore samples caused heavy infection in all differentials. These isolates were therefore classified as race 4. No further occurrences of this race have been demonstrated in studies conducted at Charlottetown.

Gene pools for resistance to races 1, 2, 3, and 4 were demonstrated in four turnip (B. rapa L.) varieties, and clubroot reaction data are presented in Table 4 together with reactions of six additional crucifers. The relatively broad type of resistance of turnip varieties under test indicates that such stocks would be potentially useful in cross breeding with York rutabaga to obtain progeny resistant to all races classified in this paper. The broccoli selection B-0-23 (N.Y.) showed resistance to races 1 and 3 and complete susceptibility to race 2. The writer has tested numerous lines of cole crops and has not encountered any genes for resistance to race 2.

Discussion

The identification and distribution of races of the clubroot organism as determined in studies conducted by the author should provide a useful guide to those engaged in breeding for clubroot resistance in rutabagas and cole crops. York, a purple top rutabaga selected for clubroot resistance at Charlottetown and registered for commercial production in 1964, has proven resistant to races 2, 3, 6, 6A, and 7. It is now extensively planted in areas of Eastern Canada where races 2 and 3 are the prevalent biotypes of the pathogen. The York variety has thus replaced Laurentian because of the high susceptibility of the latter to races 2 and 3. Wilhelmsburger rutabaga, although possessing similar resistance to that of York, is not in commercial table stock production, largely because of its green top and heavy root system. York is susceptible to races 1 and 4 but these pathogen variants are not of widespread occurrence; if the York variety is planted in a rotation of 5 or more

Table 4. Reaction to clubroot races 1, 2, 3, and 4 in turnips and other crucifers

Crucifer	Variety	Percentage clubbing*			
		Race 1	Race 2	Race 3	Race 4
Turnip	Meetjeslander	2.5	0.0	0.0	10.0
Turnip	Halflange 70K	30.0	0.0	7.5	6.7
Turnip	Halflange Gele	10.0	5.0	7.5	0.0
Turnip	Novitas	5.0	0.0	0.0	12.5
Broccoli	B-0-23 (N.Y.)	17.5	100.0	20.0	
Cabbage	Badger Shipper	0.0	100.0	0.0	97.5
Rutabaga	Wilhelmsburger	95.0	0.0	0.0	100.0
Rutabaga	Laurentian	95.0	100.0	100.0	100.0
Rutabaga	York	77.5	0.0	0.0	100.0
Rutabaga	Ditmars S2	80.0	0.0	100.0	100.0

* Based on numbers of plants clubbed of 40 examined per crucifer-race exposure.

years resistance should be maintained in most areas for many years.

Badger Shipper cabbage was officially named and released in 1959 by the University of Wisconsin. In studies reported herein, this variety proved resistant to unrestricted clubbing when exposed to races 1, 3, 6, and 6A. A broccoli line showed resistance to races 1 and 3. No cole crop lines, including stocks of cabbage, cauliflower, and broccoli obtained from breeding stations, have shown any resistance to race 2 in screening trials conducted at Charlottetown. The importance of finding cole crop resistance to this race is apparent in results tabulated in Table 2, wherein 49 out of 68 isolates of P. brassicae under test were found to harbor race 2 inoculum. To obtain resistance to race 2 in cole crops, breeders must continually search for resistant germ plasm in these crops or possibly rely on interspecies crosses to effect a transfer of race 2 resistant genes from turnip and rutabaga.

In limited screening of isolates from Ontario and British Columbia, race 2 was not encountered and the spore samples tested were classified as race 6. In Ontario Reyes (4) identified four isolates from cabbage and cauliflower as race 6 and one from rutabaga as race 2. The presence of race 6 in British Columbia was established by Williams and Walker (8) and Williams (7). As the common rutabaga varieties are resistant to race 6, clubroot would not appear to be as serious a rutabaga production problem in British Columbia as in areas of Canada where races 2 or 3 are prevalent.

With the exception of isolates designated as racial mixtures, most isolates showed marked individual homogeneity when subjected to race differentiation. In the extensive testing of isolates from Prince Edward Island over the period 1959-71, the author found little change in patterns of race infestation irrespective of whether isolates were obtained early or late during this period. Extensive plantings of resistant York rutabagas in Prince Edward Island may, in time, result in changes in racial patterns of infestation as the fungus adapts to this variety.

Acknowledgments

I am grateful to those who forwarded samples of clubroot infected root tissue, and to Mr. J. N. Richard for technical service rendered during the course of this investigation.

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CONTROL OF POWDERY MILDEW OF WHEAT BY SYSTEMIC SEED TREATMENTS[1]

H. Winston Johnston [2]

Abstract

Field experiments carried out for 2 years showed that damage from powdery mildew of wheat may be reduced by seed treatment with two systemic fungicides. In 1970 and 1971 the highest yields of Opal wheat were obtained through the use of ethirimol [5-butyl-2-(ethylamino)-6-methyl-4-pyrimidinol] at the rate of 1.0 lb per acre. Yields of Selkirk wheat in 1970 and 1971 were greatest with ethirimol treatment at 2.0 and 1.0 lb per acre respectively. Mildew severity was reduced more by ethirimol than by benomyl; however, ethirimol tended to reduce yield at higher concentrations.

Introduction

Powdery mildew of wheat incited by Erysiphe graminis DC. ex Mérat f. sp. tritici Marchal causes significant yield reduction of spring wheat in the Maritime Provinces and is considered the major wheat pathogen in this area (2, 3). Control of the disease is inadequate at this time since no commercial licensed cultivar possesses a high degree of resistance. Cultural methods of control are unsatisfactory and commercially available seed treatment fungicides are not effective against powdery mildew.

Several experimental fungicides have potential for controlling cereal mildews, but data on their usefulness as seed treatments under Maritime disease conditions are lacking (1, 3). The field experiments reported herein describe the efficacies two such fungicides, ethirimol and benomyl, used as seed treatments for the control of powdery mildew of wheat.

Materials and methods

Field trials were conducted in 1970 and 1971 at Charlottetown in which the systemic fungicides Milstem 50% 'COL', 50% ethirimol [5-butyl-2-(ethylamino)-6-methyl-4-pyrimidinol] (Chipman Chemicals Ltd.); and Benlate 50% W.P., 50% benomyl (DuPont of Canada Ltd.) were applied to the seed for evaluation of their effectiveness for controlling foliar invasion by E. graminis f. sp. tritici. Seed was treated in 200 g lots in quart jars in which the seed was left for 24 hr before packaging into row weights. Rates of active ingredient for ethirimol were 0.5, 1.0, and 2.0 lb/acre in 1970 and 0.75, 1.0, and 1.5 lb per acre in 1971. Benomyl was applied at rates of 0.75 and 1.0 lb active per acre each year. Seeding was at the rate of 2 bushels per acre for both 'Opal' and 'Selkirk' spring wheat. These cultivars were selected because they are recommended in the Maritime Provinces and because Selkirk is very susceptible while Opal possesses a moderate degree of resistance to powdery mildew. A randomized block design was used, with plots replicated four times and consisting of eight rows 9 inches apart and 10 feet long. For yield determinations, the center 8 ft of each of the center four rows of each plot were harvested. Disease severity was measured at the time of flowering (growth stage 10.5) according to the assessment scale of Large and Doling (4), with the degree of infection being reported as a percentage of leaf area mildewed on the flag and second leaf blades. Ten main tillers per plot were selected at random from the center four rows for each reading.

Results and discussion

In 1970, ethirimol was found to be more effective than benomyl for the control of powdery mildew, as evidenced by reduction in mildew lesioning (Table 1). Benomyl decreased mildew on Selkirk, but not to the degree that was evidenced by ethirimol. Although a reduction in mildew severity on Selkirk brought about significant increases in yield, the moderately resistant cultivar Opal did not respond in a similar manner; with Opal only ethirimol induced a reduction in leaf lesioning but without a corresponding increase in yield.

A greater degree of control was evidenced in the second experiment, conducted in 1971 (Table 2). Yields of Selkirk were again

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Table 1. Influence of ethirimol and benoyml seed treatment on yield and on severity of powdery mildew in Opal and Selkirk wheat in 1970

Treatment (lb a.i./acre)		Opal		Selkirk	
		Yield (bu/acre)	Leaf infection %	Yield (bu/acre)	Leaf infection %
Ethirimol	0.5	34.2	45.0*	23.1**	71.3**
	1.0	35.2	39.5*	23.7**	65.8**
	2.0	31.6	34.1**	26.2**	53.8**
Benomyl	0.75	31.2	45.3	23.0**	75.0*
	1.0	32.4	45.8	25.9**	69.2**
Check		30.7	47.0	20.0	80.8

Asterisks indicate a significant difference between treatments and check; the absence of asterisks indicates the difference is not significant; *P = 0.05, **P = 0.01.

Table 2. Influence of ethirimol and benomyl seed treatment on yield and 1000-kernel weight of Opal and Selkirk wheat, and on severity of powdery mildew infection in 1971

Treatment (lb a.i./acre)		Opal			Selkirk		
		Yield (bu/acre)	1000-kernel weight (g)	Leaf infection %	Yield (bu/acre)	1000-kernel weight (g)	Leaf infection %
Ethirimol	0.75	31.2	27.3**	38.5**	27.6*	32.2**	71.0**
	1.0	35.3*	28.9**	36.8**	30.8**	34.5**	70.9**
	1.5	33.8	29.5**	34.3**	27.5*	29.5	65.5**
Benomyl	0.75	31.2	29.2**	45.8	23.8	29.2	80.5
	1.0	32.2	28.8**	49.0	24.3	30.6**	78.3
Check		26.7	26.0	48.5	22.6	29.7	78.0

Asterisks indicate a significant difference between treatments and check; the absence of asterisks indicate the difference is not significant; *P = 0.05, **P = 0.01.

increased by ethirimol, although the highest treatment rate, 1.5 lb per acre, appeared to be slightly phytotoxic; no phytotoxicity symptoms were present on the leaves, but both yield and seed size were reduced at this rate of treatment. Opal responded to a greater degree than in the 1970 test, in that yield was increased by the medium rate and seed size by all three rates of ethirimol. Benomyl treatment resulted in greater seed size but not increased yield in both Selkirk and Opal. In both cultivars ethirimol was more effective in reducing mildew lesioning in 1971 than in 1970.

The results reported herein indicate that, in the absence of wheat cultivar possessing a high degree of resistance to powdery mildew, seed treatment with certain systemic fungicides may offer an effective method of control. The value of such systemics could be enhanced by using them in larger field-sized plots where there would be fewer spores to invade treated areas, since untreated plots, the major source of secondary inoculum, would not be randomized within treated plots. The larger the treated area the more effective these materials should be through their reduction of leaf lesioning and sporulation (1). However, since these compounds are not registered for this purpose and are of unknown cost, their economic value to growers cannot be predicted at present.

Acknowledgments

The author wishes to thank Chipman Chemicals Ltd. and DuPont of Canada Ltd. for supplying samples of ethirimol and benomyl.

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APIOPORTHE VEPRIS ON RED RASPBERRY IN NOVA SCOTIA[1]

C.O. Gourley

Abstract

In April 1970 the fungus Apioporthe vepris was found colonizing red raspberry, Rubus idaeus, canes that had been subjected to an unusual period of freezing temperatures in mid September 1969. It was not found on winter-killed canes. This fungus has been found only on Rubus spp. and it is not considered to be an active parasite. Isolations made from both perithecia and pycnidia yielded colonies that produced pycnidia of the conidial state, Phomopsis vepris, on agar media and mature perithecia on autoclaved stems of red raspberry.

Introduction

On April 7, 1970, floricanes of red raspberry, Rubus idaeus L., cv. Newburg, in a dead or dying condition were found in a plantation at Billtown, Kings County, Nova Scotia. The moribund condition of the canes was thought to be the result of severe winter injury. Subsequent examination of red raspberry plantings showed that this condition affected all the cultivars examined and it was widespread throughout Kings, Annapolis and Digby counties.

Most of the affected canes had prominent fungal stromatic pustules containing perithecia and ascospores of Apioporthe vepris (Delacr.) Wehm. embedded in the bark. A specimen of A. vepris collected at Greenwich, Kings County, has been filed in the National Mycological Herbarium, Plant Research Institute, Ottawa, Ontario, as DAOM 129901.

A. vepris has been recorded only on Rubus spp. (1,3,5). Connors (3) listed A. vepris on Rubus macropetalus Hook in British Columbia (UBC 1960 and DAOM 34168) a report previously published by Barr (2), and on Rubus spp. in Nova Scotia on the authority of Wehmeyer (7). Wehmeyer (5) also reported A. vepris on Rubus spp. from Ontario in Canada, from U.S.A., and from Europe.

Mrs. Ruth (Horner) Arnold, Mycologist, Plant Research Institute, Ottawa, Ontario, in a private communication stated that four collections of A. vepris deposited in the National Mycological Herbarium, Ottawa, have not been reported in the literature. Three of these collections were made by H. S. Jackson in Ontario: DAOM 85345, EX TRTC 3335, on Rubus sp., Hogg's Hollow, North of Toronto, April 16, 1932, sub Diaporthe obscura (Peck) Sacc.; DAOM 85142, EX TRTC 3842, on Rubus idaeus L., Bear Island, Lake Timagami, June 17, 1932; and DAOM 82442, EX TRTC 16357 on Rubus sp., Bear Island, Lake Timagami, July 20, 1940. Specimen DAOM 54350 on Rubus idaeus L. was collected by D. Creelman at Isle au Haute, Cumberland County, Nova Scotia, June 5, 1953. In addition, A. vepris was collected at Kentville on June 20, 1960 on Rubus idaeus L. (seedling X) by K. A. Harrison and was filed with the Research Station Pathological collections as specimen KP 2479.

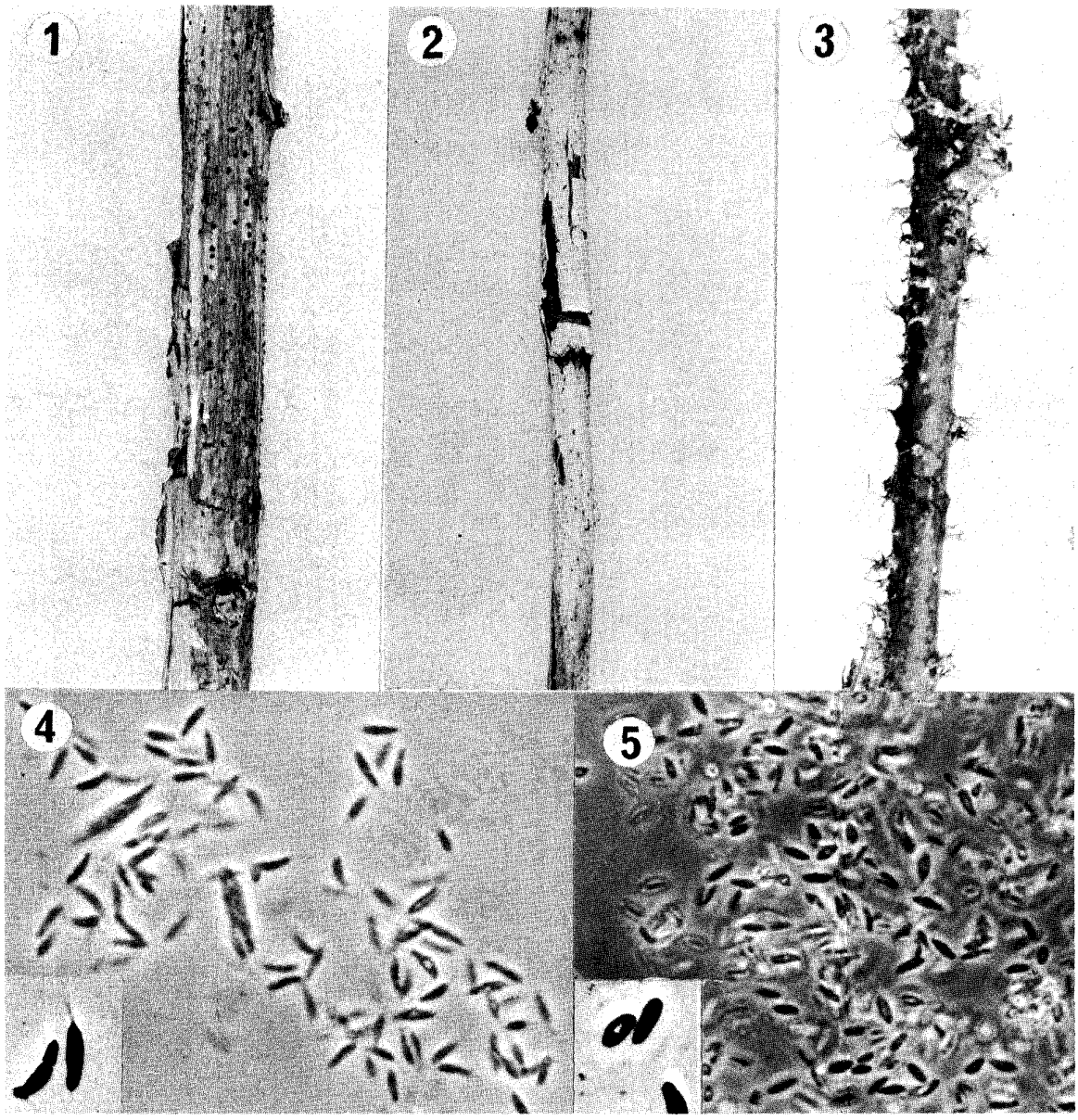
The syndrome of A. vepris on red raspberry canes, the fungus and its pathological significance are discussed in this paper.

Symptoms

The syndrome for A. vepris appeared to be similar on all red raspberry canes examined. Generally the fungus was most prevalent on dead canes. Many large, erumpent, stromatic pustules (Fig. 1) containing mature perithecia were usually present and they were most numerous near the base of the canes. Moribund canes which later showed weak growth had fewer pustules and perithecia than dead canes. The foci of infection could not be determined consistently. It appeared to be near a bud from which it spread to form an elongated lesion that girdled the stem. The outer dead bark was almost white and sloughed off easily. A few light-coloured lesions (Fig. 2) on moribund canes contained many pycnidia of Phomopsis vepris (Sacc.) Höhnel the imperfect state of A. vepris. In Nova Scotia mature perithecia and ascospores (Fig. 4) of A. vepris and pycnidia and conidia (Fig. 5) of P. vepris on red raspberry canes were similar to those described by Wehmeyer (5). Specimens from Nova Scotia were also compared with an authentic specimen from the Wehmeyer Herbarium by Mrs. Ruth (Horner) Arnold.

Perithecia of the spur blight pathogen, Didymella applanata (Niessl.) Sacc. were found occasionally on the same canes as A.

[1] Contribution No. 1461, Research Station, Canada Department of Agriculture, Kentville, Nova Scotia.



Figures 1–5. *Apioporthe vepris* on raspberry; 1) Stromatic pustules on a dead cane of 'Newburg' red raspberry, collected April 1970; 2) Lesion and pycnidia of *Phomopsis vepris* on cane of 'Newburg' red raspberry, collected April 1970; 3) Stromata and perithecia produced on raspberry stem in vitro; 4) Ascospores of *A. vepris*, X 400; insert ca. X 1000; 5) Conidia of *Phomopsis vepris*, X 400; insert ca. X 1000.

vepris, and they were usually in the immediate vicinity of a bud. Spur blight lesions were found on only a few canes.

Experimental

Pustules of A. vepris in cane tissues were cut horizontally and bits of perithecium contents were transferred aseptically to potato dextrose agar, potato malt agar, 2% malt agar, and Leonian's agar. Pycnidia teased from the bark were also plated on these media. The fungus from both sources grew on Leonian's agar and potato malt agar but not on potato dextrose agar or 2% malt agar. The ingredients of the 2 media, Leonian and potato malt, which supported growth of the fungus were the same as those given by Tuite (4). Pure cultures were obtained by making single hyphal tip transfers to Leonian's agar which was used

for all subsequent work. Cultures were incubated at 18°C in the dark. The perithecium and pycnidium sources of inoculum gave rise to identical colonies. Pycnidia and conidia formed in all cultures and they were similar to those found in the bark on the light-coloured lesions.

To produce the perithecial state in vitro, autoclaved stems of R. idaeus were inoculated with A. vepris from both perithecium and pycnidium sources. Stems were cut into 7.5 cm sections each of which was placed in a test tube containing 5 ml distilled water. After autoclaving at 121°C for 15 minutes six stem sections were inoculated for each inoculum source with a small, ca 2 x 2 mm, agar plug cut from a colony growing on Leonian's agar. They were incubated for 1 month at room temperature and then at 0°C for 11 months. Perithecia containing mature asci and ascospores developed on all the stem sections (Fig. 3). Isolates obtained from the perithecia in the stromatic pustules and those obtained from the pycnidia teased from the bark of the light-coloured lesions produced identical stromatic structures with mature perithecia and ascospores. A specimen of the perithecia produced in vitro and prepared slides of conidia and ascospores were filed in the Mycological Herbarium, Ottawa, as DAOM 138594 and DAOM 138595, respectively.

Discussion and conclusions

As far as the author is aware A. vepris has not been shown to be pathogenic to Rubus spp. Its reported occurrence at irregular intervals suggests it may be a weak parasite or a colonizer of injured tissue. In the fall the bark of primocanes may contain many incipient infections of A. vepris. A sudden severe injury or killing of tissue when A. vepris inoculum was abundant may have resulted in rapid and complete colonization of the injured or dead raspberry floricanes.

Because A. vepris was widespread on red raspberry canes in the spring of 1970, the canes may have been predisposed to infection in the fall or early winter of 1969. The number of days having minimum air temperatures 4 ft above ground level of 32°F or less, and rainfall data for the Kentville area from September to December, 1966-70, were as follows:

	No. days with minimum air temp. ≤32°F				Rainfall (inches)			
Year	Sep.	Oct.	Nov.	Dec.	Sep.	Oct.	Nov.	Dec.
1966	0	4	15	24	3.2	5.9	2.5	3.4
1967	0	6	17	27	3.8	3.9	3.0	5.0
1968	0	0	23	24	2.7	7.5	7.2	3.7
1969	1	8	14	26	4.1	1.8	3.6	3.9
1970	0	5	15	30	3.3	5.3	5.6	0.8

During these years freezing temperatures occurred in September only in 1969, when on September 20 air temperatures recorded in the Annapolis Valley ranged from 27° to 32°F (-2.8° to 0°C). Three days prior to the freeze a rainfall of 1.14 inches (2.9 cm) was recorded at Kentville. Meteorological data recorded at the Research Station, Kentville, showed grass minimum temperatures of 26°, 26°, 31°, and 27°F (-3.3°, -3.3°, -0.6°, and -2.8°C) for September 20, 21, 22, and 23, respectively. Air and grass temperatures below freezing did not occur again until October 2. The sudden onset of sub-freezing temperatures for four successive days during a period of excessive moisture may have severely injured raspberry canes in the Annapolis Valley. These frost-injured canes may have been particularly susceptible to A. vepris. The abundance of stromatic pustules on the lower portion of the canes early in the spring of 1970 indicated that the injury was most severe and fungal colonization most active in this region. It is not uncommon to have freezing temperatures in October, November and December, but by that time of year canes have usually become dormant as a result of gradual cooling conditions and decreasing daylength.

From previous reports and on the basis of this occurrence A. vepris cannot be considered an active pathogen of Rubus spp. It was found early in the spring on raspberry stems thought to have been injured by frost in September of the previous year. In Nova Scotia cold-temperature injury is common on red raspberry floricanes and the amount of winterkilling varies from year to year. Canes are often killed back from the tips for varying distances but are seldom completely killed. A. vepris has not been found on winter-killed canes.

Acknowledgments

I am grateful to Mrs. Ruth Horner Arnold for her suggestion to publish this information and for her review of the manuscript.

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INFLUENCE OF SOME CULTURAL PRACTICES ON YELLOW LEAF BLIGHT OF MAIZE

J.C. Sutton,[1] A. Bootsma,[2] and T.J. Gillespie[3]

Abstract

Yellow leaf blight of maize (Zea mays) caused by Phyllosticta maydis was more severe in field plots with high than in those with low population densities. Air temperatures and dew duration in plots with widely differing population densities were similar. Blight was more severe in maize cultured with minimum tillage than with conventional tillage. The relationship of the amount of infected maize residues from previous growing seasons to blight severity is discussed.

Introduction

Yellow leaf blight, caused by Phyllosticta maydis Arny and Nelson (1), was widely distributed in Ontario in recent years (3, 6). The disease was usually minor and occurred in the form of scattered lesions, mostly on the lower leaves. Occasionally, however, severe blight developed and caused economic losses, particularly in grain and silage maize.

Casual field observations indicated that cultural practices influencing plant vigor, the microclimate in the plant canopy, and the amount of maize debris from previous seasons remaining on the soil surface may be important in the development of severe outbreaks of blight. In the present study the influence of population density of maize plants and certain tillage practices on the development of yellow leaf blight and the effect of population density on microclimate was examined.

Materials and methods

The effect of plant population density on blight severity was examined in the field at Elora, Ontario, in 1970.

Maize (Zea mays L.) var. Funks G-43, carrying Texas male-sterile cytoplasm, was planted by hand in field plots on May 27-28. In each plot there were five parallel rows 76 cm (2.5 ft) apart and 7.6 m (25 ft) long. Kernels were sown at intervals of 18, 23, 28, and 36 cm within the row to give the equivalent of 73,360, 57,300, 46,930, and 36,930 plants per hectare (29,700, 23,200, 19,000, and 14,950 plants per acre). Two kernels were sown at each spacing and plants were thinned to one per spacing after emergence. Ten plots were sown at each planting density. The plants in five of these plots were later inoculated and those in the remaining plots served as noninoculated checks. Plots were arranged in a randomized complete block design. Spaces 5 ft. across between blocks were planted with barrier rows of maize continous with the rows within the blocks. The entire plot area was surrounded by 107 m (350 ft) or more of maize, except on the northwest side where an 8-row border was planted.

Plants were inoculated with pycnidiospores obtained from P. maydis cultures grown on potato dextrose agar for 2 weeks under cool-white lights at approximately 22° C. Cultures were flooded with sterile water for 15 min and the spore suspensions diluted to give 1×10^5 spores per ml. Spore suspensions were atomized onto plants just before sunset on June 22 and again on June 28. Only plants in the inner 3 rows of each treated plot were inoculated.

To minimize spread of inoculum between plots, zineb (3 lb 75% W.P. in 100 gal per acre) was applied at weekly intervals to plants in the outer rows of all plots, in the barrier rows between the blocks, and in four rows immediately surrounding the plot area. No symptoms of yellow leaf blight appeared on the treated plants.

Yellow leaf blight was assessed in plants in the center row of each plot on August 24. Three leaves of each plant at 30-45 cm, 105-120 cm (mid-canopy) and at about 180 cm (penultimate leaf) above ground level were rated for disease according to the scale of Horsfall and Barratt (5).

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Possible differences in microclimate in plots of differing population densities was studied by monitoring temperature and duration of leaf wetness. Temperatures were measured during September 7-19 in two plots at each population density. A thermistor-based temperature sensor (2) was mounted at a height of 130 cm midway along the center row in each of the plots. The sensors provided mean air temperatures during four separate 12 min intervals in each hour. Data obtained from the two plots at each population density were averaged, and observations taken during the times of maximum and minimum air temperatures in each 24 hr period were used for comparative purposes. The duration of leaf wetness was monitored continously from August 13 to September 2, using sensors that respond to moisture by changes in electrical resistance (2). The wetness sensors were mounted at a height of 130 cm in the center row of each 2 replicate plots with plants spaced at 18, 23, and 36 cm intervals.

The relationships of tillage practices to blight severity was investigated in the field at Arkell, Ontario, in 1970. Blight severity was assessed in four areas of a single field with the following cultural histories: sod in 1969 and maize with conventional tillage (soil ploughed and disced in Spring) in 1970; maize with conventional tillage in 1969 and 1970, harvested as grain in 1969; maize with zero tillage in 1969 and 1970, harvested as silage in 1969. Maize had been grown with conventional tillage in 1968 in all plot areas except were sod was present in 1969. The areas of differing tillage were 201 m (660 ft) long, more than 122 m (400 ft) in width, and were separated by fallowed land at least 12 m (40 ft) wide. Maize hybrid 'Funks G-43' with Texas male-sterile cytoplasm was grown in both 1969 and 1970. In 1970 the maize was machine planted on May 10-11 in rows spaced at 76 cm (30 inch) intervals to give a population of about 51,900 plants per hectare (21,000 plants per acre). Standard fertilizer and herbicide treatments were used in the entire field. Blight was assessed on August 28. Three replicate transects in directions diagonal to that of the rows were made in each tillage area. In each transect, 30 plants at intervals of 5-6 paces were assessed for blight as above. Horsfall-Barratt ratings for each replicate plot of each treatment were summed and the average rating was converted to percent leaf area discolored using statistically adjusted conversion tables.

Results

Blight was more severe in maize plots with high than with low population densities (Table 1). Symptoms were well-developed on only the lower leaves at the time when blight was estimated. Some lesions were present at mid-canopy level (105-120 cm) and few appeared on the upper leaves. Blight symptoms were observed on the lower leaves of noninoculated plants, especially those at the highest population density, but pycnidia failed to appear on most of the blighted leaves of noninoculated plants in the field or after incubation for 6-7 days in moist chambers.

Air temperatures in the maize population plots usually differed by less than 1° C. This was true on nights with heavy dew and thus strong radiative cooling, in days with more than 5 hr of bright sunlight and thus strong radiative heating, as well as on nights without dew and days with less than 5 hr bright sun. Measured temperature differences did not usually exceed the limits of accuracy (± 0.5° C) of the temperature sensing apparatus.

The times of the initiation of dew periods as seen with a hand lens on the maize leaves corresponded closely (< 15 min difference) with the detection of water by the wetness sensors.

There was little difference in dew duration in maize plots with different population densities (Table 2). The time of dew formation in these plots differed by less than 12 min in 14 of 15 periods studied. The average duration of the 15 measured dew

Table 1. Influence of plant spacing in the row on blight severity in maize inoculated and noninoculated with *Phyllosticta maydis*

Treatment	Distance of leaf above ground (cm)	Leaf area blighted (%)			
		Plant spacing (cm)			
		18	23	28	36
Inoculated	30-45	39.0± 3.7*	28.9±10.1	10.4±5.1	8.8±5.1
Noninoculated	30-45	39.2±28.2	2.3± 0.8	3.2±1.4	4.2±2.8
Inoculated	105-120	1.3± 0.4	1.4± 0.2	1.3±0.3	1.4±0.1
Noninoculated	105-120	0.2± 0.3	0.1± 0.1	0.2±0.2	0.1±0.2

* Standard deviation.

Table 2. Eight representative periods of dew duration in canopies of maize plants spaced at different intervals in the row

Date of dew period	Dew duration (min)		
	Plant spacing (cm)		
	18	23	36
August			
14-15	777	761	774
16-17	726	766	739
20-21	750	753	771
21-22	754	766	794
23	343	355	363
27-28	694	715	755
28-29	693	714	730
31	310	282	266

periods in the plots also differed by less than 12 min. However in 11 of the 15 dew periods, wetness durations in plots with plants spaced at 36 cm intervals averaged 19 and 24 min longer than in those with plants spaced at 23 and 18 cm intervals, respectively. Slightly lower minimum temperatures in the lower population plots had resulted in more dew deposition to be evaporated in the morning. Observations with a hand lens indicated that the times of dew appearance and disappearance on leaves located 30-45 cm and at 105-120 cm above ground differed by less than 30 min. Dew disappeared 30-60 min earlier from leaves in the upper canopy than from those in the mid- and lower canopy.

Yellow leaf blight was strikingly more severe in maize cultured with zero tillage than with conventional tillage (Table 3). With zero tillage, blight severity was greater where the previous crop was harvested for grain than for silage. Disease severity was correlated with the amount of maize residues remaining on the soil surface from previous growing seasons.

Isolates of P. maydis collected from each of the plots and the isolate used for inoculating the plots with differing plant population densities showed similar virulence on maize var. 'Funks G-43'.

Discussion

The greater severity of yellow leaf blight in maize grown at high than at low population densities appears related to factors other than temperature and dew duration. Temperatures found in the different population density plots were notably similar. Gillespie and King (4) measured temperatures in the corn canopy and found that temperatures at 30 cm above ground were less than 0.3°C higher than at 130 cm during nights with strong temperature inversion and heavy dew. Thus in the population density plots it is unlikely that important temperature differences existed between the 30-45 cm level, where disease was severe, and the 130 cm level where the temperature sensors were located and disease was mild. Because of the close synchrony of dew appearance and disappearance in maize grown at various population densities the observed differences in blight severity are not attributable to dew duration (2). Dew periods were measured late in the growing season when a greater diversity in dew duration in maize grown at differing population densities is expected than earlier in the season when canopies are more open.

Stress factors related to intensive interplant competition may have contributed to enhanced disease severity in maize grown at high population densities. Marked symptoms indicative of nutrient deficiencies developed in the lower leaves of both inoculated and noninoculated plants spaced at 18 cm intervals in the row. Deficiencies of less intensity but of significance in host-parasite interactions may have existed in plants spaced at 23 cm intervals. P. maydis is considered a weak parasite (3) and appears to proliferate extensively on maize leaves that are physiologically weakened.

Table 3. Effect of recent cropping history and tillage practices in maize on yellow leaf blight development from natural sources of inoculum, 1970

1969 crop	Tillage practice for maize in 1969 and 1970	Mean % leaf area blighted		
		Distance (cm) of leaf lamina above ground		
		30-45	105-120	180+
Sod	Conventional	0.1	0.1	0.1
Maize for grain	Conventional	3.2± 0.9*	1.4±0.4	0.0
Maize for grain	Zero	56.4±12.8	11.6±3.7	0.6±.1
Maize for silage	Zero	27.2± 1.2	5.1±0.2	0.6±.1

* Standard deviation.

The correlation of blight severity with maize residues remaining on the soil surface confirms numerous field observations and indicates that the development of severe disease may be dependent upon large amounts of primary inoculum. This conclusion is supported by the restricted secondary development of yellow leaf blight that we have frequently observed in plants grown in field plots free from maize debris and inoculated once with suspensions of P. maydis spores. Repeated infections from inoculum derived from maize debris may reduce host resistance and allow greater proliferation of this weak parasite than in plants with fewer infections.

Acknowledgments

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EFFECTS OF REDUCING INTERPLANT COMPETITION FOR LIGHT AND WATER ON STALK ROT OF CORN

C.G. Mortimore and L.F. Gates[1]

Abstract

Stalk rot in resistant and susceptible corn (Zea mays) hybrids was studied under conditions of reduced interplant competition for light and water or for water only. A reduction in competition for both light and water decreased stalk rot by 63% and 20% in resistant and susceptible hybrids respectively, when compared with plants for which stress conditions were not altered. Susceptible hybrids, especially in very dry periods, responded very little to reduced competition for water, and this appeared to limit their response to reduced competition for light. Resistant hybrids were more resilient than susceptible ones in that, when stress was decreased, they showed greater reductions in stalk rot. Susceptible plants tended to maintain yield at the expense of stalk deterioration and susceptibility to stalk rot.

Introduction

Fungi invade the crowns and stalk bases of corn plants (Zea mays L.) as the ears mature and the plants become senescent. The fungus most often involved in southwestern Ontario is Gibberella zeae (Schw.) Petch (imperfect state Fusarium graminearum Schwabe). Factors which impose stress on the plants during ear development, such as competition for light and water, accentuate stem deterioration and rotting by fungi. However the stalks of resistant cultivars remain in good condition during and after maturation of the ear.

Experiments in which stands were thinned at various times to reduce interplant competition indicated that adverse effects on the stalk, due in part to interplant competition, become irreversible during the 4 weeks preceding physiological maturity of the ear (1).

The adverse effects of competition for water and light were studied further to determine their importance in stalk rot development in resistant and susceptible hybrids.

Methods

Experiments were carried out in sandy loam field plots at the Research Station, Harrow. Plants were spaced at 19.8 cm in rows 102 cm apart, giving 49,420 plants/ha. Hybrids used are given in the tables for each experiment. Plots consisted of six 5.1-m rows, with data taken from 4.1 m of the center four rows. Sets of such plots constituted main plots which, in experiments with irrigation, either were not irrigated or received water from hoses on the ground between the rows to supplement rainfall to 2.5 cm/week.

In each plot, alternate plants were cut at ground level on the dates indicated for each experiment. Cut plants were either removed, thus reducing competition for light and water, or staked in place, thus retaining light competition but reducing water competition.

Stalk rot was assessed 3 weeks after physiological maturity (35% grain moisture) either by determining the percentage of infected plants or by splitting lengthwise the stems of 20 plants and recording the number of totally or partially decayed internodes.

Results and discussion

Good responses to reduction in stress were not obtained later than 4 weeks after mid-silk in 1966 or later than 2 weeks after mid-silk in 1967 (Table 1).

In 1966, 11.2 cm of rain in August and 7.9 cm in September gave adequate moisture, and no response was obtained with the susceptible hybrid to reduced water competition (alternate plants cut and staked in place); however when light competition was also reduced by removing alternate plants 4 weeks after mid-silk, stalk rot was decreased by nearly half.

In 1967, rain in August and September totalled only 8.8 cm, half of which fell on 2 days at the end of September. The resistant hybrid developed much less stalk rot when competition for water was reduced 2 weeks after mid-silk and still less when

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Table 1. Effects of reducing water and light stress on stalk rot in susceptible and resistant corn hybrids in 1966 and 1967, expressed as % diseased plants 3 weeks after physiological maturity

	Date of treatment[a]					
	1966		1967			
	Susceptible hybrid[b]		Susceptible hybrid[b]		Resistant hybrid[c]	
Treatment	Aug. 23	Sept. 6	Aug. 9	Aug. 23	Aug. 9	Aug. 23
Control, 49,420 plants/ha	53.7		83.1		70.6	
Reduced competition for water[d]	47.6	53.7	74.2	81.1	49.3	74.0
Reduced competition for water and light[e]	28.3	47.3	74.3	79.8	37.4	52.2

[a] Treatment dates were 4 and 6 weeks after mid-silk in 1966; 2 and 4 weeks after mid-silk in 1967. Later treatments were without effect.

[b] Pioneer 371.

[c] B14 x CH9.

[d] Alternate plants cut at ground level and staked in place.

[e] Alternate plants cut at ground level and removed.

competition for light was also reduced (Table 1). When competition was reduced 4 weeks after mid-silk, there was no response to reduction in water stress and moderate response in the resistant hybrid to reduction in competition for water and light. The susceptible variety was severely affected by drought and showed severe stalk rot despite reduced interplant competition. However irrigation of susceptible hybrids did reduce stalk rot and halved it when the population was also reduced (Table 2). Again the resistant hybrids were more resilient, and irrigation almost eliminated stalk rot in them.

Table 2. Effects of irrigation on stalk rot in susceptible and resistant hybrids, 1967

Hybrid and no. plants/ha	No. of rotted internodes per plant	
	Not irrigated	Irrigated[a]
Resistant, 49,420		
B14 x CH9	2.1	0.1
592.46 x 591.23	1.9	0.2
Resistant, 24,710[b]		
B14 x CH9	1.5	0.0
592.46 x 591.23	1.6	<0.1
Susceptible, 49,420		
Pioneer 371	2.3	2.0
Pioneer 3775	2.4	2.0
Susceptible, 24,710[b]		
Pioneer 371	2.0	1.0
Pioneer 3775	1.9	0.7

[a] Irrigation started August 11 (2 weeks after mid-silk) to total, with rain, 2.54 cm/week.

[b] Rows thinned by removing alternate plants 4 weeks after mid-silk (August 22).

In 1968-1970 (Table 3), the resistant hybrids were usually more responsive to decreased stress than the susceptible ones. There was no response by resistant varieties to reduced water competition in 1969, when rainfall in August-September was average (total 12.4 cm), or on nonirrigated plots in the very dry autumn of 1970 (August-September rain 6.8 cm). However reduced competition for water in 1968, and in 1970 on irrigated plots, reduced stalk rot in resistant hybrids by approximately one-half and one-quarter respectively. In all four comparisons, resistant varieties responded well to reduced light competition. The behaviour of susceptible varieties followed a similar pattern, but with smaller responses.

Resistant hybrids throughout the experiments were more resilient than susceptible hybrids in that where stress conditions were ameliorated resistant plants were better able to take advantage of the improved conditions and showed greater reduction in stalk rot. Reduction in stalk rot in populations of resistant hybrids when interplant competition for both light and water was reduced, or when water was supplied by irrigation to reduced populations, averaged 63% of that in populations growing under unaltered stress conditions (Table 4). The corresponding figure for susceptible hybrids was 20%. When the effects of reduced

Table 3. Effects of stress reduction and irrigation on stalk rot, expressed as avg no. rotted internodes per plant, in susceptible and resistant hybrids, 1968-1970

Treatment	1968		1969		1970			
					Susceptible		Resistant	
	Susceptible	Resistant	Susceptible	Resistant	Not irrigated	Irrigated[a]	Not irrigated	Irrigated[a]
Control, 49,420 plants/ha	0.6	0.3	2.1	0.2	1.0	1.2	1.0	0.8
Reduced competition for water[b]	0.6	0.1	1.8	0.2	1.0	1.3	0.9	0.6
Reduced competition for water and light[c]	0.4	<0.1	1.6	0.1	1.0	1.1	0.6	0.2

[a] Irrigated for 2 weeks after mid-silk to total, with rain, 2.54 cm/wk.

[b] Alternate plants cut at ground level and staked in place 3 weeks after mid-silk each year.

[c] Alternate plants cut at ground level and removed 3 weeks after mid-silk each year.

Table 4. Effects of reducing stress after pollination on stalk rot in susceptible and resistant hybrids; reduction in stalk rot as % of the stalk rot in untreated control

Hybrid, year, and treatment*	Reduced competition for water (A)	Irrigated (C)	Calculated effect of reduced light competition (B-A) or (D-C)	Reduced competition for light and water (B)	Reduced light competition and irrigation (D)
Susceptible hybrids[†]					
1966 (a)	11		36	47	
1967 (a)	11		nil	11	
1967 (b)		16	48	16	64
1968 (a)	10		20	30	
1969 (a)	14		11	25	
1970 (a)	nil		nil	nil	
1970 (b)		-22	15		- 7
Mean 1967-70	5		16	20	
Resistant hybrids[††]					
1967 (a)	30		17	47	
1967 (b)		93		23	99
1968 (a)	46		50	96	
1969 (a)	nil		58	58	
1970 (a)	12		28	40	
1970 (b)		17	62		79
Mean 1967-70	33		43	63	

* Treatment (a): experiments in which stress was reduced by cutting alternate plants at ground level and either staking the tops in place (reduced competition for water) or removing them (reduced competition for light and water), 2 or 4 weeks after mid-silk; treatment (b): plots irrigated weekly from 2 weeks after mid-silk to supplement rainfall to 2.54 cm/wk.

† Susceptible hybrid Pioneer 371 in 1966-1970, plus Pioneer 3775 in 1967.

†† Resistant hybrid B14 x CH9 in 1966-1970, plus 592.46 x 591.23 in 1967.

competition for water and light are assessed separately, susceptible varieties, especially in very dry periods, show little response to a reduction in interplant competition for water. Possibly so little water was available in dry periods that reducing interplant competition was not significant in changing drought effects. Water shortage also appears to limit their response to reduced light competition (Table 4). Presumably the roots of susceptible hybrids deteriorate considerably under stress conditions very soon after pollination. Even the resistant hybrids were not able to withstand full stress conditions in very dry seasons and showed severe stalk rot in 1967 and 1970.

In yield, resistant and susceptible varieties responded very similarly to reduced interplant competition for light and water (resistant, + 19%; susceptible, + 16%) and to irrigation (resistant, + 23%; susceptible, + 26%). Under conditions of least stress the yields of susceptible hybrids were 87-102% of those of resistant hybrids; under conditions of greatest stress they yielded 84-96% of the resistant hybrids. Susceptible plants thus tend to maintain their yield at the expense of stalk deterioration and susceptibility to stalk rot.

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SCLEROTINIA SCLEROTIORUM ON HORSECHESTNUT TREES[1]

C.O. Gourley and R.W. Delbridge[2]

Abstract

Sclerotinia sclerotiorum was determined for the first time as the cause of a disease of horsechestnut (*Aesculus hippocastanum*) trees. Infection of current season's growth resulted in wilt and leaf necrosis; sclerotia were produced in cavities in decayed pith tissue. The occurrence of the disease in Nova Scotia in 1970 extends the host range of *S. sclerotiorum*.

In July 1970, several 5- to 7-ft trees of horsechestnut, *Aesculus hippocastanum* L., growing in lawns at Onslow, Colchester County, Nova Scotia, were severely blighted. *Sclerotinia sclerotiorum* (Lib.) de Bary, one of the most widespread and destructive pathogens of agricultural crops and ornamental plants (2, 3), was the only organism isolated from diseased wood. As far as the authors are aware, this fungus has not heretofore been reported as a pathogen of horsechestnut.

Figure 1. *Sclerotinia sclerotiorum* canker on new wood of horsechestnut.

The foliage on the affected trees was severely wilted and many leaves were necrotic. This blight condition resulted from a fungal infection of the succulent tissue of the current season's growth. Often the pith was exposed in cankers which formed on this wood (Fig. 1). Diseased wood appeared water soaked and the infection advanced most rapidly in the pith region. In many cases, the entire shoot was diseased and the fungus had advanced into the pith of adjacent one-year-old wood. Sclerotia of *S. sclerotiorum* formed in cavities left by decaying pith (Fig. 2).

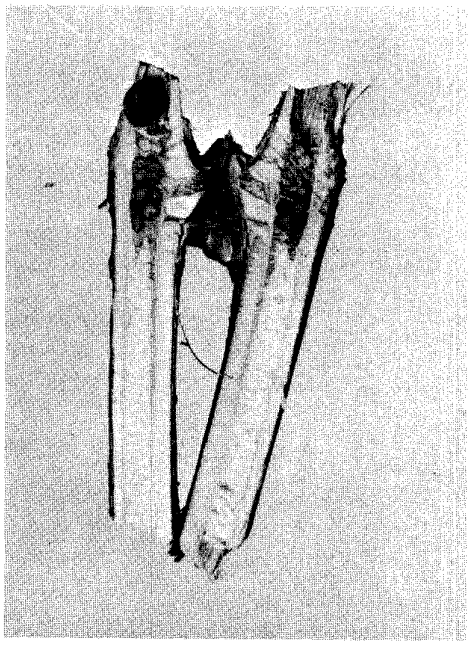

Figure 2. Sclerotium of *S. sclerotiorum* in pith cavity of new wood of horsechestnut.

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Infected tissue was surface sterilized in 1:1000 $HgCl_2$ solution, rinsed in two changes of sterile water, and plated on potato-dextrose agar. Sclerotia excised from the pith region of infected wood were plated on the same medium. Diseased wood and sclerotia yielded only S. sclerotiorum. All colonies produced sclerotia, ca 3.2 x 2.4 mm, on potato-dextrose agar in petri plates.

The method of Henson and Valleau (1) was used to produce apothecia and ascospores of S. sclerotiorum in vitro. Sclerotia produced in culture and held at 5°C for 75 days were transferred to 2% agar in petri plates and exposed at room temperature to constant fluorescent light. Apothecia and ascospores typical of those described for S. sclerotiorum developed within 3 weeks. The size, ca 13.9 x 6.4 µ, of ascospores was within the range given for this fungus (3).

S. sclerotiorum usually attacks stems and other succulent tissue at or near ground level, and generally the infection is most severe during periods of cool, moist weather (3). Excessive rainfall in July of 1970 may have increased the amount of fungus inoculum and provided ideal conditions for infection of the new growth of the horsechestnut trees. The disease syndrome indicated that the initial infections occurred on the most succulent tissue. The source of the inoculum is not known, but because of the height at which the infections occurred, air-borne ascospores were undoubtedly the cause of the primary infections. Lawn grasses are not normally hosts of S. sclerotiorum so the inoculum probably came from outside the lawn area.

The morphological characteristics of the fungus indicate that is is a common strain of S. sclerotiorum. The occurrence of the disease on horsechestnut extends the host range of this pathogen.

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FUNGICIDAL CONTROL OF POPLAR LEAF SPOTS IN ALBERTA AND SASKATCHEWAN

L.W. Carlson[1]

Abstract

Seven fungicides were tested for control of poplar leaf spots caused by species of Septoria and Marssonina at the Alberta Horticultural Station, Brooks, and at the PFRA Tree Nursery, Indian Head, Saskatchewan. Effective control was obtained with 4-5 applications of either benomyl or thiophanate methyl. The five other chemicals tested also gave some degree of control.

Résumé

Essai de sept fongicides contre les taches des feuilles de peuplier causées par Septoria et Marssonina à la Station horticole de l'Alberta, Brooks, et à la Pépinière de l'ARAP à Indian Head (Saskatchewan). Un contrôle efficace fût obtenu avec 4-5 applications de benomyl ou de thiophanate de methyl. Les cinq autres composés utilitisés ont eu des effets variables.

Introduction

Leaf spots of poplar caused by species of Septoria and Marssonina in nursery cutting beds have been a problem for some time in the prairie nurseries (2, 6). The species commonly found in the prairies are Septoria musiva Pk. and Marssonina populi (Lib.) Magn. These fungi also cause cankering of the young whips in the cutting beds. Initially infections occur on the leaves and then spread to young shoots (6). Septoria infected leaves soon become covered with lesions with brown margins and light tan centers. Black pycnidia form in the center and are readily observed. Marssonia leaf spots are reddish-brown in color without distinct centers. In either case the heavily infected leaves drop and axillary buds are forced to break and develop side shoots. Infected leaves that do not drop have reduced photosynthetic capabilities because of the area that is lesioned. Both leaf drop and partial spotting of leaves are responsible for reduction in vigor of the stools. Cankering of the whips accounts for a further loss in production when poplar cuttings are taken. Control of the leaf spot stage should reduce cankering. There are many European works on the control of Marssonina spp. (1, 3, 4), but few on the control of Septoria spp. (5). In most cases maneb base chemicals and copper oxychlorides have shown the most promise for control of Marssonina spp. (1, 3, 4). Copper fungicides also give some control of Septoria spp. (5). Reported here are the results of field tests of seven fungicides used for control of poplar leaf spots in 1971.

Materials and methods

Experimental plots of 'Brooks No. 6' hybrid poplar (Populus 'Brooks No. 6') were located at the Alberta Horticultural Station, Brooks. 'Northwest' poplar (Populus 'Northwest') was used at the PFRA Tree Nursery, Indian Head, Saskatchewan. Plots, containing 4-5 poplar stools each, were replicated six times and arranged in a completely randomized block.

The following fungicides were used in the experiments: Benlate 50%, W.P., 50% benomyl; Captan 50, W.P., 50% captan; C-O-C-S, W.P., 50% fixed copper (basic copper chlorides); Manzate D, W.P., 80% maneb; Manzate 200, W.P., 80% coordination product of zinc ion and maneb; NF44, W.P., 70% thiophanate methyl; Polyram, W.P., 53.5% metiram.

Fungicides were applied at 10-day intervals starting in early July and continuing for four applications at Brooks and five at Indian Head. They were applied at 150 psi from a high-pressure sprayer at the rate of 100 gallons per acre. Later's spreader-sticker was used in the Brooks experiment, no spreader-sticker was used at Indian Head.

Leaf spot severities were rated on a scale of 1 to 11, corresponding to the percentage

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of leaf area spotted, with 1 = no disease and 11 = all leaves dead, e. g. visual ratings of 2 and 10 indicate ranges of disease of 0-3% and 94-97% respectively, while a rating of 6 has a range of 25-50%. During these tests no distinction was made between leaf spots caused by Septoria spp. or Marssonina sp., thus the leaf spot severities take into account spots caused by both fungi. During the growing season at Brooks, ratings were made on 10 poplar whips from nonsprayed stools adjacent to the experimental plots. Final ratings were made from five whips of each replicate. The data are given as means of six replicates, with Duncan's multiple range test used for mean comparisons.

Results

The incidence of disease was at a fairly high level at the beginning of the spray schedule on nonsprayed stools. On 7 July 1971 leaf spot severity was 27.1% at Brooks (Table 1), and 21.4% at Indian Head. Leaf spot severity increased throughout the growing season to 37.3% at Brooks and 52.7% at Indian Head. While the proportion of leaves with spots did not increase during the growing season, the number of leaves spotted increased from 11.8 per whip to 26.5 per whip (Table 2). The percentage and number of dead leaves increased gradually from 12.2% to 40.2% and from 1.9 to 15.9 leaves per whip.

Table 1. Leaf spot development on nonsprayed poplar hybrid, Brooks No. 6

Date	No.* leaves per whip	Leaves with spots		Dead leaves		% disease
		No.*	%	No.*	%	
7 July 71	16.2	11.8	72.6	1.9	12.2	27.1
16 July 71	21.7	15.8	72.6	5.7	26.3	32.0
26 July 71	28.4	17.3	60.9	7.7	27.1	30.4
5 Aug. 71	34.1	22.0	64.5	9.3	27.3	33.1
16 Aug. 71	35.8	23.6	65.9	11.1	31.0	37.6
31 Aug. 71	39.6	26.5	67.0	15.9	40.2	37.3

* Average of 10 whips.

In the test at Brooks two chemicals, benomyl and thiophanate methyl, showed significant reductions in leaf spot severity (Table 2). However all chemicals showed significant reductions in percentage of leaves infected and in the percentage of dead leaves. At Indian Head all chemicals significantly reduced leaf spot severity, the percent leaves infected and the percent dead leaves (Table 3). Benomyl was significantly more effective than the other chemicals tested with regard to control of leaf spot severity and reduction of percent dead leaves.

Table 2. Effect of fungicides on poplar leaf spots, Brooks, Alberta

Fungicide and rate per 100 gallons	Leaves per whip	% disease	% leaves with spots	% dead leaves
C-O-C-S, 4.0 lb	36.3 a*	30.5 ab	46.2 bc	29.4 b
Manzate 200, 2 lb	36.5 a	29.6 b	47.1 b	27.5 bc
Benlate, 1 lb	33.6 a	21.4 b	39.7 bc	20.6 c
Manzate D, 2 lb	37.3 a	27.3 b	45.1 bc	25.8 bc
NF-44, 0.75 lb	36.5 a	21.3 b	38.6 c	20.5 c
Check	39.5 a	37.3 a	67.0 a	40.2 a

* The small letters indicate Duncan's multiple range groupings of treatments which do not differ significantly at the 5% level.

Table 3. Effect of fungicides on poplar leaf spots, Indian Head, Saskatchewan

Fungicide and rate per 100 gallons	Leaves per whip	% disease	% leaves with spots	% dead leaves
C-O-C-S, 4 lb	33.4 a*	40.7 b	49.6 d	40.3 b
Polyram, 2 lb	33.6 a	41.0 b	75.3 b	39.5 b
Benlate, 1 lb	32.6 a	33.4 c	50.0 d	32.3 c
Manzate D, 2 lb	33.1 a	41.3 b	72.2 b	39.7 b
Captan, 3 lb	34.0 a	41.0 b	60.2 c	39.8 b
Check	32.4 a	52.7 a	83.1 a	50.5 a

* The small letters indicate Duncan's multiple range groupings of treatment which do not differ significantly at the 5% level.

Data in Tables 2 and 3 show that the chemicals had no effect on leaf production. More leaves per whip were produced at the Brooks station than at Indian Head. Reasons for this were not determined in this study.

Data presented here indicate that poplar leaf spot incidence can be reduced by fungicides. Leaf spot development was completely inhibited within 10 days after the first application of NF-44 or benomyl, as shown in the data from Brooks. Ten days after the first spray (July 16) the average number of infected leaves per whip was 15.8. At the end of the growing season the average numbers of infected leaves per whip in plots sprayed with thiophanate methyl and benomyl were 15.2 and 15.7 respectively. Similar data are available for the number of dead leaves per whip, 5.7 on July 16 and 6.0 and 6.1 respectively for thiophanate methyl and benomyl on August 31.

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PLANT-PARASITIC NEMATODE GENERA ASSOCIATED WITH CROPS IN ONTARIO IN 1971

C.F. Marks, J.L. Townshend, J.W. Potter, Th.H.A. Olthof,[1] P.W. Johnson,[2] and J. Lounsbery[3]

In 1971 personnel of the Ontario Nematode Diagnostic and Advisory Service processed 802 samples, which represented a broad cross-section of Ontario crops. Extension specialists submitted 350 samples in 1971 an appreciable increase from the 213 samples submitted in 1970 (1). In contrast, agricultural chemical companies concerned with assessment of candidate nematicides on flue-cured tobacco submitted only 194 samples in 1971 compared with 651 in 1970. The number of samples submitted by growers has not changed for the past 2 years. As techniques become available to predict whether treatment with a nematicide is required to prevent nematode damage it is possible that the number of grower samples will increase. Studies on sampling techniques and on relationships between nematode population densities in the soil and crop loss are now under way at the CDA Research Station, Vineland Station, Ontario.

Table 1 shows essentially the same general pattern for the prevalence of the common nematode genera as obtained in 1970 (1). The root-lesion nematodes Pratylenchus spp. continue to be the most prevalent and, economically, the most important nematode pests in Ontario. Pratylenchus spp. were associated with 46 of the 56 crops sampled. Pin nematodes (Paratylenchus spp.) were the second most prevalent, being associated with 39 of the 56 crops sampled. Though the economic importance of pin nematodes has not been established in Ontario it is suspected that these pests affect the development of roots on rhubarb sets resulting in poor yields, particularly in forcing sheds, and occasionally in the field. The northern root-knot nematode, Meloidogyne hapla Chitwood 1949, occurred in 13% of all crops sampled. It was diagnosed in 31% of the vegetable crops sampled and it is the most important nematode pest of vegetables grown on muck soils in Ontario. This pest has also caused serious damage to flue-cured tobacco seedlings in greenhouse seedbeds, but it has not caused losses in the field. There is no indication of any increase in the prevalence of the northern root-knot nematode in flue-cured tobacco soils. Apparently this is because rye is not a host for this species and the common rotation is rye-tobacco. The oat-cyst nematode, Heterodera avenae Filipjev 1934, continues to be the most important species of this genus in Ontario and in association with a Pratylenchus sp. causes considerable damage to successive corn (Zea mays L.) crops. Spiral (Helicotylenchus spp.), stunt (Tylenchorhynchus spp.), dagger (Xiphinema spp.), and ring (Criconemoides spp.) nematodes are relatively common in Ontario soils but at this time the importance of these genera is unknown.

The 1971 survey of forages in eastern Ontario showed that root-lesion, pin, spiral, and root-knot nematodes (M. hapla) were common plant-parasitic genera associated with alfalfa, red clover, white clover, trefoil, brome and timothy. Stunt, cyst, ring, and dagger nematodes were also diagnosed in some of the samples.

Observations associated with field research activities in 1971 showed the needle nematode, Longidorus elongatus Thorne and Swanger 1936, to be present in a flue-cured tobacco field at Delhi and in a peach orchard at Harrow. At both locations the soil was sandy. It is probable that this nematode is more prevalent in Ontario than had been suspected. An unidentified species of Meloidogyne, only the second species of this genus to be found in the field in Canada, was found on several cultivars of turf grasses at Preston. The southern root-knot nematode, Meloidogyne incognita Chitwood 1949, is a perennial problem on cucumber and tomato in many greenhouses, but is not a threat to the field production of these crops as it is unable to survive in the field in Ontario.

An infestation of onions by stem and bulb nematode, Ditylenchus dipsaci Filipjev 1936, in Erieau Marsh, Kent County, was confirmed in 1971. It had previously been reported (2) on onion in the point Pelee Marsh, Essex county. A bud and leaf nematode, Aphelenchoides sp. (tentatively identified as A. fragariae Christie 1932) caused severe damage to begonia in a greenhouse in Leamington and 4000 plants originating from both Canada and the USA were destroyed.

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Table 1. Genera of plant-parasitic nematodes identified from soil samples processed by the Ontario Nematode Diagnostic and Advisory Service in 1971

Crop	No. of samples	Cyst (Larvae)	Root knot	Root lesion	Spiral	Stunt	Pin	Dagger	Ring
Alfalfa	3	18/2**	5/1	833/3	1204/2	39/2	1305/2		
Apple	6			1025/3			175/3		
Barley	3	900/2		651/3	3675/2	350/2	1125/2		
Beans	1								
Birdsfoot trefoil	1			3600/1			100/1		
Cabbage	3								
Carrot	8		225/2	50/1			1925/2		
Cereals	1						6150/1		
Celery	1		350/1				50/1		
Cherry	73			774/71		200/1	334/65		
Cherry (sour)	7			1850/7			542/6	750/1	
Chrysanthemum	1		2150/1				200/1		
Clover (sod)	1		50/1	4050/1					
Clover (red)	2	700/1	1100/1	1900/1	50/1	100/1	1150/2		
Corn	25	100/3	50/1	487/23	168/3	100/3	455/5		
Corn (sweet)	1			1600/1		250/1	50/1		
Crucifers	2	1400/1							
Fallow	9			850/6		100/1	480/5		
Gladiolus	3			1250/1			4083/3		
Grain (mixed)	4			50/1			250/1		
Grape	7	50/1		325/6	190/5	100/1	388/4		
Grass	5			450/2		50/1	1460/5		50/1
Grass (orchard)	1			150/1			1250/1		
Hay	1								
Juniper	5			100/1			50/1		950/1
Kale	1			100/1		50/1			
Lettuce	1								
Mushroom	6			50/1					
Oats	2	2550/1	50/1	950/2	150/1		3150/1		
Onion	21		2317/5	163/3	175/4	38/2	168/8		
Pasture	1			50/1					
Pea	1			5200/1					
Peach	16			1501/16		250/1	625/15		63/3
Plum	2			1475/2			600/1		
Potato	7		400/2	150/3	50/1	50/2			
Radish	2			150/1					
Raspberries	1			250/1	100/1				
Rhubarb	3			1117/3			4017/3		
Rhubarb (forcing)	1			50/1			3250/1		
Rose	11		15,850/1	650/8	300/2		100/2	750/1	
Rutabaga	2								
Rye	28		100/1	437/25		136/7	399/12	100/1	400/1
Shrubs (evergreens)	6			288/4			50/2		60/1
Shrubs (*Taxus*)	1			50/1		50/1			
Shrubs (dogwood)	1			800/1			50/1		
Sod	1			200/1			200/1		
Spinach	1								
Spruce (blue)	1			50/1			100/1		
Strawberry	19		50/1	2083/17			273/13		
Tobacco (seedbed)	2								
Tobacco	115	150/1	625/2	622/91		125/5	155/33		
Tobacco*	194		50/1	4391/176	50/2	50/3	126/90		
Tobacco (survey)	148		169/31	735/146		86/21	246/117		50/4
Tomato (greenhouse)	14			663/4		110/1			
Tomato (field)	1			250/1			50/1		
Turnip	1			50/1			50/1		
Wheat	8	50/1		585/6	50/2	50/3	570/7		
Miscellaneous	9			193/7	50/1		115/5		
Total	802								

* Samples from nematicide trials - averages are not included because of treatment effects.

** Average number of nematodes per lb of soil/number of samples containing the nematode.

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CONTROL OF NEMATODES IN PEAT WITH FORMALDEHYDE[1]

C.L. Lockhart

Abstract

Dripping 37% formaldehyde solution at the rate of 5 ml per ft^3 onto dried peat on a conveyor belt before sealing in polyethylene bags eliminated saprophytic and free-living nematodes.

In 1968, a commercial peat processing company at Aylesford, Nova Scotia, was losing peat moss sales to mushroom growers due to nematode infestations. Using the Baermann funnel extraction technique (1) random samples of processed peat from polyethylene bags contained 0 to 69 nematodes per pound. The nematodes, identified by R. H. Mulvey and Dr. L. Y. Wu, Entomology Research Institute, CDA, Ottawa, consisted mostly of saprophytic or free-living forms of Panagrolaimus sp., Plectus sp., and Seinura sp.; a Ditylenchus sp. was found in an occasional sample.

Peat is generally stockpiled in heaps for 4 to 6 months before drying and bagging. Temperatures measured at depths of 8 and 36 inches from the surface in stockpiled peat were 100°F (37.8°C) and 139°F (59°C) respectively. At 139°F nematodes should not survive since most are killed after 30 min exposure to 120°F (48.9°C) (1). In 1968 samples taken from piled peat at depths of 0, 15, and 24 inches contained 44, 484, and 198 nematodes per pound of peat respectively. A 4-month-old pile sampled in 1969 contained 2414, 2147, 166, 0, and 0 nematodes per pound at depths of 6, 9, 18, 27, and 36 inches respectively. Processed peat from the center of the stockpile was nematode free but in the commercial operation it was impractical to separate the outer and inner layers of the pile. During processing the peat was subjected to an air temperature of 174°F (78.9°C) for about 15 sec but nematodes survived this exposure. It was impractical to increase either the temperature or the exposure time. Thus, nematodes were usually present in the bagged peat.

To evaluate the use of formaldehyde in killing nematodes in peat, bioassays were conducted by adding 37% formaldehyde solution (formalin) at rates of 5, 10, or 20 ml per ft^3 to 12 ft^3 polyethylene bags of peat. The bags were immediately closed with staples and were sampled for nematodes 7 and 14 days later. At 7 days nematodes were present at all rates of formaldehyde used, but at 14 days there were no nematodes present in any of the treated samples. At each sampling date nematode counts averaged 110/lb in the untreated peat. Subsequent tests were done with formaldehyde dripped onto peat on the conveyor belt at the rate of 5 ml per ft^3, either just before the peat entered the dryer or before the dried peat was bagged. The bags of peat were sampled for nematodes 1, 7, and 14 days later. Peat treated just before bagging was free of nematodes, but the drying process apparently destroyed the effectiveness of the formaldehyde (Table 1). Nematode counts increased in bags of untreated undried peat during the 14 day period following bagging but counts did not increase in untreated dried peat.

Thus in our tests 37% formaldehyde at the rate of 5 ml per ft^3 freed peat from nematodes. This process is being used commercially at a cost between 2 and 3 cents per ft^3 of peat.

Table 1. Nematode counts in peat exposed on a conveyor belt to drip treatment with 37% formaldehyde and packaged in sealed polyethylene bags

Treatment	Avg no.* nematodes/lb of peat 1-14 days after treatment		
	1 day	7 days	14 days
Formaldehyde, 5 ml/ft^3, added after drying	0	0	0
Formaldehyde, 5 ml/ft^3, added before drying	9	21	3
Untreated control, packaged after drying	15	18	6
Untreated control, packaged without drying	12	69	579

* Avg of three 12 ft^3 bags.

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CHEMICAL CONTROL OF THE GOLDEN NEMATODE, HETERODERA ROSTOCHIENSIS: GREENHOUSE OBSERVATIONS ON THE USE OF DPX 1410 AS A POTATO SEED PIECE TREATMENT[1]

K.G. Proudfoot and Ray F. Morris[2]

Abstract

Treatment of whole potato tubers with solutions of Insecticide-Nematicide DPX 1410 [s-methyl 1-(dimethylcarbamoyl)-N-(methyl carbamoyl)oxy thioformimidate] before planting in pots of soil artifically infested with cysts of the golden nematode (Heterodera rostochiensis) reduced significantly the number of cysts in the soil at harvest. Treatment of cut seed also reduced cyst populations but some phytotoxicity occurred at the concentrations used.

Introduction

The use of chemicals to control the golden nematode (Heterodera rostochiensis Woll.) has been investigated for many years. Recently Peachey et al. have reviewed this aspect of nematode control and compiled a bibliography of relevant literature published between 1932 and 1967 (3-6). Some of the chemicals that have been used depend for their effectiveness on diffusion through the soil in the gaseous state, and an eradication program using such compounds was developed at Long Island, New York, by Spears (7). Best results with these chemicals were obtained when soil temperatures were above 60 F (15.6 C) and the soil was fairly moist.

More recently chemicals have become available that appear to have insecticidal and nematicidal properties and it seemed of value to test the effectiveness of some of these in controlling the golden nematode. One such chemical, DPX 1410, has a broad margin of safety to many crops and because of its systemic activity suggestions have been made for its use in soil, foliar, and seed treatments (2).

Seed piece treatment

In August 1970 a preliminary investigation was commenced using DPX 1410 [s-methyl 1-(dimethylcarbamoyl)-N-(methyl-carbamoyl)oxy thioformimidate] as a seed piece treatment at the rates of 50 g and 100 g active ingredient per liter. Seed pieces of the potato cultivar Pink Pearl were dipped in the nematicidal solution for 2 minutes and then allowed to dry for 30 minutes before planting in 5-inch pots containing soil naturally infested with nematode cysts. Plants were grown to maturity in the greenhouse and cysts were extracted from the soil using normal flotation techniques. Seven replicates of each treatment were planted and cyst numbers were counted in two 25-g samples of air dried soil from each replicate.

Using DPX 1410 as a seed piece treatment at the rate of 100 g active per liter caused phytotoxicity, and the seed pieces failed to produce plants. This may have been partly attributable to the poor condition of the seed pieces since the tubers had been stored for 10 months before starting the experiment. At the 50 g active per liter rate no visible plant phytotoxicity occurred and yields were only slightly less than those of the control, as shown in Table 1. The reduction in the number of new cysts formed was extremely satisfactory and a further experiment was undertaken to investigate other concentrations of DPX 1410.

Table 1. Effects of dipping seed pieces of Pink Pearl potato in DPX 1410 solutions on tuber yield and on production of golden nematode cysts

Treatment (g active/liter)	Total cysts recovered (no./100 g soil)	Estimated no. new cysts formed (no./100 g soil)	Tuber yield (g/plant)
Control, water only	73	52	54
50	27	6	46
100	21	0	0

Whole tuber treatment

In the second experiment, eight concentrations of DPX 1410 were tested, ranging from 2 to 66 g active ingredient per liter (Table 2). Small whole tubers of the cultivar Arran Victory were dipped for 2 minutes and allowed to dry for approximately 5 hours. They were then planted in soil

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Table 2. Effects of dipping whole tubers of Arran Victory potato in solutions of DPX 1410 on tuber yield and on production of golden nematode cysts

Treatment (g active/liter)	Mean no. of cysts/pot at harvest	Mean yield of tubers (g/pot)	Mean no. of cysts/g soil
Control, water only	547	118	76.8
2	223	124	31.2
4	152	126	22.8
8	137	112	18.6
16	63	121	10.1
24	56	97	9.7
40	93	127	15.7
50	83	98	13.2
66	53	126	8.6
SE ±			1.3

artificially infested with nematode cysts at the rate of 50 cysts per 5-inch pot. Tests indicated that slightly less than 60% of the cysts contained viable contents. Each treatment was replicated five times and tubers were planted on 2 February and harvested 6 July 1971. No phytotoxic effects were observed with any treatment.

The weight of air-dried soil in each pot was determined and two 25-g samples of soil from each pot were then examined for nematode cysts. The number of cysts produced in each pot was calculated and the means determined for each treatment are shown in Table 2. Analysis of the cyst data was completed using a log (x+1) transformation, and the mean numbers of cysts/100 g soil calculated from the detransformed data are shown in column 4, Table 2.

Dipping tubers in DPX 1410 solution resulted in significantly fewer cysts than in the control. With increasing concentration of DPX 1410 the numbers of cysts declined markedly though not uniformly, since fewer cysts resulted from dipping in 16 g active per liter than from 40 or 50 g active per liter. This discrepancy was probably due to the difficulty of ensuring even distribution of the small number of cysts with viable contents added to each pot, and to experimental errors in estimating cyst numbers. Differences in tuber yield between treatments were nonsignificant. If these results are confirmed by field experiment DPX 1410 will provide a relatively cheap and simple method of preventing the build-up of nematode infestations in potato soils. Liquid treatments for the control of fungal or insect pests are not widely used but seed piece dusts for the control of fungal diseases, e.g. fusarium seed-piece decay, are now recommended (1). Investigations into the use of granular DPX 1410 together with a fungicide to give control of both nematode and fungal pests have been initiated.

Acknowledgments

The authors thank DuPont of Canada for the supply of DPX 1410 used in these studies and W.O. Coles for technical assistance.

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STEM AND BULB NEMATODE FOUND IN ERIEAU MARSH, KENT COUNTY, ONTARIO

P.W. Johnson and W.E. Kayler [1]

In Canada, the stem and bulb nematode, Ditylenchus dipsaci (Kuhn, 1857) Filipjev, 1936 was first reported on onion (Allium cepa L.) in the Point Pelee Marsh, Essex County, Ontario, by Mountain (1957). In a survey conducted the same year, Mountain (1957) confirmed the presence of D. dipsaci on 19 farms in that marsh.

During 1957-58, surveys for this pest were conducted in all onion growing areas of Ontario (Sayre and Mountain 1962). The nematode was not found in any area other than the Point Pelee Marsh.

Several cases of suspected nematode injury to onions in the Erieau Marsh have been reported over the past few years. In 1971 the presence of D. dipsaci was confirmed, and severe splitting and cracking of infested bulbs (Fig. 1) was evident. Thus, the nematode has now been positively identified in a second onion growing area of Ontario. Several other fields in the Erieu Marsh are suspected to contain D. dipsaci, but this has not been confirmed.

The nematode has apparently been present in this marsh for several years. Imported sets are suspected as being the medium for the nematode introduction. The major onion growing areas in Ontario including those known to be infested with D. dipsaci, are shown in Fig. 2.

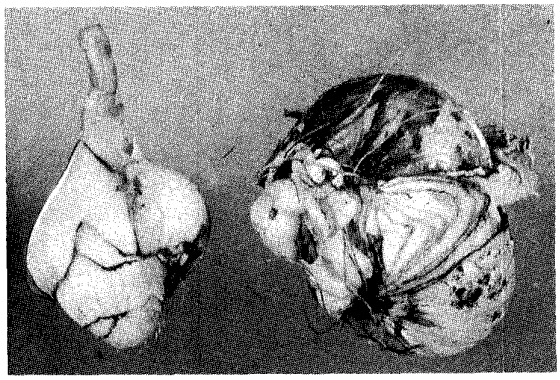

Figure 1. Onion bulbs infested with *Ditylenchus dipsaci*, from the Erieau Marsh; note severe cracking and splitting.

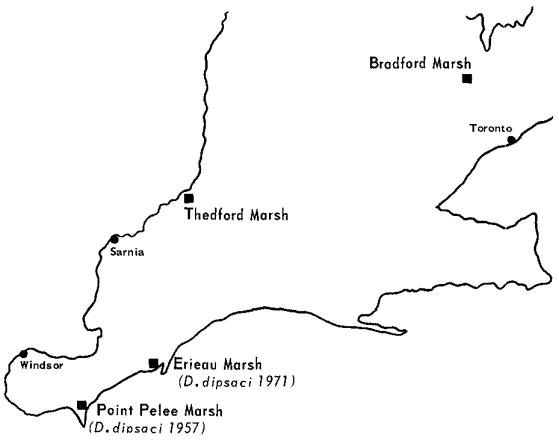

Figure 2. Location of the four major onion growing areas in Ontario, including those known to be infested with *Ditylenchus dipsaci*.

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BRIEF ARTICLES

DISEASES OF RAPESEED IN MANITOBA IN 1971[1]

C.C. Bernier

Two disease surveys of rape were made in Manitoba in 1971, one in the southern part of the province during the third week of July, and a second in the northern section during the third week of August. In the south (Morden, Darlingford, Swan Lake, and Carman), Argentine rape (Brassica napus) is grown almost exclusively and the crop was virtually free from diseases in the 12 fields visited.

In the northern survey (Neepawa, Dauphin, Swan River, The Pas, and Roblin), diseases were observed in many of the 40 fields visited. Both the prevalence in the field and the general severity of the diseases were assessed in each case. The disease ratings, expressed as % of fields in each category, for the staghead form of white rust caused by Albugo candida (Pers. ex Lév.) Ktze. and for black spot caused by Alternaria spp. were as follows:

	Turnip rape* (26 fields)		Rape† (14 fields)	
Disease rating	Black spot	Staghead	Black spot	Staghead
Trace	35	23	64	0
Slight	15	11	21	0
Moderate	15	4	0	0
Severe	0	35	0	0
% of fields infected	65	73	85	0

* *Brassica campestris* L.

† *Brassica napus* L.

Staghead was prevalent and damaging in turnip rape (B. campestris), where 39% of the fields visited were found to be moderately to severely affected. Yield reductions in severely affected fields were estimated to range from 30 to 60%, and areas within a few fields were essentially a total loss. Although fewer fields of rape than turnip rape were assessed, rape appears to be highly resistant to white rust. Traces of sclerotinia stem blight and aster yellows were also observed in about 10% of the fields visited.

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LAWN AND TURF DISEASES IN THE VICINITY OF WINNIPEG, MANITOBA[1]

R.G. Platford,[2] C.C. Bernier, and A.C. Ferguson[3]

A record was kept of the diseases occurring in The University of Manitoba Plant Science Department turf grass plots and from diseased grass samples sent to the Plant Science Pathology Laboratory during 1968-71. The diseases varied with the season of the year and with the particular grass species and cultivar.

Damage done by snow molds during the winter months becomes evident in early May when the grasses resume growth. Untreated bentgrass golf greens have been observed to be heavily infected with a nonsporulating low temperature Basidiomycete. This disease has been observed every year during the survey period and is probably the most serious turf grass disease in Manitoba. Bentgrass and bluegrass are hardest hit by this organism. Typhula snow mold has not been a major problem in golf greens, but it has been observed on creeping red fescue in Winnipeg lawns, where it causes scattered damage. The Typhula species involved has not been determined.

During periods of cool moist weather in May and early June, melting out of bluegrass caused by Helminthosporium spp. and a disease caused by Septoria macropoda Pass. have been observed. The latter causes a leaf chlorosis and basal crown rot of bluegrass. Melting out and septoria were severe on some cultivars of bluegrass in May 1969. Cultivars susceptible to Septoria were not affected by Helminthosporium. The Helminthosporium was not identified as to whether it was H. sativum or H. vagans. The melting out type diseases are a serious problem in Manitoba.

There were relatively few disease problems encountered during the summer months aside from a few minor cases of rust caused by Puccinia graminis Pers. and powdery mildew caused by Erysiphe graminis DC. ex. Mérat.

The autumn of 1971 was very favorable for rust on some bluegrass varieties in the

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University turf grass varietal trial plots. The varieties that were most severely damaged were those that remained green into October. Varieties that became semi-dormant in October were not seriously affected by rust but some of these varieties showed considerable Septoria infection.

In late October 1971, small circular dead patches were observed in the University bentgrass greens. Fusarium nivale (Fr.) Ces. was isolated from the diseased grass.

Several other diseases of only occasional occurrence were identified during the survey period. Red thread caused by Corticium fuciforme (Berk.) Wakef. was observed at a Winnipeg golf course in July 1968. This disease was likely favored by the cool moist weather prevailing at the time. In June 1970 brown patch caused by Rhizoctonia solani Kühn was observed in the University bentgrass plots.

FIRST RECORD OF SEPTORIA DIGITALIS IN CANADA

R.S. Dickout[1] *and D.J. Ormrod*[2]

In July 1972, seedsman F.O. Blake of Milner, British Columbia, applied to the B.C. Department of Agriculture for inspection of a crop of Digitalis lanata Ehr. being grown for seed on Southern Vancouver Island. The potential buyer in England requested certification that the crop was free of Septoria digitalis Pass. and Colletotrichum fuscum Laub., as a requirement for possible re-export to Australia.

A field inspection carried out by the Victoria office of the Plant Protection Division, Canada Department of Agriculture, revealed that up to 75% of the plants in the 0.5 acre field were affected by a conspicuous leaf blotch. Microscopic examination by R.G. Atkinson, Canada Department of Agriculture Research Station, Saanichton, showed the causal organism to be a Septoria. Final identification as S. digitalis Pass. was made by J.A. Parmelee, Plant Research Institute, Canada Department of Agriculture, Ottawa, who found good comparison with a fungus exsiccatus in DAOM from Italy (Sacc., Myc. Ital. 558).

By inquiring into the history of this planting, it was found that the seed originated from a nearby farm where the crop had been grown for approximately 30 years. As the disease is known to be seed-borne (1), it is presumed that it has occurred in the area for many years but had not been previously recognized. Examination of young seedlings ready for planting out showed no apparent infection, thus it seems likely that, under our conditions, the crop must remain in the field over the wet winter and spring seasons before infection becomes extensive.

Septoria leaf spot can be an important disease in crops grown for leaf as it has been shown to reduce the yield of cardiac glycosides (used in the treatment of heart disease) from approximately 0.473% in healthy leaves to 0.121% in severely infected leaves (2). Because S. digitalis is carried as pycnidiospores on the surface of the seed, it seems likely that appropriate seed disinfection procedures would help to reduce spread to new areas. Seed treatment with captan or thiram has been reported as successful (1).

Figure 1. Leaves of *Digitalis lanata* showing irregular lesions with purple borders and pale centers, typical of infection by *Septoria digitalis*.

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GLOMERELLA CINGULATA FROM ALABAMA-GROWN TOMATOES OFFERED FOR SALE AT OTTAWA

W.I. Illman [1]

Typical water-soaked depressions symptomatic of anthracnose were observed on a high percentage of tomato fruits offered for sale in an Ottawa supermarket produce department on July 12, 1972. Some of the lesions had erupted to produce the salmon-colored masses of yeast-like conidia characteristic of the imperfect state of Glomerella cingulata, named by von Arx Colletotrichum gloeosporioides (Penz.) Sacc. in his monograph of Colletotrichum (1). Enquiry of an attendant produced the shipping container which fixed Alabama as the source of these fruits.

Subsequent observation microscopically and of cultures which developed from lesioned fruit confirmed the identity of the incitant. This organism, which is widely prevalent in southeastern North America, rarely poses much of a problem in field tomatoes in Ontario and adjacent regions. Earlier studies (1, 2) had confirmed that the bulk of field tomato anthracnose in the latter area was incited by Colletotrichum coccodes (Wallr.) Hughes, which had long masqueraded under the epithets C. phomoides (Sacc.) Chester or C. atramentarium (B. & Br.) Taubenh.

Figure 1. Spore masses of *Colletotrichum* state of *Glomerella cingulata* on decayed portion of Albama-grown tomato fruit offered for sale at Ottawa.

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CORRECTIONS

DIDYMELLA STEM EYESPOT OF FESTUCA SPP. IN NORTHERN ALBERTA AND BRITISH COLUMBIA IN 1970 AND 1971

J. Drew Smith and C.R. Elliott

Volume 52, No. 2, June 1972, p. 38-41

On page 40, column 1, lines 1 to 10 were imperfectly printed and should read as follows:

> bank of the Redwillow River due south of Beaverlodge. This is the southern part of the main red fescue seed-growing area.
>
> The survey results indicate that the disease on seed crops was much more severe in 1971 than in 1970 and as severe as that reported in 1969 (3). This is reflected in the seed yield statistics for the 3 years. Canadian seed production of red fescue in thousands of metric tons (millions of lb in

SOUTHERN LEAF BLIGHT OF CORN IN SOUTHWESTERN ONTARIO IN 1971

L.F. Gates and Bart Bolwyn

Volume 52, No. 2, June 1972, p. 64-69

On page 67, column 1, the five paragraphs beginning "Surface-sterilized seed..." and ending "...fungus grew very slowly" should follow the second paragraph under Seed infection on page 66.

The heading Discussion (p. 68) should precede the last paragraph on page 67, column 2, beginning "The widespread overwintering...".