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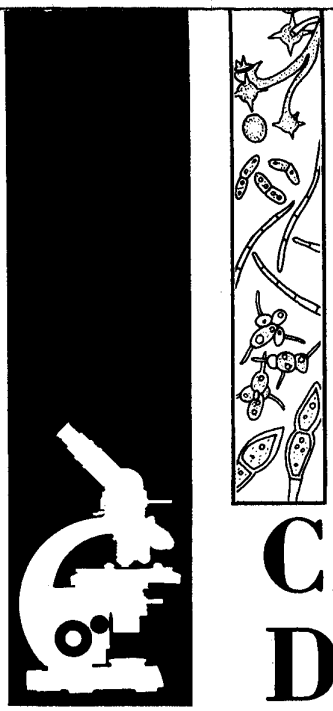
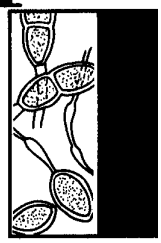


CANADIAN PLANT DISEASE SURVEY



EDITOR W.L. SEAMAN

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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. It will not accept results of original research suitable for publication in more formal scientific journals".

THE RELIABILITY OF SEROASSAY FOR THE DETECTION OF CARNATION MOTTLE VIRUS IN CRUDE SAP[1]

W.G. Kemp[2]

Abstract

Serological assay for carnation mottle virus in crude carnation sap by the double-diffusion technique was comparable to a bioassay method that used Chenopodium amaranticolor and Dianthus barbatus as indicator hosts. On only a few occasions were results for both methods divergent. Virus concentration, a major factor affecting the reliability of any seroassay method, fluctuated from month to month and differed among cultivars. The advantages and limitations of this serological method are discussed.

Introduction

Carnation mottle virus (C. Mot. V.) can be detected serologically in crude, undiluted sap by immunodiffusion tests in agar, even though the sap contains other constituents (2, 3, 6). Should such a test be as accurate and sensitive as an infectivity test that involves days of delay before the results are available, then its advantages would warrant its acceptance as a substitute or adjunct for the biological activity test.

To test its reliability, the seroassay method was compared monthly in the spring and summer of 1963 and 1964 with a conventional bioassay method. Serological estimates of the relative virus concentration in each sap sample were also determined at these times to gain some insight into seasonal changes in virus synthesis in various cultivars.

Materials and methods

Five plants were selected at random from each of the following carnation cultivars: 'Scania', 'Yellow Sim', 'Peace River', 'Petersen's Improved Sim', 'Peppermint Sim' and 'Flamingo'. All cultivars were grown in a commercial greenhouse at St. Catharines, Ontario. Each was tagged clearly to ensure that subsequent tests were made from the same source material. It was not known if the selected plants were infected with C. Mot. V.

A top lateral shoot weighing approximately 3-4 g was broken from each of the selected plants at monthly intervals between March and August in 1963 and 1964, collected in individual polyethylene bags, and brought to the laboratory on the day of testing. Enough sap was squeezed from each shoot to give a 1-ml sample.

The virus content of the crude sap from each of the 30 samples was assessed by the agar double-diffusion method with an antiserum that had been prepared in earlier experiments (3) against an isolate of C. Mot. V. from the cultivar 'Apollo'. The titer of the antiserum against its homologous antigen in crude undiluted sap of Dianthus barbatus L. was in excess of 1/256. The serum was unabsorbed but had given no reaction previously with sap from either healthy D. barbatus or D. caryophyllus L. However, control tests were conducted each month with undiluted sap prepared as above from a healthy seedling carnation clone.

Relative virus concentration was determined from serial twofold dilutions of each sap sample made in distilled water and tested against a constant serum dilution (1/16) in agar plates prepared as previously described (5). Approximately 0.1 ml antiserum was pipetted into the central well and 0.1 ml of each of the dilutions of every sap sample into the peripheral wells. All plates were incubated immediately at 27° C. After 24 and 48 hr, the highest dilution of each virus sample producing a visible precipitate was recorded.

A single reference isolate of C. Mot. V. was used with its antiserum to compare the homogeneity of the virus isolates, because variations in virus endpoint of any of the samples possibly might be due to major antigenic differences among the isolates. The reference isolate was placed in alternate peripheral wells and the other isolates were added to the adjacent ones. The precipitin patterns were noted after 48 hr and they were interpreted by the theories discussed by Crowle (1).

At the time of serological testing, bioassay tests were also made on each of the sap samples by the mechanical inoculation of both D. barbatus clone 26 and Chenopodium amaranticolor Coste & Reyn. These plants are also indicators of other unrelated sap-transmissible viruses of carnation, whose presence might affect the multiplication of C. Mot. V. in a mixed infection. The plants were maintained at

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70° F under a bank of fluorescent lights supplemented by incandescent light (14 hr/day) and observed for 21 days.

Results

Reliability of the seroassay method

Comparative serological and biological assays of crude saps extracted from the same 30 carnation plants between March and August were made in two successive years. The initial March test indicated that each of the selected plants was infected with C. Mot. V. before the start of the experiment (Table 1). It and the subsequent monthly tests established the fact that the results of both assay methods were highly correlated. In only two cases did infection occur on an assay plant when the serological reaction was negative. Crude sap from the leaves of a single plant of the cultivars 'Peace River' and 'Scania' did not react with C. Mot. V. antiserum in April 1963 and March 1964, respectively.

All sap samples gave a positive reaction on C. amaranticolor but on 11 occasions no response occurred on D. barbatus 26. In 1963, six failures to infect the latter host were associated with the cultivar 'Yellow Sim', two with 'Petersen's Improved Sim', and one each with 'Peace River' and 'Scania'. They occurred more often between May and July than in March, April or August. In 1964, D. barbatus failed to become infected after inoculation on only one occasion. Only twice did a negative response occur on D. barbatus 26 with sap extracted from the same plant in different months.

Precipitin zones appeared in the agar plates within 24 hr and they were usually sharp and distinct. On occasion, these sharp zones later became diffuse towards the antigen wells, which indicated excess virus antigen in the crude sap. Infectious sap induced local lesions on the inoculated leaves of C. amaranticolor in four days and on those of D. barbatus in 12 days.

In March 1963 there was no evidence that any other sap-transmissible carnation virus was present in the selected plants. Later, however, carnation ringspot virus (CRSV) was detected in three plants. Crude sap from two plants of 'Peace River' and from one of 'Flamingo' induced systemic symptoms on the uninoculated leaves of D. barbatus 26 in April and August 1963, respectively. These symptoms were identical with those Kemp and Heald (4) showed to be characteristic of CRSV infection in this clone. CRSV was not associated with either of the plants in which C. Mot. V. was not detected serologically. Incidentally, the sap from healthy seedling carnations produced no precipitin reaction when reacted with C. Mot. V. antiserum nor did it produce visible symptoms on either of the assay plants.

Frequency distribution of the relative concentration of C. Mot. V. in the crude sap samples

In the 360 sap samples taken in the spring and summer of 1963 and 1964, virus concentrations ranged from 1/1 to 1/16. On two occasions, although the virus was detected by bioassay, it could not be measured serologically. The frequency distributions of the concentrations in 1963 and 1964 had the same range but differed in their prevalence at the high and low values (Table 2). The mode of the concentration distribution in all samples and that calculated for the scatter in both 1963 and 1964 was 1/4.

Factors influencing the C. Mot. V. concentration

Month—Considerable fluctuation in the virus concentration in individual plants occurred from month to month in both 1963 and 1964 (Table 3). In general, the lower concentrations were more prevalent in June, whereas the higher ones occurred most often in March and August.

Cultivar—Concentration differences also existed between the different cultivars. The mode of the concentration distribution for individual cultivars varied noticeably (Table 4). In both years, the modal concentration of the virus in 'Scania' was low, whereas it was high in 'Petersen's Improved Sim' and 'Flamingo'.

Strains and unrelated viruses—Only a single plant of 'Peace River' contained an isolate of C. Mot. V. that was antigenically distinct from the reference virus. The concentration of this distinct strain was never below the modal concentration of 'Peace River' at any sampling date in either year. Neither was it associated with sap samples that failed to react serologically. No evidence was found to suggest that the isolates from 'Scania', in which the concentration was consistently low, were serologically or biologically different from the reference virus.

Although CRSV was found to be associated with C. Mot. V. in three plants, this unrelated virus had no apparent effect on the C. Mot. V. concentration in the sap. It was never detected in samples that failed to react with C. Mot. V. antiserum. Neither was the estimated concentration of C. Mot. V. in these doubly infected plants below the most frequent concentration in the same cultivar infected only with C. Mot. V.

Discussion and Conclusions

The agar double-diffusion technique appears to be a reliable, rapid and practical method for the detection of C. Mot. V. in crude sap. Although the results of the serological tests were closely correlated with those of the bioassays, it might be argued

Table 1. Number of positive serological and infectivity reactions of crude sap extracts from 30 carnation plants belonging to six cultivars sampled during six-month periods in 1963 and 1964

Cultivar	Year tested	Serological reaction						Infectivity: C. amaranticolor						Infectivity: D. barbatus 26					
		Mar.	Apr.	May	June	July	Aug.	Mar.	Apr.	May	June	July	Aug.	Mar.	Apr.	May	June	July	Aug.
Petersen's Imp. Sim	1963	5*	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	1964	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Yellow Sim	1963	5	5	5	5	5	5	5	5	5	5	5	5	5	5	3	4	2	2
	1964	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Peace River	1963	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5
	1964	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Flamingo	1963	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	1964	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Scania	1963	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	1964	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Peppermint Sim	1963	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	1964	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5

* Number of sap samples giving a positive serological or infectivity reaction of five samples tested.

that the former appeared to be more consistently reliable under our conditions. In no case did virus infection go undetected in two successive seroassays of the same plant. On the other hand, consistent results with the bioassay evidently depend on the assay host. C. amaranticolor was considerably more sensitive to C. Mot. V. than D. barbatus 26. The latter plant failed to respond to the virus in sap samples on 11 occasions when both bioassays on C. amaranticolor and seroassays were positive.

Both assay methods have at least one similar disadvantage. Virus concentration, a major factor affecting the precipitin reaction and infectivity, fluctuates considerably from month to month and among different cultivars. Extremely low concentrations or possible uneven distribution of the virus in carnation shoots, or both, at any time could influence the successful application of either test. Failure to detect the virus conceivably could occur in June, when the environmental conditions in Ontario apparently encourage lower concentrations. The presence of the virus might remain undetected in a cultivar such as 'Scania', in which the concentration is consistently lower than in other cultivars.

In spite of this potential weakness, seroassay was very reliable under Ontario conditions in 1963 and 1964. This method has the advantage over bioassay in that it not only reduces the time for testing but eliminates the need for extensive greenhouse facilities. Such a test could serve, at least, in a primary screening program for the establishment of C. Mot. V. - free mother plants with the purpose

Table 2. Frequency distribution of relative concentrations of carnation mottle virus in 360 crude sap samples

Relative concentration*	1963 (No.)	1963 (%)	1964 (No.)	1964 (%)	Total (No.)	Total (%)
Below detectable level	1	0.5**	1	0.5**	2	0.5***
1/1	8	4.4	3	1.6	11	3.2
1/2	47	26.1	42	23.3	89	24.7
1/4	55	30.6	54	30.0	109	30.2
1/8	54	30.0	49	27.2	103	28.6
1/16	15	8.3	31	17.2	46	12.7

* Highest dilution of a sample to produce a precipitin reaction.

** Frequency of each concentration calculated as a percentage of the samples extracted each year.

*** Frequency of each concentration calculated as a percentage of all samples.

Table 3. Frequency distribution of relative concentrations of carnation mottle virus in crude sap extracted at monthly intervals in 1963 and 1964

Relative concentration*	Year	Sampling date: March	April	May	June	July	August
Below detectable level	1963	0	1	0	0	0	0
	1964	1	0	0	0	0	0
1/1	1963	0	1	0	5	2	0
	1964	0	1	0	1	1	0
1/2	1963	2	2	9	18	10	6
	1964	5	6	4	12	11	4
1/4	1963	8	12	13	6	10	6
	1964	6	15	5	10	10	8
1/8	1963	18	11	8	1	5	11
	1964	10	8	13	4	8	6
1/16	1963	2	3	0	0	3	7
	1964	8	0	8	3	0	12

* Highest dilution of a sample to produce a precipitin reaction.

Table 4. Frequency distribution of the relative concentrations of carnation mottle virus in crude sap samples extracted from six commercial cultivars in 1963 and 1964

Relative concentration*	Year	Cultivar sampled** PIS	YS	PR	FL	SC	PS
Below detectable level	1963	0	0	1	0	0	0
	1964	0	0	0	0	1	0
1/1	1963	1	0	1	0	3	3
	1964	0	0	1	0	1	1
1/2	1963	5	7	7	5	11	12
	1964	0	6	5	2	17	12
1/4	1963	6	15	7	6	13	8
	1964	8	9	8	5	11	13
1/8	1963	13	8	12	12	3	6
	1964	9	14	8	14	0	4
1/16	1963	5	0	2	7	0	1
	1964	13	1	8	9	0	0

* Highest dilution of a sample to produce a precipitin reaction.

** PIS = Petersen's Improved Sim; YS = Yellow Sim; PR = Peace River; FL = Flamingo; SC = Scania; PS = Peppermint Sim.

of dividing an apparently healthy carnation population into two groups. The one would be exempt from further examinations because the test detected the virus, and the other group would be examined further by the most sensitive bioassay method available if the serological test failed to detect the virus.

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SOUTHERN BACTERIAL WILT OF FIELD TOMATOES IN SOUTHWESTERN ONTARIO

R.E.C. Layne and C.D. McKeen [1]

Abstract

Pseudomonas solanacearum E. F. Sm., the causal agent of southern bacterial wilt of tomato, was found in Kent County in six fields of processing tomatoes set with transplants imported from Georgia, USA. Infection ranged from 1 to 4%, and only limited secondary spread occurred in two of the six fields. This is the first report of bacterial wilt of tomato in Canada that could be traced to transplants of known origin and for which the identity of the pathogen was fully established. The overwintering potential of the pathogen in southwestern Ontario soils is being investigated. Until the possibility of overwintering is established, several precautionary measures have been recommended.

Southern bacterial wilt, caused by Pseudomonas solanacearum E. F. Sm., is an important disease of tomato, potato, tobacco, eggplant, pepper and peanut in the southern United States (2). The disease seldom occurs north of Maryland and Virginia or west of the Appalachian Mountains. Vaughan (11) proved experimentally that the causal bacterium overwintered in the soil as far north as central New Jersey. The disease has occurred on field tomatoes in the North Central States, where it was introduced from southern-grown transplants, but losses have been small and overwintering has not been established (10).

The only previous report of southern bacterial wilt in Canada appeared in 1949 (3). The causal bacterium was isolated in Ontario by Prof. E. H. Gerrard from a field tomato plant of unknown origin that had symptoms of "brown rot." The diseased plant was found near Kitchener, Ontario. Identification was based on cultural characters of the bacteria and on disease symptoms (4). No confirmatory pathogenicity tests were made with the bacterial isolate.

In 1967, about three to four weeks after several tomato fields were set with imported transplants from Georgia, up to 4% of the plants in some fields showed symptoms sufficiently similar to those described for southern bacterial wilt (2, 5, 6) to suggest that this may have been the disease involved. Diseased plants were collected from several locations for isolation and identification of the pathogen(s). Several surveys of tomato fields in southwestern Ontario were made throughout the growing season to determine the incidence and extent of wilt, varieties affected, origin of transplants, and evidence of secondary spread.

Materials and Methods

Small pieces of internally discolored tissue from the xylem and pith were mounted in drops of sterile water and examined by phase-contrast microscopy (400X).

Crude sap expressed from systemically infected plants was strained through cheesecloth and applied to upper leaf surfaces by gently rubbing leaves from base to tip with pads of cheesecloth soaked in inocula, as described by Layne (8) for inoculation with Corynebacterium michiganense (E. F. Sm.) Jensen.

Pieces of stem, root and petiole from diseased plants were surface-sterilized by immersion in 70% ethyl alcohol for 5-10 seconds and flamed to burn off surplus alcohol. These sections were split longitudinally and small pieces of discolored tissue were removed aseptically and placed in screw cap tubes containing 3 ml of sterile water. The tubes with contents were thoroughly agitated with a Vortex Jr. Mixer. A loopful of the suspension was streaked on King's B media (7) in petri plates and incubated for several days at room temperature, about 25° C. Observations of the resulting bacterial colonies for presence of pigment and fluorescence in ultraviolet light were made 3-5 days later. UV fluorescence was determined with a long-wave UV lamp. All bacterial isolates were transferred to slopes of mannitol agar and potato-dextrose-peptone agar (PDPA) and examined again for color, diffusible pigment and UV fluorescence. Transfers were also made to sterile steamed potato plugs, and the color of the bacterial growth and the change in color of the potato plugs were noted after incubation for 3-5 days.

Pure cultures of the bacterial isolates obtained were tested for pathogenicity on tomato 'Michigan-Ohio' and 'Ohio W-R 25', and on potato 'Irish Cobbler'. The tomato plants were at least 30 to 60 days old, were individually potted in a mixture of peat and sand, and were fertilized on a weekly schedule. Three methods were used to inoculate tomato plants:

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Leaf rub. Cheesecloth soaked in turbid suspensions of the bacterial isolates in sterile water was rubbed over the leaf surface.

Stem inoculations. Tips of sterile needles were coated with bacteria from petri dishes and stems stabbed about midway between their bases and shoot apices.

Root inoculations. Turbid suspensions of the bacteria were poured into trenches made with sterile scalpels near the tap roots, thus ensuring that the secondary roots were severed.

Potato plants were stem-inoculated about 10 cm from the shoot apex. All plants were maintained in the greenhouse at 25-30° C. Plastic canopies were used to provide additional humidification for the leaf rub inoculations.

Cultural and pathogenic characteristics of nine isolates of P. solanacearum were compared with the three common bacterial pathogens of tomato: Pseudomonas tomato (Okabe) Altstatt, Xanthomonas vesicatoria (Doidge) Dows., and Corynebacterium michiganense.

Fields of processing tomatoes known to be infected with the southern wilt pathogen were surveyed in June, July, August and September, 1967, to observe incidence of wilted plants and evidence of secondary spread. Soil samples were collected at the base of diseased plants on October 20 for subsequent studies of the overwintering potential of the pathogen.

Results

Symptoms—Naturally diseased plants were stunted and wilted, and extensive breakdown of the pith occurred in the lower part of the stem and tap root (Fig. 1:A, C, D). In the stem, reddish-brown vascular discoloration and water-soaking of the pith extended well above and below the regions where internal breakdown was severe. Adventitious root development was extensive on stems of wilted plants. Spots were not present on the leaves, stems or fruit of wilted plants, but dark-brown to black streaks on the stems and petioles were sometimes observed (Fig. 1:B).

Microscopy—Examination of water mounts of discolored stem tissues from affected plants revealed the presence of large numbers of highly motile, rod-shaped bacteria, occurring singly or in pairs.

Preliminary bioassay test—Three to five days after inoculation, small irregular lesions with tan centers and dark brown margins were observed and they were distinguishable from those associated with other bacterial pathogens of tomato (1, 6). The disease became systemic seven days after inoculation as indicated by wilting of leaflets and the appearance of dark-brown to black streaks on the petiole (Fig. 1:B). Wilting progressed until all leaves were affected.

Cultural characters in vitro—In the nine pathogenic isolates obtained from systemically infected tomato plants most cultural characters were similar. On PDPA media, they were at first white, but they became brown with age and produced a brown diffusible pigment that did not fluoresce in UV light. No diffusible pigment was produced on mannitol, but some isolates produced the brown pigment on King's B. No UV fluorescence was obtained with any of the isolates on King's B or mannitol. Bacterial growth on potato plugs was at first white but soon became brown. The potato plugs changed from white to gray to grayish brown after several days. Such characters have been described for P. solanacearum (5, 6).

Several important differences in color, pigment production, UV fluorescence, and other characters distinguished our isolates of P. solanacearum from other bacterial pathogens of tomato. P. tomato produced a diffusible green pigment on King's B and mannitol. The pigment gave a strong bluish green fluorescence in UV light. Neither X. vesicatoria nor C. michiganense produced a diffusible fluorescent pigment on any of the media tested. X. vesicatoria was yellow and distinctly mucoid on all media, whereas C. michiganense was cream on PDPA and mustard yellow on mannitol. P. tomato was gray to white on all media but P. solanacearum was white on mannitol and white to brown on King's B and PDPA. On steamed potato plugs, the color of bacterial growth and the color changes of the plug differed with each of the four bacterial pathogens. P. solanacearum isolates were brown and changed the color of the plugs from white to brown. P. tomato was white or gray and changed the plug color from white to gray. X. vesicatoria was yellow and mucoid, and changed the plug color from white to brown. C. michiganense was mustard yellow and changed the plug color from white to gray. C. michiganense was also gram-positive, whereas the other three pathogens were gram-negative. Other workers have obtained similar results with similar media and stains (5, 6, 9).

Pathogenicity tests—The pathogenicity tests on tomato were sufficiently definitive to distinguish our isolates of P. solanacearum from the other three bacterial pathogens of tomato. P. solanacearum and C. michiganense produced local as well as systemic symptoms on tomato, but their symptoms were distinctly different (2, 6, 8, 9). P. tomato and X. vesicatoria each produced distinctive local symptoms but no systemic symptoms (1, 5, 6).

Our isolates of P. solanacearum produced brown water-soaked streaks, sometimes with brown

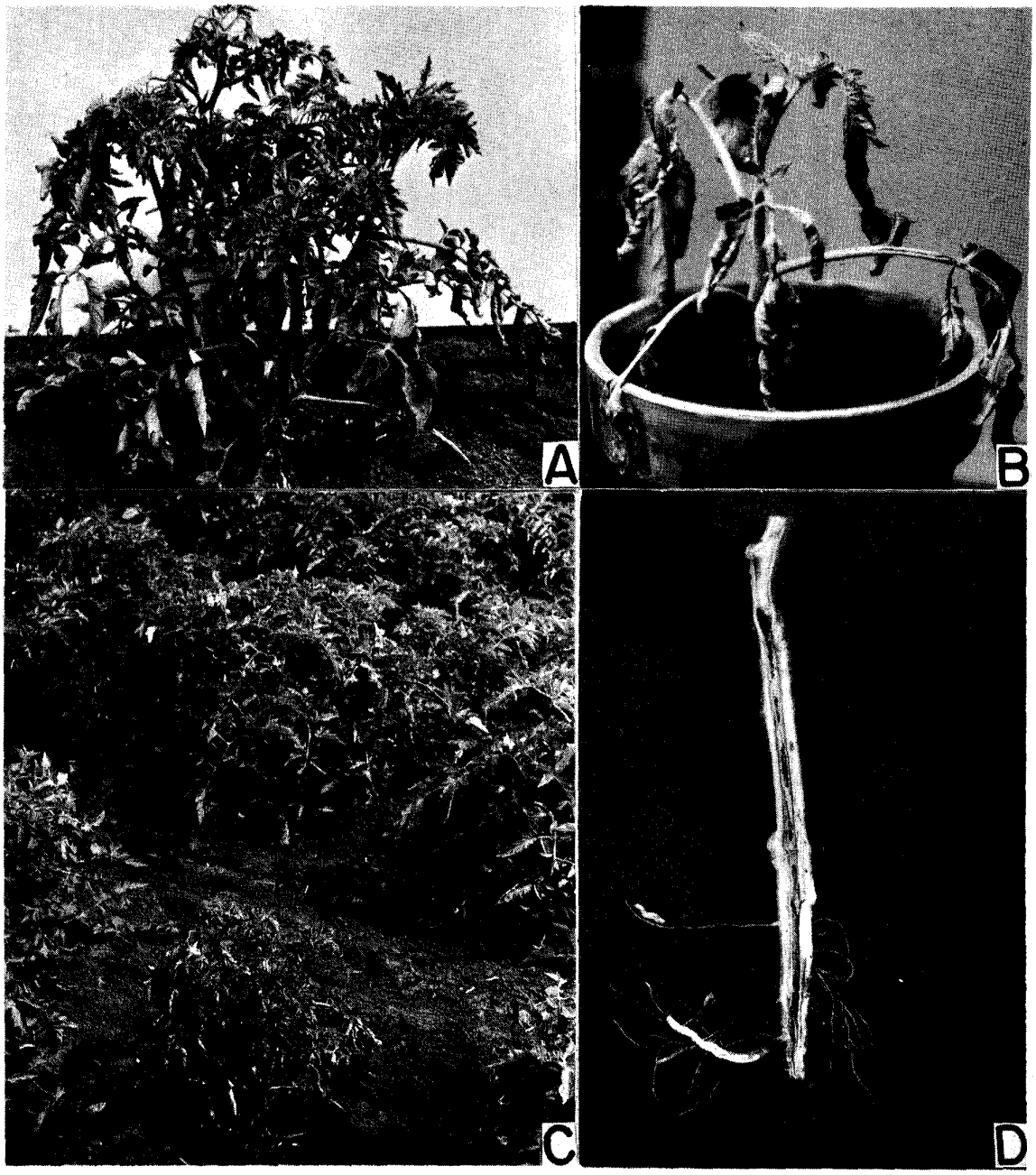

Figure 1. Tomato plants infected with *Pseudomonas solanacearum*. A and C) Naturally infected plants at mid-season. Note severe stunting and wilt compared with healthy neighboring plants. B) Typical symptoms obtained from stem or root inoculation. Note severe wilting of leaves and black streaks on petiole and leaflet on 2nd lowest leaf. Photographed 11 days after inoculation. D) Longitudinal section of the lower portion of a stem from a naturally infected plant showing vascular discoloration and typical internal breakdown with cavities in the pith.

bacterial ooze, on inoculated stems of potato. Epinasty and wilt of the upper leaves occurred in plants inoculated with the most virulent isolates. The three other bacterial pathogens of tomato were non-pathogenic on potato.

Confirmatory identification—Our limited cultural and pathogenicity tests showed that all nine of our isolates were P. solanacearum. Dr. Arthur Kelman, Department of Plant Pathology, University of Wisconsin, confirmed our identification after he examined four of our isolates.

Survey of tomato fields in Kent County—On six Kent County farms where southern bacterial wilt was present, transplants imported from Georgia were being grown (Table 1). Infection ranged from 1 to 4%, and there was evidence of secondary spread within the row on two farms. Very few plants adjacent to diseased ones became infected later in the season at one farm. At another farm, where secondary spread was considered to be moderate, the disease was mainly confined to a low area, which was flooded several times in June and July. Vaughan (11), too, found that the disease spread more readily in wet, low-lying areas. The diseased plants were removed in July and no further evidence of spread was observed in August and September. Losses caused by the disease were quite small on all farms.

Discussion

With only a few cultural and pathogenicity tests we were able to identify P. solanacearum and to distinguish it from P. tomato, X. vesicatoria and C. michiganense. The tests were easy to perform and gave positive results in 2-10 days.

The sudden collapse of the foliage and the extensive decay of the pith were the symptoms that distinguished southern bacterial wilt from fusarium or verticillium wilts. In addition, it has been shown that the exudate obtained by squeezing the base of diseased tomato stems infected with P. solanacearum is not obtained from plants infected with the fungus-induced wilts (10).

During the past five years, about 80% of the field tomato plants grown in Essex and Kent counties in southwestern Ontario have been imported transplants from Georgia. The disease is of common occurrence in Georgia (2). It has probably been introduced into Ontario on infected transplants in previous years but it was only detected once (4). In 1967, exceptionally warm, wet weather prevailed during June, when the transplants were quite small. Rapid disease development is common under these conditions (2, 6, 11). Conspicuous stunting and wilt occurred during this period, so that by July diseased plants were easily recognized (Fig. 1:A, C).

Table 1. Occurrence of southern bacterial wilt in processing tomatoes imported as transplants from Georgia and grown in fields in Kent County, Ontario, 1967

Location of fields	Infection (%)	Varieties affected	Secondary spread
Lot 2, Conc. 4, Tilbury E. *	4	Campbell 17 and 19	trace
Lot 3, Conc. 3, Tilbury E.	2	Campbell 17 and 19	none
Lot 15, Conc. 4, Dover*	2	Campbell 19 and 24	moderate
Lot 9, 10, Conc. 2, 3, Chatham	1	Campbell 24	none
Lot 4, Conc. 1, Howard	1	Campbell 17 19, 24, 135	none
Lot 14, Conc. 8, Raleigh	1	Campbell 19	none

* P. solanacearum was isolated and identified as the pathogen causing the wilt and internal breakdown symptoms on plants sampled.

Later in the season, diseased plants were not readily detectable because they were overgrown by healthy plants.

Southern bacterial wilt is repeatedly introduced into the northern United States from southern-grown transplants but it has failed to become established and has caused only minor damage to the field tomato crop (10). It has overwintered in field soils as far north as New Jersey (11), but overwintering in Ohio, Michigan, Illinois or Wisconsin has not been demonstrated. We are presently investigating the overwintering potential of the pathogen in southwestern Ontario.

Until proof or disproof of overwintering in southwestern Ontario is obtained, certain precautions should be followed with subsequent crops. No solanaceous crop, especially potatoes, peppers, eggplants, or tobacco, should be grown in tomato fields that had plants infected with southern bacterial wilt the previous season. Diseased plants should be removed and burned when they are first observed. Replants should not be made where diseased plants were located.

Acknowledgments

The authors thank D. K. Thorburn for technical assistance, H. J. Thorpe for taking the photographs, and personnel of the Campbell Soup Company, Chatham, for help in the survey.

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SCREENING OF POTATO FUNGICIDES IN 1967[1]

L.C. Callbeck[2]

Introduction

The weather in Prince Edward Island was generally favorable for the development and spread of potato late blight, Phytophthora infestans (Mont.) de Bary, in the growing season of 1967. At the Research Station, the rainfall of 9.65 inches was well distributed throughout the 13-week period beginning July 1, and recordable amounts were collected for 33 days. In addition, trace amounts were observed on a number of other days. Mean relative humidities of over 80% were recorded for 10 of the weeks and there were many periods of 24 hours or longer in which 90 to 100% readings were recorded. The longest of these was 96 hours. Dews were frequent and often heavy, and these, because of generally low evaporation rates, maintained moisture on the foliage and provided the spores with ideal conditions for germination. Thus the conditions under which the fungicides were screened were the severest in years.

Materials and Methods

The 13 fungicides briefly described below were compared in the 1967 screening test at Charlottetown, P.E.I.

Brestan 60. American Hoechst Corporation, California. A combination of triphenyltin acetate (60%) and maneb (20%). 7 oz/acre.

Cela A-36. Cela, Ingelheim, Germany. Confidential. 7 oz/acre.

Cufram Z. Niagara Brand Chemicals, Burlington, Ontario. Complex containing Zn, Mn, and Cu. 1.5 lb/acre.

Daconil 2787. Diamond Alkali Company, Painesville, Ohio. Tetrachloroisophthalonitrile (75%). 1.0 lb/acre.

Difolatan, flowable. Chevron Chemical (Canada) Limited, Oakville, Ontario. Cis-N- (1, 1, 2, 2-tetrachloroethyl) thio -4-cyclohexene-1, 2-dicarboximide. Product contained 1.0 lb actual per 0.8 Imperial qt and was used at 1.2 qt per acre, giving an acre dosage of 1.5 lb actual chemical.

Difolatan 80 W. Supplier and chemical as above. Used at 1.5 lb/acre, giving an acre dosage of 1.2 lb actual chemical.

Dithane M-45. Rohm and Haas Company of Canada Limited, West Hill, Ontario. Zinc coordinated manganese ethylenebis(dithiocarbamate). Mn, 16%; Zn, 2%. 1.5 lb/acre.

DuTer. Philips-Duphar, Amsterdam, Holland. Triphenyltin hydroxide (20%). 1.0 lb/acre.

Fennite. Fisons (Canada) Limited, Toronto, Ontario. Confidential. 1.5 lb/acre.

Organil 66. Procida, Neuilly sur Seine, France. Confidential. 1.5 lb/acre.

Polyram 80W. Niagara Brand Chemicals, Burlington, Ontario. Zinc activated polyethylene thiuram disulfide. 1.5 lb/acre.

RH-90. Rohm and Haas Company of Canada Limited, West Hill, Ontario. Confidential. 2.4 lb/acre.

Siaprit. S.I.A.P.A., Rome, Italy. Zineb (47%). 3.7 lb/acre.

Plots of the blight-susceptible potato 'Green Mountain' were planted by hand on June 9, 50 seed pieces being dropped in each 50-ft row. Individual plots were 50 ft long by four rows wide and 14 of them were laid out in each of five ranges. Single rows of the same cultivar were planted as buffers between plots and as borders for the area. These rows were not treated with fungicides.

During the first part of the season the experiment was adversely affected by the weather. Precipitations for May and June were respectively 6.23 inches and 5.72 inches, the highest recorded for these months since the station was established in 1909. Fortunately, no rain fell in the first few days of June and it was during this time that tillage, fertilization, and planting were carried out. During the remainder of the month there were periods of heavy rain as, for example, June 15-18 with 1.83 inches and June 21-23 with 2.43 inches. The result was that standing water over a part of the first range caused so much seed-piece decay that this replicate had to be eliminated from the test. The low yields obtained this season were probably caused by the removal of some of the fertilizer through erosion and seepage.

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No insecticides were added to the fungicide mixtures. Instead insects were controlled by spraying the entire area with endosulfan at appropriate times. The fungicides were applied on July 18, 26; August 3, 10, 17, 28; and September 7, 12, at a mean interval of 8 days. The applications were made with a tractor-sprayer unit, which delivered 120 gal/acre.

On July 29, the buffer and border rows were inoculated by sprinkling the foliage with a water suspension of spores produced on cultures of race 1, 2, 3, 4, 5, 6, 7 and race 1, 3, 4, 6, 7, 8. The disease established itself at a moderate pace through August and accelerated rapidly early in September, when showers and intermittent rains prevailed during the first six days of the month. This latter period provided constant ideal conditions for sporulation and germination and made it impossible to spray the plots. The multiplicity of leaf infections during these days was soon manifested by the severe defoliations shown in Table 1. The defoliation of the check plots reached 80% on September 5, and differences in the fungistatic abilities of the test products, under these extreme conditions, became apparent.

The test ended when the plants were sprayed with a sodium arsenite top killer on September 18, 101 days after planting. In the first week of October the crops were lifted, graded, weighed and examined for tuber rot Data are presented in Table 2.

Table 1. Percentage defoliation

Treatment	Sept. 5	Sept. 12	Sept. 15
Brestan 60	14	30	40
Cela A-36	27	58	80
Cufram Z	22	58	68
Daconil 2787	16	38	43
Difolatan, Flowable	12	19	22
Difolatan 80W	17	26	34
Dithane M-45	9	14	18
DuTer	13	46	54
Fennite	22	41	54
Organil 66	9	17	23
Polyram 80W	13	31	41
RH-90	7	14	20
Siaprit	9	25	40
Check	80	100	100

Results and discussion

The fungicides in the 1967 trials were compared under a very severe disease epidemic. After the fourth application, on August 28, spraying was delayed because it rained for several days, and, during this period, the foliage in the treated plots would have been under constant attack by spores from the inoculated rows. Under these severe conditions, Dithane M-45, RH-90, Difolatan (flowable), and Organil 66 gave the best control of foliage blight. The flowable preparation of Difolatan was superior to the 80% wettable powder form; but plots sprayed with the 80W powder received 0.3 lb less of actual chemical per acre per treatment. Plots treated with Difolatans had the smallest percentages of loss from tuber rot. That the unsprayed control showed a lower percentage of tuber rot than seven of the treatments is probably the result of the rapid and early death of its foliage, a phenomenon commonly observed in these tests in years of severe blight attack. The marked effects in the control were the great reduction in yield and the high proportion of small tubers. None of the fungicides showed visible phytotoxic effects.

Table 2. Effect of treatments on yield and rot

Treatment	Total (bu/ acre)	Small (bu/ acre)	Rot (bu/ acre)	No. 1 (bu/ acre)	Rot (%)
Brestan 60	296.1	43.1	4.8	248.2	1.7
Cela A-36	269.5	46.0	4.2	219.3	1.6
Cufram Z	242.2	37.6	15.4	189.2	6.3
Daconil 2787	259.4	31.4	6.4	222.6	2.5
Difolatan, Flowable	296.1	30.6	2.2	263.3	0.7
Difolatan 80W	259.6	35.2	2.0	222.4	0.8
Dithane M-45	314.8	35.2	13.2	266.4	4.2
DuTer	272.6	51.3	9.0	212.3	3.3
Fennite	251.9	35.4	8.6	207.9	3.4
Organil 66	306.2	34.5	11.0	260.7	3.6
Polyram 80W	255.4	33.9	13.6	207.9	5.3
RH-90	317.7	35.4	9.5	272.8	3.0
Siaprit	263.5	34.5	9.7	219.3	3.7
Check	184.4	44.5	5.7	134.2	3.1
L. S. D. 5%	38.1			30.0	2.5
L. S. D. 1%	51.0			40.1	3.4

VIRUS DISEASES OF CEREALS AND POPULATIONS OF VECTORS IN THE CANADIAN PRAIRIES IN 1967[1]

C.C. Gill and P.H. Westdal[2]

These observations are based on weekly surveys during the growing season in south-central Manitoba, and on a survey trip through Saskatchewan and Alberta in the second week of August.

Aster yellows

Although the worst recorded outbreak of aster yellows virus (AYV) on barley was in 1966, the incidence of the disease in 1967 was very low. Only a trace of AYV was observed in two of 40 fields of barley examined in Manitoba, Saskatchewan and Alberta. Both fields were in Saskatchewan, one near Swift Current, the other near Bolney. There was a high incidence of AYV on stinkweed near Bolney, indicating that the virus had overwintered on these plants.

The absence of the disease reflected the very low population of the vector, the six-spotted leafhopper, Macrosteles fascifrons (Stål). The spring migration of this leafhopper into Manitoba occurred late in May, but it was smaller, and about two weeks later, than usual. Nymphal collections on rye and grasses in the spring indicated that there was virtually no survival of overwintered leafhopper eggs. Thus, there were few leafhoppers on cereals during June and July, the period during which leafhoppers are usually abundant and when AYV infection occurs.

Barley stripe mosaic

Barley stripe mosaic virus (BSMV) infections were found in four of 12 barley fields near Lethbridge, Alberta. The incidence of the disease in the four fields was: trace, 1, 20 and 50%. Elsewhere, BSMV was seen in only two of 30 barley fields examined. Both fields were about 25 miles south of Winnipeg, and the incidence of the disease was 10 and 15%.

In all cases the BSMV infections occurred on a two-row variety of barley. Two-row barley was the predominant type grown around Lethbridge, and it is possible that this type is more susceptible to BSMV than the six-row varieties such as 'Parkland', which are grown more extensively in other areas.

BSMV was isolated from all samples collected in fields with BSMV infection, even when symptoms were so slight as to be questionable. It is thus possible that the incidence of the disease may have been higher than indicated.

Barley yellow dwarf

The incidence of barley yellow dwarf virus (BYDV) was low in Manitoba and southern Alberta and negligible in other areas. Ratings for BYDV in commercial fields were as follows: oats, nil in 20, trace in 11, 1% in two, 5% in two, 10% in two, 12% in one and 24% in one out of 39 fields; wheat, nil in 12, trace in 11, 1% in four, 5% in two, and 10% in one out of 30 fields; barley, nil in 25, trace in 11, 1% in one, 2% in one, 5% in two and 10% in one out of 41 fields; durum, nil in one, and trace in one out of two fields.

In Manitoba, BYDV was isolated from samples of cereals and from aphids collected in the field. Many of these isolates appeared to be relatively weak and were transmitted by the greenbug Schizaphis graminum (Rondani) or the corn leaf aphid, Rhopalosiphum maidis (Fitch), or both, but not by the English grain aphid, Macrosiphum avenae (Fabricius), the rose grass aphid, Acyrthosiphon dirhodum (Walker), or the cherry oat aphid, Rhopalosiphum padi (L.). Moderately virulent isolates with a different pattern of transmission by these five species of aphids were also found.

The proportions of field-collected aphids that transmitted BYDV when allowed to feed on oat seedlings were as follows: English grain aphid, 1/452; corn leaf aphid, 1/202; greenbug, 0/199; rose grass aphid, 0/46; cherry oat aphid, 0/21; and the quackgrass aphid, Sipha kurdjumovi Mordvilko (= S. agropyrella Hille Ris Lambers), 0/17.

Oat blue dwarf

Oat blue dwarf virus (OBDV) was not observed in commercial fields of cereals in 1967, although a single plant of wild oats with typical OBDV symptoms was noted. However, when individuals of the vector, the six-spotted leafhopper, collected in the fall from commercial fields of oats and carrots near Portage la Prairie, were allowed to feed on indicator plants in the greenhouse, 4.3% from oats and 2.6% from carrots transmitted OBDV. Similarly 11.2% of migrant leafhoppers collected in the spring transmitted the virus.

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[2] Virologist and Entomologist, respectively.

Host-range studies showed that symptoms of OBDV on many of the susceptible plant species, including the cereals, were mild or absent. This finding may account for the apparent low incidence of diseased plants in the field, despite the high percentage of viruliferous vectors.

Wheat streak mosaic

Wheat streak mosaic virus (WSMV) was found in volunteer winter wheat on the experimental farm at Swift Current, Saskatchewan. This virus was previously reported near Shaunavon, Saskatchewan in 1954 (1).

WSMV was also present on spring cereals in the region around Lethbridge, Alberta. Ratings for the disease in this area were as follows: wheat, nil in three, trace in one, 1% in two, 5% in one, 15% in one and 75% in three out of 11 fields; oats, nil in four and trace in three out of seven fields; barley, nil in nine, and trace in one out of 10 fields; durum, trace in the only field examined.

Other Diseases

A trace of oat necrotic mottle virus was found in one field of oats, about 10 miles west of Winnipeg.

No cereals infected with wheat striate mosaic virus were found this year.

Populations of cereal-infesting aphids

In southern Manitoba, sweeping for aphids on cereals began on 11 May. The first aphids (5 in 400 sweeps) were found on 18 May on winter rye, and all were winged forms of the English grain aphid. Populations were slow to increase in number, probably because May and early June were colder than normal. Thus, on 27 June, only six aphids (all English grain aphids) were collected in 50 sweeps on rye.

The first of the other species of aphids was found on the following dates: corn leaf aphid (one in 100 sweeps) on rye on 14 June; greenbug and cherry oat aphid (eight and one, respectively, in 200 sweeps) on wheat on 27 June; quackgrass aphid (one in 100 sweeps) on wheat on 13 July; and rose grass aphid (23 in 100 sweeps) on oats on 18 July.

During the third week in July there was a sudden marked increase in the numbers of aphids. From 150 to 700 aphids in 50 sweeps were then collected on spring cereals. The size of the populations remained about the same until mid-August, when they began to decline as the crops ripened.

During the last week in July and the first two weeks of August, an estimation of the distribution of aphid populations on cereals across the prairies was made. A total of 59 fields of wheat, oats and barley was swept by net in this period. Sweeping was often supplemented by visual observation. The crops sampled for aphids were between the shot blade and green headed stage.

Populations of the cereal-infesting aphids were largest in south-central Manitoba (Fig. 1). Six species could be found in many fields in this region, but the greenbug and English grain aphid were clearly the most numerous. In southwestern Manitoba and across most of Saskatchewan, aphid numbers were very low but they were slightly higher in Alberta, particularly around Lethbridge and Edmonton.

The English grain aphid was the most widespread species and was often the dominant, and sometimes the only, aphid. The greenbug was found only in the southern and eastern parts of the prairies. This aphid was most numerous in southern Manitoba, where it was often the dominant species or was codominant with the English grain aphid.

The rose grass aphid was not found in the southern part of the prairies except in the Red River valley of Manitoba. Very small populations were found north of a hypothetical line joining Lacombe, Alberta, and Yorkton, Saskatchewan, and the aphid was often the dominant species in the northwestern part of this area. The distribution of the cherry oat aphid was very similar to that of the rose grass aphid, but the cherry oat aphid was usually less numerous. The corn leaf aphid was very scarce and was found in south-central and northwestern Manitoba and around Lethbridge in southern Alberta. The quackgrass aphid was found on cereals only in south-central Manitoba and near Lethbridge.

The western wheat aphid, Brachycolus tritici Gillette, was found infesting heads of durum wheat in experimental plots at Swift Current. It was apparently responsible for causing distortion of the infested heads.

Acknowledgments

We are grateful to Dr. T. G. Atkinson, C. D. A. Research Station, Lethbridge, for his helpful advice regarding wheat streak mosaic, and to Dr. A. G. Robinson, University of Manitoba, for identification of Brachycolus tritici Gillette.

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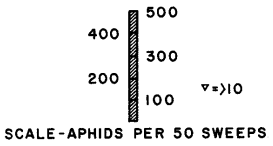
3. CHERRY OAT APHID, Rhopalosiphum padi L.
4. ROSE GRASS APHID, Acyrthosiphon dirhodum (Walker)
5. CORN LEAF APHID, Rhopalosiphum maidis (Fitch)
6. QUACKGRASS APHID, Sipha kurdjumovi (Mordvilko)



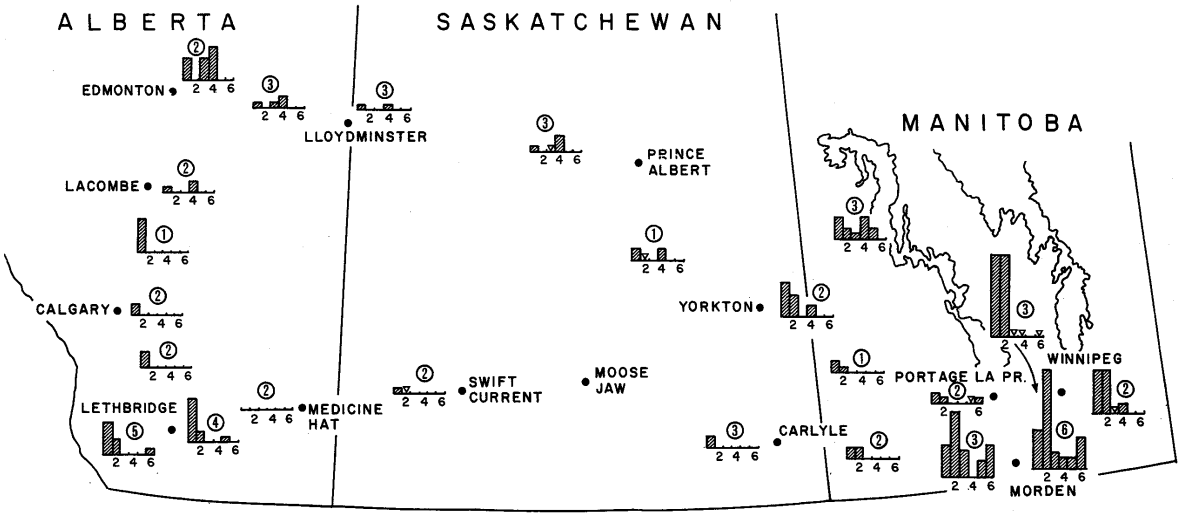


Figure 1. Relative abundance and distribution of six species of cereal-infesting aphids on the Canadian Prairies, 1967. The samples were taken during a 3-week period from 24 July to 14 August. Each histogram represents the average number of aphids collected from one or more fields of wheat, oats, and barley. The number of fields involved for each histogram is shown by the circled numeral.

A SYSTEMIC FUNGICIDE (FUNGICIDE 1991) FOR THE CONTROL OF GRAY MOLD AND POWDERY MILDEW IN STRAWBERRIES AND RASBERRIES

Jack A. Freeman[1] *and H.S. Pepin*[2]

Abstract

Fungicide 1991 (Du Pont), a systemic fungicide, showed considerable potential for the control of gray mold caused by Botrytis cinerea, and powdery mildew caused by Sphaerotheca macularis in strawberries and raspberries. Berry infection by both fungi was practically eliminated in 'Stelemaster' strawberries when the fungicide was applied at 0.25 lb active ingredient/acre. Fungicide 1991 was equally as effective as dinocap and slightly better than sulfur for the control of powdery mildew on the leaves of 'Northwest' strawberries. Repeated applications of Fungicide 1991 at intervals of about 14 days were required to control powdery mildew when the disease was active. Fungicide 1991 proved as effective as captan, dichlofluanid and DAC 2787 for preharvest fruit rot control in 'Willamette' raspberries, and was more effective for postharvest rot control. Dichlofluanid reduced berry size, but captan, DAC 2787, and Fungicide 1991 tended to increase the size.

Introduction

Gray mold caused by Botrytis cinerea Pers. ex Fr. often causes rotting of strawberry and raspberry fruit in coastal British Columbia.

Powdery mildew caused by Sphaerotheca macularis (Wallr. ex Fr.) P. Magn. is also a problem on these crops. This disease is particularly serious during periods of warm day temperatures with heavy dews at night, a common weather condition in the coastal area. Although no precise data on the extent of yield reduction from this disease are available, severely infected strawberry plants are much reduced in vigor, and young canes of raspberries are stunted, somewhat distorted, and spindly. Fruit of both crops may also be infected and, in severe instances, they are covered with a white powdery film. The 'Northwest' strawberry and the 'Willamette' raspberry, the main varieties grown in the coastal area, are susceptible to this disease.

On the basis of earlier research conducted at the Small Fruits Substation, Abbotsford, British Columbia, captan was recommended for the control of gray mold in strawberries and raspberries (1, 2, 3). Even though a captan spray schedule results in a marked increase of sound fruit, there are still many rotted berries in the field. It has been suggested that the incomplete control of botrytis rot with a fungicide such as captan is due to poor coverage or incomplete dispersion of the spray. Therefore, it is probably that with a systemic fungicide this problem could be solved. Captan does not control powdery mildew. Thus, a systemic fungicide that would control both gray mold and powdery mildew would be particularly advantageous.

Experiments were conducted in 1967 with strawberries and raspberries to obtain information on the effectiveness of the systemic Fungicide 1991 (1-(butylcarbamoyl)-2-benzimidazole carbamic acid, methyl ester) for the control of gray mold and powdery mildew.

Methods

Gray mold and powdery mildew on strawberries

Vancouver trial — A field test with 'Stelemaster' strawberries was conducted at the Vancouver Research Station to evaluate the efficacy of Fungicide 1991 for control of gray mold and powdery mildew. The experiment was laid out in a randomized block design with four replicates. A plot consisted of a single 10-ft row with plants grown by the matted row system. Fungicide 1991 at 0.25 lb active ingredient/acre and calcium polysulfide at 0.75 lb active ingredient/acre were applied May 23, June 2, June 13, June 23, and July 4. The amount of berry infection was determined by counting the number of berries with powdery mildew, with botrytis and other rots, and with no infection. These figures were converted to a percentage of the total number of berries.

Abbotsford trial — Fungicide 1991 was compared with dinocap (Karathane) and sulfur (Magnetic 6) for the control of powdery mildew in a field test at the Small Fruits Substation, Abbotsford, A 2-year-old planting of 'Northwest' strawberries was used in this trial. The experiment was laid out in a

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randomized block design. Each plot consisted of a single 30-foot row. The test originally consisted of six replications with the following treatments. Fungicide 1991, 0.25 lb active ingredient/acre, was applied in three different regimes: spraying only once during the season, on July 21; spraying three times at approximately 14-day intervals, on July 21, August 3, and 18; and spraying five times, also at approximately 14-day intervals, on July 21, August 3 and 18, September 1 and 15. This plan allowed for a study of the residual nature of the fungicide. Dinocap, 0.75 lb active ingredient/acre, and sulfur, 3.6 lb active ingredient/acre, were applied three and five times only. All sprays were applied in 180 gal of water/acre.

A random sample of 20 leaves was collected from each plot in each replicate on September 1 and 20 and October 5 to determine the percentage of mildew infection. The total area of mildew infection on each leaf was determined as a percentage and was averaged for each replicate. Percentages were transformed for statistical analysis.

Gray mold on raspberries

Fungicide 1991 was tested at the Small Fruits Substation, Abbotsford, on a first-year crop of 'Willamette' raspberries. The experiment was laid out in a randomized block design with three replicates. Each plot consisted of a single 25-ft row. The plots were grown by the matted row system. Three sprays of each of the fungicides captan, 1.5 lb active ingredient/acre; DAC 2787 (tetrachlorisophthalonitrile), 1.5 lb active ingredient/acre; dichlofluanid (N-(dichlorofluoromethylthio)-N',N'-dimethyl-N-phenylsulfamide), 1.0 lb active ingredient/acre; and Fungicide 1991, 0.25 lb active ingredient/acre were applied. The first sprays were applied June 5, when many of the plants were in full bloom. The follow-up sprays were applied on June 14 and 22. Sprinkler irrigation was used.

Control of preharvest infection was determined by weighing all infected berries from each plot at each picking. The crop was picked six times between July 5 and July 29. In addition to the weights of infected fruit, the weights of marketable and cull fruit were also recorded. The size index of sound berries from each plot was determined at each picking. The effect of treatment on postharvest fruit rot was determined from a random sample of at least 2 lb of sound berries picked on July 6, 11, 18, and 25 from each plot in each replicate. The berry samples were placed in common storage at Agassiz. The percentage of sound berries was recorded 24 and 48 hr after harvest.

Results and discussion

From the results of the Vancouver test, Fungicide 1991 showed considerable potential for control of gray mold and powdery mildew in strawberries (Table 1).

By September 1, at Abbotsford, three sprays of Fungicide 1991 or of dinocap proved equally effective in controlling powdery mildew on strawberry foliage (Table 2). The sulfur sprays were not as effective as either Fungicide 1991 or dinocap. Plants that were sprayed only once, on July 21, with Fungicide 1991 showed a very slight reduction in powdery mildew symptoms by September 1, which indicated that this fungicide does not persist in or on the plant for any appreciable length of time. From the September 20 readings, it is apparent that, in order to control powdery mildew when weather conditions are conducive to the development of

Table 1. Influence of Fungicide 1991 and calcium polysulfide on gray mold and powdery mildew infection of fruit of 'Stelemaster' strawberries

Fungicide	Rate (lb active ingredient/acre*)	Berry infection (%)		Sound fruit (%)
		Gray mold**	Powdery mildew	
Unsprayed	0.25	42.9	14.8	42.2
Fungicide 1991	0.25	6.6	0	93.4
Calcium polysulfide	0.75	45.3	6.1	48.5

* Sprays were applied in 100 gal water/acre on May 23, June 2, June 13, June 23, and July 4.

** Includes some damage from rhizoctonia rot, leather rot, and sun scald.

this disease, any one of the three fungicides must be applied at about 14-day intervals. Fungicide 1991 and sulfur showed no phytotoxicity but dinocap caused some leaf curl and burn. There was no increase in powdery mildew on the leaves after September 20. The weather by this time had become cool and wet, and the disease was no longer active.

Fungicide 1991 proved as effective as the other fungicides for preharvest control of fruit rot in raspberries (Table 3). Even though the incidence of rot in the field was relatively low (about 7%), considerable postharvest rot developed (50%). A relatively high postharvest rot was also reported in raspberries in 1965 (2), when the incidence of fruit rot in the field was 1% or less. In the present test, Fungicide 1991 tended to be more effective than the control of postharvest rot. In a previous test (3) with strawberries, fruit size was affected by treatment with dichlofluanid, which caused a significant

Table 2. Influence of Fungicide 1991, dinocap, and sulfur on control of powdery mildew on 'Northwest' strawberries

Fungicide	Rate (lb active ingredient/ acre)	Number of applications**	Powdery mildew rating* on: Sept. 1	Sept. 20	Oct. 5
Unsprayed			54.1 a***	72.5 a	61.3 a
Fungicide 1991	0.25	1	42.1 b	71.7 a	54.1 ab
Fungicide 1991	0.25	3	15.5 d	53.7 b	50.0 abc
Fungicide 1991	0.25	5		25.7 c	38.6 bcd
Sulfur	3.6	3	27.7 c	58.9 ab	59.9 a
Sulfur	3.6	5		29.9 c	35.9 cd
Dinocap	0.75	3	17.9 d	51.6 b	53.8 ab
Dinocap	0.75	5		34.3 c	28.0 d
Mean			31.5	49.8	47.7
S.E. Mean			2.02	5.09	4.86

* Arcsine transformation of mean percentages of leaf surface affected.

** Sprays applied: 1-July 21;
3-July 21, August 3, August 18;
5-July 21, August 3, August 18, September 1, September 15.

*** Means not followed by the same letter are significantly different at the 5% level (Duncan's Multiple Range Test).

Table 3. Influence of fungicides on preharvest and postharvest fruit rot and berry size of 'Willamette' raspberries

Fungicide	Rate (lb active ingredient/ acre*)	Rotted fruit (lb/plot)	Sound fruit (lb/plot)	Increase over unsprayed (%)	Size index (g/25 fruit)	Sound fruit (%) *** after picking: 24 hr	48 hr
Unsprayed		4.3 a**	54.6 a	0	80.7 bc	70	51
Captan	1.5	3.1 a	63.2 a	15.7	83.3 ab	84	73
DAC 2787	1.5	3.1 a	58.5 a	7.2	85.0 a	87	74
Dichlofluanid	1.0	2.9 a	66.4 a	21.7	78.7 c	91	83
Fungicide 1991	0.25	1.0 b	60.4 a	10.6	84.3 a	97	87
Mean		2.9	60.6		82.4		
S.E. Mean		0.59	3.15		1.03		

* Sprays were applied in 180 gal water/acre on June 5, June 14, June 22.

** Means not followed by the same letter are significantly different at the 5% level (Duncan's Multiple Range Test).

*** Mean of four harvests.

reduction in fruit size. In the present test with raspberries, dichlofluanid also reduced berry size, whereas captan, DAC 2787, and Fungicide 1991 all tended to increase size.

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SOME OBSERVATIONS ON THE INCIDENCE OF ROOT ROT IN BARLEY GROWN UNDER VARIOUS CULTURAL PRACTICES

L. Piening, D. Dew and R. Edwards [1]

It is well known that the root-rot diseases of wheat and barley caused by soil-inhabiting pathogens such as Bipolaris sorokiniana (Sacc.) Shoemaker and Fusarium culmorum (W. G. Sm.) Sacc. are favored more by certain crop sequences than by others.

Crop sequences determine the type and amount of organic matter introduced into the soil, which, in turn, influences the types and numbers of pathogenic and nonpathogenic soil microorganisms. Chemical nutrients also influence the types of microorganisms found (2).

An examination of barley in fields in the Lacombe, Alberta, area in the summer of 1967 suggested that there was more root rot than there had been in the previous two years. Not knowing the reason for this increase in root rot, we decided to make observations on the incidence of root rot in 'Jubilee' and 'Gateway' barley grown in plots for experiments designed to test the effects of various rotations and fertility treatments on grain yields and maturation rates. Although these trials have been in progress since 1911, reference will be made only to the previous treatment in 1966.

The rotations included barley, oats, hay grasses, wheat or corn in 1966. Fertilizers were applied at the rate of 50 lb/acre of 11-48-0 (monammonium phosphate) and 150 lb/acre of 33-0-0 (ammonium nitrate) on stubble or 50 lb/acre of 11-48-0 on fallow land.

Over 100 barley plants in the heading stage were sampled at random from each treatment, and the amount of tissue disintegration and discoloration of the subterranean portions of the plant was noted. On our scale maximum discoloration was rated 5, a trace of infection was rated 1, and no visual infection was rated 0.

The data in Table 1 contradict the general belief that root rot is more common on barley following barley (3). The lower incidence of root rot in 'Gateway' barley growing on barley stubble is hard

Table 1. Incidence of root rot in 1967 on two barley cultivars grown in various rotations, with and without fertilizer

Barley cultivar	Previous treatment	Disease index*	
		With fertilizer**	Without fertilizer
Gateway	Gateway stubble	1.50	2.00
Gateway	fallow	3.46	4.08
Jubilee	fallow	1.00	1.56
Jubilee	breaking (hay)	1.01	1.56
Jubilee	Jubilee stubble	0.89	1.31
Jubilee	wheat stubble	0.90	1.20
Jubilee and bromegrass	wheat stubble	1.83	2.55

* Where 5 represents severe disease and 0 no symptoms.
** On stubble: monoammonium phosphate (11-48-0), 50 lb/acre and ammonium nitrate (33-0-0), 150 lb/acre; on fallow: monoammonium phosphate (11-48-0), 50 lb/acre.

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to explain. Microbial activity in the barley stubble, which received extra nitrogen, may have adversely affected the pathogenic microflora (1).

The beneficial effects of fertilizer in reducing root rot of barley was demonstrated in all the experiments. The effect may have been due to increased vigor of the host, though the effect of mineral fertilizers on the soil microflora must not be ignored. Guillemat and Montégut (2) found an appreciable increase in the growth of soil fungi in fertilized plots when compared with growth in non-fertilized soil.

A generally higher disease index for 'Gateway' barley than for 'Jubilee' might suggest that the former cultivar is more susceptible to root rot. The high disease index of 'Jubilee' barley undersown with bromegrass could be due to the weakening of the barley in competition with the grass for limited moisture. As the summer of 1967 was drier and warmer than usual, these conditions may have predisposed the plants to attack by soil-borne pathogens.

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PLANT-PARASITIC NEMATODE GENERA ASSOCIATED WITH CROPS IN ONTARIO IN 1967

Th. H.A. Olthof[1], *J.L. Townshend*[1], *J.W. Potter*[1] *and H.D. Francis*[2]

The Ontario Nematode Diagnostic and Advisory Service processed 724 soil samples for growers between January 1 and November 1, 1967. A modified Baermann pan method (2) was used to extract actively moving nematodes from soil and roots and the Fenwick can method (1) for the separation of cysts from the soil. Tobacco soil samples far outnumbered all other samples combined. This was partly due to inclement weather conditions resulting in poor growth of the tobacco soon after planting.

Root lesion nematodes, Pratylenchus spp., were present in nearly all the thirty-odd crops investigated. They were present in large numbers in the roots of junipers (Juniperus spp.) and yews (Taxus spp.) and caused severe stunting of the conifers. These nematodes continue to cause decline and replant failures in Ontario orchards. Large numbers were present in soil samples from apple, cherry, and peach orchards. Practically all tobacco soil samples contained root lesion nematodes, averaging 1256/lb of soil. Fumigation against brown root rot of tobacco, which is recommended when the number of root lesion nematodes exceeds 500/lb of soil, has become a widespread practice.

The northern root knot nematode, Meloidogyne hapla Chitwood, was found in several crops, such as cherries, oats, corn, wheat, and tobacco. It is believed that there is a widespread background infestation present in Ontario soils, and that this nematode may become a serious problem when susceptible crops are grown. The nematode was found in 16 tobacco soil samples this year, compared to only one in 1966 and none in 1965. An interesting case of root knot nematode damage was found in ginseng (Panax quinquefolius L.). In one sample, affected ginseng plants showed heavy galling of the roots, accompanied by severe stunting of the plants and bronzing of the leaves.

Cyst nematodes, Heterodera spp., were found in soil samples from several crops. Heterodera avenae Wollenweber, the oat cyst nematode, was found in soils supporting barley, corn, and oats, and H. schachtii Schmidt, the sugar beet nematode, in soils supporting rhubarb and strawberry. Those found in the strawberry field were probably left over from the preceeding rhubarb crop; the source and species of the cyst nematodes found in compost soil were not determined.

Spiral nematodes, Helicotylenchus spp., occurred on many more crops and in larger numbers than in the previous 3 years, whereas the stunt nematode, Tylenchorhynchus spp., was found on approximately the same number of crops but in smaller numbers. Ring nematodes, Criconemoides spp., and dagger nematodes, Xiphinema spp., were only occasionally found. There is good evidence that the extraction method used is ineffective for the isolation of the last two genera and that they may be much more common than the data in Table 1 indicate.

Roots were included in 399 tobacco soil samples and were rated visually for severity of black root rot caused by the fungus Thielaviopsis basicola (Berk. & Br.) Ferr. Black root rot was absent in 32 samples; trace infection occurred in 128, light infection in 132, moderate in 58, severe in 40, and very severe in 9.

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Table 1. Plant parasitic nematodes associated with Ontario crops in 1967

Crop	Praty-lenchus	Paraty-lenchus	Xiphi-nema	Criconé-moides	Helicoty-lenchus	Tylencho-rhynchus	Meloidogyne larvae	Heterodera larvae
Apples (51)*	2010/50**	284/25	24/9	10/5	405/21	0/0	0/0	0/0
Asparagus (2)	150/2	50/2	0/0	0/0	0/0	0/0	0/0	0/0
Barley (5)	216/5	131/3	0/0	0/0	550/2	0/0	0/0	45/1
Beans (1)	<1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Cabbage (2)	36/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Celery (1)	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Cherries (27)	1592/7	990/14	131/6	45/1	273/3	0/0	630/1	0/0
Clover (2)	4167/2	720/1	0/0	0/0	90/1	0/0	0/0	0/0
Compost pile (2)	0/0	4500/1	0/0	0/0	0/0	0/0	0/0	960/1
Corn (51)	2504/51	886/42	0/0	0/0	428/26	86/3	225/1	100/2
Cucumber (2)	1100/1	50/1	0/0	0/0	0/0	0/0	0/0	0/0
Conifers (13)	1469/13	265/4	0/0	0/0	65/2	0/0	0/0	0/0
Fallow (10)	2187/10	232/5	0/0	0/0	327/7	0/0	112/4	0/0
Ginseng (5)	84/4	0/0	0/0	0/0	0/0	0/0	250/1	0/0
Gladiolus (1)	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Grapes (4)	762/4	575/4	45/1	0/0	500/1	0/0	0/0	0/0
Hay (2)	825/2	250/2	0/0	0/0	450/2	151/1	0/0	0/0
Lettuce (3)	270/1	148/2	175/2	0/0	0/0	75/2	0/0	0/0
Oats (11)	738/11	394/11	50/1	0/0	515/8	100/1	100/1	43/2
Onions (2)	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Parsley (2)	0/0	0/0	0/0	0/0	0/0	0/0	54/2	0/0
Peaches (21	5312/21	4093/14	153/5	10/11	453/6	360/1	0/0	0/0
Peat bog (2)	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Potatoes (4)	139/4	150/1	20/1	0/0	0/0	0/0	0/0	0/0
Radish (2)	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Rhubarb (3)	0/0	3615/2	0/0	0/0	0/0	0/0	0/0	850/3
Roses (6)	2025/6	480/2	0/0	0/0	920/2	180/11	250/2	0/0
Rye (2)	540/2	18/1	18/1	0/0	0/0	0/0	0/0	0/0
Strawberries (17)	1043/16	416/10	0/0	0/0	50/1	27/2	15/3	1850/1
Tobacco (458)	1256/444	427/73	72/39	0/0	156/59	133/13	190/16	0/0
Tomato (4)	342/2	0/0	0/0	0/0	0/0	18/2	1370/2	0/0
Wheat (6)	1095/6	270/2	50/1	0/0	72/5	0/0	27/2	0/0
Total samples (724)	1501/674	817/222	77/66	12/17	300/146	89/36	234/35	569/10

* Number of soil samples processed.

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

BROMEGRASS LEAF SPOTS IN SASKATCHEWAN, ALBERTA AND THE PEACE RIVER REGION OF BRITISH COLUMBIA IN 1967[1]

J. Drew Smith[2]

In 1967 the incidence of foliage diseases of smooth bromegrass, Bromus inermis Leyss, was estimated in commercial fields and test plots at several locations. In addition, the reaction of varieties and synthetics of B. inermis and of Bromus spp. was determined with particular reference to brown leaf spot, Pyrenophora bromi (Died.) Drechsl.

Disease survey

Surveys for leaf spots of smooth bromegrass caused by P. bromi, Selenophoma bromigena (Sacc.) Sprague & Johnson, and Rhynchosporium secalis (Oud.) J. J. Davis were made in Alberta and the Peace River region of British Columbia in the first two weeks of July. In Saskatchewan, the severity of these diseases was noted from early June to late August. The association of disease with soil zones previously recorded for Saskatchewan (4, 5) prompted a similar classification for the fields in the present survey (Table 1).

Table 1. Severity of Selenophoma, Pyrenophora, and Rhynchosporium leaf spots of bromegrass in soil zones in Saskatchewan and Alberta and the Peace River region of British Columbia in 1967

Region	Soil zones	Number of locations surveyed	Leaf spot pathogen	Number of locations in each severity class* 4	3	2	1	0
Saskatchewan	Black and gray	49	S. bromigena	0	0	0	10	39
			P. bromi	0	8	11	18	12
			R. secalis	0	0	2	7	40
	Brown and dark brown	33	S. bromigena	0	0	5	23	5
			P. bromi	0	0	0	17	16
			R. secalis	0	0	0	7	26
Alberta and Peace River region of British Columbia	Black and gray	73	S. bromigena	0	0	6	30	37
			P. bromi	0	10	26	26	11
			R. secalis	0	0	5	19	49
	Brown and dark brown	25	S. bromigena	0	0	3	22	0
			P. bromi	0	0	3	3	19
			R. secalis	0	0	0	3	22

* Where 4 represents severe disease and 0 no symptoms seen.

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2 Plant Pathologist.

In Saskatchewan in 1967 few leaf spots were seen on bromegrass before the first week in June, which is two to three weeks later than in 1966. Throughout the growing season, infections were light in the brown and dark brown soil zones and on drought-affected areas on the thin-black and black soils. P. bromi caused slight to moderately severe damage in late July and August in hay and seed crops in some northern areas on black and gray soils.

P. bromi was the dominant leaf spot pathogen of B. inermis on black and gray soils in Alberta and the Peace River region of British Columbia. This was previously found to be the case in Saskatchewan (4, 5). S. bromigena was widely distributed over all soil zones; R. secalis was of sporadic distribution.

Varietal resistance to leaf spot diseases

Bromegrass strains and registered varieties were sown at six centers in different soil zones in Saskatchewan in the spring of 1966. At each center there were four randomized blocks of 16 strains and varieties. Each bromegrass was sown in three rows 3.3 m long and 0.15 m apart. An infector strip 1 m wide of 'Carlton 1961', susceptible to P. bromi and S. bromigena, was sown round each block.

When leaf spot infection appeared to be at its maximum in July or August 1967, at each center, 25 tillers were plucked at random from the middle row of each bromegrass and rated for infection. A 0 to 4 infection scale, in which 0 represents no disease and 4 very severe disease (6), was used. Where more than one disease was present in significant amounts, separate ratings were used for each.

Strains and varieties of bromegrass in hay and seed tests at Beaverlodge and Lacombe, Alberta, were rated for leaf spot infection in early July following sampling for hay yield. These six replicate tests had been sown in 1965.

Table 2. Disease ratings for three leaf spot pathogens of smooth bromegrass grown at six locations in 1967

Bromegrass		Pyrenophora bromi						Rhynchosporium secalis			Selenophoma bromigena
		Saskatchewan				Alberta					
Variety or strain	Type[a]	Big River	Nipawin	Loon Lake	Av.[b]	Beaverlodge	Lacombe	Nipawin	Loon Lake	Av.[c]	Unity, Sask.
Carlton 1961	N	1.99[d]	1.67	1.48	1.71	1.47	1.59	0.19	0.35	0.27	1.33
Common	N	1.81	1.44	1.58	1.61	1.17	1.36	0.28	0.36	0.32	1.47
Brandon 1000	NS	1.55	1.67	1.25	1.49		1.33	0.25	0.61	0.43	1.30
Manchar	N	1.66	1.41	1.21	1.43			0.17	0.33	0.25	1.39
Brandon 988	NS	1.56	1.52	1.09	1.39		1.43	0.18	0.32	0.25	1.20
S-6733 Syn 1	NS	1.66	1.29	1.21	1.38			0.27	0.20	0.24	1.05
Brandon 1065	NS	1.61	1.44	1.02	1.36		1.47	0.26	0.32	0.29	1.24
S-6733 Syn 2	NS	1.64	1.33	1.05	1.34			0.27	0.20	0.24	1.23
S-6324 Syn 2	N	1.74	1.32	0.97	1.34	1.01	1.28	0.24	0.21	0.23	1.16
Redpatch	S	1.49	1.28	1.11	1.29	0.67	1.31	0.33	0.44	0.39	1.14
S-6363 Syn 2	S	1.37	1.41	1.00	1.26		1.20	0.10	0.21	0.16	1.14
B.S.G. 1	S	1.49	1.28	0.99	1.25			0.31	0.31	0.31	1.19
Saratoga	S	1.29	1.46	0.97	1.24		1.17	0.10	0.44	0.27	1.27
Magna	S	1.27	1.47	0.97	1.24	0.54	1.46	0.17	0.12	0.15	1.16
Brandon 987	S	1.36	1.25	0.90	1.17		1.32	0.22	0.28	0.25	1.25
Lincoln	S	1.09	1.23	1.07	1.14	0.55	1.31	0.18	0.16	0.17	1.09
Average		1.54	1.40	1.12		0.90	1.35	0.22	0.30		1.23
L.S.D. 5%		0.05	0.05	0.06		0.04	0.05	0.20	0.28		0.05
1%		0.06	0.06	0.08		0.05	0.07	0.27	0.37		0.06

[a] N = northern type; S = southern type

[b] r = +0.711

[c] r = +0.029

[d] Average disease severity rating of 100 (25 per replicate) plants where 4 represents very severe disease and 0 no disease.

There was insufficient disease at Saskatoon and Melfort for reliable ratings to be made.

At the Saskatchewan centers, southern strains had generally lower ratings for P. bromi than northern strains (Table 2). Northern-southern hybrids occupied an intermediate position in disease rating. Although there was good correlation (r = 0.711) between variety ratings for P. bromi at the three Saskatchewan centers, there was some variation in response of varieties at each center. This variation may have been due to either interference from R. secalis, which was present in rateable amounts at Nipawin and Loon Lake, or to different physiological races of P. bromi at each center. The levels of infection by P. bromi in the tests at Big River and Nipawin were higher than those at Loon Lake; the greater incidence was probably due to abundant external inoculum from adjacent large fields of infected common and 'Carlton' bromegrass. There were no bromegrass fields close to the Loon Lake test. The test at Big River, where there was the most infection, and the test at Loon Lake, with the least infection, were on gray woodland podzol. The test at Nipawin, which showed an intermediate amount of infection, was on a dark gray soil in the parkland-forest transition.

Although present in rateable amounts in the Nipawin and Loon Lake tests, infection by R. secalis was light on most varieties. There was no consistent varietal response to infection with R. secalis in the tests. This was confirmed by the lack of significant differences in each test and by the very low correlation (r = 0.029) between ratings at the centers (Table 2).

Ratings for P. bromi on bromegrass varieties at Beaverlodge and Lacombe, Alberta, are not directly comparable with those at the three Saskatchewan centers because of differences in the age of stand, time of rating, and trial layout. At Beaverlodge there was significantly more P. bromi on the northern 'Carlton' than on the southern bromegrasses. At Lacombe 'Saratoga' showed the lowest incidence of P. bromi. 'Lincoln' did not excel at this center as it had done at others (Table 2).

At Unity, Saskatchewan, on dark brown soil, where S. bromigena was the only pathogen present in sufficient amount for reliable rating, S-6733 Syn 1, 'Lincoln', 'Redpatch', S-6363 Syn 2, and S-6324 showed significantly less spotting than northern common bromegrass, 'Manchar', and 'Carlton 1961'. The former strains were reported by Smith and Knowles (6) to be resistant to this pathogen at Saskatoon (Table 2).

Resistance of four synthetics of B. inermis and of five Bromus species to P. bromi

Four greenhouse synthetics of smooth bromegrass were made in the winter of 1966-67:

S-7222 44 plants, previously shown in greenhouse infection studies to be resistant to S. bromigena, from the northern type S-6342 Syn 2.

S-7269 25 plants from the northern-southern hybrid S-6733 Syn 2 with high resistance to S. bromigena in greenhouse and field tests.

S-7270 33 plants of northern common, with a low incidence of P. bromi, from heavily infected bromegrass fields at Big River, Saskatchewan.

S-7271 57 plants of northern and southern strains of bromegrass, with low P. bromi ratings, from Indian Head, Saskatchewan.

Plants from these synthetics were put out in rows of 20 at 0.92 m spacing. There were three replications of each strain with three interplanted check rows of 'Carlton 1961' and S-6733 Syn 2 bromegrass. Planting was done in May 1967 at Big River, Saskatchewan, in a half-acre test plot in a field of common bromegrass which later showed heavy natural infection with P. bromi.

Average ratings for the four synthetics and two check varieties in early September ranged from 1.10 (S-7269) to 1.52 (S-7270). Although differences between ratings were not significant, seven plants of S-7269 showed no apparent infection with P. bromi. All other plants were infected.

Twenty plants of each of five introduced Bromus spp. were planted in single rows in the same location as the test of synthetics. In early September, average ratings for P. bromi infection for these were: B. variegatus (OT 1927-9845), 0.10; B. syriacus (OT 1927-9840), 0.33; B. erectus (S-1172), 0.38; B. erectus (OT 1927-8651), 0.44; B. macrantherus (OT 1927-9833), 2.0. Sixteen plants of B. variegatus showed no infection with P. bromi; all plants of B. macrantherus were infected.

With the exception of B. macrantherus all introduced Bromus spp. showed considerably less infection than the B. inermis strains. B. erectus (S-1172) showed useful agronomic characters. B. variegatus (OT 1927-9845), with the lowest disease rating, was a small low-growing perennial. B. erectus (OT 1927-8651) was less robust in growth habit than B. erectus (S-1172). The former, introduced from Minsk, USSR, and B. syriacus (OT 1927-9840) fall taxonomically into the B. tyttholepis complex of species of Nath and Nielsen (4). Introgression between B. tyttholepis and B. inermis has been reported (3) and hybrids between B. erectus and B. inermis have been produced (1). The wide range in chromosome number and meiotic behavior in material distributed in North America as "B. erectus"

was considered by Hanna (2) as perhaps due to interspecific hybridization in nurseries in which Bromus spp. were grown.

It may be possible to combine in hybrids the superior resistance to P. bromi of "B. erectus" or of members of the B. tyttholepis complex with the best agronomic features of selected strains of B. inermis. B. macrantherus, being very susceptible to P. bromi, may be a useful indicator of inoculum potential in field test areas.

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BRIEF ARTICLES

OBSERVATIONS ON SCLEROTINIA ROT OF FIELD BEANS IN SOUTHWESTERN ONTARIO AND ITS EFFECT ON YIELD

V.R. Wallen and M.D. Sutton[1]

Since 1923, cottony soft rot of beans caused by Sclerotinia sclerotiorum (Lib.) deBary has been reported from all provinces except Newfoundland (1). Most of the reports have been concerned with the presence of the disease on garden beans, but a few reports have been concerned with the disease on canning and field beans. Estimates of the number of infected plants ranged from a trace to 100%. Even total crop destruction has been reported.

In 1967, surveys during August of the field bean crop in southwestern Ontario showed that this disease was again present. At the time of inspection, pods were fully formed. Estimates of infected plants were made on 21 foundation plots ranging in size from 1 to 1.75 acres. Two varieties, 'Sanilac' and 'Seaway', were involved.

Six plots on high well-drained land were free from S. sclerotiorum. Seven plots contained a trace of infection to 10% infected plants, and most of these plots showed infection in small shaded or low-lying areas. The remaining plots, which were mainly on low very moist land, contained up to 50% infected plants. The moist conditions resulted in dense foliage and a microclimate conducive to infection and spread of the pathogen.

Disease intensity on individual plants did not vary greatly, and most pods on infected plants were a total loss.

Yields varied from 19.4 bu/acre in a plot in which 50% of the plants were infected to 35 bu/acre in one of the healthy plots. The average yield from the six healthy plots was 30.8 bu/acre compared with 24.3 bu/acre for the eight plots in which 10 to 50% of the plants were infected. Plots that contained a trace of infection to 10% infected plants yielded an average of 28.2 bu/acre.

Although plots varied as to soil type, available nutrition, and moisture, infection was general throughout the bean-growing area, and the results indicated that this disease was of considerable economic importance. Although the fungus does not damage the plant until pod formation, infected plants usually produce little or no seed because the pods become completely rotted.

Literature cited

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[1] Plant Pathologists, Cell Biology Research Institute, Canada Department of Agriculture, Ottawa, Ontario.

THE OCCURRENCE OF FUSARIUM YELLOWS OF CABBAGE IN ONTARIO IN 1967

Andres A. Reyes[1] *and Charles A. Warner*[2]

Apparently there are no recent records of the occurrence in Ontario of fusarium yellows of cabbage caused by Fusarium oxysporum Schlecht. f. conglutinans (Wr.) Snyd. & Hans. During extensive surveys of diseases on vegetable crops in this province in 1967, this disease was observed in 5 of 24 fields of early-heading cabbage. On June 15, in Norfolk County, one field was observed with a trace infection (10% of the plants affected). On June 22, in the Burlington area of Haltan County a severe infection (95% of the plants affected) was encountered in one field and a slight infection (15% of the plants affected) in two fields. On June 29, a slight infection was observed in one field in the Holland-Bradford Marsh.

According to growers, fusarium yellows has been present in the Burlington area for at least 5 years, but it has not been as widespread as noted this year. June was dry with daytime temperatures ranging up to 90° F. These weather conditions are considered to be favorable for the development of this disease.

The common symptoms of the disease were stunting, yellowing, and shedding of the leaves (Figure 1). Affected leaves were usually twisted and, when cut crosswise, a brownish discoloration of the vascular tissues of the midrib was observed. The causal fungus was readily isolated from these brownish vascular tissues.

Varieties affected included Market Topper, Wisconsin Golden Acre, Emerald Cross, Early Marvel, and Copenhagen Cross. Market Topper and Wisconsin Golden Acre are considered to be resistant to this disease.

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Figures 1 and 2. Symptoms of fusarium yellows in Wisconsin Golden Acre cabbage. Figure 1. Incidence of stunted plants in the field. Figure 2. Leaf symptoms. (Photographs by T.R. Davidson)

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CORRECTION. Vol. 47, No. 2, Contents, item 2: for 1965 read 1966.