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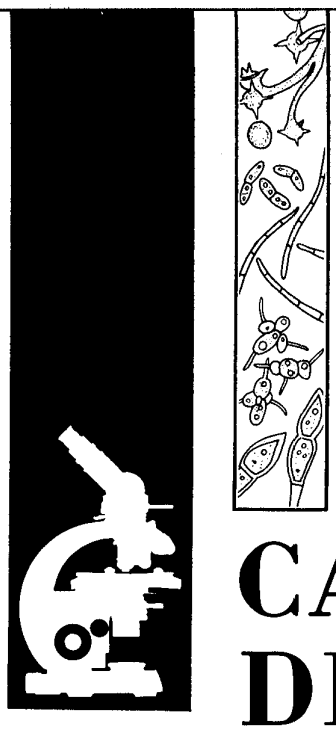
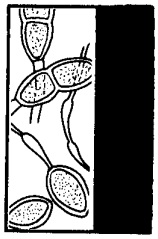


CANADIAN PLANT DISEASE SURVEY



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CANADIAN PLANT DISEASE SURVEY

RESEARCH BRANCH CANADA DEPARTMENT OF AGRICULTURE

CONTENTS

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

STRESSES AFFECTING BARLEY GROWTH IN CANADA[1]

J. T. Mills and A. Tekauz

Abstract

Stresses affecting barley growth and quality in Canada and cultivar resistance and susceptibility to these stresses are summarized. Information was obtained by questionnaire from barley pathologists, breeders, soil scientists, and extension personnel in industry, universities, and provincial and federal governments. Considerable information is known on cultivar reactions to diseases but inadequacies exist concerning the response of cultivars to edaphic and climatic effects, particularly those of nitrogen and of heat and moisture during flowering and filling of the grains. A list of indicator-standard cultivars susceptible or resistant to particular stresses is presented for use with field trials and for investigating crop failures.

Résumé

On trouvera au présent rapport un résumé des agressions qui influent sur la croissance et la qualité de l'orge au Canada, de même que de la résistance et de la sensibilité de ses cultivars à ces agressions. Cette information provient de questionnaires adressés à des pathologistes et des sélectionneurs de l'orge, des pédologues et des vulgarisateurs du secteur privé, des universités et des gouvernements fédéral et provinciaux. On sait beaucoup de choses sur les réactions des cultivars aux maladies, mais il existe encore des lacunes concernant leurs réactions aux effets édaphiques et climatiques, en particulier ceux de l'azote, de la chaleur et de l'humidité durant la floraison et le remplissage du grain. On trouvera une liste des cultivars servant d'indicateurs, sensibles et résistants aux agressions particulières, et qui doivent servir aux essais en plein champ et aux enquêtes sur les mauvaises récoltes.

A biologic stress may be defined as any environmental factor capable of inducing a potentially injurious strain in living organisms (4). Barley is subject to many climatic, edaphic, biotic, and other stresses which adversely affect its growth, yield, and quality. This is particularly so in Canada because of the wide variation in climate and soils in the areas in which it is grown. Barley workers across Canada are familiar with particular stresses affecting the crop in their own areas and with varietal response to these stresses, but some of this information has not been published or widely circulated. Because of the importance of stresses in breeding, pathology, and quality, information on stresses was collected by means of a postal survey of barley workers across Canada in industry, universities, and federal and provincial governments. The 55 respondents included barley breeders, pathologists, soil scientists, brewers and maltsters, field extension personnel, and administrators. The information received is summarized in four sections: nature of the stresses and their geographical occurrence, varietal response to stresses, use of stress data to maximize barley production and quality, and suggestions for further work.

Results and discussion

1. The main stresses affecting barley growth in Canada

Stresses affecting barley growth for the purposes of this study were placed in five main categories: climatic, edaphic and atmospheric, biotic, physiologic, and those caused by applied chemicals. Lists of stresses in each of the five main categories were given on the survey forms, and respondents were asked to indicate which were the most important stresses affecting barley growth and yield in their area in most years. Replies received are summarized in Table 1.

On a regional basis, tendencies to certain types of stress are apparent. These include soil acidity in northern Alberta and

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Table 1. Stresses that affect barley growth in Canada, their present regional importance and cultivar susceptibility and resistance

Growth stress	Region affected*				Cultivars**	
	Park Belt	Prairies	Central	Maritimes	Susceptible	Resistant
Climatic						
1 Spring frost	A,B,F		I	N,O		
2 Fall frost	A,B,C,F	G	I	O		
3 Heat at emergence						
4 Heat at heading	H	E,H			Olli	Conquest, Palliser
5 Drought	A,H	D,E,G,H			Husky	Galt, Palliser
6 Excess moisture	H	G,H	I,J,M	N	Galt	Centennial
7 Hail	C					
Edaphic & atmospheric						
8 High alkalinity						Pallidum, California Mariout
9 High acidity (low pH)	A		J,M	N	Herta, Husky	Volla, Gateway
10 Aluminum toxicity	A		J		Herta	Volla, Trebi
11 Sulphur dioxide						
12 Ozone						
13 Nitrogen deficiency	A,B,H	H			Fergus	UM 6451
14 Nitrogen excess						
15 Phosphorus deficiency						
16 Potassium deficiency						
17 Minor element deficiency						
Biotic						
A) Diseases						
18 Stem rust					Betzes	Bonanza
19 Leaf rust					Bonanza	Wisc H379-2
20 Covered smut					Odessa	Galt
21 False loose smut					Odessa	Galt
22 Loose smut			J		Regal	Bonanza, Trebi
23 Common root rot	A,B,C,H	D,E,H		O	Galt, Olli	Bonanza
24 Spot blotch	A,H	H	J	O	Galt	Br X6D-33
25 Net blotch	A,B,C,H	H		O	Betzes	CI 5791
26 Speckled leaf blotch					Bonanza	65-593
27 Scald	A,B,C				Bonanza	BT 609, Keystone
28 Powdery mildew			J		Bonanza	Trent
29 Bacterial blight						
30 Stripe mosaic					Black Hulless (CI 666)	Moreval
31 Yellow dwarf	H	H	M	O	Herta	CI 5791
32 Aster yellows					Herta	none
33 Oat blue dwarf					62-528	none
34 Ergot					Herta	none
35 Neck break		E	K	N	OAC 21	Centennial
36 Seedling blight				N		
B) Fauna						
37 Thrips						Herta
38 Aphids	H	H				OAC 21
39 Mites					OAC 21	Gem
40 Cereal leaf beetle						
41 Grasshoppers	H	H				
42 Nematodes			L		Herta	Sabarlis
C) Weeds						
43 Weeds	A,B	E,G				
Physiologic+						
44 Lodging	B,H	E,H	I,J,M	N	Betzes, OAC 21	Centennial
45 Shattering		E		N	Montcalm	Centennial
46 Discoloration					Bonanza	Conquest
Chemical						
A) Herbicide						
47 Carbyne					Herta	
48 2,4-D					Unitan	
49 Bromoxynil					Charlottetown 80	Olli
50 Atrazine residues from previous corn crop						
B) Insecticide						
51 Insecticide						
C) Fungicide						
52 Fungicide						
Other						
53 Late seeding					Herta, Olli	Trent, Conquest

* A = Beaverlodge, Alta.; B = Edmonton, Alta.; C = Lacombe, Alta.; D = Lethbridge, Alta.; E = Saskatoon, Sask.; F = Melfort, Sask.; G = Regina, Sask.; H = Winnipeg and Brandon, Man.; I = Kapuskasing, Ont.; J = Ottawa, Ont.; K = Guelph, Ont.; L = Vineland, Ont.; M = Ste. Foy, P.Q.; N = Truro, N.S.; O = Charlottetown, P.E.I. Blanks indicate that a particular stress is either not present in a region, is not recognized, or is only a potential threat due to successful breeding programs or improved management practices.

** Selected either because of multiple listings by respondents or because of the expertise of a respondent working with a particular stressing agent. Blanks indicate a lack of information on cultivar response to the particular stress.

+ Items 44-46 are actually the visible effects of physiologic stresses.

Table 2. Barley growth stress symptoms and their probable causes

Plant part and symptoms	Cause*
Young leaves	
horizontal bands of damaged tissues	heat, spring frost
Young plants	
pale yellow	spring frost
brown streaks on leaves	seedling blight
dwarfed, few tillers, leaves pale-yellow green	nitrogen deficiency
dwarfed, few tillers, leaves dark-blue green	phosphorus deficiency
dwarfed, excessive tillering, leaf scorch	potassium deficiency
Leaves	
brown spots	net or spot blotches
scalded appearance	scald, some herbicides
V-, inverted V-, W-shaped brown streaks	barley stripe mosaic
white, powdery areas	mildew
white, chlorotic areas	sulphur dioxide (3), roadside salt
water-soaked areas, bacterial ooze	bacterial blight
darkening, yellowing, wilting from tip	mites
Leaves and stems	
pale brown areas with black spots	speckled leaf blotch
purplish tints	phosphorus deficiency
red-orange or black raised areas	rusts
Sub-crown internode, crown	
brown areas or brown spots	common root rot
Whole plant	
yellowing	barley yellow dwarf, aster yellows, oat blue dwarf, excess moisture, nitrogen deficiency, drought, mites
yellow, red and purple tinting	wireworms, cutworms, drought
thin, wiry stems	salinity
fallen	lodging, excess moisture, hail
defoliation	grasshoppers, armyworms
Stems	
broken	lodging, neck or stem break
Heads	
black spores filling or on heads	loose, false loose, covered smuts
black projecting bodies	ergot
distortion	aster yellows, hail, 2,4-D
disintegration	shattering
tips of awns white, banded	sulphur dioxide
unfilled individual grains	thrips
kernels black, brown	staining, weathering, black point
kernels shrunken	fall frost, lack of moisture
heads small	nitrogen, phosphorus deficiencies
grain formation poor	potassium deficiency

* For more detailed descriptions of disease symptoms see (1) and of nutritional deficiencies, which are much less clearly seen and complicated by other stresses in older plants, see (8).

eastern Canada; length of growing season in northern Alberta, northern Saskatchewan, and northern Ontario; moisture, wild oats, and common root rot in the Prairie Provinces; neck break in southern Ontario; and cold wet springs, soil acidity, and seedling blight in Quebec and the Maritimes. These tendencies reflect regional differences and similarities in soil type, rainfall, and number of frost free days (2). Common root rot, neck break, and seedling blight are diseases caused by the fungus Cochliobolus sativus (Ito & Kurib.) Drechsl. ex Dastur. The soil-borne phase of the disease is favored by conditions in western Canada and the aerial phases by the wetter conditions of eastern Canada.

In local regions growth can be adversely affected by a large number of stresses (Table 1). The stresses listed reflect those that are important in most years because resistant varieties are not yet available, because of difficult management practices, or because of

climatic factors beyond human control. Some stresses, e.g. stem rust, are at present only potential threats due to successful ongoing breeding programs and thus probably have not been emphasised by respondents (Table 1).

When emerging from the soil young plants can be damaged by heat or by spring frost. Seedling blight and herbicide damage can reduce the photosynthetic area of the young leaves, and excessively moist or saline conditions severely restrict growth. Barley leaves are affected by many diseases, including spot blotch, net blotch, scald, powdery mildew, rusts, stripe mosaic, and yellow dwarf. Aphids, grasshoppers, root rot, and lodging can all seriously reduce yields of older plants. Loss of grain or reduction in grain size and quality can occur through the action of hail, smut, aster yellows, thrips, shattering, staining, weathering, and late frosts.

A simplified outline of stress symptoms is given in Table 2. Symptoms of some stresses are not documented, e.g. heat and moisture stress at flowering and filling of the grain. Also some symptoms, e.g. yellowing, are common to several stresses and may mask or modify others.

Apart from the five main types, stresses also occur through poor management practices. To obtain good barley yields the crop should be sown early in moist, well drained soil with optimal fertilization. Rapid early nitrogen uptake is essential for good yields (6) and any interference through bad management practices, e.g. by deep or delayed seeding, poor fertilization, poor drainage or poor weed control, will reduce growth and yields. Furthermore, late-seeded crops are more likely to be affected by aphids, barley yellow dwarf, ergot, staining, weathering, and fall frost, which will result in either a further loss in yield or of quality. Poor management practice, particularly inadequate fertilization, is probably the single most important factor adversely affecting barley yields in Canada today.

2. Varietal response to barley stresses

Each respondent was asked to submit the name of a cultivar known to be highly resistant or susceptible to a particular stress. Since a major proportion of the questionnaires were sent to agricultural scientists, it is probable that most selections were based on experimental results. These replies are also summarized in Table 1. Some indicators for particular stresses were well defined as they were chosen by several workers; others were mentioned once. For some stresses no information on indicator cultivars was received, showing that either these stresses are not important or are not recognized.

From the data in Table 1, a list of 10 susceptible indicator cultivars (Table 3) was chosen to delimit selected growth stresses in Canada. The usefulness of such a series of indicator cultivars is described below in Sections 3B and C.

3. Use and importance of stress data to maximize barley production and quality

The survey data obtained are useful in:
A) Assisting barley workers in recognizing the symptoms and the relative importance of stresses and in giving them an overall awareness of the important factors affecting barley quality and yield.

B) Choosing susceptible cultivars to determine the occurrence of stresses in field trials and in areas of frequent crop failures. These susceptible cultivars could also be used as standards against which the reactions of test cultivars could be compared on a year-to-year basis. Preliminary trials with such indicator-standards have already shown promise in Manitoba (J. T. Mills and A. Tekauz, unpublished data).

C) Investigating the effects of specific stresses on yields, e.g. common root rot. By using indicator cultivars to determine the presence or absence of other stress factors, the effects of a single factor such as root rot, when other stresses are found to be absent, can be obtained more precisely. This could enable a more accurate assessment of the individual causes behind crop losses.

D) Maximizing quality. Some information was obtained on differences in susceptibility of cultivars to staining and weathering but none to fall frosts. Cultivars should be evaluated for these factors as they are important in determining quality.

E) Determining gaps in our knowledge of stresses. Considerable information exists on response to many diseases, but more information is needed on cultivar response to N, P, and K levels, to alkalinity, air pollutants, spring and fall frosts, to heat and drought at flowering and filling of the grain, to staining and weathering, and to thrips, aphids, and grasshoppers. In some instances the symptoms of these stresses, e.g. drought at flowering, are not adequately described.

4. Suggestions for further work

A) Cultivar response to nitrogen - This could be determined by sowing selected cultivars in soils containing different known levels of nitrogen and comparing the resulting yields. Nitrogen determinations for developing leaves, stems, heads, and kernels should be made, and experiments on the rate of nitrogen transfer from leaves to heads should also be carried out.

Table 3. Susceptible indicator cultivars for delimiting some growth stresses occurring in Canada

Susceptible cultivar	Biotic stresses	Climatic, edaphic, and physiologic stresses
1 Betzes	Stem rust, net blotch	Lodging
2 Bonanza	Leaf rust, speckled leaf blotch, scald, powdery mildew	
3 Odessa	Covered smut*, false loose smut*	
4 Regal	Loose smut*	
5 Galt	Common root rot, spot blotch	Excess moisture
6 Herta	Aster yellows, barley yellow dwarf, ergot, nematodes	High acidity, aluminum toxicity
7 Husky		Drought, high acidity
8 Fergus		Nitrogen deficiency
9 OAC 21		Lodging, neck break
10 Montcalm		Shattering

* Presence of smut can only be determined by sowing harvested seed and examining resulting heads.

B) Cultivar response to heat and moisture at flowering and filling of the grain - Selected cultivars could be subjected to different soil moisture levels and temperatures during flowering and filling of the grain. Kernel weights and other quality parameters, e.g. starch enzymes, could then be determined during growth and maturation (5).

Two recent reports support the importance and need for working on environmental stresses:

1. The recommendations of the Committee on Genetic Vulnerability of Major Crops, Washington, D. C. (7), state that a) non-specific characteristics of wheat (barley) that render the crop less subject to damage from biotic and environmental hazards should be investigated; and b) preoccupation with diseases and insects may have led to lack of concern for vulnerabilities to environmental stresses and other hazards of wheat (barley) production.

2. Environmental stresses were observed by farmers in 815 fields in Manitoba during 1972 as reported in a postal survey conducted by the Provincial Soils Testing Laboratory, Manitoba Department of Agriculture. Nitrogen and drought stresses were severe, while damage from excess moisture, visible diseases, hail, and frost were less frequently reported (Table 4).

In conclusion results of the survey indicate that there is a lack of information on cultivar response to many environmental stresses. It is considered that additional information in this area may be helpful because of the importance of these stresses to growth, quality, and yield.

Table 4. Stresses reported by farmers in 815 fields in Manitoba, 1972

Stress	No. of fields with stress			
	None	Light	Moderate	Severe
Nitrogen*	177	305	199	134
Drought	316	211	246	42
Excess water	735	38	37	5
Disease	732	56	22	5
Frost	757	27	24	7
Hail	786	14	9	6
Other**	644	53	108	10

* Nitrogen stress computed in laboratory; based on results from soil tests to determine NO_3-N levels plus amount of fertilizer added by farmer.

** Includes weeds.

Acknowledgments

The authors wish to acknowledge the 55 barley workers across Canada who filled in the survey forms. We regret that the number of persons involved precludes individual acknowledgement.

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OVERWINTERING OF ERYSIPHE GRAMINIS F. SP. TRITICI ON MARITIME GROWN WINTER WHEAT[1]

H. Winston Johnston[2]

Abstract

Primary infection of winter wheat (Triticum aestivum) by Erysiphe graminis f. sp. tritici was observed to take place in October. The pathogen was capable of overwintering as conidia on the leaves providing the host did not winterkill. The recommendation is made that varieties of winter wheat resistant to powdery mildew should be available before any increase in winter wheat acreage occurs in the Maritime Provinces.

Résumé

On a constaté que l'infection primaire du blé d'hiver par Erysiphe graminis f. sp. tritici survenait en octobre. L'organisme pathogène a pu hiverner sous forme de conidies sur les feuilles, pourvu que l'hôte n'était pas détruit par l'hiver. On recommande que des variétés de blé d'hiver résistantes au blanc soient rendues disponibles avant qu'on envisage une augmentation des superficies en blé dans les provinces Maritimes.

Powdery mildew of wheat (Triticum aestivum L.) incited by Erysiphe graminis DC. ex Merat f. sp. tritici Marchal has existed in eastern Canada for many years and is one of the major diseases on both spring and fall seeded wheat in the Maritime Provinces (3, 4, 9). Investigators in both Europe and North America have reported the overwintering of E. graminis as conidia on winter barley and on winter wheat (8, 11), but contradictory reports are also present (6). Several European authors have reported that ascospores discharged in spring from overwintered perethecia are largely ineffective in inciting primary infections and that overwintering conidia may be the more effective incitant (7, 12, 17).

Simultaneous cultivation of winter wheat and spring wheat in the same locality may provide an ideal environment for severe outbreaks of powdery mildew if the pathogen utilizes the autumn seeded wheat as a 'green-bridge'. Large amounts of inoculum produced on winter wheat in the spring may enhance disease severity in spring sown wheats, as has occurred with winter and spring barleys in Europe (8). The purpose of the studies described herein was to determine if fall sown wheat was serving as an overwintering host for powdery mildew in Prince Edward Island and thus perhaps increasing the disease severity on wheat seeded the following spring.

Materials and methods

Observations on the overwintering of the pathogen were carried out for 3 years on winter wheat, cultivar Yorkstar, which was sown by September 15 of each year near Charlottetown, Prince Edward Island. Initial collections of winter wheat leaves were made in early October and sampling was continued bi-weekly until mid-April of the following year. The wheat leaves collected were subjected to a 2-hour thawing period at room temperature, and were then placed on 2% water agar. On removal of the leaves, the viability of the conidia remaining on the agar was assessed by the percent germination after incubation for 48 h. For each determination of viability 4 counts of 50 spores were used. A conidium was considered to have germinated if the germ tube was equal in length to the width of the spore after 48 h on agar. Only single isolated spores were considered.

In the summers of 1971, 1972, and 1973, the severity of mildew was assessed on a number of spring wheat cultivars at Charlottetown, P.E.I., and Kentville, N. S., by estimating the percent area of the flag and second leaves mildewed at the milky ripe stage of development. These estimates were then compared to winter survival data of the wheat.

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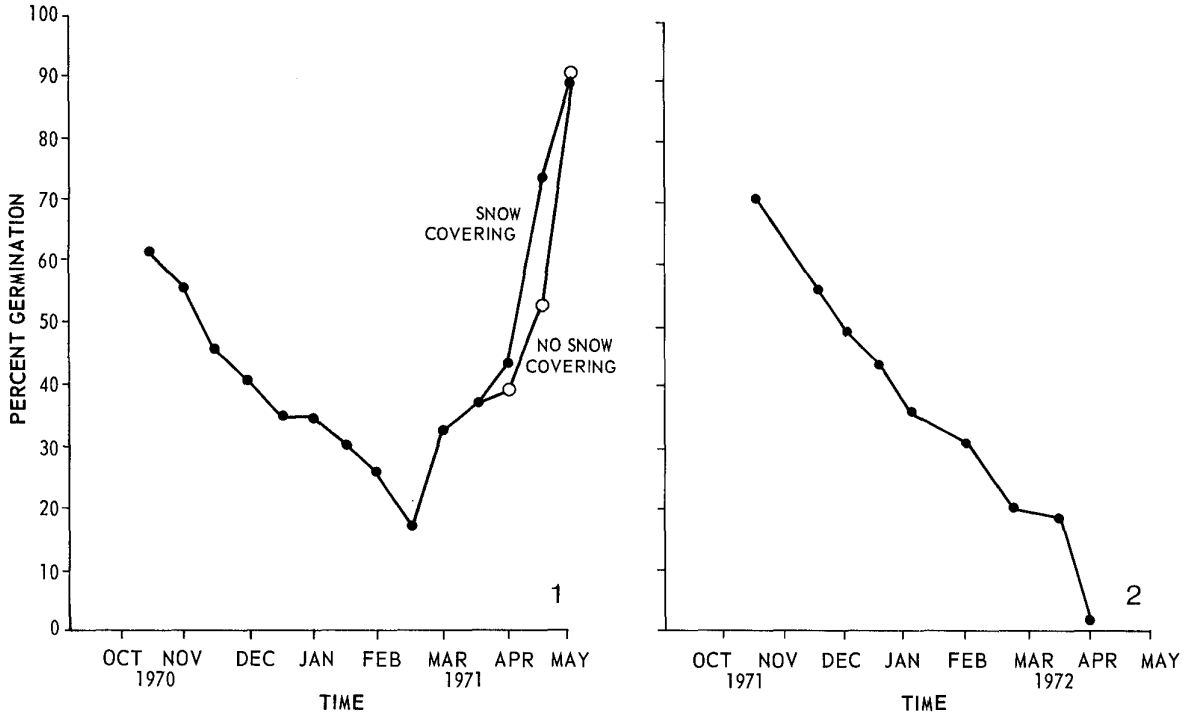

Figures 1 and 2. Viability of powdery mildew conidia during the overwintering period 1) 1970-71, 2) 1971-72.

Results and discussion

No perithecia were found on leaves collected from the field; abundant lesions were found each season, but only mycelium and conidia were produced.

The germination of overwintering conidia in 1970-71 ranged from a high of 61% in November to a low of 16% in February (Fig. 1). Conidia collected in April, however, did exhibit rapid germination. The mean minimum and maximum air temperatures during January were -13.7 C and -5.7 C respectively, the mean temperature being -9.7 C. February was a warmer month, the mean minimum and maximum air temperatures being -11.0 C and -8.9 C, respectively. Soil temperatures at a depth of 5 cm were higher and showed less variation than air temperatures, with mean monthly values of 1.1 C and 0.6 C during these two months, respectively. Snowfall during the entire winter was 245 cm and very little exposure of the wheat crop took place (1). During spring thaws, more conidia were viable from leaves which had snow cover for a longer period of time than from leaves exposed directly to fluctuating air temperatures.

During 1971-72, germination of conidia ranged from a high of 72% in mid-October to a low approaching zero in early April, after which no conidial germination was detected (Fig. 2). Weather conditions in the 1971-72 winter were much more severe than in the previous year with mean minimum and mean maximum air temperatures in February of -13.0 C and -4.8 C, respectively, the average temperature being -9.2 C (2). Although these temperatures were not lower than the previous year, snow cover was minimal during the first month of the year. Lack of a snow cover during January and February of 1972 was considered to be correlated with a lower soil temperature at the 5 cm soil depth than in the comparable period of 1971. Thus, although air temperatures were considered similar from year to year, the year when mildew survival was greatest coincided with adequate snow cover to enable survival of the plant itself. Lack of winter survival of the mildew spores in 1972 was therefore attributed to the winterkilling of the wheat plants.

Survival of the mildew fungus during the winter of 1972-73 was very similar to that in 1970-71. Mildew conidia remained viable throughout the winter and winterkill was limited to land areas unsuited to winter wheat. The low period of conidial germination was found to occur in early March when over 32% of the conidia were viable on water agar. The increased conidial germination observed in April could have been due to the production of new conidia.

At Kentville, N. S., powdery mildew was found to be more severe on spring sown wheat

in 1972 than at Charlottetown where no winter wheat survived in 1971-72. In the other two years of observation mildew was also more severe at Kentville but there was less disparity between the two locations. Severity of mildew recorded on Selkirk spring wheat at Charlottetown was 66%, 40%, and 93% of that recorded on the same variety at Kentville in 1971, 1972, and 1973, respectively. The Annapolis Valley has had a history of better winter wheat survival as compared to the Charlottetown area, and the greater severity of mildew at Kentville may perhaps be attributed to the availability early in the spring of inoculum that has overwintered on winter wheat.

Finney and Hall (5) have reported that fall infection of winter barley by powdery mildew reduces the production of adventitious roots. Lack of adequate root development in winter wheat infected by mildew may well be an important factor in the overwintering of this crop in the Maritime Provinces (16). Roots of wheat plants were not examined in the present study.

Infection data obtained through growing winter and spring cereals at the same locale was reported by Smith & Davis (13) who found that the presence of an adjacent infected winter barley crop raised the number of airborne powdery mildew spores over adjacent spring barley crops by 5-6 fold. Increases in disease severity are also directly related to the number of spores above the spring cereal crop (10).

In the Maritime Provinces, winter wheat will outyield spring wheat in years when winterkill is limited. A similar situation exists in Denmark with winter barley (13, 14). The success of the banning of winter barley cultivation in Denmark has been encumbered by the introduction of wind-blown mildew spores from neighboring countries (15). The use of mildew resistant winter wheats in the Maritimes would be a more practical means of reducing high levels of inoculum. The production of mildew resistant winter wheat is considered necessary since the acreage devoted to this winter crop is still very low and should it increase before the introduction of resistant varieties, control of this disease in both winter and spring wheats would be more difficult in future years.

Acknowledgments

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POTATO SEED TREATMENT FOR THE CONTROL OF VERTICILLIUM WILT AND FUSARIUM SEED PIECE DECAY[1]

G.W. Ayers[2]

Abstract

Dust formulations of the systemic fungicides benomyl and thiophanate-methyl, when applied to potato (Solanum tuberosum) seed pieces at time of planting, proved highly effective in the control of seed-borne verticillium wilt (Verticillium albo-atrum) and fusarium seed piece decay (Fusarium coeruleum). Seed treatment with metiram or mancozeb dusts provided effective control of fusarium seed-piece decay, but these chemicals showed only minimal effectiveness in the control of seed-borne verticillium wilt.

Résumé

Appliqués en poudrage aux plantons de pomme de terre (Solanum tuberosum) au temps de la plantation, les fongicides endothérapiques bénomyl et thiophanate de méthyle se sont révélés très efficaces dans la lutte contre la flétrissure verticillienne (Verticillium albo-atrum) transmises par la semence et contre la pourriture fusarienne du planton (Fusarium coeruleum). Le poudrage de la semence ou métirame ou au mancozèbe a été efficace contre la pourriture fusarienne du planton, mais très peu contre la flétrissure verticillienne transmise par la semence.

Chemical treatment of potato (Solanum tuberosum L.) seed for the control of seed-borne diseases has not been widely supported by potato growers because of insufficient evidence that the costs involved were justified by better plant stands and increased yields. Before mercury formulations became unavailable, many growers treated their seed yearly with mercuric chloride or organic mercury and found this practice to be economic because of the rather broad spectrum of disease control. When mercury fungicides were banned, there was no comparable alternative among compounds registered for commercial use. The purpose of studies reported herein was to assess various chemicals in an effort to find a replacement compound with superior disease control characteristics.

Materials and methods

All materials used in seed treatment studies, whether fungal contaminants or chemical formulations, were applied to freshly cut seed pieces immediately prior to planting. Inocula of organisms for which fungicidal control was sought were grown on sterilized wheat media, and seed-pieces were contaminated by dipping in a water suspension of the fungal elements. Surface dispersal of inocula on the seed pieces was followed by thorough admixing with chemical dusts at the rate of 1 pound per 100 pounds of cut seed. Chemicals were tested for control of wilt caused by Verticillium albo-atrum R. and B., and fusarium decay caused either by Fusarium coeruleum (Lib.) Sacc. or Fusarium sambucinum Fckl, f.6 Wr. (Fusarium sulphureum Schl.). Susceptible potato varieties used were Irish Cobbler for verticillium wilt, Hunter for seed-piece decay by F. coeruleum, and Sebago for decay by F. sulphureum.

Chemicals under test were: thiophanate-methyl (NF 44, Ciba-Geigy Canada Ltd., Etobicoke, Ontario); benomyl and benomyl + thiram (Benlate and Benlate T, E. I. DuPont de Nemours Inc., Wilmington, Delaware); metiram (Polyram, Niagara Chemicals, Burlington, Ontario); captan + mancozeb (TF 3177, Chipman Chemicals Ltd., Hamilton, Ontario); mancozeb (Dithane M-45, Rohm & Haas Co. of Canada Ltd., West Hill, Ontario). Rates of chemical dust treatments are presented in Tables 1 and 2. There were four randomized plots for each treatment and each plot was planted with 30 seed pieces. Controls received no treatment or inoculum treatment only.

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Table 1. The effect of seed treatment chemical dusts on yield and on verticillium wilt in Irish Cobbler potatoes

Treatment and rate	1971 % wilt	1972 Yield (lb/plot)	1972 % wilt	1973 Yield (lb/plot)	1973 % wilt
Thiophanate-methyl 5%	8.3*	78.4*	0.8*	79.8*	0.0*
Thiophanate-methyl 10%	4.2*	77.0*	4.1*	79.0*	0.0*
Benomyl 10%	4.6*	75.5*	1.6*		
Benomyl 10% + thiram 10%				79.6*	0.0*
Metiram 7%	27.3	52.9	60.0	63.2*	42.8*
Captan 3% + mancozeb 5%		61.6*	45.8*	62.4*	44.4*
Mancozeb 8%				63.7*	39.4*
Control, no treatment	6.9*	66.8*	2.5*	73.3*	0.8*
Control, inoculated	53.7	37.4	80.7	42.4	85.7

* Indicates difference between inoculated control and treatment was significant at the 1% level for each year of testing.

Table 2. Influence of seed treatment chemical dusts on plant stand and yield in Hunter potatoes following seed-piece surface inoculation with *Fusarium coeruleum*

Treatment and rate	1971 % plant stand	1971 Yield* (lb/plot)	1972 % plant stand	1972 Yield* (lb/plot)	1973 % plant stand	1973 Yield* (lb/plot)
Thiophanate-methyl 5%	90.8	63.0	94.1	74.7	88.3	72.9
Thiophanate-methyl 10%	90.8	62.6	91.7	68.8	97.5	74.1
Benomyl 10%	85.0	62.7	93.3	66.4		
Benomyl 10% + thiram 10%					91.6	70.5
Metiram 7%	84.2	54.6	86.6	65.4	89.2	72.0
Captan 3% + mancozeb 5%			89.2	64.5	95.0	75.1
Mancozeb 8%					97.5	71.3
Control, no treatment	84.1	59.5	97.5	74.3	98.3	80.0
Control, inoculated	66.3	40.7	83.3	45.0	63.3	49.7

* Yields from chemically treated seed lots were not significantly different from one another, but in each year of testing all were significantly greater at the 1% level than the inoculated controls.

Results and discussion

Potato seed-piece treatment with dust formulations of the systemic fungicides benomyl and thiophanate-methyl provided highly effective control of seed-borne verticillium wilt in 3 years of testing (Table 1). Readings on wilt infection were based on symptoms evident at the end of August, at which time the plants were entering a period of natural senescence. Treatment with metiram, mancozeb, and a combination of captan and mancozeb gave minimal wilt control in tests conducted over periods of from 1 to 3 years. Tuber yields were not recorded in the 1971 verticillium wilt seed treatment trial because of moderate to severe chance infection by the blackleg organism, Erwinia atroseptica (van Hall) Jennison. None of the chemicals under test showed any effective action against this bacterial pathogen.

All chemicals under test were effective in reducing or preventing fusarium seed-piece decay when applied to seed lots that had first been dipped in spore suspensions of Fusarium coeruleum. Inoculated seed receiving no chemical treatment contracted moderate to severe seed-piece decay, resulting in poor stands, weak plants, and lowered yields (Table 2). Yields from chemically seed-treated plots were not significantly different from one other, but all were in excess of yields from the inoculated controls.

When the same chemicals were applied to Sebago seed that had been inoculated with Fusarium sambucinum f.6 there were no significant differences in plant stand or yield between chemically treated plots and inoculated controls, and tabulated data are, therefore, not recorded in this paper. F. sambucinum f.6 is an important potato storage rot organism, but it became apparent in tests conducted by the author that seed-piece surface inoculation just prior to planting caused insufficient set decay to affect plant establishment and subsequent growth.

No phytotoxic action on seed-pieces or on the growing plants was observed following application of the various seed treatment chemicals. Cole et al. (3) found benomyl to be phytotoxic to seed-piece tissues, but the rates they employed were in excess of that used by the author. Mancozeb, metiram, captan, and thiram are not regarded as being phytotoxic to most plant tissues, and there is little data other than that reported in this paper on the possible phytotoxic effects of thiophanate-methyl as a potato seed treatment. Certain other chemicals tested earlier (1,2) proved fungicidal against verticillium wilt but were phytotoxic to seed-piece tissues and in such cases there appeared to be a narrow range of safety between rates causing phytotoxic effects and those providing effective fungicidal action.

Benomyl and thiophanate-methyl appear to be the most promising fungicidal replacements for the organic mercurial fungicides which in the past provided moderate protection against verticillium wilt, blackleg, and fusarium seed-piece decay (4). Chemicals under test showed no bactericidal effect on chance occurrences of blackleg, and the various formulations were not screened for control of such diseases as common scab and rhizoctonia.

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CHEMICAL CONTROL OF THE GOLDEN NEMATODE, HETERODERA ROSTOCHIENSIS: GREENHOUSE OBSERVATIONS ON PERFORMANCE OF GRANULAR INSECTICIDES-NEMATICIDES AND THE EFFECT OF CYST PLACEMENT ON INOCULATION[1]

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

Abstract

Granular applications of Furadan (carbofuran), Nemacur (fenamiphos), Temik (aldicarb), and Vydate [S-methyl 1-(dimethylcarbamoyl)-N-(methylcarbamoyl)oxy thioformimidate] at rates of 25, 50, and 75 lb ai/acre in a greenhouse experiment significantly reduced formation of new golden nematode cysts. Applications of 75 lb/acre were not significantly better than 50 lb, although Temik at 75 lb was the most effective of the 10 treatments tested and gave the greatest reduction in new cyst formation. Dispersing the cysts throughout the soil was the most effective method of five procedures evaluated for inoculating potted potato plants with the golden nematode.

Résumé

Dans une expérience en serre des applications de Furadan (carbofuran), de Nemacur (fenamiphos), de Temik (aldicarbe) et de Vydate [dimethylcarbamoyl-1 (carbamoyl-N) oxime thioformimidate de S-méthyle] sous forme granulaire, aux doses de 25, 50 et 75 lb de substance active à l'acre ont significativement réduit la formation de nouveaux kystes de nématodes dorés. Les applications de 75 lb/acre n'ont pas été significativement meilleures que celles de 50 lb, même si à 75 lb, le Temik était le plus efficace des 10 traitements et réduisait le plus la formation de nouveaux kystes. La dispersion des kystes dans le sol a constitué la plus efficace des cinq méthodes évaluées pour l'inoculation de plants de pommes de terre en pots avec le nématode doré.

The world distribution of the golden nematode and the international problem of controlling this important pest have been described by Spears (8). The distribution and biology of the golden nematode in Newfoundland was published by Morris (2).

In Great Britain, Continental Europe, and Long Island, N.Y., U.S.A., chemical control of the golden nematode, Heterodera rostochiensis Woll. has been investigated for many years. Peachey et al. compiled and published a bibliography of relevant literature on nematode control from 1932 to 1967 (3-6), and more recent experimental work is reviewed by Whitehead (9).

More recently chemicals combining insecticidal and nematicidal properties have become available. In a previous paper (7) we described the use of one such compound, Vydate (DPX 1410), as a seed piece treatment. To further evaluate Vydate and to compare its effectiveness with other nematicides we established a greenhouse experiment at the Research Station in mid-January 1973. An additional experiment was set up on 18 March 1973 to determine the best way to inoculate pot soil with cysts to ensure maximum infestation of potato plant roots.

Methods

In the first experiment (Table 1) 10 nematicide treatments, Nemacur 15G (fenamiphos 15%), Temik 10G (aldicarb 10%), and Vydate 10G [s-methyl 1-(dimethyl carbamoyl)-N-(methylcarbamoyl)oxy thioformimidate 10%] at 25, 50, and 75 lb ai/acre and Furadan 10G (carbofuran 10%) at 75 lb ai/acre, were established in a greenhouse in mid-January 1973. In this test the controls included untreated infested and non-infested soils, and untreated infested soil planted to the nematode-resistant cultivar Wauseon.

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Table 1. Effects of nematicide treatments on tuber yield and on the number of new cysts formed

Nematicide	Rate (lb a.i. per acre)	Avg wt tubers (g per pot)	Avg no. new cysts per pot	Avg no. new cysts per g soil
Nemacur 15 G	25	121	779	0.9
Nemacur 15 G	50	99	589	0.7
Nemacur 15 G	75	94	433	0.5
Temik 10 G	25	105	440	0.5
Temik 10 G	50	113	171	0.2
Temik 10 G	75	118	139	0.2
Vydate 10 G	25	95	648	0.8
Vydate 10 G	50	135	297	0.4
Vydate 10 G	75	106	211	0.2
Furadan 10 G	75	119	328	0.4
Control - untreated, non-infested		87	0	0.0
Control - untreated, infested		117	1,038	1.2
Control - untreated, infested, Wauseon seed		82	0	0.0
L.S.D. 5% level		37	77	
L.S.D. 1% level		49	102	

Soils were infested by adding 50 nematode cysts to approx. 850 g air-dried potting soil in a 5-inch plastic pot. Soil, nematicide, and cysts for each pot treatment were blended together in a twin shell mixer for 5 min. Dosages were calculated on the assumption of 2.5 million lb soil/acre 6-7 inches deep. All treatments and controls were replicated 8 times. Each pot in 12 of the 13 treatments was seeded with one small round Arran Victory potato tuber, placed in a shallow saucer, and watered from the bottom. Tubers were harvested during the last week of June, weighed, and the number of new cysts determined.

In the cyst placement experiment the size of pot, quantity of soil, and number of cysts used were the same as those used in the nematicide experiment. The five positional placements of cysts are described in Table 2. The inoculators used for three of the five treatments were similar to those described by McKenna and Winslow (1). The body of the inoculator was formed by a 3/4 inch piece of Tygon tubing of 3/8 inch external diameter. Nylon netting through which newly hatched larvae could pass was held in place at one of the tubing by a Tygon tubing collar of 3/8 inch internal diameter. Cysts were placed inside the narrower diameter tubing, the other end of which was closed with cotton wool. The experiment was established in a greenhouse on 18 March 1973 and results were evaluated 10 May 1973, when newly formed cysts were in the white stage of development, and after harvest, 13 August 1973, when cysts had matured.

In May appraisal of the different methods of inoculation was made by lifting the entire "root ball", which averaged approximately 11.5 cm high, from the plastic pot. The ball was then inverted and cysts that had formed on the bottom were counted and recorded. The root ball was then placed on a turntable and with the aid of a magnifying glass the cysts on the root system were counted by slowly rotating the turntable. To aid in counting, the root system was divided into three sections by using a marker divided into three equal parts (3.8 cm) at the margin of the turntable. The number of visible immature white cysts in each section was counted as they passed the marker. Mature brown cysts were recovered from the soil after harvesting by flotation using a Fenwick can apparatus. Cysts from two 25 g samples of air dried soil from each pot were counted.

Results and discussion

In the nematicide experiment (Table 1) all chemical treatments reduced the number of new cysts formed compared to the untreated infested control pots, in which a 20-fold increase in the number of cysts was recorded. Reduction in the number of new cysts formed was proportional to the quantity of nematicide applied.

Temik was the most effective nematicide in preventing cyst development with less than a 4-fold increase in cysts occurring. The 75 lb application was only slightly more effective than the 50 lb application. Vydate was more effective than Furadan which was slightly better than Nemacur.

No new cysts were formed in the pots planted to the nematode resistant variety

Table 2. Effect of cyst placement on the formation of white cysts and their position on the root system, and on the number of brown cysts formed under greenhouse conditions

Treatment no. and cyst placement (15 January 1973)	Avg no. visible white cysts and position on root[a]				Total immature white cysts/pot (10 May 1973)	Avg no. brown cysts/pot (13 August 1973)
	Bottom	I	II	III		
1. Cysts in circle around and close to tuber	0.0	1.3	26.3	11.5	39.1	958
2. In inoculator, above tuber and slightly below soil surface	0.0	0.0	0.0	0.0	0.0	132
3. In inoculator, between bottom of tuber and bottom of pot (2.5 cm from bottom)	24.0	1.0	0.3	0.0	25.3	572
4. In inoculator, 5 mm from bottom of pot	57.0	2.3	0.8	0.0	60.1	592
5. Dispersed throughout soil with twin shell mixer	14.5	19.5	23.3	31.3	88.6	914

[a] Bottom = bottom of root ball; I = lower 1/3 of side of root ball; II = center 1/3 of root ball; III = upper 1/3 of side of root ball.

Wauseon and 46 of the 50 cysts used for inoculum were recovered after harvesting.

The untreated control with cysts had an average yield of 117 g per pot, 30 g more than the control without cysts (Table 1). This difference though not statistically significant may have resulted from the synergistic reaction of the plants to the light inoculation of cysts, 0.06 per g of soil. No significant differences in yields were recorded between nematicide treatments and only the Vydate treatment at 50 lb ai/acre differed significantly from the untreated non-infested control.

In the cyst placement experiment, dispersing the cysts through the soil by mixing in a twin shell blender for 5 min (treatment 5) produced the highest number (88.6) of new white cysts (Table 2). However, in final soil recovery counts at harvest on August 13, treatment 1 (cysts in circle around and close to tuber) produced the highest number (958) of brown cysts, but this was only slightly ahead of treatment 5 (914). In treatment 2, where no visible white cysts were detected on the root ball when examined on 10 May, 132 brown cysts were collected on 13 August. The lack of white cysts and the small number of brown cysts in treatment 2 was undoubtedly due to the inoculum being near the soil surface and hence above the root area and zone of root diffusate. From the number of white cysts and their position on the root system (Table 2) it is evident that most larvae invade the root in the immediate area of inoculation. The present method of distributing the cysts throughout the soil with a twin shell blender proved to be an effective method of inoculation.

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FUNGICIDAL CONTROL OF POPLAR LEAF SPOTS

L.W. Carlson[1]

Abstract

Four fungicides were tested for control of poplar leaf spots caused by species of Septoria and Marssonina at the Alberta Horticultural Research Center, Brooks, and at the PFRA Tree Nursery, Indian Head, Saskatchewan. Effective control was obtained with six applications of either benomyl, thiophanate-methyl, maneb, or fixed copper. Studies on the timing of applications, using benomyl, demonstrated that effective leaf spot control can be obtained with three fungicide applications, beginning mid- to late June and continuing at 10-day intervals until early to mid-June.

Résumé

L'auteur éprouva quatre fongicides afin de réprimer les taches des feuilles de Peuplier causées par certaines espèces de Septoria et de Marssonina à l'Alberta Horticultural Research Center, à Brooks, et au PFRA Tree Nursery, à Indian Head, Saskatchewan. La répression s'avéra effective avec 6 applications de soit du bénomyl, du thiophanate méthylique, du maneb ou du cuivre "fixé" (chlorures basiques de cuivre). Avec le bénomyl, la répression efficace s'opère dans le temps suivant: 3 applications, la première commençant vers le milieu ou la fin de juin et les autres se poursuivant à intervales de 10 jours jusqu'au début ou au milieu de juillet.

Fungicidal control has been indicated for Septoria and Marssonina leaf spots in the Canadian Prairies (1) and in Europe (2, 3, 4, 5). The diseases, their control, and their impact in Alberta and Saskatchewan nurseries have been previously reviewed (1).

In previous data (1) there was an indication that the first application of fungicides (benomyl and thiophanate-methyl) effectively curtailed the development of poplar leaf spots. This implies that proper timing of fungicide applications could produce satisfactory control of the disease with fewer applications of fungicide, thus eliminating the need for extensive spraying for leaf spot control, which can be quite expensive.

Field tests of four fungicides for control of poplar leaf spots were made in 1972, and timing of applications was evaluated in 1972 and 1973. The results of these tests are reported here.

Fungicide Evaluation Experiments

Materials and methods

Experimental plots of 'Northwest' poplar (Populus 'Northwest') and 'Brooks No. 6' (P. 'Brooks No. 6') were located at the PFRA Tree Nursery, Indian Head, Saskatchewan and the Alberta Horticultural Centre, Brooks, respectively in 1972. Plots of 5-6 stools each were arranged in a completely randomized block design and were replicated 6 times at Indian Head and 4 times at Brooks.

The following fungicides were used in the experiment: Benlate 50% W.P., 50% benomyl; C-O-C-S, W.P., 50% fixed copper (basic copper chlorides); Manzate-D, W.P. 80% maneb; NF-44 (Topsin), W.P., 70% thiophanate-methyl.

Six applications of fungicides were applied at 10-day intervals, starting in mid-June. They were applied at 150 psi from a high-pressure sprayer at the rate of 100 gallons per acre. Triton 1956-B spreader-sticker was used in the experiments.

Leaf spot severities corresponding to the percentage of leaf area spotted were rated on a scale of 1 to 11, 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 range of 25-50%. As in previous experiments (1) no distinction was made between leaf spots caused by Septoria spp. or Marssonina sp. During the growing season at Brooks, ratings were made on five whips from each check plot. Final ratings were made from five whips of each replicate. All data are given as means of six and four replicates (Indian Head and Brooks, respectively) with Duncan's multiple range test used for mean comparisons.

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Table 1. Leaf spot development on the nonsprayed poplar hybrid Brooks #6, 1972

Date	No.* leaves per whip	Leaves with spots		Dead leaves		Disease %
		No.*	%	No.*	%	
June 15	14.5	0.6	4.4	0.2	1.5	1.6
June 27	18.8	5.6	29.5	0.2	1.1	2.3
July 6	20.8	11.6	55.7	0.6	2.6	7.0
July 17	24.3	17.5	71.8	1.7	6.8	12.2
July 27	28.5	18.9	66.1	3.4	11.9	18.9
August 8	29.2	24.5	83.7	7.3	25.0	41.5
August 28	35.3	29.5	83.4	12.4	35.1	43.2

* Average of 5 whips × 4 replicates.

Results

The incidence of disease at Brooks at the beginning of the growing season was considerably lower in 1972 than in 1971. On July 7, 1971, the leaf spot severity was 27.1% at Brooks (1) whereas on July 6, 1972, it was only 7.0% (Table 1). However, leaf spot severity increased gradually throughout the growing season to 43.2% at Brooks (37.3% in 1971) and 50.9% (Table 2) at Indian Head (50.5% in 1971). In 1972, the percentage and number of dead leaves increased steadily from 1.5% to 35.1% and from 0.2 to 12.4 leaves per whip.

In both tests at Brooks and Indian Head all chemicals significantly reduced leaf spot severity, percentage of leaves infected, and percentage of dead leaves (Tables 2 & 3). With the exception of C-O-C-S at Brooks there were no differences in effectiveness between the chemicals with regard to control of leaf spot severity and reduction of percent dead leaves. Benomyl was significantly more effective than the other chemicals in reduction of leaves infected at Indian Head; however, at Brooks, thiophanate-methyl compared favorably with benomyl.

Data in Tables 2 and 3 show that six applications of the chemicals had no effect on leaf production. Again, as in 1971, more leaves per whip were produced at the Brooks station than at Indian Head.

Data presented here and elsewhere (1) confirm that poplar leaf spot incidence can be reduced by fungicides. Leaf spot development was completely inhibited after the first application of benomyl or thiophanate-methyl as shown in the data from Brooks (Tables 1 and 3). The final percent disease for the two chemicals was 1.1 and 0.6 respectively, where the initial disease percentage on June 15, 1972, in the check plots was 1.6. Similar data are shown for the percentage of dead leaves, 1.5 on June 15, 1972, and 0.7 and 0.3, respectively, for benomyl and thiophanate-methyl on August 28, 1972.

Table 2. Effect of fungicides on poplar leaf spots, Indian Head, Saskatchewan, 1972

Fungicide and rate per 100 gallons	Leaves per whip	Disease %	Leaves with spots %	Dead leaves %
Benlate, 1 lb	32.2 a*	15.5 a	23.6 a	15.2 a
NF-44, 0.75 lb	32.8 a	16.2 a	48.9 c	15.0 a
C-O-C-S, 4 lb	32.5 a	20.4 a	36.3 b	18.9 a
Manzate D, 2 lb	30.7 a	16.7 a	66.6 d	14.9 a
Check	33.2 a	50.9 b	93.0 e	43.6 b

* 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, Brooks, Alberta, 1972

Fungicide and rate per 100 gallons	Leaves per whip	Disease %	Leaves with spots %	Dead leaves %
Benlate, 1 lb	35.8 a*	1.1 a	9.9 a	0.7 a
NF-44, 0.75 lb	34.2 a	0.6 a	9.2 a	0.3 a
C-O-C-S, 4 lb	35.9 a	10.4 b	33.8 b	8.9 b
Manzate D, 2 lb	33.5 a	4.3 a	36.1 b	3.1 a
Check	35.3 a	43.2 c	83.4 c	35.1 c

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

Table 4. Leaf spot development on the nonsprayed poplar hybrid Brooks #6, 1973

Date	No.* leaves per whip	Leaves with spots		Dead leaves		Disease %
		No.*	%	No.*	%	
June 14	11.8	0.0	0.0	0.0	0.0	0.0
June 25	16.24	0.0	0.0	0.0	0.0	0.0
July 5	20.0	12.1	60.3	0.0	0.0	2.0
July 16	25.8	14.0	54.3	0.5	1.9	5.8
July 26	30.2	15.2	50.4	2.4	7.8	13.9
August 9**	34.9	17.9	51.1	5.9	16.7	20.60
August 27**	35.8	32.3	90.1	8.9	24.80	29.5

* Average of 5 whips × 5 replicates.

** Average of 5 whips × 4 replicates.

Table 5. Time of benomyl application vs. poplar leaf spots, Indian Head, 1972

Date† of application	Leaves per whip	Disease %	Leaves with spots %	Dead leaves %
1, 2, 3, 4, 5, 6	32.2 a*	15.5 a	23.6 a	15.2 a
1, 2, 3	32.1 a	18.0 a	46.5 b	16.9 a
2, 3, 4	31.5 a	19.4 a	42.0 b	18.6 a
3, 4, 5	30.7 a	22.6 a	58.2 c	20.7 a
4, 5, 6	32.5 a	23.9 a	65.9 c	20.4 a
Check	33.2 a	50.9 b	93.0 d	43.6 b

† 1 - June 15; 2 - June 27; 3 - July 6; 4 - July 17; 5 - July 27; 6 - August 8.

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

Fungicidal Spray Timing Experiments

Materials and methods

It is not economically feasible to spray over the entire growing season, as this would require 6 to 9 fungicide applications. To determine the optimum timing of fungicide applications, several overlapping spray series of three applications each were evaluated, with each series started at different times. For convenience of tracking, each spray application was given a number 1 through 6 to correspond to the date when applied. The first series of sprays started on June 15 in 1972, and on June 14 in 1973. Once started, spray applications within a series were continued at 10-day intervals. The latest application in a series was on August 7 in both years. Benomyl (Benlate) was used at 1 lb per 100 gal in both 1972 and 1973.

The plot size, the method of fungicide application, and final evaluation of the data were as described in the previous section on fungicide evaluation. The timing experiments were carried out at Brooks and Indian Head in 1972 and at Brooks in 1973. Plots were replicated 5 times at Brooks in 1973; however, between July 26 and August 9, the first replicate was destroyed.

Table 6. Time of benomyl application vs. poplar leaf spots, Brooks, 1972

Date† of application	Leaves per whip	Disease %	Leaves with spots %	Dead leaves %
1, 2, 3, 4, 5, 6	35.8 a*	1.1 a	9.9 a	0.7 a
1, 2, 3	36.9 a	4.1 a	30.9 b	3.2 ab
2, 3, 4	35.1 a	4.2 a	18.1 a	3.5 ab
3, 4, 5	32.1 a	11.4 b	44.7 bc	9.2 bc
4, 5, 6	34.1 a	15.3 b	53.4 c	13.0 c
Check	35.3 a	43.2 c	83.4 d	35.1 d

† 1 - June 15; 2 - June 27; 3 - July 6; 4 - July 17; 5 - July 27; 6 - August 8.

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

Table 7. Time of benomyl application vs. poplar leaf spots, Brooks, 1973

Date† of application	Leaves per whip	Disease %	Leaves with spots %	Dead leaves %
1, 2, 3, 4, 5, 6	34.5 a*	2.0 a	4.6 a	2.0 a
1, 2, 3	34.5 a	3.7 a	33.6 cd	2.9 a
2, 3, 4	40.0 ab	5.8 ab	28.6 cd	4.7 ab
3, 4, 5	42.3 c	10.7 c	30.2 cd	9.4 c
4, 5, 6	40.6 bc	17.3 d	39.8 d	15.2 d
1, 3, 5	39.3 abc	5.1 ab	15.4 ab	4.5 ab
2, 4, 6	38.4 abc	8.7 bc	25.9 bc	8.1 bc
Check	35.8 ab	29.5 e	90.1 e	24.8 e

† 1 - June 14; 2 - June 25; 3 - July 5; 4 - July 16; 5 - July 26; 6 - August 6.

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

Results

Leaf spot development in the non-sprayed plots at Brooks in 1972 and 1973 are shown in Tables 1 and 4 respectively. The onset of the disease was considerably later in 1973 than in previous years; however, the pattern of development throughout the growing season was similar. Leaf spot severity increased from 0% on June 14 to 29.5% on August 27. Similar increases in numbers of leaves spotted and numbers of dead leaves were observed, 0 to 32.3 and 0 to 8.9, respectively.

The results of the spray timing experiments, shown in Tables 5, 6, and 7, demonstrate the importance of fungicidal coverage during late June to mid-July. The best series of three sprays (1, 2, 3) reduced leaf spot severity by 65% at Indian Head in 1972, by 91% at Brooks in 1972, and by 88% at Brooks in 1973. As expected, six sprays, covering mid-June to early August resulted in better control than three sprays, reducing leaf spot severity by 70%, 98%, and 94% respectively. Similar data are shown for percent dead leaves.

In all tests the percentages of spotted leaves in the 2, 3, 4 series were lower than in any other series of three successive sprays, but these differences were significant only at Brooks in 1972.

The data presented in Table 7 show that three sprays 20 days apart (series 1, 3, 5) gave as good control as series 1, 2, 3, 4, 5, 6; series 1, 2, 3; and series 2, 3, 4. The alternate series (2, 4, 6) gave significant control of leaf spots but was not as good as the above mentioned series. It must also be noted that all series of three sprays in all three tests gave singificant control of poplar leaf spots.

Poplar leaf spots can be effectively controlled with three applications of benomyl beginning mid- to late June and at 10-day intervals until early to mid-July. Equally effective is a series of three applications of fungicide at 20-day intervals starting in mid-June. However, a recommendation for the use of benomyl cannot be made until the chemical is properly registered for use on poplars.

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INFLUENCE OF THREE ASCOCHYTA DISEASES OF PEAS ON PLANT DEVELOPMENT AND YIELD[1]

V.R. Wallen[2]

Abstract

Yield losses of up to 50% were recorded in pea (Pisum sativum) plots inoculated with Ascochyta pinodes and Ascochyta pinodella. Six weeks after planting, reductions in stand of 24% and 14%, caused primarily by a foot rot, were recorded for A. pinodella and A. pinodes, respectively. As well, severe leaf infection and early defoliation were followed by a reduction in the number and weight of pods on plants affected by the two fungi. Only a slight yield reduction occurred in plots inoculated with Ascochtya pisi.

Résumé

On a enregistré des baisses de rendement pouvant atteindre 50% dans des parcelles de pois (Pisum sativum) inoculées avec Ascochyta pinodes et Ascochyta pinodella. Six semaines après le semis, on a signalé des réductions de densité de 24 et de 14% respectivement pour A. pinodella et A. pinodes, surtout attribuables au pourridié aschochytique. De plus, une infection grave des feuilles et une défoliation précoce ont été suivies par une réduction du nombre et du poids des cosses des plants attaqués. On n'a signalé qu'une faible baisse de rendement dans les parcelles inoculées avec Ascochyta pisi.

In an extensive survey of processing peas, Pisum sativum L., conducted in seven provinces of Canada in 1970 and 1971 (1), it was found that the ascochyta diseases leaf and pod spot caused by Ascochyta pisi Lib.; blight caused by Mycosphaerella pinodes (Berk. & Blox.) Vestgrn., imperfect state Ascochyta pinodes L.K. Jones; and foot rot caused by Phoma medicaginis var. pinodella (L.K. Jones) Boerema, syn. Ascochyta pinodella L.K. Jones, were second in prevalence only to fusarium root rot.

The three Ascochyta pathogens are seed-borne (7) and A. pinodes and A. pinodella are also soil-borne (10). Seed-borne A. pinodes and A. pisi are effectively controlled by treatment with chemical seed treatments (5, 6, 9).

In an earlier study in Canada (7), more samples of processing pea seed were internally infected with Ascochyta pisi than with the other two ascochytas, and similarly the average infection within the samples was higher with A. pisi. A. pisi was also the most prevalent species affecting field pea (P. arvense Poir.) seed until the variety Century with specific resistance to Ascochyta pisi was introduced in 1961 (2). Century is now the predominant field pea variety in Canada.

A. pisi causes lesions on leaves, stems and pods; in young seedlings the stems may be girdled and occasionally such plants are killed. A. pinodes and A. pinodella also affect leaves, stems, and pods and, in addition, cause a foot-rot symptom which is not present on plants affected by A. pisi. In view of this, it would be suspected that the blight and foot-rot diseases may be more important from a yield loss aspect because of the death of many plants affected by the foot-rot phase. In the United States, it has been stated that blight is the most destructive of the three organisms (3, 4), and in preliminary trials at Ottawa blight, foot rot, and leaf and pod spot reduced yields by 45%, 25% and 11%, respectively (8).

The purpose of this work was to determine the yield losses, as expressed in green pod weight, caused by the three organisms under field conditions and to follow the progress of the epiphytotics in the field by weekly disease assessments.

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Materials and methods

The experiment was carried out in 1971 and 1972, using the same experiment procedures each year. The design was a randomized block consisting of four treatments, a non-inoculated control plot and plots inoculated with one of the three ascochyta pathogens. Each treatment was replicated four times. Plots were isolated from one another by a 20 ft strip that was kept harrowed throughout the growing season. Twenty-one rows were seeded on May 29 with Pisum sativum L. 'Improved Laxton's Progress' in each 25 x 15 ft plot. Seeds were sown 2 inches apart in the rows. At harvest, July 27, the outside three rows of each plot and 2.5 ft at each end of the rows were discarded. Harvesting of the pods was done when the pods were green and full. Yields were recorded in pod weight. Green pod weights were used instead of dry seed weight because it is impossible to grow peas to maturity in this area because of bird damage.

Epiphytotics in the plots were produced using the method previously described (7) except that the inoculum was distributed over the rows of peas just prior to emergence.

Detailed assessments were made during the growing season to give an indication of the rate of disease development and to provide information on the amount of damage to the leaves, stems, and pods. Assessments were made on 10 tagged plants chosen at random in each plot when the disease was first noted and at weekly intervals thereafter until harvest. The number of nodes per plant and at each node the number of infected leaflets, the percent defoliation, and the percent leaf area affected were recorded at each assessment. Assessments of foot rot were made at harvest.

Emergence counts were made 3 weeks after sowing, and at harvest plant counts were made for both the harvested area and the total area of each plot.

Results and discussion

The development of the diseases varied between the 2 years. Environmental conditions were more favorable for epiphytotics of ascochyta diseases in 1972, and losses were proportionately greater in 1972 although similar trends were apparent each year. For this reason, the results of the first year are regarded as preliminary and only the 1972 results are reported here.

Severe yield losses of up to 50% were recorded in the plots inoculated with A. pinodes and A. pinodella. Only a slight yield reduction occurred in the A. pisi affected plots (Table 1). With A. pinodes and A. pinodella, yield losses were influenced by 1) a reduction in stand initially; 2) a progressive reduction in stand throughout the growing season, caused in particular by the foot-rot type of infection in the A. pinodella affected plots and to a lesser extent in the A. pinodes affected plots (Fig. 1); 3) a reduction in the number of pods produced (Figs. 1, 4); and 4) leaf infection (Fig. 3) causing subsequent early defoliation (Fig. 2).

Stand counts recorded 6 weeks after planting were lower than in the control by almost 24% and 14% for A. pinodella and A. pinodes respectively. A. pisi did not affect the overall stand.

The stand reductions in the A. pinodella plots and to a lesser degree in the A. pinodes plots is understandable with the nature of the diseases. Severe foot rot

Table 1. Effects of *A. pisi*, *A. pinodes*, and *A. pinodella* on stand, yield, and plant development

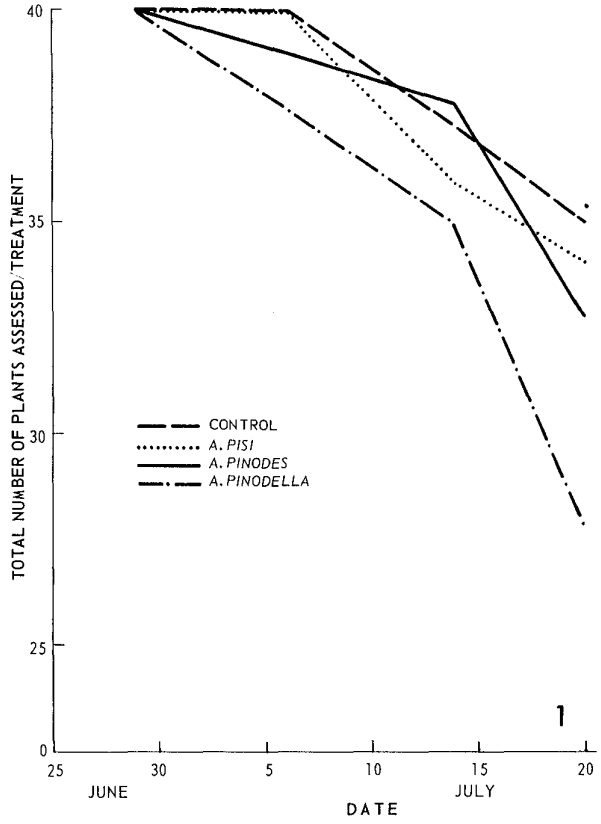
Pathogen	Percent stand*	Average no. pods affected per plant**	Avg yield*** (kg)	Pod yield per plant (g)	Avg pod weight (g)
Control	100	0.0	8.53	37.25	5.46
A. pisi	106	1.0	7.84	29.71†	5.76
A. pinodes	86	4.1	3.97†	21.66†	4.83
A. pinodella	76	4.6	3.22†	19.16†	3.39

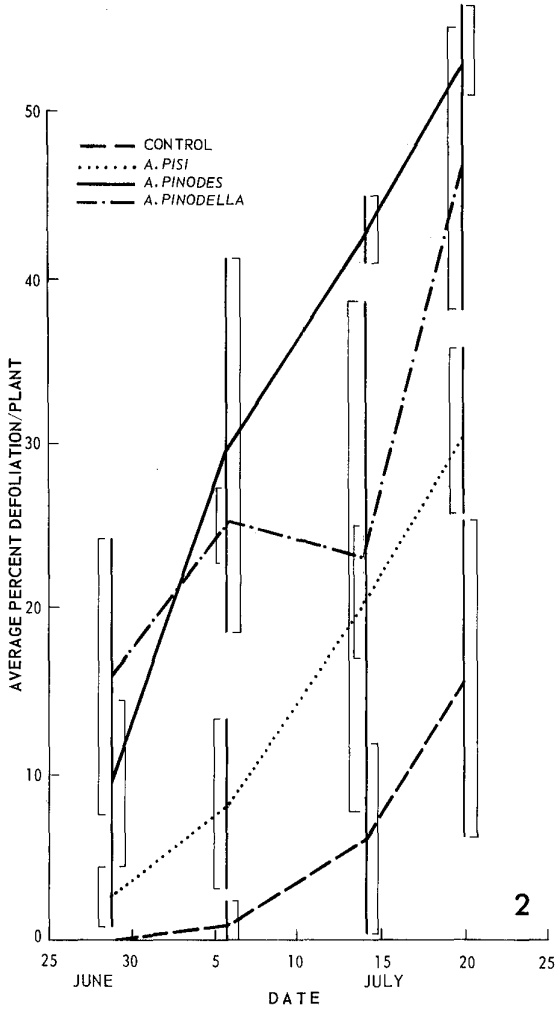
* Percent stand is based on the total plant count in the harvested areas of the plots for the various treatments, expressed as a percentage of the count in the control plots.

** Based upon the number of pods at harvest on the 40 tagged plants for each treatment used for disease assessment.

*** Average pod yield per replicate of all plants within the harvested area for each treatment of four replicates.

† Significant at the 5% level.





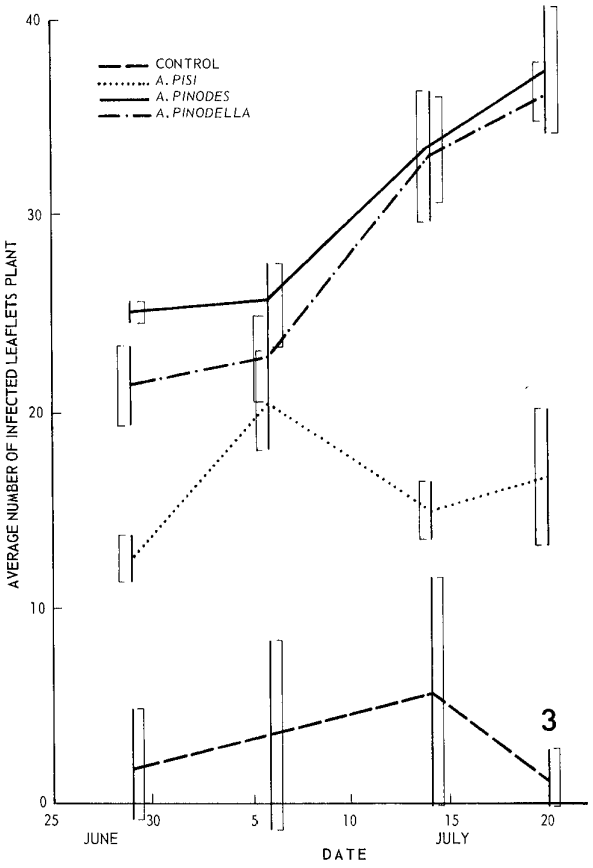
Figures 1-2. Progress curves for three ascochyta diseases of peas in field trials. Effect of the diseases on 1) stand reduction, 2) defoliation.

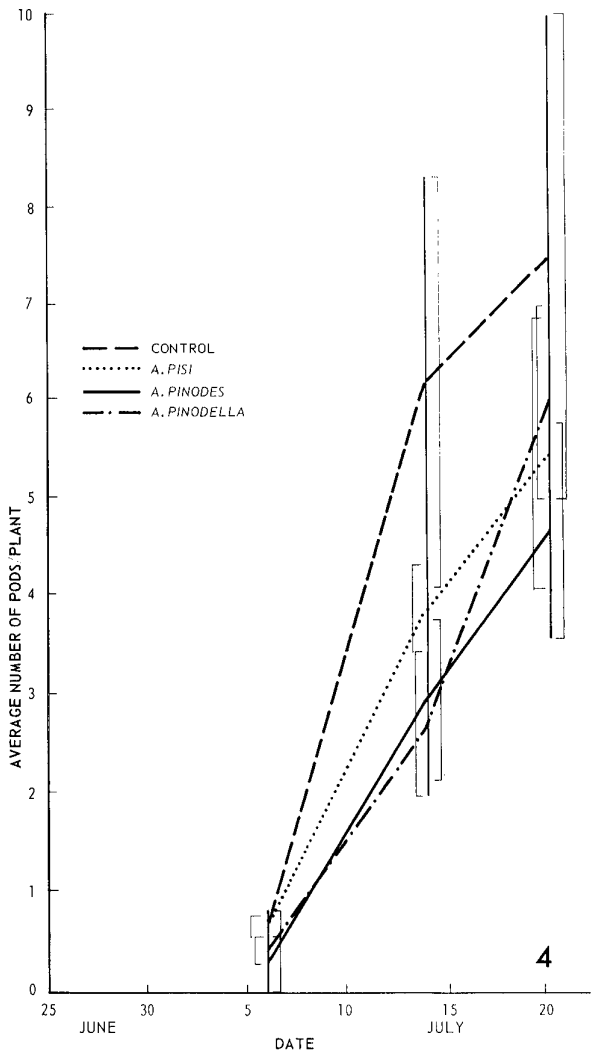
developed and killed a considerable number of the plants in all plots (Fig. 1). Of the original 40 plants assessed in the A. pinodella affected plots, only 8 remained on the last assessment date. Assessment of the remaining plants at harvest did not reveal any significant differences in the amount of foot rot among the plots affected with the three diseases.

Plant development was affected by all three diseases as expressed by a trend toward decreased pod production. Control plots developed on the average 1.5 more pods per plant than did any of the affected plots (Table 1).

Between 30 and 40 leaflets per plant became infected with A. pinodella and A. pinodes. From the onset of infection until harvest, the progress of these diseases was similar. Considerably fewer leaflets became infected in the A. pisi plots (Fig. 3). Premature defoliation occurred in all affected plots but was more severe in the A. pinodes and A. pinodella plots and closely paralleled the intensity of leaf infection with these two diseases (Fig. 2). Almost 50% defoliation had occurred just prior to harvest in these plots. By July 1 more defoliation had occurred in these plots than was evident in the control plots by July 20. The amount of defoliation at harvest was closely correlated with the number of infected leaflets per plant.

Pod assessments for diseases were recorded 1 and 2 weeks prior to harvest. Pod infection was prevalent in the three treatments but in surprisingly low percentages. A. pinodella plots had the highest number of pods infected per plant, 4.6, and the greatest average pod area infected, slightly over 4%. Lower pod infection levels were recorded with A. pinodes and A. pisi (Table 1). Despite the relatively low amount of pod infection at this stage of growth, yield losses were high. It is apparent that early infection of leaves and stems was the principal factor





Figures 3-4. Progress curves for three ascochyta diseases of peas in field trials. Effect of the diseases on 3) number of infected leaflets, and 4) pod production.

influencing plant development and subsequent yield losses in these experiments, and that pod infection occurred too late to influence yield.

Acknowledgments

The expert technical assistance of D. Galway in carrying out work in relation to plot design, disease assessments, and statistical analysis is greatly appreciated.

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BACTERIAL POD SPOT OF RAPE IN ALBERTA

A.W. Henry[1]

Abstract

A bacterial disease of rape (Brassica campestris) affecting the pods conspicuously was found on two farms in southern Alberta in 1973. The causal bacterium, a species of Pseudomonas, was isolated and proved to be pathogenic on certain new varieties, eg. Span and Torch, inoculated with it. It appears to infect most readily through wounds.

Résumé

En 1973, on a trouvé dans deux fermes du sud de l'Alberta une maladie bactérienne du colza (Brassica campestris) qui s'attaque aux siliques. La bactérie responsable, une espèce de Pseudomonas, a été isolée et s'est avérée pathogène à certaines nouvelles variétés, notamment Span et Torch. Les infections semblent se propager très facilement par des meurtrissures.

During July 1973 damaged specimens of Span rape (Brassica campestris L.) plants affected with an apparently undescribed bacterial disease were received at the Plant Industry Laboratory, Alberta Department of Agriculture, Edmonton, from the Rockyford district of southern Alberta. They came from two separate farms in the area and were submitted from the office of the district agriculturist at Strathmore.

Extent and nature of the damage

The damage reported affected as much as 20% of one crop and 50% of the other. The pods in particular were directly attacked, many of them failing to develop properly and to produce normal seed. Stem injuries though less conspicuous also occurred and probably contributed appreciably to the total damage. Considerable financial loss as a result of reduced yield and quality of the seed in all probability was incurred by the damage on both farms.

Field symptoms and signs

Pod specimens from affected crops were commonly discolored with scattered dark brown irregularly-shaped spots. These tended to be more angular than circular. In the case of young pods in particular, marked curling, stunting, and other forms of distortion were common symptoms (Fig. 1). Older pods developed spots but remained more normal in shape (Fig. 2). Pale gray exudates were commonly present on the surface of the spots or lesions. These constituted the principal signs of the disease and indicated that it was probably caused by a bacterium. The presence of exudates on the spots would be useful in distinguishing bacterial pod spot lesions from those caused by fungal pathogens such as Alternaria spp. with which they might be confused.

Etiology

The first attempts to isolate a causal organism from the necrotic tissues of the pod spots, using several procedures, yielded a yellow bacterium mainly but it failed to produce infection of wounded green rape pods inoculated with it. Hence it was concluded that it was a saprophyte associated with the lesions.

Since bacterial exudates were commonly present on the pod spots, suspensions of the bacteria in them were made in sterile water and these were smeared on sterile potato sucrose agar in petri plates. A variety of bacterial colonies developed, among which were numerous grayish white shiny ones. From single colonies of these, cultures were obtained which were used to inoculate green Span rape pod by pricking them with a sterile needle coated with bacteria from a young culture. In the case of detached pods these were placed following inoculation on sterile water agar in petri plates which were kept at room temperature on a laboratory bench for 2 to 3 weeks. As a rule each pod under test was inoculated at two points near the ends, and a sterile needle wound was made in the centre to serve as a check (Fig. 3). A few pods attached to their mother plants were also inoculated using similar methods except

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Figures 1 and 2. Pods of Span rape affected with bacterial pod spot, collected from two fields at Rockyford, Alberta. 1) Deformed pods; note dried exudate on lesions of central pod. 2) Pods from a second field show less deformity than those in Figure 1. possibly as a result of later infection.

for those of the incubation period. These pods were sprayed after inoculation with sterile water and covered with plastic bags moistened inside to assure high humidity around the pods. The plants bearing the inoculated pods were then placed in a growth chamber at 21 - 23 C.

The pathogenicity of the above-mentioned grayish white bacterium for green rape pods was established by following through Koch's rules of proof. A day or so after inoculation slightly sunken water-soaked areas a few millimeters in diameter began to appear aound the points of application of the inoculum. These gradually darkened as the affected cells became necrotic. The spots developed slowly requiring around 2 weeks to become a dark brown color in the case of Span rape. The spots tended to be limited in lateral development by the nerves of the pods and to be more elongated and angular than circular in shape.

From preliminary examinations to date of certain cultural and other physiological characters of the bacterial pod spot pathogen it would appear that it is a species of Pseudomonas, but further work will be required to determine its exact identity. It is clear, however that it is quite different from the bacterium which causes the

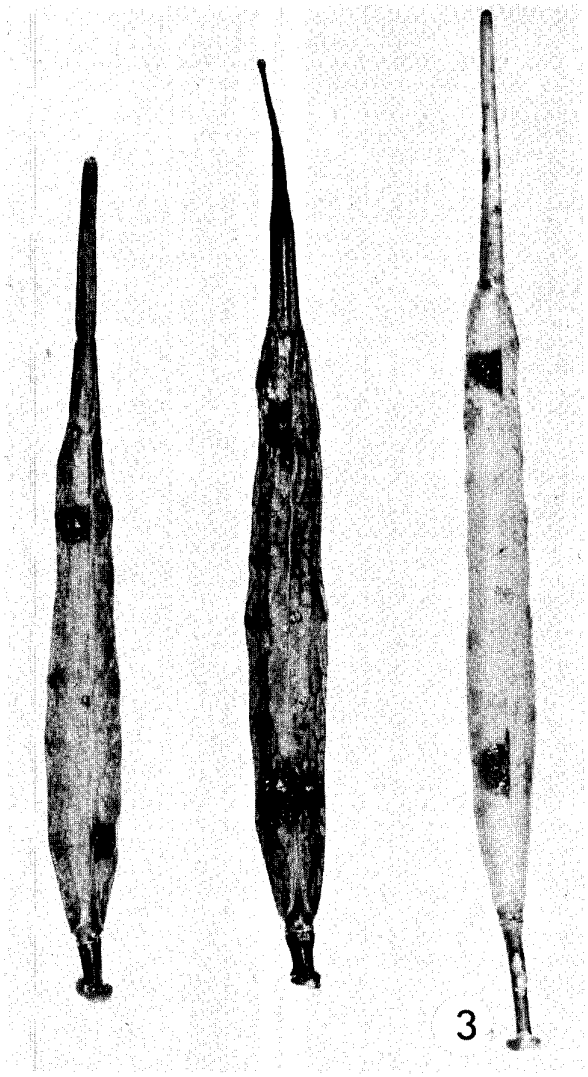

Figure 3. Pods of Torch rape artificially inoculated with the bacterial pod spot bacterium. The dark spots near the pod ends mark the points of inoculation through needle wounds. The wound in the center of each pod was not inoculated.

destructive black rot disease of cruciferous vegetables; this organism, Xanthomonas campestris (Pamm.) Dowson, has been found to attack rape (3) but, judged by seed inoculation tests made by Bain (1), much less severely than cruciferous vegetables.

Predisposition of the host

Studies made so far have indicated that the bacterium under study is primarily a wound parasite. This has been repeatedly confirmed by inoculation of wounded and unwounded parts of immature rape pods. Infection occurred almost exclusively in wounded areas. Uninoculated wounds serving as checks remained free from infection (Fig. 3). So far the chief method of artificial wounding used has been by needle pricking but abrasion with sandpaper has also been successful. In the field it is probable that wounding, permitting entry and establishment of the pathogen in the host, may be accomplished in a variety of ways. The action of wind and wind-blown soil may well be important as it has recently been shown to be for bacterial diseases of alfalfa and beans by Claflin et al. (2) and for bacterial spot of tomatoes by Vakili (4). Environmental factors such as moisture, temperature, and light may also be criticial as predisposing factors along with wounding of the host and at the same time as direct determinants of the activity of the pathogen.

Varietial reactions

The reactions of different varieties of rape to the bacterium causing bacterial pod spot may differ but this has yet to be determined. It is possible that some of the newer varieties are more susceptible than older ones and that their appearance in western Canada has given the bacterial pod spot organism a chance to express itself. So far our observations on this disease have been made mainly on the Polish varieties Span and Torch, both of which differ in chemical composition from some of the older varieties notably in having a lower erucic acid content. Tests of the reactions of other varieties are presently under way.

Transmission

As yet methods of transmission of the bacterial pod spot pathogen have received little attention. The role of seed in transmission from season to season may well be important. Very poor seed from pods severely affected with bacterial pod spot have been germinated and it is suspected that seedlings from it may provide primary inoculum. Also diseased rape pods and other infected residues deposited on the soil in all probability will harbour the pathogen over winter. Moreover, the possibility of inoculum being produced by other cultivated and wild host plants should also not be overlooked. Secondary spread from such sources may then occur through the action of wind, insects, or other agents.

Acknowledgments

Thanks are extended to Mr. J. Letal for making certain preliminary physiological tests of the pathogen.

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VIRUSES OF CLOVERS AND ALFALFA IN ESSEX COUNTY, ONTARIO, 1970-73

L.F. Gates[1] and Joan F. Bronskill [2]

Abstract

Surveys of legume viruses in cultivated and wild clovers and alfalfa in Essex County were made in 1970-73. The incidence of alfalfa mosaic virus averaged 11% in alfalfa (Medicago sativa) crops in the first year, and 44% in the second and later years of cut. Bean yellow mosaic, alfalfa mosaic, red clover vein mosaic, and pea streak viruses occurred at low levels in red clover (Trifolium pratense) crops, though they were frequently encountered in wild clovers. White clover mosaic virus and tobacco ringspot type viruses were also isolated from wild clovers. Bean common mosaic, pea common mosaic, clover yellow mosaic, and clover yellow vein viruses were not encountered in this survey.

Résumé

De 1970 à 1973, on a effectué dans le comté d'Essex, des relevés de virus de légumineuses dans les trèfles cultivés et sauvages et dans la luzerne. La fréquence du virus de la mosaïque de la luzerne a atteint en moyenne 11% dans les cultures de luzerne (Medicago sativa) durant la première année, et 44% pendant la seconde et les autres années de coupe. La mosaïque jaune du haricot, la mosaïque de la luzerne, la mosaïque des nervures du trèfle rouge et la bigarrure du pois ne se sont manifestées qu'à un faible degré dans les cultures de trèfle rouge (Trifolium pratense), bien qu'on ai pu fréquemment les trouver chez les trèfles sauvages. On a également isolé sur ces derniers le virus de la mosaïque du trèfle blanc et ceux de la tache annulaire du tabac. Dans cette enquête, on n'a pas trouvé de virus de la mosaïque commune du haricot et du pois, de la mosaïque jaune et de la mosaïque jaune des nervures du trèfle.

In Essex County, Ontario, red clover (Trifolium pratense L.) and alfalfa (Medicago sativa L.) occupy about 4% of the arable land as forage crops and, being perennials, provide a likely source of viruses for soybeans, beans, peas, tomatoes, and peppers. Legume viruses recorded in southwestern Ontario include those inciting alfalfa mosaic (AMV), soybean mosaic, bean mosaic, tobacco ring spot (TRSV), red clover vein mosaic (RCVMV), pea enation mosaic, pea common mosaic (PCMV), pea streak (PSV), bean yellow mosaic (BYMV), and white clover mosaic (WCMV) (1, 6, 22).

In many areas of Ontario, eastern Canada and the U.S.A., red clover is a frequent source of BYMV, PCMV, RCVMV, PSV, and less frequently of AMV, WCMV, and clover yellow mosaic virus (CYMV) (10, 12, 19, 20, 22, 24). White clover (Trifolium repens L.) is often infected with WCMV, AMV, and less frequently with RCVMV and PSV (1, 19, 20, 22). AMV, often at high levels of incidence, is usually found in alfalfa (2, 5, 10, 18, 26), which may also contain WCMV, CYMV, BYMV, tobacco streak virus, and TRSV (7, 10, 19, 20). CYMV has been found only in and west of Wisconsin, Kentucky, and Oklahoma (1, 7, 20), and clover yellow vein virus (CYVV) only in Quebec, eastern Canada (22), and North Carolina (15).

Spread of BYMV from red clover into beans has been detected for 200 m downwind and 60 m upwind (10). Although AMV has been reported to spread from clover and alfalfa into beans and soybeans, several workers note that AMV was not observed to spread, or that it spread very much less than BYMV (2, 5, 10, 26).

Viruses reduce the productivity of legume crops and resistance to winter temperatures of clovers, though not always of alfalfa (7, 21, 23, refs. in 12). White clover may lose up to half of its yield from strains of AMV and BYMV, especially in combination, and also from CYMV (14, 17, 21). AMV is often mild or symptomless in alfalfa (2, 5, 26), but high levels of infection caused yield losses of 22-30% in early cuts, and smaller losses in later cuts, in the season after inoculation (7, 9).

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Several forage legume viruses, including WCMV, CYMV and a virus related to tomato ringspot in red clover, and AMV in alfalfa, have been found to be seed transmitted (8, 11).

In Essex County, wheat and oat fields are usually undersown with red clover, which is cut the following season, and then ploughed under. Alfalfa is similarly undersown, but usually is cut for several years. These crops, and roadside legumes, were examined for virus infection during 1970-73.

Methods

The reactions of indicator hosts and virus particle size were the major means of identification. Indicator plants were tobacco (Nicotiana tabacum L. 'Samsun NN' and 'Haronova'), pepper (Capsicum frutescens L., 'California Wonder'), French bean (Phaseolus vulgaris L. 'Topcrop' and 'Bountiful'), pea (Pisum sativum L. 'Thomas Laxton' and 'Little Marvel'), cowpea (Vigna sinesis (Torner) Savi 'Early Ramshorn'), Chenopodium amaranticolor Coste and Reyn., broad bean (Vicia faba L. 'Long Pod'), Gomphrena globosa L., snapdragon (Antirrhinum majus L.), and other hosts useful for particular viruses. Plants were sap-inoculated by the leaf-rub method with carborundum as an abrasive. They were kept in a greenhouse maintained at 22-28 C.

AMV, BYMV, and TRSV were recognized by their typical effects on these plants. WCMV rapidly produced light green local lesions on cowpea. It infected French bean, but not C. amaranticolor, G. globosa, or the solanaceous hosts. PSV and RCVMV gave local lesions on G. globosa and C. amaranticolor. They were distinguished by particle size and by the fact that RCVMV was slower than PSV in producing lesions on G. globosa. Snapdragons were checked for CYMV, and Haronova tobacco for CYVV.

Particles of the rod-shaped viruses were examined in leaf-dip preparations stained with phosphotungstic acid (pH 7.0) or shadowed with platinum - palladium (80:20) (Figs. 1-4). The mean lengths and the size range of particles, based on the examination of 5-8 isolates of each virus (n = total number of particles measured), were; RCVMV 630 nm (615-653, n = 253); WCMV 457 nm (436-473, n = 237); PSV 591 nm (562-615, n = 120); BYMV 779 nm (757-798, n = 77). Particle widths, based on 14-20 particles from 2-3 isolates of each virus, were; RCVMV 12.1 nm, WCMV 13.5 nm, PSV 12.6 nm, and BYMV 14.2 nm. These measurements agree with the published measurements for these viruses.

Local isolates of WCMV reacted positively with antiserum to this virus from the American Type Culture Collection.

Virus incidence

Estimations of viruses in clovers depended on counts of shoots or plants with virus symptoms in 6-10 quadrats of 1 M2 per field usually once during the season, with collection of 2-3 typical shoots per field for virus identification. Some collections of symptomless clovers were made early in the season in 1972 and 1973. Only 2 out of 30 collections of symptomless plants contained viruses so that reliance on symptoms appears justified. Alfalfa crops were carefully examined for virus-like symptoms in 1970 and 1971. In 1972 and 1973, 10 shoots per field, regardless of symptoms, were collected at random early in the spring and, later, from the regrowth that occurred shortly after cutting the crop, while the shoots were still only a few cm tall. These shoots were tested individually for viruses and, although their numbers were insufficient for conclusions about any one field, the results gave an estimate of virus incidence over the 30-40 fields tested each year.

Results and discussion

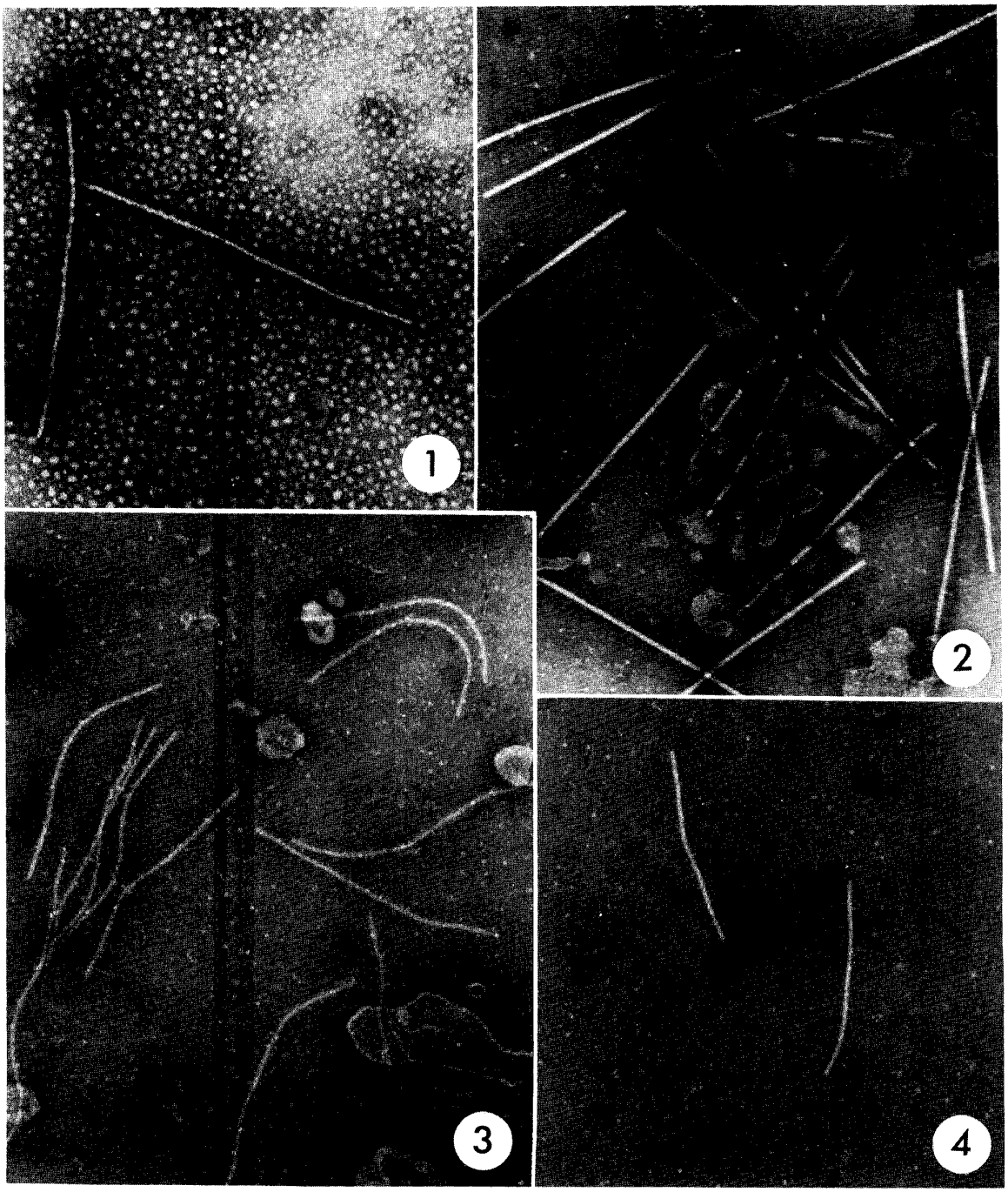
Alfalfa mosaic virus

AMV occurred with unexpected frequency in alfalfa crops, infecting 11% of the shoots in first year crops, and 44% in crops in their second and later years of cut (Table 1). These levels of infection would cause estimated yield losses of 2% and 7% respectively (7, 9). The incidence of AMV in red clover field crops was low, but roadside clovers were often infected.

Isolates of AMV could be divided into two main groups based on their effects on French beans: those which produced small local lesions on the primary leaves, usually without becoming systemic, and those which multiplied in local areas with diffuse edges, causing chlorosis and vein necrosis on the inoculated leaves, and later becoming systemic and causing necrosis in uninoculated leaves. These two types of isolate were obtained about equally from alfalfa, and both were isolated from red and white clovers and from yellow sweet clover (Melilotus officinalis L.).

About half the AMV isolates from alfalfa in Essex County became systemic in French beans, as observed in Indiana (3), whereas in England only 1.7% of isolates from alfalfa were of this type (9).

Isolates from Essex County that became systemic in French beans usually produced very mild symptoms in tobacco, moderate symptoms in pepper, and did not infect cucumber. Systemic strains described by Zaumeyer and Patino (26, 27) also showed these tendencies, but those isolated by Houston and Oswald (13) gave typical symptoms on solanaceous hosts. Four of 71 Essex County isolates tested resembled the "alfalfa yellow mosaic" virus in producing an intense systemic yellow mosaic in cowpea (25). A few isolates produced small green rings on the inoculated primary leaves of 'Bountiful' French beans as described by Frosheiser (8).



Figures 1-4. Virus particles from leaf-dip preparations, stained with phosphotungstic acid, pH 7.0, X 66,875. 1) Bean yellow mosaic virus, 2) Red clover vein mosaic virus, 3) Pea streak virus, 4) White clover mosaic virus.

Table 1. Legume viruses in Essex County, Ontario, 1970-73

Source plants	Virus*	Number of times isolated from source plant collections[a]	No. of fields or locations	Number of fields or locations with infection level (%) indicated[a]				Average infection (%) in all fields of each crop and year of cut
				Trace	Up to 10	11-50	51-100	
Field crops								
Red clover, 1st year of cut	none		13					
	AMV	9	4	1	3			0.2
	BYMV	29	14	5	8	1		1.1
	PSV	4	4	4				
	RCVMV	1	1	1				
Red clover, 2nd year of cut	BYMV	4	1			1		20.0
Alfalfa, 1st year of cut	none]		16					
	AMV]	324	19	4	5	8	2	11.1
Alfalfa, 2nd year or older	none]		9					
	AMV]		57	1	5	29	22	44.4
Yellow sweet clover	none		2					
	AMV	1	1		1			
	BYMV	2	2	1		1		
	RCVMV	1	1	1				
Alsike clover	none		2					
	AMV	1						
	BYMV	9	1		1			
Roadsides and waste ground								
Red clover	none		18					
	BYMV	9	9	7	2			
	PSV	7	6	4	2			
	RCVMV	3	3	2	1			
	TRSV[b]	9	9	8	1			
	WCMV	4	4	2			2	
Alsike clover	none		6					
	AMV	1	1	1				
	BYMV	1	1			1		
	PSV	1	1	1				
	TRSV[b]	2	1		1			
	WCMV	1	1			1		
White clover	none		9					
	AMV	3	3				3	
	RCVMV	2	2		2			
	TRSV[b]	3	2		2			
	WCMV	8	7	1	2	3	1	
Yellow sweet clover	none		3					
	AMV	6	4	2		1	1	
	BYMV	8	6	2	2	1	1	
	PSV	1	1	1				
	RCVMV	3	2	2				
	TRSV[b]	3	3	2	1			
Alfalfa	none		4					
	AMV	17	3	2		1		

[a] Collections and estimates of infection were of plants with symptoms, except from alfalfa fields, where in 1972 and 1973 random samples of plants were collected. Viruses in plants with mixed infections are recorded separately.

[b] Includes tobacco and tomato ringspots and possibly other ringspot types.

* AMV - alfalfa mosaic virus; BYMV - bean yellow mosaic virus; PSV - pea streak virus; RCVMV - red clover vein mosaic virus; TRSV - see (b) below; WCMV - white clover mosaic virus.

The frequency of AMV in clovers and alfalfa in Essex County may be related to the presence of many solanaceous crops, especially tomatoes, peppers, eggplants (Solanum melongena L.), and tobacco, as well as to large acreages of soybeans and green beans. Pratt (22) did not isolate AMV from clovers in other areas of Ontario, though it was found in Quebec. AMV was the most frequently isolated virus in red clovers in Washington (10), where large acreages of field beans and alfalfa are grown, and it was frequent in Rhode Island (19). Frosheiser (8) suggested that most initial AMV infections in alfalfa stands may arise from infected seeds.

Bean yellow mosaic virus

BYMV (Fig. 1) occurred widely in red and yellow sweet clovers on roadsides and waste ground. It was the most commonly found virus in red clover field crops, but its incidence in these crops, which normally are kept for only 1 year of cutting, was low (Table 1). Most isolates produced bright mosaics without necrosis in French bean, but a few produced necrosis, as described in the literature (4, 16). Necrotic and mild isolates were recovered from white bean plots at Harrow.

BYMV was estimated to affect 10-50% of the plants in red clover fields in Wisconsin,

Minnesota, Idaho, and Kentucky, compared with 2-10% for AMV (12, 24).

Red clover vein mosaic virus and pea streak virus

These viruses (Figs. 2, 3) occur frequently in red clover crops in Wisconsin, Minnesota, Idaho, and Kentucky (12, 24), but in Essex County red clover crops they were found only infrequently. This may be because pea crops are less frequent, except possibly near Windsor, than in some U.S.A. areas. They were, however, often encountered in roadside clovers in Essex County (Table 1), and RCVMV has been recorded in peas in the county (6). Pratt (22) encountered these viruses in red and white clovers in other parts of Ontario and eastern Canada.

White clover mosaic virus

This virus (Fig. 4), recorded once (1) in clovers in Essex County, was often isolated from white and red clovers on roadsides and in orchards but not from field crops of clovers. White clover patches were often extensively infected with the virus.

Tobacco ringspot and related viruses

Viruses of the tobacco ringspot type, recorded once from red clover field crops in Essex County (6) were frequently encountered in clovers on roadsides and waste ground. In cross-protection tests on local isolates of this type, using known isolates of TRSV and tomato ringspot virus, one local isolate behaved like TRSV, one like tomato ringspot virus, and one behaved like TRSV but did cause some lesions on plants previously inoculated with TRSV. The local tomato ringspot virus isolate, compared with TRSV, caused fewer necrotic patterns on the upper leaves of tobacco, caused more rapid necrosis of C. amaranticolor and did not infect spinach (Spinacia oleracea L.). However, it behaved like TRSV in infecting snapdragon and lima bean (Phaseolus limensis MacF.).

Other viruses

Pea common mosaic and bean common mosaic have been recorded in Essex County (6), but were not encountered in this survey. Clover yellow mosaic virus and clover yellow vein virus have not been found in Essex County.

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ALTERNARIA ALTERNATA STORAGE DECAY OF PEARS[1]

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Abstract

A severe outbreak of Alternaria alternata decay occurred on stored pear, Pyrus communis cv. Clapp Favorite, fruit during the 1972-73 and 1973-74 seasons. This is the first report of A. alternata on pears in Canada. The incidence of A. alternata on other cultivars is noted.

Résumé

Un grave foyer d'infestation d'Alternaria alternata s'est déclaré dans les poires entreposées (Clapp's Favorite) durant les campagnes 1972-1973 et 1973-1974. C'est la première manifestation déclarée de ce champignon dans les poires au Canada. On a également relevé la présence d'A. alternata sur d'autres cultivars.

Decay in stored pears caused by Alternaria alternata (Fr.) Keissler was observed, in the cultivar Clapp Favorite, for the first time in Nova Scotia during the 1972-73 and 1973-74 storage seasons. The severity of the decay increased as the pears ripened. A. alternata was first reported on some pear cultivars by Messetti (2) in southern Europe in 1937. This is the first known report of this fungus causing a rot of pears in Canada.

The identity of A. alternata was verified by K. A. Pirozynski, Mycology Section, Biosystematics Research Institute, Ottawa. This study gives a description of the decay symptoms and the incidence of A. alternata on the fruit of several pear cultivars over a 2-year period.

Observations

In 1972 and 1973, five 1-bushel lots of each of the pear cultivars Clapp Favorite, Bartlett, and Flemish Beauty and two 1-bushel lots of several other cultivars were stored for varying periods at -1.1 C or 0 C. In 1972 all pears received a preharvest spray or postharvest dip of thiabendazole for the control of Penicillium and Gloeosporium storage rots. However, in 1973 only the cultivars Clapp Favorite, Bartlett, and Flemish Beauty received a postharvest drench of thiabendazole.

Table 1. Incidence of *Alternaria alternata* decay on pear cultivars during ripening after storage at -1.1 C or 0 C; incidence figures averaged for two storage seasons, 1972-73 and 1973-74

Cultivar	Weeks in storage	% fruit infected
Clapp Favorite	13	88
Cayuga	21	16
Ewart	11	15
Aurora	31	10
Conference	16	10
Bartlett	13	8
Flemish Beauty	20	1
Bosc	18	0.1
Anjou	22	0
Comice	24	0

Clapp Favorite pears stored at -1.1 C or 0 C for up to 3 months appeared normal when removed from storage but on ripening (2 days at 18 C followed by 5 days at 10 C) superficial dark brown lesions resembling advanced stages of handling scald developed in 2 to 5 days. By 7 days dark-brown to blackish-brown, firm, irregular rotted areas up to 2 cm diameter and 0.5 cm deep developed

[1] Contribution No. 1532, Research Station, Agriculture Canada, Kentville, Nova Scotia.

Figure 1. Pear cv. Clapp Favorite with *Alternaria alternata* decay.

within the scalded areas (Fig. 1). A. alternata was isolated from these decayed areas and the fungus readily produced a rot when inoculated into healthy Clapp Favorite and Bartlett pears from storage. One to several lesions occurred on each affected fruit and the lesions often coalesced in advanced stages of decay. On Clapp Favorite and other pear cultivars stored for more than 3 months circular rots up to 2.5 cm diameter caused by A. alternata were present when pears were removed from storage. During ripening these lesions enlarged and often additional lesions developed.

Clapp Favorite, which is very susceptible to handling scald, was found severely infected with A. alternata during both storage seasons (Table 1). Five cultivars, Cayuga, Ewart, Aurora, Conference, and Bartlett, had a light incidence of A. alternata and two cultivars, Bosc and Flemish Beauty, had a trace to 1% decay. Anjou and Comice were free of A. alternata both seasons, and it did not develop on Clara Frijs, Gorham, Grand Champion, Magness, Precocce de T., Packhams Triumph, and Passe Crassane, which were stored only in 1972-73.

There was no evidence that thiabendazole enhanced the incidence of A. alternata. In other tests with Clapp Favorite pears which were not treated with thiabendazole, there was also a high incidence of A. alternata.

Controlled atmosphere storage showed some promise for control of A. alternata. Previously Lockhart (1) reported that no Alternaria decay was found on pears ripening in air after they had been exposed to 2% CO_2 and 2% O_2 for 16 and 20 weeks.

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SOME PLANT DISEASES IN HOME GARDENS IN THE TORONTO AREA, 1973[1]

G.B. Orlob,[2] A. Burnett, E. Kidd, and R.F. Cerkauskas[3]

During a research project on minimizing the use of chemical pesticides in the home garden, pests, diseases, and weeds occurring in 25 gardens in and around Toronto, Ontario, were brought to our attention by participating gardeners. In addition, a few other gardens were visited and the diseases present recorded. Considering the pronounced site diversity that characterizes the home garden only a small proportion of all diseases that affect ornamentals, vegetables, and trees were found.

As a rule home gardeners were more concerned about pest insects and weeds than about plant diseases. Unless diseases were severe they had to be pointed out to the gardener. Even if diseases were recognized, gardeners experienced great difficulty in diagnosing them. Plant diseases were not a serious problem in gardens we have seen regardless of whether or not controls were applied.

In the following table plant pathogens are listed as they were observed throughout the growing season. Virus diseases are not listed because of the difficulties involved in proper identification. Bacterial diseases were recorded only if they could be identified through characteristic symptoms. Fungal diseases were identified by symptoms and spore characteristics.

Table 1. Fungal and bacterial pathogens detected in home gardens in the Toronto area 1973

Host	Pathogen	Disease rating*/ occurrence†
Hollyhock	*Puccinia malvacearum*	Mod/Sp
Tulip	*Botrytis tulipae*	Mod/R
Peach	*Taphrina deformans*	Sev/W
Plum	*Dibotryon morbosum*	Sl/R
Maple	*Rhytisma acerinum*	Sl/Sp
Almond	*Monilia laxa*	Sl/Sp
Apple	*Venturia inaequalis*	Tr-Sev/W
Onion	*Peronospora destructor*	Tr/R
Euonymus; Forsythia	*Agrobacterium tumefaciens*	Sl/R
Rose	*Sphaerotheca pannosa*	Tr-Mod/Sp
Currant	*Sphaerotheca mors-uvae*	Sl/R
Rhubarb	*Ascochyta rhei*	Sl/R
Tomato	*Alternaria tomato*	Sl/R
Maple	*Gloesporium apocryptum*	Sl/R
Rose	*Diplocarpon rosae*	Tr-Sev/W
Phlox; Zinnia	*Erysiphe cichoracearum*	Mod/Sp
Grape	*Guignardia bidwellii*	Sl/Sp
Grape	*Plasmopara viticola*	Sl/Sp
Hawthorn	*Fabraea thuemenii*	Mod/Sp
Lilac; Viburnum	*Microsphaera penicillata*	Mod/W
Chrysanthemum	*Septoria chrysanthemi*	Mod/R
Sunflower	*Puccinia helianthi*	Sl/R

* Tr = trace, Sl = slight, Mod = moderate, Sev = severe.

† R = rare, Sp = spotty, W = widespread.

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