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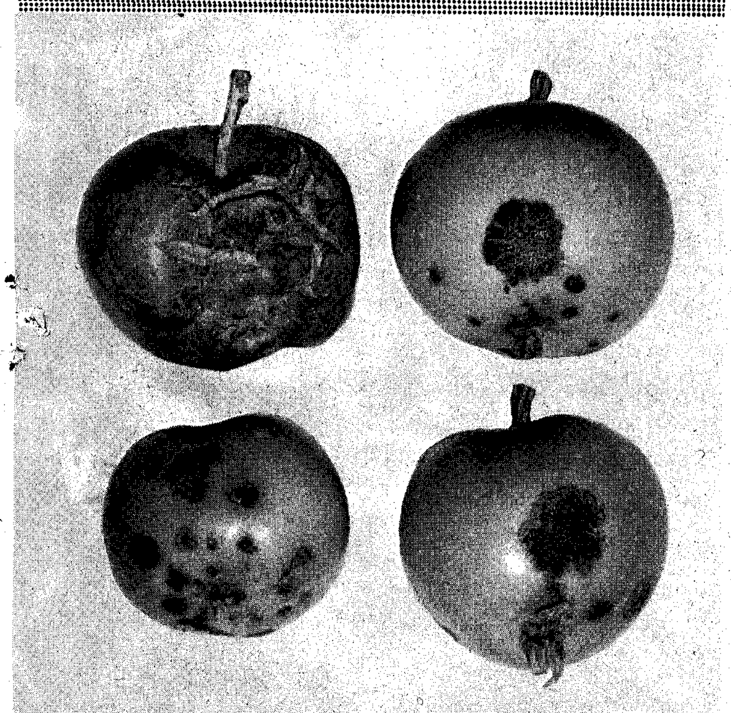

PLANT RESEARCH INSTITUTE
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Canada Department of Agriculture

CANADIAN PLANT DISEASE SURVEY

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CONTENTS

SPRAYING CARROTS FOR CONTROL OF LEAF BLIGHTS IN 1961

Jacques Simard[1]

Abstract

Five sprays with maneb at the rate of 2 lb per acre applied at 10-day intervals during July and August, in a replicated field experiment, gave good control of leaf blights of late carrot and higher yields of carrot roots (significant at 1% level). One application of maneb gave statistically significant control of leaf and petiole drop, a characteristic symptom of Alternaria blight.

Résumé

Cinq pulvérisations avec du manebe appliqué à tous les dix jours durant juillet et août, à raison de 2 livres à l' acre, ont assuré une répression des brûlures foliaries de la carotte et permis un meilleur rendement. Les résultats des parcelles traitées étaient significativement différents des résultats obtenus dans les parcelles témoins. De plus, une application de manebe prévient la chute des pétioles de la carotte, symptôme caractéristique de la brûlure alternarienne.

Introduction

The leaf blights of carrot caused by *Alternaria dauci* (Kühn) Groves & Skolko, and *Cercospora carotae* (Pass.) Solheim, have become increasingly common in the muck soils of the Montreal area during the past 2 years (3, 4). These diseases cause considerable loss in commercial plantings whether they occur singly or together.

Succesful control of these diseases by the use of Bordeaux mixture and fixed copper compounds was reported from Ohio as early as 1944 (9). In the Montreal area, as in many other carrot growing areas, the fungicides now preferred are maneb and zineb. However, repeated spraying with these fungicides has failed to give satisfactory control in many muck soil areas. Experiments were started in 1961 to obtain additional information on the effectiveness of maneb and a better timing of fungicidal applications. This paper reports the results obtained in the first year.

Symptoms

The symptoms of Cercospora blight are similar to and often confused with those of Alternaria blight, although differences in symptoms have been described in many papers (1, 2, 7). Cercospora lesions are usually marginal although any part of the leaf or petiole may be attacked. Spots are nearly circular and usually have a light tan-colored center with a darker border.

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Lesions on petioles are usually elongate and often have a more or less light-colored center, as shown in Figure 1. Under moist conditions, lesions induced by Cercospora may be dark colored.

Lesions produced by Alternaria appear first as irregular dark-brown to black spots, surrounded by yellowish areas, near the margins of the leaflets. Usually the leaves dry up, turn brown or black, die, and finally drop off. This gives the field a seared appearance, as illustrated in Figure 2.

FIGURE 1. ELONGATE AND CIRCULAR LESIONS WITH A LIGHT TAN-COLORED CENTER PRODUCED BY *CERCOSPORA CAROTAE* ON PETIOLES OF CARROT.

FIGURE 2. FOLIAGE REMAINING ON UNSPRAYED CARROTS JUST BEFORE HARVEST. NOTE THE SEARED APPEARANCE OF THE FOLIAGE.

The two diseases usually occur together. C. carotae appears earlier in the season than Alternaria and is most severe on the young leaves. Infection builds up when the plants are relatively young. A. dauci is more pathogenic on old leaves and does not become prevalent until the plants approach maturity (2).

Materials and Methods

The experiment was carried out on muck soil at the Research Substation at Ste-Clotilde, Que. Carrots of the variety Gold Pak were seeded on June 8. Randomized plots consisting of 8 rows, each 60 feet long, were sprayed with maneb at the rate of 2 lb per acre. Each treatment was replicated 4 times. The treatments were as follows:

Treatment 1 - Control
" 2 - One application of maneb
" 3 - Two applications of maneb
" 4 - Three applications of maneb
" 5 - Four applications of maneb
" 6 - Five applications of maneb

Fungicidal applications were started on July 6, and repeated at 10-day intervals during July and August, until about 4 weeks before the crop was harvested on September 20. Just before harvest, 35 plants were picked at random in each plot, and the number of petioles attached to each crown was determined. The petioles were cut 4 inches from the crown and the number of lesions was counted on each petiole. The roots were harvested and the yield determined for each treatment. The results obtained were evaluated statistically and are presented in Table 1.

Table 1. Control of Alternaria and Cercospora blights of carrot in 1961

Treatment	Number of lesions	Number of petioles	Yield (lb)
Control	824(1)	180	233
1 application	737	222	285
2 applications	668	224	281
3 applications	351	238	285
4 applications	142	235	286
5 applications	66	225	328
LSD 0.01	652	38	6

(1) Each figure is the mean of 4 replicates.

Results and conclusions

Little disease was noticeable in the control plots at the end of August, but shortly after this the plots which were not sprayed began to show characteristic symptoms of foliar blights. By mid-September, the difference in color and density of the foliage on the sprayed and unsprayed plots was very striking. The results indicate that 4 applications of maneb are necessary for effective control of Alternaria and Cercospora lesions on carrot. A fifth application of fungicide did not give significantly better control of the diseases but gave higher yields of commercial roots. One application of fungicide significantly increased yields of carrot roots, and gave significant control of leaf and petiole drop.

The results indicate that spraying carrots with maneb may be beneficial, especially if weather conditions are favorable for infection by Alternaria and Cercospora blights. Similar results were obtained in Ohio, where an increase in yield of 66.7 per cent followed 4 applications of Bordeaux mixture (8).

The information obtained in the first year of this experiment justifies further work on the problem. It is hoped that subsequent experiments, and the results of current epidemiological studies (5, 6), will permit better timing of treatments and more effective and economical control of foliar blights of carrots.

Table 1. Storage rots in the first and second pickings of Stokesdale tomatoes from spray plots at the end of 5 weeks in storage at 53°F in 1960.

	Total per cent rots		Per cent rots caused by			
			C. coccodes		A. tenuis	
Fungicide per 100 gallons	1st	2nd	1st	2nd	1st	2nd
Maneb, 2 lb.	44 ab[2]	33 de	30 a	7 a	12 abcd	21 a
" 1 lb. + thiram, 1 lb.	29 abc	53 bcd	15 a	19 a	13 abcd	23 a
" 1 lb. + Dyrene, 1 1/4 lb.	21 c	34 de	5 a	13 a	12 abcd	12 a
" 2 lb. + thiram, 2 lb.	19 c	39 de	13 a	7 a	5 cde	22 a
Zineb (factory mix), 2 lb.	34 abc	41 cde	12 a	9 a	17 ab	16 a
" 2 lb. + Dyrene, 1 3/4 lb.	34 abc	62 abc	22 a	17 a	8 bcde	24 a
" 1 lb. + thiram, 1 lb.	17 c	39 cde	5 a	10 a	9 abcde	12 a
Zineb (tank-mix nabam, 1 qt. + 3/4 lb. zinc sulphate)	50 a	63 abc	17 a	12 a	18 a	35 a
" half strength + thiram, 1 lb.	34 abc	28 c	24 a	9 a	2 e	9 a
" half strength + Dyrene, 1 1/4 lb.	25 bc	66 ab	20 a	18 a	3 de	17 a
" full strength + Dyrene, 1 3/4 lb.	21 c	43 bcde	14 a	10 a	7 cde	17 a
" full strength + thiram, 2 lb.	16 c	48 bcde	8 a	18 a	7 cde	20 a
Ziram, 2 lb. alternating with Bordeaux 10-7-100	38 ab	50 bcde	27 a	15 a	10 abcde	29 a
Blitox[1], 3 lb.	30 abc	50 bcde	14 a	16 a	13 abcd	26 a
Control	50 a	77 a	27 a	21 a	15 abc	21 a

[1] 50% copper as the oxychloride.

[2] Small letters indicate Duncan's Multiple Range grouping of treatments which do not differ significantly at the 5% level.

THE CONTROL OF STORAGE ROTS OF MATURE-GREEN TOMATOES IN NOVA SCOTIA[1]

C.L. Lockhart[2] and K.A. Harrison[2]

Abstract

Field sprays of a mixture of thiram and maneb or tank-mix zineb consistently gave some control of storage rots of mature-green tomatoes. Other mixtures gave variable results. The dominant microorganisms causing rots of stored tomatoes were: Colletotrichum coccodes (Wallr.) Hughes and Alternaria tenuis Nees.

Introduction

At the present time tomatoes have a very short storage life and must be marketed soon after they are harvested. Extending the storage life of mature-green tomatoes would be advantageous to the tomato industry. Eaves and Lockhart (1) found that tomatoes could be held in controlled atmospheres for an extended period but concluded that fungal decay was the major limitation to prolonged storage.

In 1960 and 1961 tomatoes were stored to determine the effects of different fungicide spray programs for the control of storage rots. The results obtained are given in this paper.

Methods

Tomatoes of the variety Stokesdale were obtained from the fungicide plots previously described by Harrison (2). Each treatment was replicated 4 times in a randomized block design. Fungicidal sprays were applied when an infection period by the late blight organism appeared imminent. In 1960 four applications were made between July 22 and September 15, inclusive, and in 1961 six applications between July 10 and September 11, inclusive. The tomatoes for storage were picked in the mature-green stage on September 30 and October 12, 1960, and on September 12 and 20, 1961. Twenty-five tomatoes were harvested from each plot on each picking date and stored at 53°F for 5 weeks in single layers on trays (18 x 36 in.) lined with brown paper. The tomatoes were examined at weekly intervals and all fruits showing rot were removed from the trays. Isolation and identification of unknown rots were made on potato-dextrose-agar. A thermograph recorded the field temperatures during September and October.

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[1] Contribution No. 1090 from the Research Station, Canada Department of Agriculture, Kentville, Nova Scotia.

[2] Plant Pathologists.

Acknowledgements

I wish to express my thanks to J.J. Jasmin, Officer-in-Charge, and the personnel of Canada Department of Agriculture Research Sub-station at Ste-Clotilde, and to T. Simard, R. Garneau, A. Paris, K. Choquette, and P. Lavigne of the Quebec Department of Agriculture Muck Crops Plant Protection Station, for their kind collaboration in this work. The author is also indebted to Dr. W.E. Sackston, Professor of Plant Pathology at Macdonald College, for his critical reading of the manuscript.

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Table 2. Storage rots in the first and second pickings of Stokesdale tomatoes from spray plots at the end of 5 weeks in storage at 53° F in 1961.

Fungicide per 100 gallons	Total per cent rots		Per cent rots caused by *C. coccodes*		*A. tenuis*	
	1st	2nd	1st	2nd	1st	2nd
Maneb, 2 lb.	14 bc[2]	14 bc	8 bc	9 c	3 a	3 a
" 1 lb. + thiram, 1 lb.	9 bc	13 bc	3 bc	8 c	2 a	3 a
" 1 lb. + Dyrene, 1 1/4 lb.	7 bc	17 bc	4 bc	13 bc	1 a	3 a
" 2 lb. + thiram, 2 lb.	6 bc	8 c	3 bc	4 c	1 a	3 a
Zineb (factory mix), 2 lb.	9 bc	16 bc	5 bc	13 bc	4 a	1 a
" 2 lb. + Dyrene, 1 3/4 lb.	8 bc	10 c	6 bc	8 c	0 a	1 a
" 1 lb. + thiram, 1 lb.	11 bc	13 bc	5 bc	5 c	4 a	6 a
Zineb (tank-mix nabam, 1 qt. + 3/4 lb. zinc sulphate)	10 bc	7 c	6 bc	4 c	3 a	2 a
" full strength + Dyrene, 1 3/4 lb.	5 bc	10 c	1 c	5 c	2 a	2 a
" full strength + thiram, 2 lb.	3 c	10 c	1 c	4 c	1 a	3 a
Ziram, 2 lb. alternating with Bordeaux 10-7-100	12 bc	13 bc	9 bc	7 c	2 a	3 a
Blitox[1], 3 lb.	26 a	22 b	22 a	19 b	4 a	2 a
Control	16 ab	37 a	13 b	32 a	2 a	3 a

[1] 50% copper as the oxychloride.

[2] Small letters indicate Duncan's Multiple Range grouping of treatments which do not differ significantly at the 5% level.

Results and Discussion

The effects of the various fungicide schedules on storage rots in 1960 and 1961 are shown in Tables 1 and 2 respectively. Less total rot developed in 1961 than in 1960. This difference was largely due to the higher incidence of Alternaria rot in 1960 (Table 1). The decrease in rots may have been due to the increased number and more regular applications of fungicides in 1961. Another factor that may have influenced the incidence of Alternaria rots was low field temperatures. According to McCollock and Worthington (3) low temperatures favor the development of Alternaria rots in tomatoes. In 1960 a minimum temperature below 40° F occurred on 6 different days whereas in 1961 the minimum temperature never dropped below 40°F.

The dominant microorganisms causing rots of stored tomatoes were: Colletotrichum coccodes (Wallr.) Hughes and Alternaria tenuis Nees. Microorganisms of lesser importance were: Botrytis cinerea Pers. ex Fr., Sclerotinia sp., Phoma destructiva Plowr., Fusarium spp., Penicillium spp., Mucor sp., and bacteria.

The results in Tables 1 and 2 show some significant differences in the control obtained with the various fungicide schedules. Thiram combined with the higher rates of maneb or the full strength tank-mix zineb gave the most consistent control of the various rots. These schedules also give good control in the field of late blight and Botrytis grey mold (2). The alternating program of ziram and Bordeaux gave a significant reduction of anthracnose in the second picking of 1961 (Table 2). Blitox was unsatisfactory and in most other schedules the results varied between the two years and the two picking dates. In spite of the variable results obtained on the effect of fungicides on storage rots, there is some indication that the storage life of tomatoes can be lengthened by the use of suitable fungicides in the field.

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BLOSSOM AND POD BLIGHT - AN UNUSUAL DISORDER OF THE PEA[1]

V.R. Wallen and M.D. Sutton[2]

Abstract

A sporadically occurring blossom and pod disease of garden pea was found in epiphytotic proportions in 1957 and in trace amounts in 1958 and 1961. Only plants of short-stemmed varieties growing in sandy soil were affected. Infected blossoms all contained sand crystals that had been propelled into the blossoms by means of severe hard-driving rain or hail. Alternaria tenuis and two unidentified species of bacteria were isolated from diseased blossoms and pods. Under specific conditions described in the text the Alternaria reproduced the disease. The occurrence of the disease is dependent upon a sequence of events that must occur during blossom and early pod formation.

Introduction

During the summer of 1957, particularly in the month of June, a characteristic symptom unlike those of any of the common pea diseases appeared on the blossoms and young pods of peas of the garden variety Improved Laxton's Progress growing in sandy soil. In 1958, in an adjacent plot, a few blossoms of the variety Profusion were noted with similar symptoms. In 1961, the disease was noted on a few plants of the variety Improved Laxton's Progress in the same area as in 1957. These observations, together with one record in 1931 (1) of a "blossom blight" caused by a species of Alternaria constitute the only records of a distinct blossom disorder of peas in Canada. Unfortunately the 1931 record did not give any description of symptoms or other pertinent information; it is therefore impossible to determine if the sequence of events that brought about the disease described below was similar to that recorded in 1931.

Symptomatology

When the disease was first observed in the field, blossoms in all stages of development were affected. A few small pods emerging from the affected blossoms were also diseased.

Depending on the stage of blossom development when attacked, symptoms ranged from a slight water-soaked appearance to complete necrosis of the petals with subsequent petal fall and death of the young flowers (Figure 1). Slightly affected flowers formed pods, but in the majority of cases the pods failed to develop and did not set seed. Pod infection caused a necrotic, water-soaked appearance at the stem end of the pod that gradually spread over most of the pod. Severely affected pods shrivelled and died shortly after emergence from

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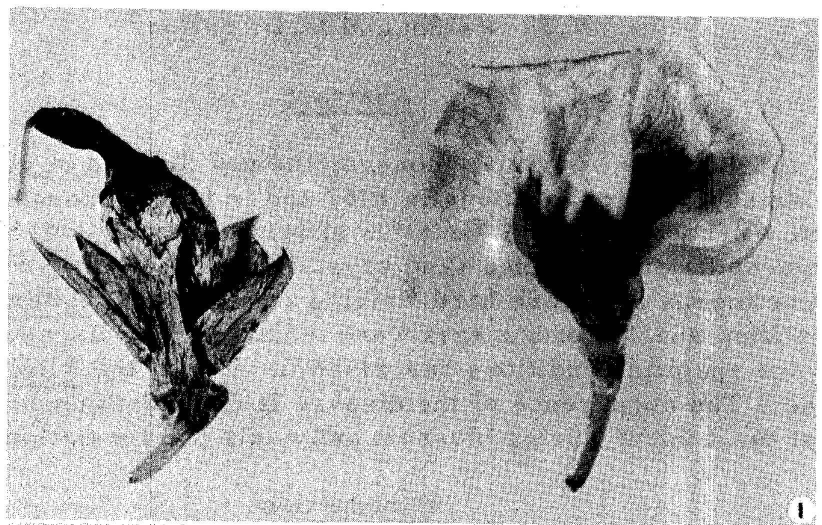
[1] Contribution No. 176 from the Plant Research Institute, Research Branch, Canada Department of Agriculture, Central Experimental Farm, Ottawa.

[2] Plant Pathologists.



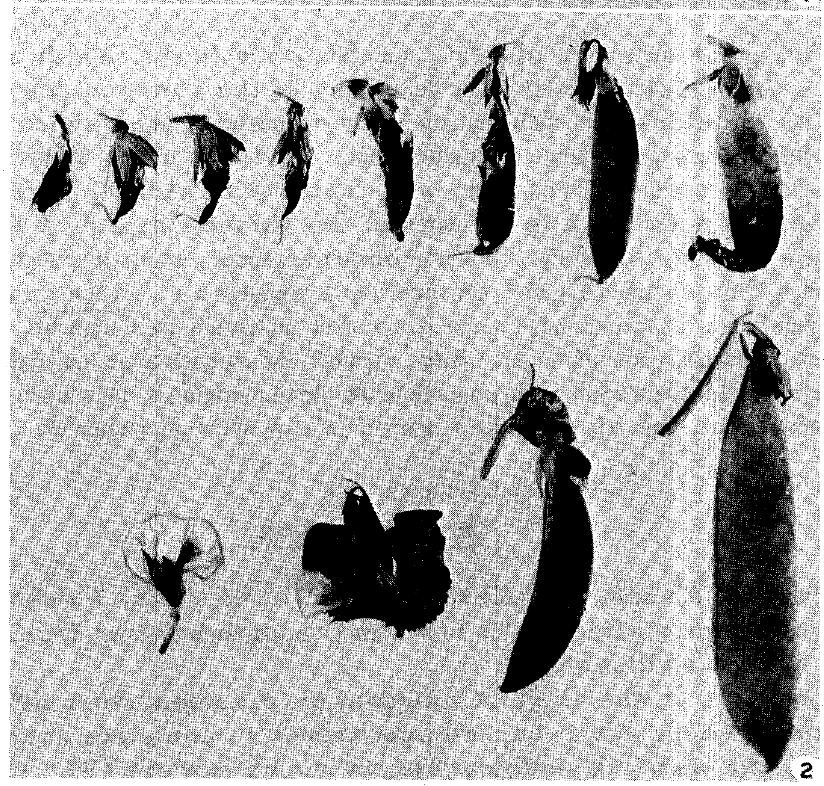


FIGURE 1. LEFT, APEA BLOSSOM AFFECTED WITH BLOSSOM BLIGHT. RIGHT, A HEALTHY PEA BLOSSOM OF SIMILAR AGE.

FIGURE 2. UPPER SERIES, EIGHT PODS IN VARIOUS STAGES OF DEVELOPMENT SHOWING SYMPTOMS OF POD BLIGHT. LOWER SERIES, TWO HEALTHY BLOSSOMS AND TWO HEALTHY PODS.

the flower (Figure 2). In many cases the petiole turned dark-brown to purple and broke off, leaving only a short stump attached to the pod.

Materials and Methods

To detect pathogenic microorganisms, petals and pods from affected blossoms were surface-sterilized for 2 minutes in 2 per cent chlorine solution (Javex standardized to 2 per cent available chlorine as sodium hypochlorite), washed in sterile distilled water, and plated on pea and yeast beef agars. The pea agar plates were incubated for 10 days at room temperature and examined for fungi. The yeast beef agar plates were incubated at 28°C for 96 hours and examined for bacteria. In addition, smears were prepared, stained and examined.

For inoculation studies, pea seedlings, variety Improved Laxton's Progress, were grown in pots in the greenhouse until flowering. Bacterial and fungal spore suspensions were prepared from affected tissues in water, nutrient broth and distilled water respectively. In replicated tests, blossoms were atomized with suspensions of the isolated organisms separately and removed to four growth chambers held at 15°, 20°, 25° and 30°C. The chambers provided sufficient light for growth (1000 foot candles) and a high R.H. of approximately 90 per cent. Other lots of flowering pea plants were treated similarly and removed to a greenhouse held between 18° and 22°C. The R.H. was maintained close to saturation.

In a second test the blossoms of seedlings of similar age were treated as before with the exception that the young blossoms were blasted with fine sand delivered by means of a small hand-operated duster used for dusting fungicides on foliage. The blossoms were subjected to the sand blast for 10 seconds. Following treatment, the seedlings were inoculated with suspensions of the test organisms and removed to the growth chambers and greenhouse.

In both growth room and greenhouse tests, suitable controls were provided.

Results and Observations

An *Alternaria* of the *tenuis* type was isolated and maintained on pea agar. Two gram-negative bacterial species frequently found in leguminous plant tissues were isolated and demonstrated by smearing and staining. Both species grew well at 28-32°C on yeast beef agar. The most prevalent organism found in the tissues was a small coccal bacillus which, on isolation, produced a small, white, circular, convex, smooth, entire, opaque colony on yeast beef agar. On the same medium the other bacterial species isolated was a long rod that produced a yellow colony with similar characteristics.

Where the blossoms had not been sand blasted no infection was obtained in any of the tests in growth chambers or in the greenhouse following inoculation with the two species of bacteria and with the *Alternaria* However, in the 20°C chamber, on blossoms subjected to the sand blast followed by inoculation with the *Alternaria* isolate, 7 of 25 blossoms showed characteristic symptoms of blossom blight (Table 1). No infection occurred at 15°C. At 25°C and 30°C an almost complete collapse of all plants occurred followed by complete overgrowth by *Botrytis cinerea*.

Table 1. Effect of sand blasting blossoms of healthy pea seedlings maintained in a growth room at 20°C and inoculated with two species of bacteria and a species of *Alternaria*.

Organism	Treatment	No. healthy blossoms	No. diseased blossoms
Control		25	0
White bacterium	Untreated	25	0
White bacterium	Sand blasted	25	0
Yellow bacterium	Untreated	25	0
Yellow bacterium	Sand blasted	25	0
Alternaria sp.	Untreated	25	0
Alternaria sp.	Sand blasted	18	7

Several diseased blossoms, collected from the original plots in 1957, were examined microscopically. In all cases, sand crystals were present in the blossoms. Healthy blossoms, examined at that time, revealed only a trace of or complete absence of sand. It was also observed that only blossoms borne close to the ground on the short-stemmed varieties, Improved Laxton's Progress and Profusion, showed symptoms of disease; taller vine types, grown in the sar area, were disease-free.

Records obtained from the Agrometeorology Unit, Plant Research Institute, revealed that severe weather conditions prevailed during flowering time in 1957. During the last week in June, a total of four inches of rain fell in the area where the peas were grown; 1.68 inches of rain fell on June 23 together with sporadic hail showers. The remainder of the four inches fell as heavy, hard-driving rain storms on June 24, 28, 29 and 30.

Discussion

Blossom blight was found only in one section of a field where the soil was composed primarily of sand and in short-stemmed varieties where the flowers were close to the ground level. The fact that sand crystals were found in the diseased blossoms from this section and that no infection took place in growth room or greenhouse tests where sand was not used prior to inoculation indicates that sand or some other abrasive material is important in establishing infection courts for the initiation of this disease. The presence of sand in the blossoms, particularly in 1957, was the result of hard-driving rain and hail that propelled the sand into the blossoms. The absence of disease in tall pea varieties may be explained by the height of the blossoms from ground level.

In this particular test, the *Alternaria* isolate produced typical symptoms under certain growth room conditions. It is quite possible that other saprophytic fungi might produce this disease under favorable conditions. It is not the purpose of this paper to state that the disease is caused by this particular *Alternaria* isolate but more to a sequence of events that is dependent upon the initial establishment of infection courts through wounds.

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THE SUSCEPTIBILITY OF POTATO VARIETIES TO STORAGE ROTS CAUSED BY FUSARIUM SAMBUCINUM F6 AND FUSARIUM CAERULEUM AND TO WILT CAUSED BY VERTICILLIUM ALBO-ATRUM IN 1961

G.W. Ayers[1]

The susceptibility of twenty-one potato varieties and seedling lines to rots caused by two species of *Fusarium* (*F. sambucinum* f. 6 and *F. caeruleum*) and of eighteen varieties and lines to wilt caused by *Verticillium albo-atrum* was tested at Charlottetown in 1961. The tests for susceptibility to Fusarium rots were made by immersing artificially wounded tubers in spore suspensions (1000 spores per cc) of the respective pathogens. Tuber lots were inoculated with *F. sambucinum* f. 6 on January 9 and examined for decay on May 15. Similar lots were inoculated with *F. caeruleum* on February 20 and examined on May 25. The test for susceptibility to Verticillium wilt consisted of a pre-planting immersion of seed pieces in a spore suspension of *V. albo-atrum*. The relative susceptibility of the tested varieties to the three pathogens is shown in Tables 1-3.

Table 1. Relative susceptibility of twenty-one potato varieties to tuber rot caused by *F. sambucinum* f. 6 - 1961.

Variety	Average percent rot	Converted averages
F 3324	89.0	70.75
F 4724	84.8	68.00
F 5561	81.5	64.71
F 5649	81.2	64.44
Sebago	80.6	63.97
Keswick	78.7	63.20
F 4913	78.1	62.41
Kennebec	78.0	62.67
F 5510	75.6	60.85
F 5611	75.4	60.46
F 5143	72.5	58.84
Fundy	72.0	58.22
F 5317	64.9	54.00
F 4834	63.8	53.11
F 5459	62.6	52.53
Norgleam	59.6	50.60
Hunter	58.4	49.71
F 4519	53.3	46.86
F 5669	52.6	46.53
Green Mountain	51.2	45.69
Irish Cobbler	28.4	32.16
N.D.S. at P=0.05		6.65

[1] Plant Pathologist, Experimental Farm, Research Branch, Canada Agriculture, Charlottetown, P.E.I.

Table 2. Relative susceptibility of twenty-one potato varieties to tuber rot caused by F. coeruleum - 1961.

Variety	Average percent rot	Converted averages
F 5459	45.0	42.13
F 5649	41.9	40.32
F 5669	37.7	37.89
F 5561	33.8	35.42
F 5510	30.6	33.55
F 4834	30.4	33.38
Fundy	29.6	32.87
F 5317	26.3	30.69
Keswick	25.2	30.02
F 4519	24.4	29.34
Hunter	23.8	29.15
F 3324	18.3	25.14
F 4913	17.9	24.60
F 4724	17.7	24.64
F 5143	15.2	22.58
Sebago	11.6	18.54
F 5611	11.5	19.75
Norgleam	9.0	17.33
Green Mountain	8.1	15.48
Kennebec	5.8	12.92
Irish Cobbler	4.1	10.93
N.D.S. at P=0.05		5.61

Table 3. The relative susceptibility of eighteen potato varieties to wilt caused by Verticillium albo-atrum - 1961.

Variety	Percent wilt[1]
Norgleam	62.5
F 5284	43.0
Irish Cobbler	35.5
F 5247	34.5
F 5609	32.0
Kennebec	26.5
Norland	26.0
ND 3324	23.0
F 5669	23.0
Fundy	17.0
F 5649	17.0
F 5611	14.5
F 5350	12.5
F 5570	10.5
F 5459	10.0
F 5113	3.5
F 5559	3.0
F 5561	0.5

[1] Based on 4 replicates, 50 plants per replicate.

On the basis of the known susceptibility of the varieties Sebago and Keswick to F. sambucinum f. 6 the results of the trials in 1961 indicate that at least ten other varieties and lines are equally or only slightly less susceptible to this organism. Relative resistance was noted in tuber stocks of Irish Cobbler, Green Mountain, F5669, F4519 and Hunter.

In several years of screening for resistance to F. caeruleum, consistent resistance has been found in stocks of Irish Cobbler, Sebago, Green Mountain and Kennebec. A high degree of varietal susceptibility has been more difficult to estimate because of the variability in results from year to year. It is felt that a minimum of three years testing is required for a true appraisal of high susceptibility. Using Keswick as a known standard of high susceptibility to F. caeruleum, the data obtained in 1961 appear to indicate that several Fredericton seedlings are quite susceptible to decay from that organism.

Several potato lines appear to be highly susceptible to Verticillium wilt when Irish Cobbler is used as a standard of known reaction. The variety Norgleam in particular showed severe symptom development. Fredericton seedlings F5561, F5559 and F5113 showed a high degree of resistance.

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RHIZOCTONIA SOLANI KÜHN AS A COMPONENT OF THE STRAWBERRY ROOT ROT COMPLEX IN BRITISH COLUMBIA[1]

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Abstract

Root rot of strawberries is estimated to cause an average loss of 20 per cent of the plants in the strawberry-growing areas of British Columbia. The typical symptom is a sudden collapse of the plants just before or during the early part of the fruiting season. *Rhizoctonia solani* Kühn was isolated frequently from such plants, and inoculations with this organism produced a severe root rot condition in British Sovereign strawberry plants. Petiole and crown infection also occurred. In controlled temperature studies the root rot symptoms were more severe at 35° - 60°F while petiole and crown infection was more pronounced at 60° - 90°F.

Introduction

During the past few years losses due to "summer dying" of strawberry plants, caused by root diseases, have averaged about 20 per cent of the plants in the main strawberry-growing areas of British Columbia. The heaviest loss observed was on a Vancouver Island plantation where 80 per cent of the plants died in a few weeks at the beginning of the 1958 picking season. *Rhizoctonia solani* Kühn has been reported to be a serious pathogen of strawberries in California (5), Ontario (1, 2, 4), Oregon (6), and Quebec (3).

Symptoms

In the early stages of "summer dying" the undersides of the leaves become purple and tend to curl upwards. The petioles turn brown and may become frayed at the base in the latter stages of plant wilt. The original crowns are frequently dead and numerous side crowns may develop.

Internal brown discoloration extending upwards is usually present in the basal tissues of living crowns. Young adventitious roots of these plants show dark-brown lesions which are typically most severe at the necks of the roots. Feeder rootlets in the lesioned areas are almost invariably killed and the steles of the roots are sometimes necrotic in the lesioned areas. Within a few weeks, plants killed by *Rhizoctonia* may be scattered throughout the plantation.

Isolations of *R. solani* were made from plants in all stages of wilt, and from young runner plants in spring. The varieties from which the isolations were made included Agassiz, British Sovereign, Northwest, Perle de Prague, and Siletz.

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Experimental Results

Inoculations were made with five different isolates of R. solani. Young, unrooted runners of the variety British Sovereign, still attached to the mother plant, were rooted into 5-inch pots filled with steam-sterilized greenhouse compost which was inoculated by mixing one Petri plate of actively-growing mycelium with the soil in each pot. Five pots were used for each isolate and five as controls.

An isolate from the crown of the variety Northwest was the most pathogenic. It caused severe root rot, discoloration of the petioles, and a brown discoloration in the cortical regions in the bases of the crowns. All the other isolates produced milder symptoms of root rot and petiole infection.

Further tests with the Northwest isolate were made and the following method of inoculation was used. The fungus was grown in 500 ml Ehrlenmeyer flasks, half filled with a cornmeal-sand medium, until it had completely penetrated the medium. One flask was used to inoculate a 6-inch-deep flat filled with steam-sterilized soil. Ten young runner plants of the variety British Sovereign were planted to a flat. One flat each of inoculated and uninoculated soil was then placed in the following temperature ranges: 35-45°F, 50-60°F, 60-70°F, and 70-90F. An artificial light period of 15 hours was provided by fluorescent lights.

Dark-brown lesions appeared on the petioles of the plants in the inoculated series after 8 days at 70-90°F (Fig. 1). Petiole infection was most severe at the higher temperatures. Many plants had all leaves infected or killed in the 60-70°F and 70-90°F ranges. The lesions completely girdled the petioles and often extended into the leaf blades. When these leaves were pulled off the plants they showed a typically frayed base.

Three weeks after inoculation the plants were lifted and examined for root and crown rot. Root rot was present at all temperature ranges, (Fig. 2), but it was more severe at the lower temperatures. Some root systems were completely rotted, while others showed the typical lesions on the necks of the roots and also along the root surface (Fig. 3). In severely affected plants the feeder rootlets had dropped off giving the roots a rat-tail-like appearance. Browning was observed in the internal crown tissues of most of the plants, starting in the region of root initiation and gradually discoloring the entire crown tissues (Fig. 4). This crown discoloration was most pronounced in plants set relatively deep in the soil. In some instances the terminal bud was killed and new side buds had started to develop (Fig. 5).

These studies show that R. solani is an important component of the strawberry root-rot complex, and is capable of causing severe losses in strawberry plantations under the climatic conditions of the coastal regions of British Columbia.

Acknowledgments

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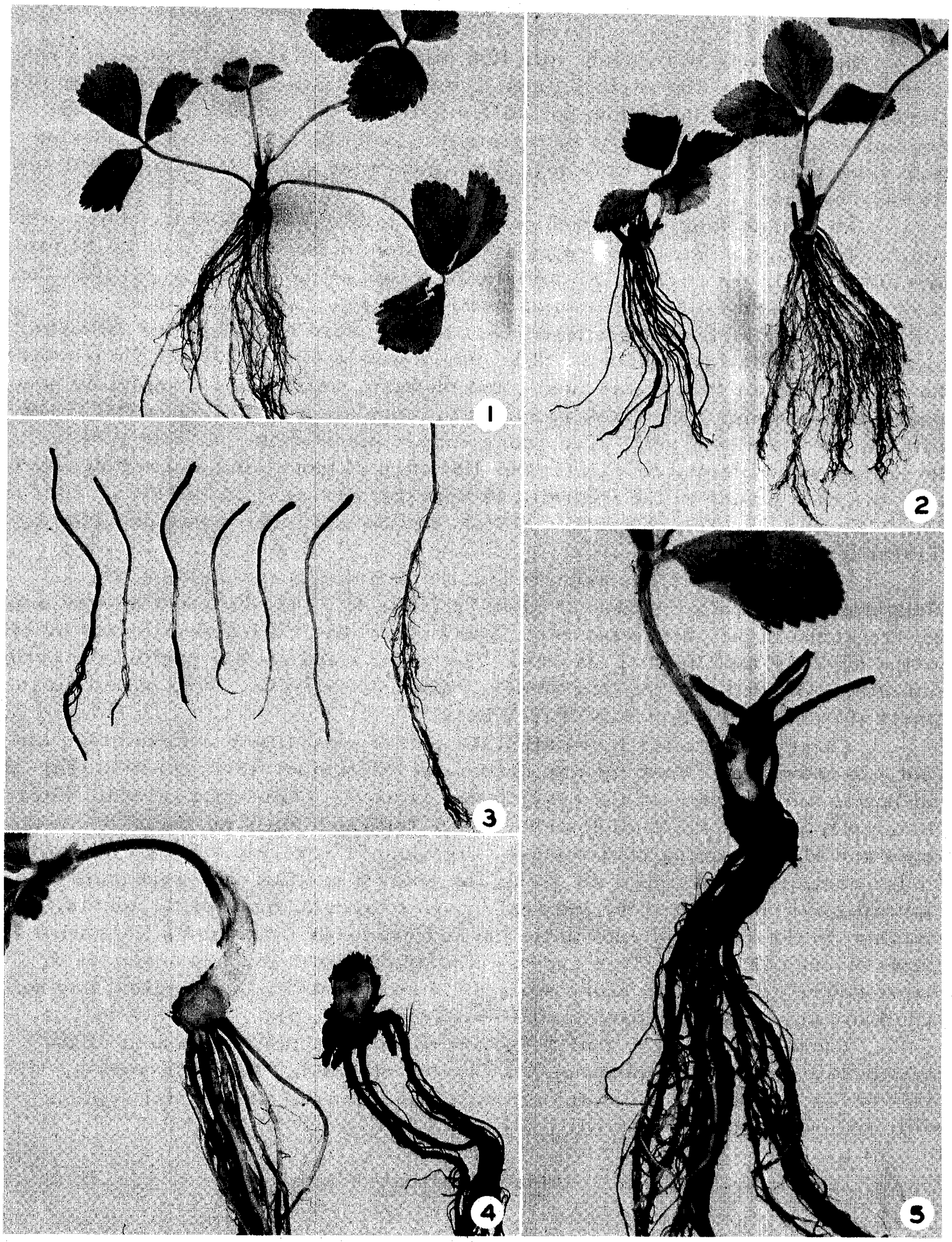

FIG. 1. BRITISH SOVEREIGN STRAWBERRY PLANT, 8 DAYS AFTER INOCULATION, IN THE 70–90°F TEMPERATURE RANGE. THE PETIOLES SHOW DARK BROWN LESIONS ON THE BASES. FIG. 2. BRITISH SOVEREIGN PLANT THREE WEEKS AFTER INOCULATION, SHOWING SEVERE ROOT ROT. PLANT ON RIGHT NON-INOCULATED. FIG. 3. ROOTS FROM INOCULATED PLANTS ON THE LEFT, CONTROL ON THE RIGHT. NOTE THE TYPICAL LESIONS ON THE NECKS OF THE ROOTS. FIG. 4. HEALTHY PLANT ON LEFT, INOCULATED PLANT ON THE RIGHT. INTERNAL BROWNING IS MOST PRONOUNCED IN THE REGION OF ROOT INITIATION. NOTE THE ABSENCE OF LEAVES. FIG. 5. TERMINAL BUD WAS KILLED AND NEW SIDE BUD IS DEVELOPING ON THE CROWN OF INOCULATED PLANT.

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EXPERIMENTAL FARM, CANADA AGRICULTURE,
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THE CONTROL OF RASPBERRY ANTHRACNOSE IN NOVA SCOTIA[1]

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Abstract

Bordeaux 10-5-100 was better than Elgetol as a delayed dormant spray for the control of raspberry anthracnose. Erad and Cyprex were less effective.

Introduction

The usual recommendation in Nova Scotia for the control of red raspberry anthracnose, caused by *Elsinoe veneta* (Burkh.) Jenk., has been a delayed dormant spray of Elgetol or lime sulphur in early May, followed by an application of ferbam in early June, and, in severe outbreaks, by another application of ferbam in August after the removal of the fruiting canes. Elgetol and lime sulphur are no longer easily obtained in Nova Scotia because they are now rarely used in orchard pest control. In 1959, a large plantation of raspberries of the variety Washington became severely and uniformly infected with *E. veneta* and it was used for fungicide tests in 1960.

Methods

Twenty-five plots, each 33 feet long, were arranged along 5 center rows in the field in a Latin square and a delayed dormant spray application was made on May 5. The fungicides used and their rates per 100 gal. were:

1. 1/2 gal. Elgetol (19% sodium dinitro-*o*-cresylate)
2. 10-5 Bordeaux (10 lb. copper sulphate, 5 lb. hydrated lime)
3. 1/2 pt. Erad (10% phenylmercuric acetate)
4. 1 lb. dodine (65% *n*-dodecylguanidine acetate)
5. Check (no fungicide)

The fungicides were applied to run-off at 200 lb. pressure with a single-nozzle gun. The remainder of the field was sprayed with Elgetol at 1/2 gal. per 100 gal. of water. On May 31, when the turions had reached a height of 7-9 inches, the entire plantation, except the checks, received an application of ferbam at 2 lb. per 100 gal.

On July 19 the number of anthracnose lesions was counted on 10 fruiting laterals from each plot. On the check, the lesions frequently coalesced and estimates were made when necessary. The figures 25 and 50 were used when it was obvious that the number of lesions exceeded either of these figures. None of the treatments was phytotoxic.

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Results and Discussion

The mean numbers of lesions per plot from each treatment were: Bordeaux, 5; Elgetol, 22.6; Erad, 38.6; dodine, 57.6; check, 327.4. L.S.D. (P = 0.05) 34.0 without check, 158.0 with check. The numerical differences are high but the only statistically significant differences are between all fungicide treatments and the check and between Bordeaux and dodine. In the past Elgetol has given practical control of anthracnose but its performance was poor in this experiment. It is a good eradicant but a poor protectant fungicide and therefore did not protect the canes from the large amount of inoculum spreading from the checks during most of the month of May. This opinion was supported by counts made in the area sprayed with Elgetol and ferbam outside the Latin square. A mean of 13.8 lesions was found on laterals from each of 5 rows. It was not possible to carry the observation further as the grower abandoned the field because of weeds and the lack of a crop. It is obvious that Bordeaux was better than the other fungicides tested and that it should be recommended as a dormant spray for control of raspberry anthracnose in Nova Scotia.

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THE MINERAL CONTENT OF THE LOWBUSH BLUEBERRY[1]

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Abstract

All lowbush blueberry plants receiving various levels of phosphorus had normal foliage and no leaf spotting occurred. The foliage of plants not containing phosphorus became necrotic and at the end of 3 months the plants were dead. The results indicated that blueberry plants require very little phosphorus for growth, since those receiving 1 ppm phosphorus grew as well as those receiving 64 ppm and contained about the same amount of phosphorus.

In a field survey of the mineral content of lowbush blueberry plants, manganese was found to be extremely high in both sprout and first-crop plants. The manganese levels were found to range from 629 to 3475 ppm. In first crop plants levels of nitrogen, phosphorus, potassium and copper were higher; calcium, cobalt and zinc generally were higher, and boron, iron and aluminum were lower than those in the sprout plants. Magnesium levels showed little or no differences between sprout and first-crop plants.

Introduction

In a previous study Lockhart (5) found that in the advanced stages of phosphorus deficiency necrotic spots on the older terminal leaves of lowbush blueberry were similar to a leaf spotting of undetermined origin. This observation on leaf spotting suggested the possible importance of the mineral content of the lowbush blueberry. Apart from reports by Chandler (1) and Chandler and Mason (2) on the mineral composition of the whole blueberry fruit there is little information in the literature on the mineral content of lowbush blueberry plants.

A study was therefore undertaken to determine the phosphorus content and effects of various levels of phosphorus on lowbush blueberries grown in sand culture in the greenhouse. Determinations were also made on the mineral content of blueberry plants growing naturally in the field. The results obtained are given in this paper.

Materials and Methods

Greenhouse experiment

Ten-week old lowbush blueberry seedlings, *Vaccinium angustifolium* var. *laevifolium* House, were transferred to nutrient solutions (5) containing

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0, 1, 2, 4, 8, 16, 32 and 64 ppm of phosphorus at pH 4.0 using the sand culture technique described previously (5). The treatments were replicated 4 times in randomzied blocks. The length of all shoots was measured at weekly intervals and totalled for each plant. After 23 weeks in culture leaf samples from new growth were analyzed for total phosphorus (13). A week later the plants were removed from sand culture, the roots washed free of sand and the weights of shoots and roots were determined after drying in an oven at 50°C for 24 hours.

Table 1. Effect of P levels on the growth and phosphorus content of blueberry plants (Mean values of 4 replicates).

P levels in ppm.	Accumulative shoot length in cm. At 3 months	At 6 months	Dry weight in gm. Shoots	Roots	% P in leaves
0	4.7	-	-	-	-
1	56.6	257.5	4.10	0.99	0.20
2	66.7	261.1	4.97	1.32	0.25
4	83.4	299.1	5.47	1.40	0.25
8	41.6	151.4	3.82	0.95	0.20
16	73.0	233.6	3.85	0.91	0.21
32	62.4	223.6	3.75	0.74	0.21
64	61.8	243.6	3.45	1.30	0.24
L.S.D. 5% level	32.2	121.8	N.S.	N.S.	0.021

Field survey

For determinations of the mineral content of the field samples of lowbush blueberry, *V. angustifolium* var. *laevifolium*, plants were collected between July 7 and 15 from sprout and first-crop fields at West Brook, Halfway River and Parrsboro, Nova Scotia. Ten random samples were collected from each of 3 sprout and 3 first-crop fields. The samples were air-dried and analyses of the whole plant were made for nitrogen, phosphorus (9), cobalt, zinc (8), copper (3) and aluminum (10).

Boron in blueberry plant tissue was determined by the Hatcher and Wilcox carmine method (4) with the following modifications:

(i) The use of $Ca(OH)_2$ in place of CaO
(ii) Centrifuging at 2000 rpm. for 10 minutes rather than filtering.

Manganese was determined by the potassium periodate method in combination with H_3PO_4 (12). The following modifications were used:

(i) Heat gently for 30 minutes.
(ii) 12 gm sample dry ashed, then digested with 8 ml of concentrated H_2SO_4 until the color becomes white, then filtered, made to 100 ml volume and an aliquot used for the determination.

Table 2. Mineral content of lowbush blueberry plants collected in the field (Mean values of 10 samples).

	Parrsboro				Halfway River				West Brook			
	Sprouts		1st crop		Sprouts		1st crop		Sprouts		1st crop	
Mineral	Range	Ave.	Range	Ave.	Range	Ave.	Range	Ave.	Range	Ave.	Range	Ave.
N (%)	2.00-2.47	2.18	1.42-1.56	1.50	1.62-2.23	1.83	1.15-1.40	1.30	1.91-2.45	2.18	1.46-1.60	1.50
P (%)	0.152-0.196	0.169	0.100-0.126	0.109	0.118-0.160	0.136	0.092-0.104	0.098	0.130-0.198	0.159	0.097-0.117	0.106
K (%)	0.57-0.76	0.64	0.43-0.56	0.46	0.49-0.63	0.57	0.37-0.49	0.42	0.56-0.83	0.67	0.45-0.63	0.51
Mg (%)	0.09-0.14	0.12	0.13-0.16	0.15	0.11-0.13	0.12	0.11-0.19	0.125	0.15-0.18	0.17	0.15-0.20	0.17
Ca (%)	0.35-0.45	0.39	0.48-0.58	0.49	0.39-0.52	0.46	0.39-0.63	0.55	0.36-0.49	0.41	0.46-0.62	0.52
Co (ppm.)	0.037-0.133	0.069	0.063-0.097	0.083	0.060-0.121	0.096	0.093-0.153	0.120	0.013-0.049	0.032	0.037-0.072	0.052
Mo (ppm.)	0.010-0.193	0.082	0.015-0.084	0.047	0.077-0.252	0.165	0.117-0.290	0.205	0.013-0.068	0.042	0.016-0.142	0.052
Zn (ppm.)	25.0-38.0	31.8	27.7-44.8	35.7	21.5-47.5	30.9	29.0-47.5	36.2	19.7-37.0	27.4	26.7-44.5	36.6
Mn (ppm.)	1659-2779	1993	1504-2317	1835	2150-2934	2442	1830-3475	2906	629-1468	1159	803-1759	1130
Cu (ppm.)	6.9-11.0	8.5	5.0-7.4	6.0	5.3-6.7	6.2	4.5-6.0	5.4	7.0-10.1	8.2	4.8-8.7	6.9
B (ppm.)	9.7-18.7	14.9	13.9-23.6	20.5	15.1-23.8	20.5	17.8-26.2	21.6	16.1-24.1	18.6	20.2-29.9	23.9
Fe (ppm.)	40.55	45	59-65	74	37.51	44	60-117	69	40-72	54	63-121	81
Al (ppm.)	70-131	88.1	102-198	155.5	89-141	106.4	86-216	148.8	59-108	89.1	122-172	143.1

Iron was determined by a dipyridyl-hydroxylamine hydrochloride method* recommended by the Macaulay Institute for Soil Research, Aberdeen, Scotland.

Potassium, calcium and magnesium were determined by the flame photometer method (6) using a Beckman DU spectrophotometer with a flame attachment. The results of the mineral content of the blueberry plants are given in Table 2.

Results and Discussion

Greenhouse Experiment

All plants at the various levels of phosphorus had normal foliage and no leaf spotting occurred. The plants not receiving phosphorus produced little growth, the foliage gradually became completely necrotic and, at the end of 3 months, the plants were dead. Typical leaf spotting did not occur.

The data in Table 1 show that at the end of 3 months accumulative shoot length of blueberry plants was significantly better at all levels of phosphorus than in those not receiving phosphorus. Plants receiving 8 ppm. phosphorus showed significantly less growth than those receiving 4 ppm. due to the considerable variation in growth which occurred between plants of each treatment, because open-pollinated seedlings were used. These results indicate either that blueberry plants require very little phosphorus, since these receiving 1 ppm. phosphorus grew as well and contained about the same amount of phosphorus as those receiving 64 ppm., or that the continuous flow method (5) of supplying phosphorus is not suitable for studies of phosphorus deficiency in lowbush blueberries. The blueberry plants apparently absorbed all the phosphorus they required from a continuous flow of 1 ppm.

Field survey

The data in Table 2 show that the levels of nitrogen, phosphorus, potassium and copper were consistently lower in first-crop plants than they were on the sprout plants. Boron, iron and aluminum were consistently higher in first-crop plants than in the sprouts. Calcium, cobalt and zinc generally were higher in first-crop plants than in sprouts but in some instances there was overlapping of values between ranges of first-crop and sprout plants. Magnesium and manganese gave variable results. The levels of potassium, phosphorus, magnesium, calcium and iron were similar to those in highbush blueberries reported by Mikkelsen and Doehlert (7). However, the manganese content of the lowbush blueberries was over 15 times that reported for the highbush blueberry. This high manganese content may be of some significance in the physiology of the lowbush blueberry. Somers and Shive (11) considered that most plants require a 2:1 Fe/Mn ratio for normal growth and freedom from pathological symptoms. The Fe/Mn ratios in Table 2 vary from 0.018 to 0.075. It is reasonable to expect that high manganese would interfere with the uptake and utilization of iron at low pH values. Further studies on the iron and manganese content are necessary to determine their effect on growth of the lowbush blueberry.

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OAT STEM RUST AND OTHER CEREAL RUSTS IN EASTERN ONTARIO IN 1961[1]

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Abstract

In the last week of July, 1961, an area in eastern Ontario between Kingston, Hawkesbury, and Lancaster was surveyed for the incidence of cereal rusts. Oats were severely infected by stem rust (Puccinia graminis Pers. f. sp. avenae Erikss. & Henn.) only in the vicinity of barberry. Traces of crown rust (P. coronata Cda.) were observed in most oat fields and, in the vicinity of buckthorn, infections were much heavier. Wheat, generally, had moderate infections of leaf rust (P. recondita Rob. ex Desm.) and stem rust (P. graminis Pers. f. sp. tritici Erikss. & Henn.) but the infections caused little damage.

Physiologic races 4A, 6, 6A, 8A, 10A and 13A of oat stem rust were identified in various localities in the area. The "A" races in this group, which do not occur in Western Canada, are capable of parasitizing the widely grown varieties Rodney and Garry. The races of crown rust identified from collections made on this survey are similar to those found in other parts of Canada. Most of them attack the commonly grown varieties including Rodney and Garry. Race 56 of wheat stem rust predominated in the area as it did in Western Canada. The importance of barberry and buckthorn in the area is discussed.

Introduction

New and dangerous races of oat stem rust (Puccinia graminis Pers. f. sp. avenae Erikss. & Henn.) were found in Eastern Canada in 1957 (2) and soon seemed to predominate in eastern Ontario and parts of Quebec (2). The rust collections from these areas that were used for race identifications were obtained by co-operators, usually in and around their experiment plots. Some of the plots were located where barberry occurs. It would be expected that races originating on barberry close to these sites would predominate in the collections. Wind-borne inoculum from distant areas is of little consequence because the local varieties are resistant to the races of stem rust prevalent in other parts of North America. Consequently, the results of physiologic race surveys may have been biased in favor of the races originating locally on barberry and the dangerous new races may not have been as prevalent as the survey results indicated.

In 1961, an attempt was made to determine whether the results of earlier physiologic race surveys had been biased. In the last week of July,

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the area between Kingston, Hawkesbury, and Lancaster in eastern Ontario was surveyed to obtain collections of the cereal rusts truly representative of the rust population of the area and to determine the severity of rust infection. This area was selected because the dangerous races found in former years occurred commonly in an area south-west of Ottawa in the vicinity of Appleton and Merrickville and because the presence of common barberry has been reported in several localities in the area (5). Several circumstances prevented the full realization of the objectives. The oat varieties Garry, and especially Rodney, occupy most of the oat acreage in eastern Ontario. In other parts of North America Garry is resistant to all of the stem rust races found and Rodney is susceptible only to race 7A. Rust inoculum carried into the district by air currents is not likely to infect them and no host variety or species susceptible to races of stem rust avirulent on Rodney and Garry was commonly found. Consequently, there was not much chance of collecting races from other regions, even though they were carried into the area. The chances of finding widespread stem rust infection on oats was reduced further by the scarcity of this rust in central North America. Little inoculum was available for movement into the eastern area. It is likely, therefore, that nearly all the stem rust collected during the survey originated on barberry bushes near the collection site. The survey served to identify the races that originated on barberry in different localities in the area but an unbiased estimate of the races represented in the primary inoculum of the area was probably not obtained and it is unlikely that such an estimate can be obtained.

Comparatively few wheat fields were found in the district. The winter wheat varieties cultivated are susceptible to both stem rust (*P. graminis* Pers. f. sp. *tritici* Erikss. & Henn.) and leaf rust (*P. recondita* Rob. ex Desm.).

Conditions for rust development in eastern Ontario were not unfavorable. The cool moist season had delayed crops, giving added time for rust development.

Results

Stem rust of oats (Table 1) occurred in important amounts in a few localities (Appleton, Merrickville, Kemptville, and Sunbury) where barberry is common (5). Elsewhere it was absent or scarce. Even where trace amounts of stem rust were found one would suspect that barberry occurred in the locality. Stem rust losses for the area were small in total but some fields in the vicinity of barberry were severely damaged.

Trace amounts of crown rust of oats were found in nearly all localities (Table 1) indicating that air-borne inoculum from other regions, probably to the south-west, was distributed throughout the area. The alternate host of crown rust, European buckthorn (*Rhamnus cathartica* L.), occurs commonly in some localities in the area (5) and inoculum from buckthorn caused epiphytotics of varying severity in a number of these localities. Although losses were small in general, some fields in the vicinity of buckthorn were damaged.

This survey confirmed the implication of local barberry as a major source of stem rust races. The same or similar races were identified in the various barberry localities (Table 1) and races able to attack Rodney and Garry predominated. Although the occurrence of the same races in different barberry areas was not anticipated it is not surprising. The widespread cultivation of resistant varieties exerts strong selective pressure favoring races capable of

Table 1. Incidence of stem-rust and crown-rust of oats in eastern Ontario July 24 to 26, 1961, and physiologic races identified.

Locality	Variety[1]	Stem Rust			Crown Rust		
		% Plants Affected	% Infection	Races Isolated[3]	% Plants Affected	% Infection	Races Isolated[3]
South March	Rodney	Tr[2]	Tr	6A(1)	Tr	Tr	--
Carp	Rodney	0	--	--	Tr	Tr	209(1)
Kinburn	Rodney	0	--	--	100	Tr	284(1)
Almonte	Rodney	Tr	Tr	6A(1), 4A(1)	100	10-20	210(2), 211 (1), 228(1)
Appleton	--	100	60	6(1), 6A(5), 10A(1)	--	--	--
Smiths Falls	Rodney	0	--	--	Tr	Tr	210(1)
Merrickville	Garry	100	80	6A(5), 13A(1)	100	60	284(2)
Kemptville	Russell	50	Tr	6A(4), 8A(1), 13A(2)	50	Tr-10	210(1), 229 (1)
Kemptville	Rodney	0	--	--	100	Tr-10	--
North Gower	Rodney	Tr	Tr	6A(1)	--	--	--
North Gower	Rodney	Tr	Tr	6A(1)	--	--	--
North Gower	--	5	Tr	--	--	--	--
Ashton	Rodney	Tr	Tr	--	Tr	Tr	284(1)
Innisville	--	Tr	Tr	--	Tr	Tr	--
Perth	Rodney	0	--	--	100	30	--
Perth	Rodney	0	--	--	90	Tr-5	--
Lombardy	--	0	--	--	50	Tr	--
Portland	--	0	--	--	100	20	--
Crosby	--	0	--	--	Tr	Tr	--
Sunbury 4E[4]	Rodney	Tr	Tr	--	100	Tr	--
Sunbury 1 1/2E	Rodney	50	Tr	6A(1), 10A(1)	100	Tr-30	210(1), 283(1)
Sunbury 1 1/4E	--	50	Tr	--	100	Tr	--
Sunbury 1E	Rodney	5	Tr	--	--	--	--
Sunbury 1/2E	Rodney	5	Tr	--	--	--	--
Sunbury 1S	Rodney	100	20-30	--	Tr	Tr	--
Sunbury 3S	--	0	--	--	Tr	Tr	--
Kingston 5W	--	0	--	--	Tr	Tr	--
Lansdowne	--	0	--	--	Tr	Tr	--
Brockville (3 fields)	Rodney	0	--	--	Tr	Tr	--
Spencerville (2 fields)	Rodney	0	--	--	Tr	Tr	--
Alfred (2 fields)	Rodney	0	--	--	Tr	Tr	210(1)
Hawkesbury	Garry	0	--	--	Tr	Tr	210(1), 230 (1), 272(2)
Vankleek Hill	Rodney	Tr	Tr	--	--	--	--
Vankleek Hill	--	0	--	--	0	--	--
Vankleek Hill	Russell	0	--	--	0	--	--
Alexandria	--	0	--	--	0	--	--
Williamstown	--	0	--	--	Tr	Tr	203(1), 284 (1)
Williamsburg	Clintland?	Tr	Tr	6(1)	100	10	--

1/ Varieties were identified, in nearly all instances, by field appearance. A dash signifies that no identification was made.

2/ Tr = Trace.

3/ Number of isolates in brackets.

4/ Miles east, south, or west of location shown.

parasitizing these varieties. These races are important from the practical standpoint because most of them can attack all of the commercial varieties of oats available today.

The identification of physiologic races of oat crown rust in eastern Ontario (Table 1) did not demonstrate conclusively that many races originated locally in buckthorn. The races of crown rust found in western Canada in earlier years were as varied as those of the eastern area in 1961, and many races have been found in both areas. But, despite the lack of evidence from race identifications, the circumstantial evidence clearly indiates that in some localities much of the primary inoculum originated locally on buckthorn.

Wheat stem rust was common but not damaging in nearly all the wheat fields examined (Table 2). Traces of stem rust were observed in the few barley fields examined and moderate infections were found on spring rye in the rust nurseries at Appleton and Merrickville.

The races of wheat stem rust found throughout the eastern Ontario area (Table 2) occurred also in other parts of Canada. The well-known race 56 predominated in eastern Ontario as it did in western Canada and presumably was carried into the eastern area by air currents. Races 11 and 15B-1L (Can.) have been found in western Canada for several years and probably were carried into eastern Ontario. Race 38 was more common in the eastern area than elsewhere in Canada but this race was common in the United States in 1961 and may also have been carried into the area.

The results discussed above indicate that barberry did not play an important part in the development of wheat stem rust in eastern Ontario in 1961. Similar results were obtained (3) in an earlier study of the varieties of stem rust occurring on barberry in eastern Canada. The small part played by barberry in the epidemiology of wheat stem rust in the area can be attributed to the relatively small acreage of wheat grown.

The rust on rye in the rust nurseries at Appleton and Merrickville probably originated on nearby barberry bushes. Rye stem rust (*P. graminis* Pers. f. sp. *secalis* Erikss. & Henn.) is common on the widely distributed *Agropyron repens* L. and has been isolated frequently from barberry in eastern Canada (3).

Discussion

The evidence presented indicates that barberry is an important local factor in the epidemiology of oat stem rust in eastern Ontario. The predominance of oats as a field crop throughout the area assures that barberry, where it exists, will be infected by oat stem rust. The spread of rust to the young oat crop seems inevitable and severe local damage can be anticipated whenever conditions favor rust development.

The responsibility of barberry in the production and perpetuation from year to year of new and dangerous physiologic races in eastern Ontario can scarcely be questioned in view of the evidence presented here and elsewhere (2). The pathogenic capacity of the races found since 1957 raises the question of the future of oat production in the area if barberry is not controlled. Oat improvement programs could prove ineffective if new races of stem rust soon offset increased rust resistance in new varieties and rust losses reduce the effects of other improvements in new varieties.

The resistance of the predominant varieties appears to be an important factor influencing the races produced on barberry. The varieties Rodney

Table 2. Incidence of stem rust on wheat, barley, and rye in eastern Ontario July 24 to 26, 1961, and the physiologic races identified.

Locality	Crop	% Plants Affected	% Infection	Races Identified 3/
Carp	Winter Wheat	100	5-20	15B-1L(1), 56(1)
Appleton 1/	Spring Wheat	100	10	17(1), 56(5)
	Barley	100	1-5	
	Rye	100	10	
Merrickville 1/	Spring Wheat	100	20	11(1), 15B-1L(1), 17(1), 38(1), 56(8)
	Barley	100	1	
	Rye	100	40	
Kemptville	Winter Wheat	100	10	11(1), 15B-1L(1), 17(1), 38(3), 56(5)
	Barley	Tr 2/	Tr	
Vankleek Hill	Winter Wheat	100	5-10	56(1)
Williamstown	Barley	Tr	Tr	56(1)
Perth	Winter Wheat	100	20-30	--
	Winter Rye	5	5	--
Kingston	Winter Wheat	100	20	11(1), 56(1)
Ganonoque	Winter Wheat	100	20	56(1)
Brockville	Winter Wheat	100	5	56(1)
Crosby	Barley	50	Tr	--
Sunbury	Barley	50	Tr	--

1/ Susceptible spring varieties sown in rust nurseries.
2/ Tr = Trace.
3/ Number of isolates in brackets.

and Garry were first distributed in quantity in Ontario in 1955. They met with immediate and widespread farmer acceptance and by 1957 were grown on over 65 per cent of the farms in Ontario (1). The results of the present survey indicate that they continued to increase in popularity after 1957. The first races found that could attack both Rodney and Garry (8A and 13A) were discovered in 1957 and along with other races able to attack these varieties soon became predominant in the barberry areas. The rapid increase of these races can be attributed largely to the selective effect of the resistance of the predominant oat varieties operating in conjunction with hybridization of the rust on barberry.

The potential economic importance of barberry in eastern Canada has been recognized for many years. In 1938 Newton (6) stated (p. 125) "In both eastern Canada and British Columbia the common barberry is present and undoubtedly plays a part in the introduction of new races of stem rust" and also (p. 138) "In eastern Canada and British Columbia some (barberries) are present, but up to the present no exhaustive survey has been made to ascertain how numerous and widely distributed they are. Consequently their importance in perpetuating stem rust from year to year has not been appraised. In these areas, although cereal production is not so important as in the Prairie Provinces, there is little doubt that eradication of barberry is justifiable".

The distribution of barberry in Ontario has been investigated more recently and its commercial importance discussed (4, 5). Both investigators state that at the time of their surveys barberry eradication seemed feasible and should be undertaken, but to be successful an eradication program must be executed with great persistence.

The distribution of buckthorn in eastern Ontario was investigated by Mulligan (5) who discussed its economic importance. In some localities buckthorn probably constitutes a greater hazard than any known concentration of barberry. In these areas the number of buckthorn bushes is so great that eradication might be difficult (5).

In 1961 the spread of rust from barberry and buckthorn in eastern Ontario was confined to certain localities and although losses were small in aggregate, some fields in these localities were severely damaged. An expansion of the barberry and buckthorn localities seems likely. Indeed, Lindsay (4) states that a barberry area in western Ontario is expanding rapidly. If barberry and buckthorn are not soon checked they may become so numerous as to be uncontrollable and, given time, will jeopardize oats and other cereal crops throughout eastern Canada.

Acknowledgements

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WHEAT STRIATE MOSAIC, A VIRUS DISEASE TO WATCH ON THE PRAIRIES [1]

J. T. Slykhuis

Abstract

Wheat striate mosaic, caused by a virus transmitted by the leafhopper Endria inimica (Say), was found on a trace to 1 percent of the plants in nearly all wheat fields examined in early July, 1961, along a route from Carlyle, Sask. to Winnipeg, Manitoba. Diseased Ramsey and Selkirk plants were severely stunted and many died before normal maturity. Several other spring wheat and all durum varieties tested at Ottawa proved highly susceptible, but the reactions of many other varieties of spring wheat, and most varieties of winter wheat ranged from immune to moderately susceptible. Most varieties of oats and barley developed only faint to moderate symptoms. Brome grass was also infected by the virus, and may be a reservoir host.

Cerealists should become aware that if wheat striate mosaic virus became abundant it could cause immense damage to highly susceptible varieties now used on the prairies, but that many other varieties and breeding lines would probably not be seriously affected by the disease.

Introduction

Wheat striate mosaic was first recognized as a destructive disease of wheat in 1951 when it was proved to be caused by a virus that was transmitted by a common grass-feeding leafhopper, Endria inimica (Say) (2). Virus workers in Nebraska have verbally reported striate mosaic virus in wheat and oats, and Dr. H. Jedlinski has reported in private communication that the disease occurs in Illinois. Timian found that the disease was prevalent on durum and hard red spring wheat in North Dakota in 1959 (4). He also stated verbally that he saw symptoms of the disease on wheat in southern Manitoba in 1959. The vector, E. inimica, is common and often extremely abundant in grassland areas across southern Canada (1).

During a survey for cereal viruses in July 1961, severe symptoms of wheat striate mosaic were found on a few plants in almost all fields of Ramsey durum and Selkirk spring wheat examined along a route from Carlyle, Sask. through Brandon to Winnipeg, Manitoba (3). Although the incidence of striate symptoms was not above 1 per cent in any of the fields, the distribution was surprisingly uniform along the route of survey. The diseased plants were characterized by fine, parallel, yellow to white dashes and streaks on young leaves, severe chlorosis and necrosis of older leaves, reduction in head development, and sterility. Diseased plants were stunted 30 to 50 per cent, and usually died prematurely. The foliage of the healthy wheat was sparse because of severe drought in 1961 and the diseased plants were readily seen, whereas they may have been hidden if the foliar growth of the

[1] Contribution No. 221, Plant Research Institute, Research Branch, Canada Department of Agriculture, Ottawa, Ontario.

healthy plants had been more abundant.

It appeared that varietal susceptibility could be an important factor related to the widespread appearance of the disease, hence tests were done at Ottawa to determine the reactions of various cereal varieties and grass species to the striate mosaic virus.

Transmission tests and host reactions

Diseased wheat plants dug from fields in southeastern Saskatchewan and Manitoba were packed with their roots in polyethylene bags to which water was added to keep the roots moist. The tops were covered with cloth sleeves to serve as cages. Live leafhoppers (*E. inimica*) collected in the vicinity of wheat fields were placed in the cages. Because the weather was hot and dry, the plants were packed in a foam plastic ice chest, cooled by a frozen pack of ice substitute, and transported by air to Ottawa. Diseased plants collected at Winnipeg later in July by Dr. W. A. F. Hagborg were also forwarded to Ottawa for tests. Striate symptoms, similar to those observed in the field, developed on Ramsey durum and Selkirk spring wheat on which *E. inimica* that had been kept on diseased wheat were allowed to feed. An incubation period of one to three weeks was required between infection and the development of symptoms on the wheat plants.

For further experiments leafhoppers were collected on lawns and on grass plots on the Central Experimental Farm, Ottawa. All *Endria inimica* from these sources were non-infective to wheat until after they had fed on diseased plants. A high proportion of the insects became infective with feeds as short as one-half hour on diseased plants, but for most tests they were left on the diseased plants for 2 days, and usually 60 per cent or more became infective. Regardless of the time on the diseased plants, the insects were not able to infect healthy plants with striate virus until 6 or more days after they first fed on the diseased plants. However, some insects remained infective for several weeks to two months, and often for the remainder of their lives.

The reactions of a large number of cereal varieties to wheat striate virus were tested in the greenhouse. The results (Tables 1 to 5) showed a remarkable range in the reactions of wheat varieties. Some spring wheats were highly susceptible, a few developed no visible symptoms, but most developed faint to moderate symptoms. The disease would not be readily recognized in the field on many of the latter varieties. It is interesting to note that Selkirk is one of the most susceptible varieties, and develops pronounced fine yellow streaks, necrosis and severe stunting. In contrast, Thatcher, Rescue and Chinook were among the few that did not develop symptoms. All the durum varieties tested were classed as highly susceptible. Most winter wheats, including all Ontario varieties, developed only vague, mild, symptoms that would not be easily recognized in the field. Severe symptoms developed on only three named varieties of winter wheat including Minter and Nebred, which were the varieties on which the disease was first recognized in South Dakota, and Winalta, a new variety with Minter parentage developed for southern Alberta. Most varieties of oats and some barley varieties developed mild to moderate symptoms. Victory oats appeared highly susceptible.

Table 1. Reactions of Spring and Durum Wheat Varieties to Straite Virus*

O No Symptoms	I Faint Chlorosis or indistinct streaks	II Mild to Moderate Straite and Stunting	III Severe Striate Stunting and Necrosis
SPRING WHEAT VARIETIES			
Thatcher C.A.N. 1820	Lee WG57920	Acadia C.A.N. 3541	Cadet WG58368
Willet	Mida WG57842	Canthatch C.A.N. 3968	Lake WG59147
	McMurachy WG57667	Cascade C.A.N. 3593	Prelude C.A.N. 1481
	Red Bobs WG59131	Ceres WG57669	Redman WG59141
	Red Fife C.A.N. 1515	Conley WG57963	Regent WG59139
		Exchange	Renown WG59138
		Henry WG59427	
		Hope WG59440	
		Marquis	
		Reward WG59135	
SPRING WHEAT CO-OP TEST VARIETIES			
C.T. 503 Thatcher	C.T. 323	C.T. 1 Marquis	Selkirk
707 Rescue	406 Saunders	229 Pembina	C.T. 253
708 Chinook	428	244	257
740		512	258
743		812	259
744			260
745			261
746			427
			429
DURUM WHEAT VARIETIES			
			Cappelli
			Carleton
			Golden Ball WG59156
			Mindum WG59154
			Nugget WG59159
			Ramsey WG59160
			Sentry WG57818
			Stewart WG59158
			Tehuacan

*These varieties were supplied by Dr. R.G. Anderson, Research Station, Research Branch, Canada Agriculture, Winnipeg, Manitoba.

Table 2. Reactions of wheat breeding material to wheat striate virus*

0 No Symptoms	I Faint Chlorosis or indistinct streaks	II Mild to Moderate Striate and Stunting	III Severe Striate Stunting and Necrosis
Bowie	Bonza WG571167	Aniversario	Helvia WG59345
Chapinge 52	Chapinge 53 WG58278	Bage	Super Helvia WG59346
H46146 WG58371	Frontana-Kenya 58-Newthatch	Frontana	Mariache WG59344
Vilufen WG59523	Gabo	Klein Titan	Mayo 54
S615 WG571071	Gabo 56 WG5944	Maria Escobar	Yaqui 53
	K338AA. 1. A. 2 WG5725	Marquis line with Sr. 6	
	Kenya Farmer WG57670	Marquis line with Sr. 7	
	Klein Lucero	Marquis line with Sr. 8	
	Lee Frontana	Marquis line with Sr. 9	
	Lerma rojo WG57715	Mentana Rhodesian	
	Mayo 48 WG58379	Mida-McMurachy-Exchange	
	Nainari 60	ND34 WG5961	
	Pergamino gaboto WG59166	ND40-2 WG58363	
	Rio Negro	ND4 WG57681	
	Rhodesian	Orofen	
	Rhodesian Sinvalocho	R. L. 2265	
	R. L. 2564	R. L. 2520	
	Yaqui 50 WG58279	Sinvalocho	
		Yaktana 54	

* These varieties were supplied by Dr. R. G. Anderson, Research Station, Research Branch, Canada Agriculture, Winnipeg, Manitoba.

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Table 3. Reactions of winter wheat varieties to striate virus*

0 No Symptoms	I Faint Chlorosis or indistinct streaks	II Mild to Moderate Striate and Stunting	III Severe Striate Stunting and Necrosis
Atlas	Bison	Austin	Minter
Cappelle Desprez	Comanche	Seabreeze	Nebred
Cheyenne	Concho		Winalta
Frisco	Cornell 595 C.A.N. 2486		
	Crockett		
	Dawbul C.A.N. 2489		
	Fairfield C.A.N. 2487		
	Genesee C.A.N. 2516		
	Kharkov 22 M.C. C.A.N. 2360		
	Michigan Amber		
	Pawnee		
	Richmond C.A.N. 2517		
	Rideau C.A.N. 2485		
	Kent C.A.N. 2532		
	Tenmarq		
	Westal		

* Most of these varieties were supplied by Dr. M.N. Grant, Research Station, Research Branch, Canada Agriculture, Lethbridge, Alberta.

Table 4. Reactions of winter wheat lines to wheat striate virus*

0 No Symptoms	I Faint Chlorosis or indistinct streaks	II Mild to Moderate Striate and stunting	III Severe Striate Stunting and Necrosis
5523 - 74	4335 - 1	4353 - 53	4354 - 118
- 116	4338 - 13	4358 - 10	
- 117	4353 - 26	4460 - 11	
	4358 - 6	4467 - 9	
	4467 - 15	4560 - 16	
	- 22	- 175	
	4560 - 3	- 178	
	- 12	- 181	
	4759 - 1	4758 - 5	
	- 10	- 21	
	4768 - 52	4768 - 8	
	- 54	- 33	
	- 66	5523 - 40	
	- 106	- 53	
	- 115	- 102	
	5419 - 8		
	- 35		
	5523 - 4		
	- 7		
	- 48		
	- 79		
	- 99		
	- 127		
	- 139		

*These winter wheat lines, received from Dr. M. N. Grant, Research Station, Research Branch, Canada Agriculture, Lethbridge, Alberta, are from the following crosses:

4335 = ?
4338 = ?
4353 = Rescue x Yogo
4354 = Kanred x S633 x Yogo
4358 = [(Kanred x S615) x 47-30] x Yogo
4460 = Wasatch x Yogo x Minter
4467 = C.I. 12421 x (Yogo - Kharkov)
4560 = Yogo x Minn 2714 x Comanche
4758 = Kharkov x Wichita
4759 = Minter x Wichita
4768 = Yogo x Wichita
5419 = (Rescue x Yogo) x Kharkov
5523 = C3575 x Yogo

Table 5. Reactions of cereal varieties to striate virus

0 No Symptoms	I Faint Chlorosis or indistinct streaks	II Mild to Moderate Striate and Stunting	III Severe Straite Stunting and Necrosis
SPRING OAT VARIETIES	Abegweit C.A.N. 693	Ajax C.A.N. 660	Victory C.A.N. 426
	Cornell 527AB-2B6	Albion C.I. 4918	
		C.I. 792	
		Clintland C.A.N. 819	
		Clintland 60 C.A.N. 891	
		Cornell 5271AB-2B6	
		Fulghum C.I. 3067	
		Fulghum C.I. 6954	
		Fundy C.A.N. 822	
		Garry C.A.N. 809	
		Glen C.A.N. 826	
		Rodney C.A.N. 761	
		Russell C.A.N. 844	
		Saia C.I. 6954	
		Shield C.A.N. 821	
		Strigosa escura C.I. 186614	
BARLEY VARIETIES			
Montcalm C.A.N. 1135	Black Hulless	Hudson C.A.N. 249	
	Club Mariout	Kenate C.A.N. 232	
	Hannchen C.A.N. 1109	Vantage C.A.N. 1162	
	O.A.C. 21 C.A.N. 1086		
	Rojo		
	Wong C.A.N. 175		
	York C.A.N. 239		
WINTER RYE VARIETIES			
Horton			
Dominant			
Petkus			
Sangaste			
CORN VARIETIES			
W79A		Gaspe Flint	
106			

Thirty grass species were tested but only brome grass and Italian ryegrass became infected and developed symptoms.

Discussion and Conclusions

It cannot be stated categorically that wheat striate mosaic has or has not caused serious losses in Canadian grain crops, but the virus has the potentialities to cause immense damage. Since the leafhopper, *E. inimica*, is widespread and usually abundant, and is highly efficient as a vector, an increase in suitable virus reservoirs and the extensive use of highly susceptible wheat varieties could lead to a spectacular increase in virus incidence and serious crop losses.

The tests done to date have demonstrated that different varieties and breeding lines of wheat differ greatly in reaction to the isolates of wheat striate mosaic virus obtained in 1961. Although some of the currently important wheat varieties are very susceptible, some other varieties appear to be resistant or even immune. If necessary, it should be possible to develop new varieties with resistance. Of course, there is no assurance that the virus itself is not variable in virulence. Future tests may show that varieties of wheat that appeared to be resistant in the above tests are susceptible to other strains of the virus not yet recognized.

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IS BARLEY YELLOW DWARF VIRUS A PREDISPOSING FACTOR IN THE COMMON ROOT ROT DISEASE OF WHEAT IN CANADA? [1]

Harvey C. Smith [2].

Abstract

Investigations of cereal root-rot diseases in New Zealand in the past five years have led to the conclusion that root-rotting fungi in the genera Fusarium and Rhizoctonia become pathogenic predominantly on wheat plants that have been previously infected with barley yellow dwarf virus (BYDV). It is suggested that a similar situation may exist in regard to common root rot of wheat in the Prairie Provinces of Canada where BYDV has been shown to be widely distributed. This hypothesis does not apply to diseases caused by Ophiobolus graminis and Cercosporella herpotrichoides, both of which cause root diseases of wheat independently of BYDV infection in New Zealand.

Introduction

This paper is presented primarily to suggest avenues of investigation which are likely to yield information on the complex disease known as common root rot of wheat. Information assembled from two widely different environments, New Zealand and Ottawa, Canada, appears to give support to a hypothesis that could have a very wide application wherever wheat crops, BYDV and the aphid vectors occur together.

The lack of distinctive virus symptoms on wheat has been the main reason for the failure of plant pathologists to recognize barley yellow dwarf infection in this crop. Most wheat varieties are relatively tolerant of BYDV infection and the principal symptoms produced are readily confused with those associated with nutritional deficiencies and the attack of root-rot pathogens. The typical symptoms of BYDV infection in wheat are:

1. Slight stunting of growth (Fig. 1).
2. Yellowing of the edges of leaves often not apparent on leaves before the flag leaf (Fig. 2).
3. Secondary fungal attack on the glumes, especially after moist weather conditions (Fig. 3).

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1. The substance of this paper was presented as an address to the 30th Annual Meeting of the Associate Committee on Plant Diseases, Winnipeg, Man., 20-22 Feb. 1962.

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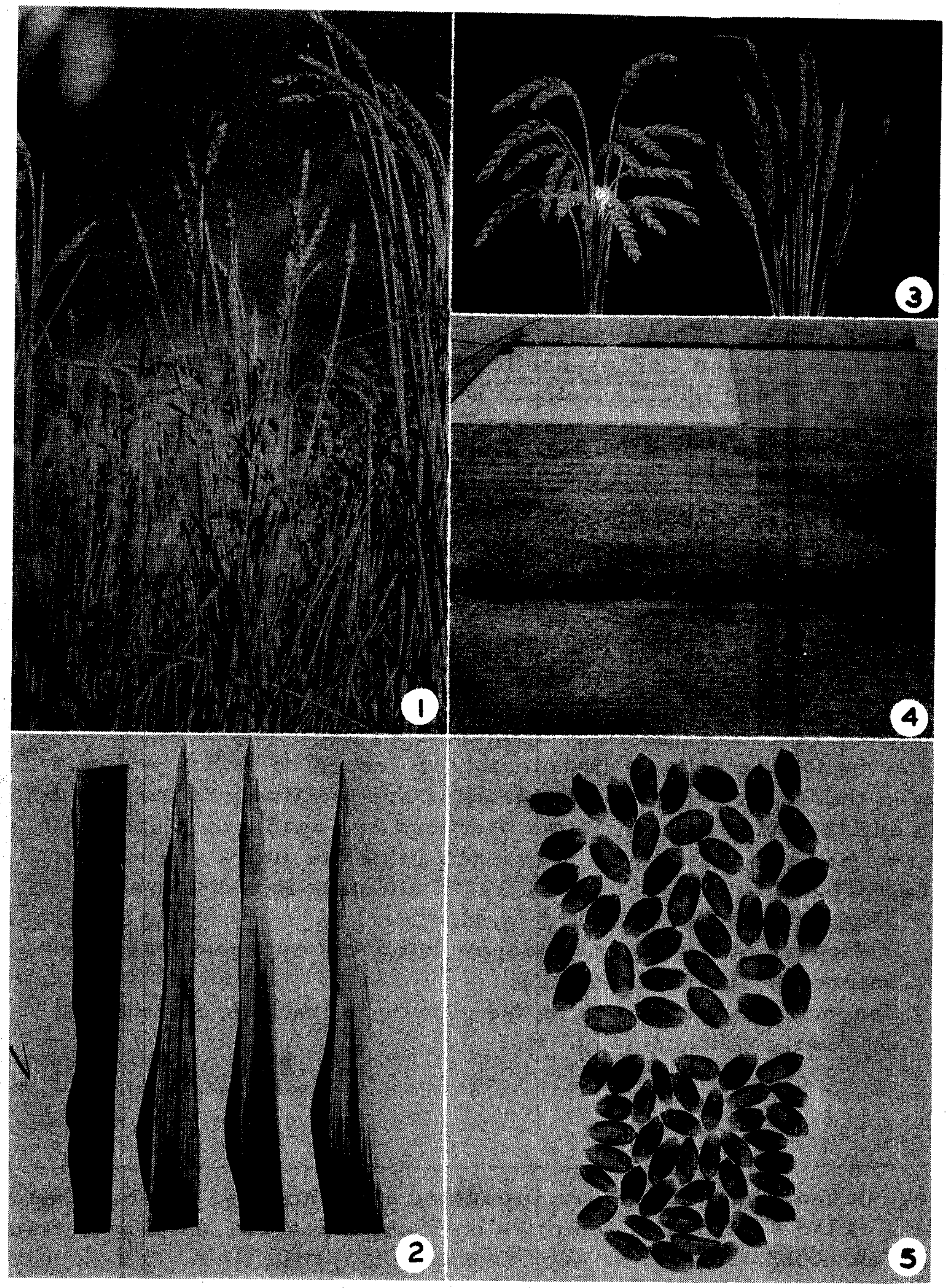

FIG. 1. WHEAT PLANTS STUNTED BY BARLEY YELLOW DWARF VIRUS. FIG.2. WHEAT LEAVES WITH YELLOWING SYMPTOMS TYPICAL OF BARLEY YELLOW DWARF VIRUS. FIG.3. LEFT: BLACKENED ERECT EARS OF WHEAT FROM BARLEY YELLOW DWARF VIRUS INFECTED PLANTS. RIGHT: HEALTHY WHEAT EARS. FIG.4. INSECTICIDE SPRAYED STRIPS WHERE BARLEY YELLOW DWARF VIRUS WAS CONTROLLED IN WHEAT. FIG.5. BARLEY YELLOW DWARF VIRUS EFFECT IN GRAIN SIZE OF WHEAT (STRAIN V 34 ON MARQUIS).

Proof of BYDV infection in wheat can be established only through experiments involving the use of virus-free aphid vectors (*Rophalosiphum padi*). The aphids must be allowed to feed on the living leaf and stem tissues of suspect plants for at least 2 and preferably 3 days before transfer to test seedlings for an infection feeding of 2 days. The seedlings must then be incubated under high light intensity and moderate temperatures (60 - 75°F) for 15 to 25 days in an aphid-free greenhouse or insectary.

The Evidence

Wheat crops in New Zealand may be either autumn- or spring-sown and, every few years, there has been an outbreak of a disease that has resulted in a serious reduction of yield in the autumn- sown crops. The cause of the disease has perplexed plant pathologists and several hypotheses have been advanced regarding its etiology. Following such an outbreak in 1956, a five-year survey of wheat crops was conducted and isolations were made from plants showing "crown rot" or "brown root rot" symptoms. No fungus was consistently isolated from the affected plants. A wide variety of species of *Fusarium* and *Rhizoctonia* were isolated. Inoculation trials with the various isolates were being planned when it was noted that the plants that showed "crown rot" or "black root rot symptoms" were those that also showed symptoms of BYDV infection.

Similarly, an examination of samples of spring wheat, variety Gabo, infected with scab (*Gibberella zeae*) confirmed the almost complete association of BYDV symptoms and infection by *Gibberella*. Evidence that the blackening of heads of wheat plants infected with BYDV was due to a susceptibility induced by the virus infection was obtained by greenhouse inoculations of both healthy and BYDV-infected plants. Wheat heads kept under conditions of high humidity were sprayed with spores of *Alternaria* and *Cladosporium* species. The glumes of the virus-infected plants were more severely blackened than those of healthy plants.

The Effect of BYDV Infection on Yield.

Field investigations of BYDV in New Zealand over a period of three years failed to demonstrate any practical means of reducing BYDV incidence either by cultural practices or preventative insecticide spraying. In the spring of 1960 a situation arose in which all early autumn-sown wheat fields in the arable district carried moderate to heavy infestations of *Rophalosiphum padi*, the principal vector of BYDV in New Zealand. Insecticide trials were laid down in an attempt to measure the degree of aphid control, virus control, and the effect on yield.

The results were quite spectacular (Table 1). The best insecticidal treatment, dimethoate (Rogor 40), gave a 38 per cent increase in yield. All treatments, besides giving excellent control of aphids, gave a considerable degree of control of the spread of BYDV as illustrated in Figure 4.

Table 1. Control of BYDV in winter wheat in New Zealand by one application of insecticide

Treatment	Spray Application 6/10/60		Aphid Counts *R. padi* per plant			Yield	
	Dose oz/ac.	Active Ingredient oz/ac.	7/10/60	19/10/60	27/10/60	Bu/ac	percent increase over Check
Rogor 40%	12	4.8	1	0	0	69	38
Metasystox 50%	16	8	0	0	0	64	29
DDT 20% E.C.	80	16	11	0	0	63	26
Lindane 20% E.C.	80	16	4	0	0	58	17
Sayfos 80%	4	3.2	67	0	0	55	11
Check	-	-	200	80	20	50	--

It was apparent, from estimates of BYDV infection in the different plots and the relatively complete control of aphids, that the increases in yield were attributable to a reduction in virus incidence rather than to the elimination of feeding damage by the aphid. However, it was deemed adviseable to carry out further trials comparing the effects of virus-free and virus- infective aphids on yield.

A greenhouse trial was carried out at Ottawa using four oat varieties that differed in their tolerance to BYDV and seven wheat varieties. Different numbers of infective and virus-free aphids were given 2-day infection feeding periods on each variety. The plants were then sprayed with an insecticide and kept insect-free in the greenhouse and later in a cold frame outdoors until they had reached maturity. The yields of grain were measured and the effect of BYDV infection was calculated by a comparison of the yields of plants inoculated with infective aphids and the yields of those inoculated with virus-free aphids. The results of this trial are presented in Table 2. Yields of varieties inoculated with infective aphids are expressed as a percentage of yields of the same varieties inoculated with virus-free aphids. Because there were no apparent differences in the relative tolerance to BYDV among the seven wheat varieties, Cascade, Selkirk, Thatcher, Marquis, Red Fife and Huron, their average yield was used in the results shown in Table 2.

Table 2. Effect of the number of infective aphids on resistance of oats and wheat to BYDV

	RVP strain, ex grass				MGV + RPV strains, ex cereals			
	Aphids per plant				Aphids per plant			
	1-5	10-20	100-200	Mean	1-5	10-20	100-200	Mean
Oat Variety								
Saia C.I 186606	70*	62	33	55	44	28	44	39
Fulghum C.I. 3067	100	100	77	92	73	41	59	58
Albion C.I. 792	36	9	--	23	14	18	--	16
Clintland 60	7	4	4	5	44	25	18	29
Wheat								
Mean, 7 Varieties	100	91	66	86	48	43	35	42

*Yield expressed as percent of yield of plants inoculated with virus-free aphids.

This trial confirmed the fact that the feeding by virus-free aphids for a 2-day period had no measurable effect on yield and that the four oat varieties differed greatly in their relative resistance to BYDV. The resistance of all seven wheat varieties tested was nearly equivalent to that of the most resistant oat variety, Fulghum C.I. 3067. Despite this relatively high degree of resistance they suffered a 50 percent reduction in yield when inoculated with some isolates of BYDV.

A field trial to test the effect on yield of a relatively late inoculation of BYDV into spring-sown wheat and oats was carried out at Ottawa. Two varieties of wheat, Marquis and Cascade, and two of oats, Clintland 60 and Rodney were each incoulated with (1) virus- free aphids, (2) aphids carrying the RPV strain of BYDV and (3) aphids carrying the MGV strain of BYDV. Check plots were provided by spraying plants of the same varieties with an insecticide. The results of this trial are presented in Table 3.

Table 3. Yield of spring oats and wheat inoculated 22 June with 2 strains of BYDV.

	Yield as percent of sprayed check			Symptoms of BYDV		
Variety	Unsprayed "virus- free" aphid inoc.	RPV	MGV	Unsprayed	RPV	MGV
Oats						
Clintland 60	90	49	115*	1**	4	2
Rodney	98	72	72	1	2	2
Wheat						
Marquis	80	42	39	trace	1	2
Cascade	85	47	48	trace	1	1

* The apparent increase in yield is due to the protective action of this strain against severe strains of BYDV from grasses in the locality.

** Severity of symptoms rated on a 0-4 scale.

Clintland 60 was only mildly affected by the MGV strain and infection with this strain apparently protected it from subsequent natural infections of the more prevalent BYDV strain from grasses. This strain, which occurred even in sprayed plots caused severe symptoms on Clintland 60. The protective effect of the MGV strain against some other strains of BYDV on Clintland 60 oats was subsequently confirmed in three greenhouse trials. Rodney was apparently more tolerant to BYDV infection than Clintland 60.

The symptoms of BYDV on wheat were very mild and consisted mainly of a premature yellowing of the flag leaf and a slight stunting. The grain harvested from the inoculated plots, however, had a marked shrivelled appearance (Fig. 5). Despite a mild expression of visible symptoms, even the late inoculations with BYDV resulted in a severe reduction in yield.

These trials have confirmed that symptom expression in Canadian wheat varieties infected with BYDV is poor, even though yields may be severely reduced. They also suggest the value of sowing oats along with the wheat in similar trials to give a readily identifiable measure of the prevalence of BYDV in the crops or plots. They have also shown that certain insecticides can give excellent control of BYDV by reducing the aphid population. This is especially true with wheat due to the relatively high degree of tolerance to BYDV which necessitates a higher population of aphids per plant to achieve the same degree of infection as caused by a small population on the more susceptible oats.

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A METHOD FOR INDUCING SPORULATION OF ALTERNARIA SOLANI IN CULTURE[1]

R. A. Ludwig[2], L. T. Richardson[3], and C. H. Unwin[3]

Alternaria solani (Ell. & Mart.) Jones & Grout has the reputation of being a difficult laboratory test organism because of its reluctance to produce, under ordinary cultural conditions, sufficient quantities of uniform spores for bioassay or plant inoculation purposes. Various workers have attempted, with more or less success, to improve its sporulation by various methods including mutilation of the mycelium (1, 2, 3, 4), addition of vitamins to the medium (3), and exposure to sunlight (3, 4), ultraviolet light (3), or fluorescent light (2).

A relatively simple method developed at this Research Institute has given good results consistently over a period of 10 years. The fungus is first grown for 2 weeks on V8 juice agar in Petri plates. The aerial mycelium is then removed by scraping the surface of the medium with the end of a glass slide. The plates, with lids removed, are then washed for 24 hours in running water. If necessary they may be wrapped individually in cheese cloth to keep the medium in place. The purpose of washing is to remove some unidentified antisporulating factor which may or may not be associated with the pigment which also leaches out.

After washing, the open plates are stacked on a tray in an inverted, slanted position so that each plate is partially closed by the bottom of the plate against which it leans. This arrangement appears to provide optimum humidity conditions for sporulation. The plates are kept in the open under the normal temperature and light conditions of the laboratory. Within 2 days a velvety layer of spores can be seen covering the agar surface. These are washed off by means of a jet of water from a wash bottle connected with an air line. By this means a minimum of immature spores or debris is removed. The plates are then restacked as before. Several successive crops of spores can be harvested at 1 to 2-day intervals before the medium becomes too dry.

The spores in suspension are collected on filter paper by suction through a sintered glass or Buchner funnel, air dried, and stored in closed Petri plates in a refrigerator. Under these conditions they have been found to retain their viability and pathogenicity for a period of 1 year or longer. Although aseptic conditions are not maintained throughout the process, contamination has not been found to interfere with bioassays or inoculations.

Occasionally the sporulating capacity of the stock cultures, maintained on P. D. A. slants stored in a refrigerator, was found to decline. This was not surprising in view of the frequency of mutations in this organism.

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Whenever this happened we were able to recover a good heavily sporulating stock selection from a large number of single spore isolates. These were obtained simply by pouring a series of dilution plates and transferring from individual colonies that were well separated from their neighbours. We have also applied the dilution plate procedure to increase sporulation in stocks of Helminthosporium sativum and Glomerella cingulata and to reduce the production of microconidia by Monilinia fructicola.

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A SPORE TRAP TO STUDY SPORULATION IN TREE CANKER DISEASES [1]

R. G. Atkinson [2] and J. G. Trelawny [3]

Fungi causing tree canker diseases usually produce wettable spores which may be trapped on a sticky surface, such as a vaselined microscope slide, in the path of rainfall splashed off the sporulating canker. Hopkins (1) has designed a vertical spore trap of this type for use on vertically-oriented cankers. This paper describes a slide spore trap for use on horizontally-oriented branch cankers. Branch cankers caused by Boydia insculpta (Oud.) Grove (2) on 35-year-old English holly trees in a commercial orchard were selected to test, over a period of one year, the efficiency of the apparatus in trapping spores.

The spore trap consists of a shallow tray made of heavy gauge galvanized sheet metal, or aluminum, large enough to accommodate two standard (3x1 inch) microscope slides side by side (Fig. 1). The slide platform was suspended with a slight downward tilt from, and approximately two inches below a branch canker of 1/2 to 3/4 inches diameter and slightly over six feet above ground level (Fig. 2). The length of the single support wire at the tapered end of the platform was used to adjust the angle of the platform. Prewarmed slides were completely coated with a thin, smooth layer of melted vaseline, using a clean spatula. A 30-ml capacity test tube with flared rim was suspended under the tapered end of the platform (Fig. 2) to gain some idea of the relative amounts of rain reaching individual canker sites between spore counts. If required in more intensive studies, the number of spores that may be carried from the slide tray into the tube may be determined by centrifugation or concentration of the contained water as in the vertical slide method of Hopkins. The characteristic hyaline Boydia spores were made readily visible under the low power of a compound microscope by flooding the exposed slides with acid fuchsin stain. The number of spores trapped over the entire surface of the slides was recorded, using an underlying slide on which a grid of squares had been etched. The values obtained for the pair of slides under each canker were averaged at each count (Fig. 3).

Temperatures given at each spore count represent maximum and minimum values recorded in the interval between the current and previous observation. Rainfall data represent the total precipitation in this interval which was usually of 7 days' duration throughout the fall and winter period. Meteorological data opposite the first spore count on September 30, 1960, is also based on the previous 7-day interval. In addition, it should be noted that total rainfall for this month was only 0.6 inches with none between September 5 and September 22.

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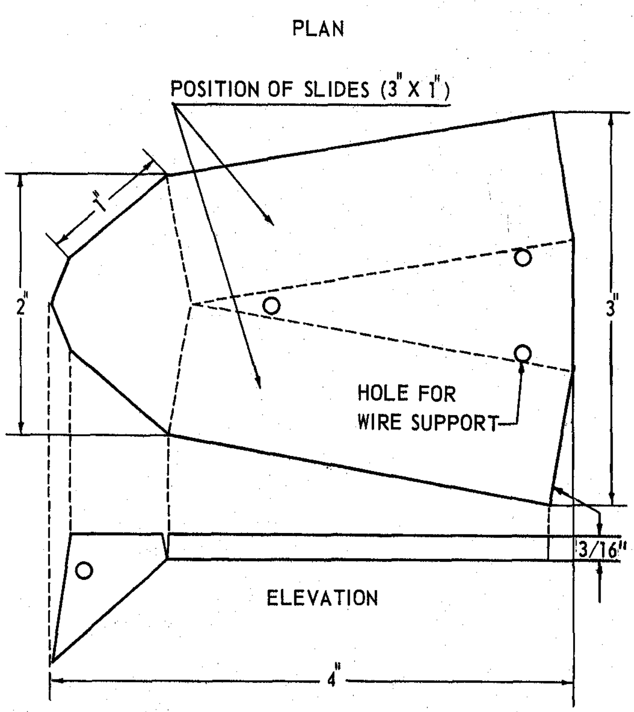

FIGURE 1. SPECIFICATIONS OF THE SLIDE TRAP SHOWN IN FIGURE 2.

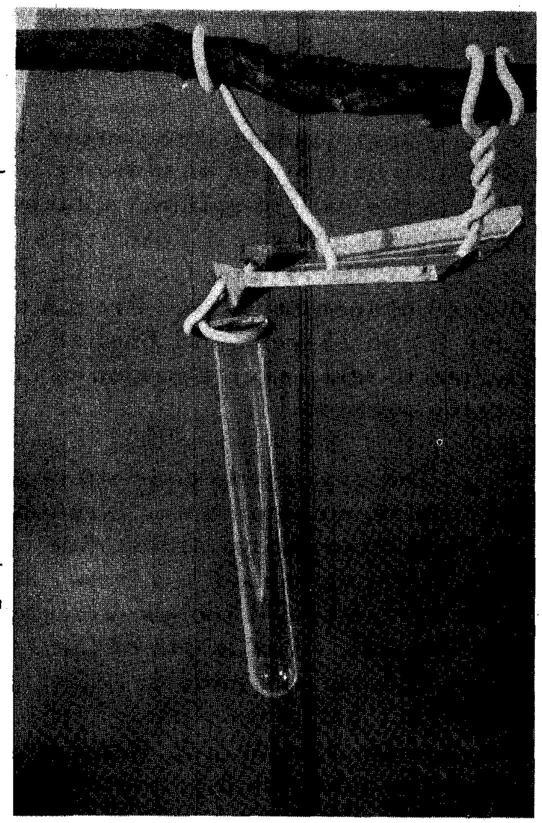

FIGURE 2. SLIDE TRAP WITH TWO MICROSCOPE SLIDES IN POSITION UNDER A *BOYDIA* CANKER ON HOLLY.

The data in Fig. 3 indicate that from the beginning of October to the end of December none or very few spores were recorded when rainfall dropped below 0. 5 inches during the intervals between counts. Large numbers of spores were trapped under some of the cankers during these months when more than one inch of rain fell between counts. The highest spore counts obtained, even during intervals of adequate rainfall through November and December, never reached the levels observed on the final day of September through October. This decline in numbers of spores trapped in November and December is correlated with gradually lowering maximum and minimum temperatures. During January and February spore counts from all five test cankers dropped to either nil or trace levels despite rainfall and temperature values that, in general, were similar to those of November and December. As temperatures again rose from the latter half of March onward so did spore counts, but in general, they did not reach the levels of the previous autumn. Also, with one exception, the number of spores trapped during this period was either nil or very few when less than 0. 5 inches of rain fell between counts. Throughout the dry months of June, July and August no spores were observed on the slides. With the advent of rains in September, when sporulation might be expected to rise sharply, only trace amounts of spores were trapped up to the middle of November when

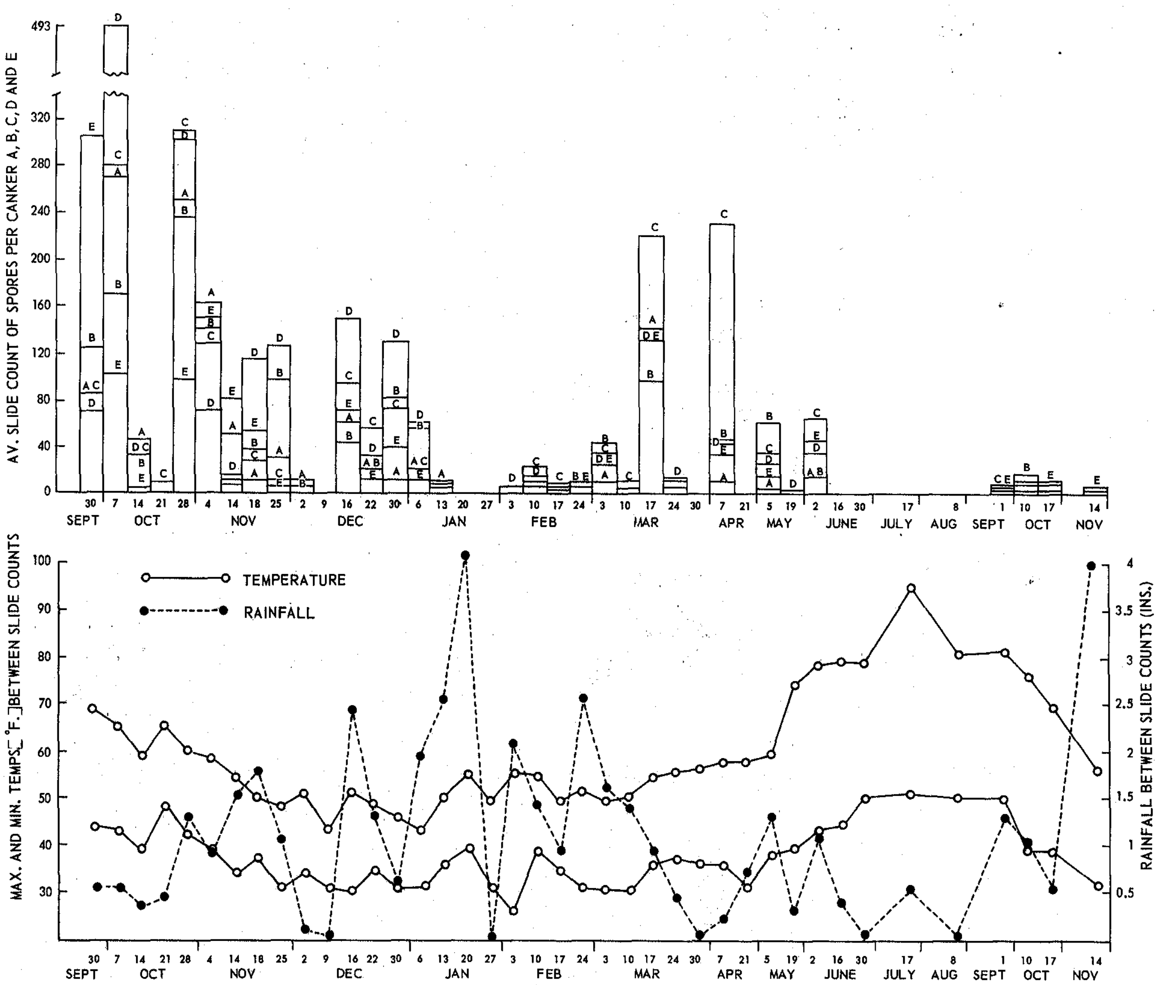

FIGURE 3. DATA ON SPORULATION OF *BOYDIA INSCULPTA* ON FIVE HOLLY CANKERS OBTAINED BY USE OF THE SLIDE TRAP DESCRIBED, AND METEOROLOGICAL DATA DURING THE TRAPPING PERIOD.

the test was terminated. Sporulation of the cankers under test then appears to have declined to a permanently low level following a very active state over the previous one-year period.

The data presented are considered to indicate that the spore trap apparatus described is sufficiently sensitive to changes in sporulation activity in response to meteorological conditions to be of value in studying canker-forming fungus pathogens.

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pH AND DECAY STUDIES ON WOOD-INHABITING ORGANISMS [1]

C. Madhosingh [2]

Introduction

Birch and poplar fence posts treated with a chemical mixture [3] succumbed to rot by various fungi after eight years in field tests. One of the principal wood-rotting organisms isolated from the decayed posts was *Coprinus micaceus* Fr., usually in association with the saprophytic *Fusarium oxysporum* Schlecht. em. Snyd. & Hansen. Other wood-rotting organisms isolated from fence posts were *Lenzites saeparia* (Wulf. ex Fr.) Fr. and *Polyporus adustus* Willd. ex Fr. The experiments described below were designed to study the growth of these organisms at various hydrogen-ion concentrations and also the decay of birch blocks by *C. micaceus*

Materials and Methods

pH Studies - The pH of the 2 per cent malt agar medium was adjusted by using a citric acid- phosphate buffer system. Growth experiments were conducted in 9-cm Petri plates which were inoculated centrally. Cultures were incubated at 70% R.H. and 80°F. Radial growth was recorded periodically.

Decay studies were carried out in jars 8.5 cm in diam. and 10 cm deep, containing 300 gm of sterilized soil with a moisture content of 40 per cent. Yellow birch sapwood blocks (3/4" cubes) were weighed, numbered and treated with various concentrations of the preservative mixture [3] in solution in the apparatus illustrated in Figure 1.

The blocks were placed 2mm apart in a container and were held down by a heavy piece of glass directly under a thistle funnel in a desiccator. The lip of the desiccator lid was smeared with a thin film of vacuum grease and slid tightly on the bowl. The outlet was closed and suction applied. The flask acted as a trap with outlets to the vacuum source and the mercury manometer. The blocks were subjected to 10 cm mercury pressure for 30 minutes in order to remove intercellular air before the impregnating solution was introduced

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1. This study was conducted by the author partly while employed at the Ottawa Laboratory, Forest Products Research Branch, Canada Dept. of Forestry and partly in the Department of Botany, University of Western Ontario, being part of a thesis submitted in partial fulfillement of the requirements for the Ph. D. degree.
2. Present address: Plant Research Institute, Canada Dept. of Agriculture, Ottawa, Ont.
3. Sodium fluoride, 34%; potassium dichromate, 34%; sodium arsenate, 25%; 2,4- dinitrophenol, 7%.

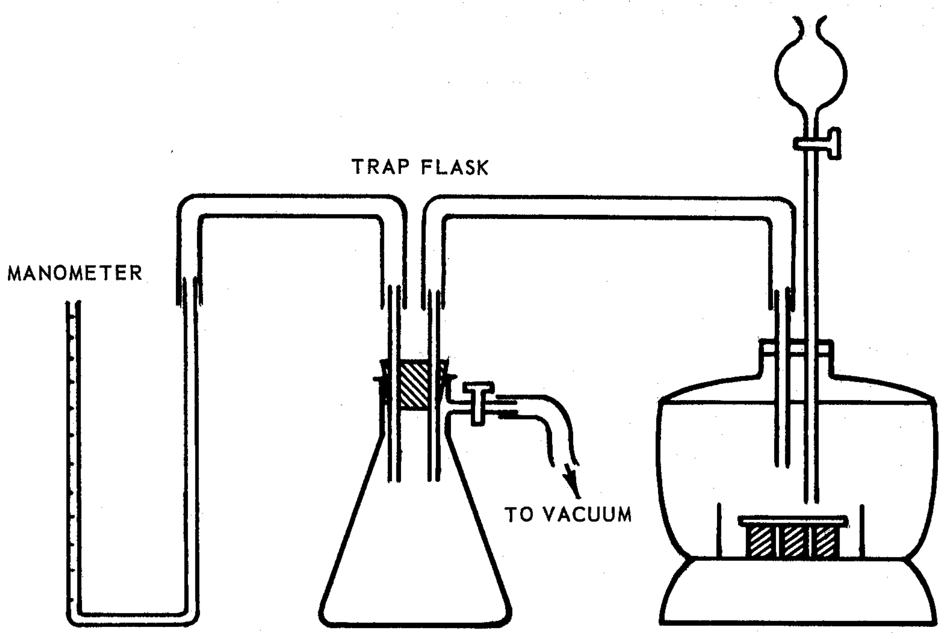

FIGURE 1. IMPREGNATION APPARATUS

through the thistle funnel. When the blocks were completely covered by the solution, the system was returned to normal atmospheric pressure and the blocks allowed to stand in the solution for another 30 minutes. The blocks were then wiped dry and weighed. The difference in weight between the air-dry blocks and the blocks after treatment represents the weight of solution in the blocks. From this, knowing the concentration of the preservative in the solution, the amount of preservative in the blocks was calculated.

Twelve blocks were used in each treatment, four in each of three jars. Two of the blocks were buried about 1 cm apart just under the soil surface. An inoculum, prepared by placing a strip of yellow birch (22 x 55 x 4 mm) in a plate with C. micaceus for 2 weeks, was placed over the two buried blocks. The two other blocks, which were treated similarly, were placed on the inoculum. The blocks were arranged so that the wood fibres ran vertically. The cultures were incubated at 80°F and 70% R.H. for a period of three months. The blocks were then cleaned with a brush and weighed again. Decay was estimated on the basis of weight losses.

Results and Discussion

pH Studies - A comparative study of the growth of the organisms at various hydrogen-ion concentrations is illustrated in Figure 2. These results show that P. adustus grew more rapidly than the other wood-rotting organisms but that its growth was definitely limited to the acid substrate. C. micaceus tolerated the higher pH, even growing at pH 9.5, whereas L. saeparia ceased growth at pH 7.5. Generally the wood-rotting organisms grew better at the lower hydrogen ion concentrations than on the alkaline substrates. By contrast, the wood saprophyte F. oxysporum grew well on all the substrates, and even better on the alkaline substrate. This probably accounts to some extent for its being widespread in nature.

Table 1 Weight losses in yellow birch, inoculated with *C. micaceus* and incubated at 80°F and 70% relative humidity for a period of three months

% Preservative in Treatment	% Preservative Retained in Blocks (average of 4 blocks)	Block Wt. before experiment (Av. of 2 blocks (gm.)	Block Wt. after experiment (Av. of 2 blocks (gm.)	Loss in Weight (gm.)	Loss % (Weight before Experiment)
		Surface Blocks			
.01	.0045	4.17	3.05	1.12	26.86
.05	.0233	4.18	3.48	.70	16.74
.10	.0412	4.35	3.67	.68	15.63
.15	.0520	4.37	3.62	.75	17.16
.20	.0570	3.19	3.60	.59	14.08
.25	.0861	4.28	3.42	.86	20.09
0.30	.109	4.35	3.75	.60	13.79
0.0		4.25	3.72	.53	12.47
		Burried Blocks			
.01	.0045	4.23	2.58	1.65	39.00
.05	.0233	4.23	1.93	2.30	54.37
.10	.0412	4.26	1.75	2.51	58.92
.15	.0520	4.25	1.70	2.55	60.00
.20	.0570	4.21	1.55	2.66	63.18
.25	.0861	4.16	2.96	1.20	28.84
.30	.109	4.32	2.30	2.02	46.76
0.0		4.23	2.83	2.40	56.74

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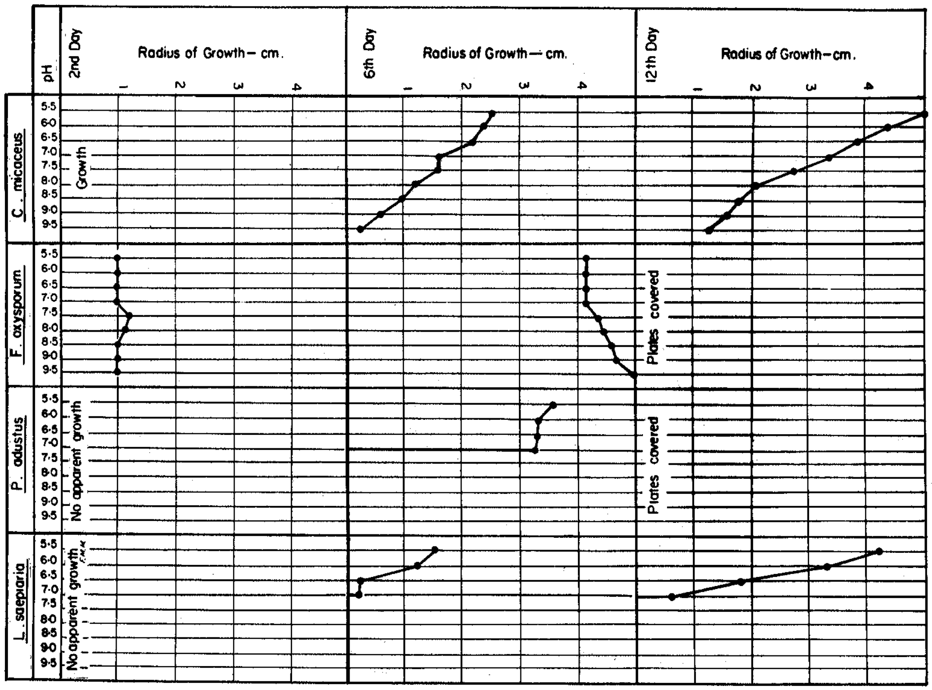

FIGURE 4. A COMPARATIVE STUDY OF THE EFFECT OF HYDROGEN ION CONCENTRATION ON THE GROWTH OF *C. MICACEUS, F. OXYSPORUM, P. ADUSTUS* AND *L. SAEPIARIA*.

Decay Studies. The results of the decay caused by *Corpinus micaceus* are shown in the Table 1. It will be seen in column 2 of the table that there was an increase in retention of the preservative in the blocks with increasing concentration of preservative in the treatments. The differences between the treatments, however, were not great enough to alter the growth of the decay organism so as to produce significant differences in percentage weight losses. There was, however, a distinct difference in decay between the buried and surface blocks. The buried blocks had a weight loss of over 30 per cent above that of the surface blocks. This was expected because of the more moist environment which facilitated the growth of the wood-rotting fungus.

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THE EFFECT OF PCNB ON THE CONTROL OF TULIP FIRE PRIMARIES [1]

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Abstract

The number of primary infections produced on tulips in fields infested with Botrytis tulipae Lind. was significantly reduced by the broadcast application of PCNB (pentachloronitrobenzene) at the rate of 200 lb. per acre. The treatment did not result in any damage to the tulip bulbs. Lower rates of broadcast application and equivalent rates in row or dust application were not effective under conditions in coastal British Columbia.

Introduction

Cold, wet springs, such as generally occur in the coastal areas of British Columbia favor the development of tulip fire and the disease may reach epidemic proportions during periods of high rainfall. Planting of healthy stocks, removal of primaries as they appear, and an adequate spray program will almost eliminate secondary infections. Unfortunately, the wet weather and the resultant difficulty in entering the fields to remove the primaries combine to prevent adequate control. Therefore, it was considered necessary to find some material that could be applied in the fall during planting that would prevent the formation of primaries. PCNB (pentachloronitrobenzene) has been found effective against sclerotia-forming fungi, such as Rhizoctonia, Sclerotinia, Sclerotium, and Botrytis spp., in the field (2). Green et al (1) reduced the number of tulip fire primaries by 25% over the checks by using 2 oz. of PCNB per sq. yard, dusted on the soil one day before planting. These results indicated that PCNB could be of value for the control of primaries. The present study was initiated to determine its effects under conditions that prevail in B.C.

Methods and Materials

Plots were set up in a field known to be heavily infested with Botrytis tulipae. Raised beds, each containing 50 bulbs of the variety Demeter in five rows of ten bulbs per row, were set out after the following treatments:

1. Check - no treatment
2. Broadcast - 100 lb. PCNB per acre
3. Broadcast - 200 lb. PCNB per acre

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4. Row - 20 lb. PCNB per acre
5. Row - 40 lb. PCNB per acre
6. Dust - PCNB
7. Dip - Semesan Bel.

Each treatment was in triplicate. In the row treatment, soil was heaped on the bed to a depth of six inches, the rows dug, the bulbs placed 6 inches apart in the rows, and dusted with the calculated amounts of PCNB. In the broadcast treatment, the soil was thoroughly mixed with the PCNB before being heaped on the bed. In the dust treatment, the bulbs were shaken, before being planted, in a bag with PCNB. In the dip treatment, the bulbs were placed in a standard Semesan Bel solution for two minutes, drained, and planted. Starting in February, the beds were inspected every three or four days, the primaries counted, and removed. In July the bulbs were harvested, weighed, and inspected for sclerotia.

Results and Discussion

The PCNB treatment at 200 lbs. per acre gave a significant (at p=0.1) reduction in the number of primaries (Table 1). None of the other treatments were significantly better than the check plots.

Table 1. Effect of PCNB on bulb weight and on production of primary infections by B. tulipae.

Treatment	Average weight/bulb	Total Primaries	*Transformed total
Checks	1.36 oz.	22	7.8
Broadcast 100 lb./A	1.40 oz.	19	7.4
Broadcast 200 lb./A	1.46 oz.	4	2.8
Row 20 lb./A	1.23 oz.	26	8.7
Row 40 lb./A	1.33 oz.	38	10.4
Dust	1.23 oz.	27	8.7
Dip	1.23 oz.	33	8.9
L.S.D. (p=0.1	none		1.27

*Data transformed by square root transformation for statistical analyses.

The average weight per harvested bulb was slightly higher with the 200 lb. per acre treatment than with any other treatment, but not significantly so. All treatments where the chemicals came in direct contact with the bulb resulted in average weights lower than the checks.

Although good control of primaries was obtained in this experiment it is doubtful whether the 200 lb. per acre rate would be as effective when applied on a large scale. Thorough mixing of the PCNB with the soil to a depth of at least six inches is required, and with the current methods of soil tillage in use this desirable situation would be hard to achieve. According to Newhall (3) the usual tillage implements, such as the spiketooth harrow, discs, and rotary tillers with spike blades, do not mix soil very much below the top 2.75 inches.

A rototiller with L-shaped knives will mix as deep as 8 inches. A tillage implement of the latter type would be necessary for successful incorporation of PCNB into the soil.

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EXPERIMENTAL FARM, CANADA AGRICULTURE, SAANICHTON, B.C.

PHENOLOGICAL RECORDS OF THE PRAIRIE FLORA[1]

R.C. Russell

Introduction

Phenological records have been collected by members of the staffs of the Canada Agriculture Laboratories of Plant Pathology at Winnipeg, Saskatoon, and Edmonton from 1936 to 1961 inclusive. These records were taken at Winnipeg by Bjorn Peturson, at Saskatoon by R.C. Russell, R.J. Ledingham or M.S. Bahrey, and at Edmonton by M.W. Cormack (1936-48), S.G. Fushtey (1949-53), and W.P. Campbell (1954-61). The records show the earliest dates of flowering for a considerable number of native prairie plants and include the dates of seeding, emergence, heading, and maturity of wheat on early-sown plots. All the data from the three stations were summarized annually by the author and published in the reports of the Canadian Plant Disease Survey for the corresponding years.

Several principles were taken into consideration when planning this project. In the first place, species that could be observed regularly without travelling far afield were selected and, as far as possible, the same trees or herbs in the same location, were used each year. The earliest date on which fully-opened flowers were seen or on which pollen was being shed, in the case of certain trees, was the date recorded. Moss (2), in collecting somewhat similar data at Edmonton, recorded the date when each species was in full bloom, thus his average dates for particular species in most cases are somewhat later than ours. When feasible, the same species were used at the three stations, but differences in local flora were such that only 25 per cent of the total species recorded were common to all stations. Since we were interested in relating the results of the observations of native plant development with that of wheat from seeding time to harvest, it was desirable to observe a succession of species from early spring to late mid-summer.

Recorded Observations

Table 1 summarizes the results of the phenological observations on native plants. The scientific names listed in the first column of the table are, with few exceptions, those used in P.A. Rydberg's "Flora of the Prairies and Plains of Central North America". Where different but closely related species were used at one or more of the stations, they are listed by their generic and their common names, e.g. Crataegus sp. (Hawthorn).

It may be seen that there is a spread of from 10 to 40 days between the earliest and latest recorded anthesis of the different species, the average spread being about one month. On the whole, the more years that a species was observed the greater the spread is likely to be, and the more reliable the calculated average date of flowering. No species is listed that was observed for less than 6 years and the majority were observed for over 15 years. The maximum number of years was 26.

The rate of development of wheat for the same period of years at Winnipeg, Saskatoon, and Edmonton is indicated by the figures in Table 2.

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[1] Contribution No. 115, Canada Agriculture Research Station, Saskatoon, Sask.

Table 1. Extreme Range and Average Flowering Dates of Native Plant Species, Winnipeg, Saskatoon, and Edmonton, 1936-1961.

	Winnipeg			Saskatoon			Edmonton		
	Earliest record	Latest record	Average date	Earliest record	Latest record	Average date	Earliest record	Latest record	Average date
Pulsatilla ludoviciana	4/4	20/4	*(7)11/4	5/4	3/5	*(26)18/4	10/4	18/5	*(9)25/4
Corylus rostrata	-	-	-	-	-	-	13/4	10/5	(9)27/4
Populus tremuloides	5/4	10/5	(24)25/4	8/4	9/5	(26)25/4	13/4	14/5	(26)27/4
Phlox hoodii	-	-	-	16/4	16/5	(26)29/4	-	-	-
Acer negundo	14/4	22/5	(22) 7/5	24/4	19/5	(26) 7/5	22/4	20/5	(25) 3/5
Shepherdia canadensis	-	-	-	-	-	-	13/4	17/5	(9) 3/5
Salix petiolaris	-	-	-	24/4	19/5	(13) 7/5	13/4	17/5	(6) 5/5
Betula papyrifera	-	-	-	27/4	25/5	(26)11/5	20/4	30/5	(25) 7/5
Prunus americana	26/4	29/5	(24)14/5	-	-	-	-	-	-
Amelanchier alnifolia	28/4	31/5	(24)18/5	28/4	27/5	(26)15/5	5/5	31/5	(26)17/5
Prunus pensylvanica	-	-	-	13/5	4/6	(25)20/5	6/5	29/5	(26)18/5
Viola rugulosa	-	-	-	7/5	1/6	(26)21/5	7/5	3/6	(23)23/5
Smilacina stellata	16/5	3/6	(15)24/5	14/5	4/6	(23)25/5	10/5	7/6	(23)25/5
Crataegus sp. (Hawthorn)	1/5	9/6	(23)24/5	12/5	12/6	(19)28/5	19/5	18/6	(18)30/5
Prunus sp. (Chokecherry)	3/5	11/6	(23)25/5	13/5	15/6	(23)28/5	18/5	14/6	(23)28/5
Cornus sp. (Dogwood)	20/5	14/6	(16) 1/6	14/5	15/6	(26)30/5	20/5	15/6	(23) 1/6
Viburnum lentago	13/5	17/6	(24) 3/6	-	-	-	-	-	-
Hierochloë odorata	12/5	4/6	(10)23/5	10/5	9/6	(20)20/5	-	-	-
Elaeagnus commutata	-	-	-	20/5	21/6	(26) 4/6	26/5	21/6	(24) 5/6
Hedysarum americanum	-	-	-	29/5	17/6	(13) 8/6	-	-	-
Thalictrum turneri	-	-	-	-	-	-	28/5	15/6	(10) 5/6
Maianthemum canadense	-	-	-	-	-	-	28/5	13/6	(10) 6/6
Lonicera glaucescens	-	-	-	25/5	22/6	(22) 8/6	22/5	20/6	(23) 7/6
Achillea lanulosa	-	-	-	2/6	22/6	(25)10/6	18/6	6/7	(18)27/6
Diholcos bisulcatus	-	-	-	29/5	22/6	(16)10/6	-	-	-
Anemone canadensis	24/5	19/6	(19) 6/6	30/5	29/6	(25)11/6	8/6	30/6	(20)23/6
Viburnum trilobum	18/5	20/6	(12) 9/6	-	-	-	30/5	17/6	(8) 8/6
Viburnum pubescens	23/5	21/6	(19)10/6	-	-	-	-	-	-
Galium boreale	-	-	-	3/6	1/7	(23)14/6	6/6	6/7	(12)21/6
Rosa alcea	-	-	-	10/6	7/7	(25)20/6	2/6	24/6	(9) 9/6
Campanula petiolata	-	-	-	12/6	8/7	(25)22/6	12/6	19/7	(9)11/7
Bromus inermis	12/6	4/7	(23)21/6	12/6	6/7	(26)23/6	18/6	16/7	(26)25/6
Gaillardia aristata	-	-	-	15/6	8/7	(22)24/6	-	-	-
Spiraea alba	-	-	-	24/6	10/7	(23)30/6	-	-	-
Chrysopsis hirsutissima	-	-	-	18/6	11/7	(20) 1/7	-	-	-
Symphoricarpos occidentalis	17/6	15/7	(15)27/6	20/6	12/7	(20) 2/7	23/6	11/7	(22) 5/7
Phleum pratense	-	-	-	-	-	-	29/6	15/7	(23) 8/7
Chamaenerion spicatum	-	-	-	24/6	18/7	(8) 3/7	1/7	16/7	(23) 9/7
Lactuca pulchella	-	-	-	27/6	26/7	(21) 8/7	10/7	20/7	(13)14/7
Psoralidium argophyllum	-	-	-	25/6	19/7	(22)10/7	-	-	-
Apocynum androsaemifolium		-	-	-	-	-	20/6	30/7	(10)11/7
Agastache anethiodora	-	-	-	-	-	-	4/7	2/8	(17)12/7
Solidago missouriensis	-	-	-	8/7	23/7	(13)14/7	-	-	-
Cirsium flodmanii	-	-	-	8/7	22/7	(9)16/7	-	-	-
Solidago canadensis	18/7	28/7	(6)21/7	-	-	-	11/7	6/8	(22)21/7
Grindelia perennis	-	-	-	13/7	1/8	(23)23/7	-	-	-
Oligoneuron canescens	-	-	-	18/7	7/8	(22)26/7	-	-	-
Aster conspicuus	-	-	-	-	-	-	20/7	29/7	(10)23/7
Aster ericoides	-	-	-	14/7	8/8	(15)29/7	-	-	-
Aster laevis	-	-	-	17/7	11/8	(22)30/7	21/7	12/8	(23)30/7

*Figures in brackets show the number of years that records were made for each species.

Table 2. Records of Wheat Development at Winnipeg, Saskatoon, and Edmonton (1936-1961); Early, Late, and Average Dates of Seeding, Emergence Heading, and Maturity.

	Winnipeg			Saskatoon			Edmonton		
	Earliest record	Latest record	Average date	Earliest record	Latest record	Average date	Earliest record	Latest record	Average date
Seeding	12/4	* 2/6	+(24)29/4	10/4	13/5	+(26)30/4	17/4	19/5	+(26)2/5
Emergence	24/4	29/5	(17)11/5	30/4	26/5	(26)13/5	2/5	29/5	(25)12/5
Heading	14/6	16/7	(22) 1/7	23/6	17/7	(26) 2/7	23/6	20/7	(21 4/7
Maturity	23/7	29/8	(24) 9/8	19/7	28/8	(26) 9/8	4/8	7/9	(26)20/8

* Excessive moisture prevented the commencement of seeding operations on heavy clay soil after one of their periodic spring floods. No date was recorded for emergence at Winnipeg that year.

+ The number of years for which we have records is shown in brackets.

Thatcher wheat was sown on the plots observed throughout most of the period involved, but other varieties of hard red spring wheat were used occasionally.

Discussion

While many of the species listed in Table 1 were recorded at only one or two of the stations, 10 of them, Populus tremuloides, Acer negundo, Amelanchier alnifolia, Smilacina stellata, Crataegus spp. (hawthorn), Prunus spp. (chokecherry), Anemone canadensis, Bromus inermis and Symphoricarpos occidentalis, were observed for 15 or more years at all three stations. The behaviour of these 10 species should give a fairly good measure of the relative earliness of the season at the three stations. If we list the average dates of flowering of these 10 species at each of the stations, take the totals and divide each by 10, we get the values 209, 224, and 246. These figures indicate very roughly the relative earliness of the season for the period starting at the first of May and ending at the last of June at the three stations. They suggest that, on the average, the native vegetation in the spring develops earliest at Winnipeg, a little later at Saskatoon, and somewhat later still at Edmonton. The same remarks apply to the average date of the commencement of wheat seeding at the three stations. The average date of maturity was however, considerably later at Edmonton than at Winnipeg and Saskatoon. The differences in general are not as great as one might expect in view of the differences in latitude of the three stations. This emphasizes the fact that the isothermal lines run from southeast to northwest across the Prairie Provinces, rather than east and west.

The average maximum variation in time of appearance of each species at the different stations over a period of 15 to 25 years was approximately one month. Naturally this spread varied somewhat in different instances. For example, the greatest variation noted was 40 days in the cases of Betula papyrifera and Apocynum androsaemifolium at Edmonton. The smallest variation was about 10 days, e.g. Lactuca pulchella and Aster conspicuus at Edmonton. It should be noted, however, that these two species had been recorded for only 13 and 10 years, respectively. Perhaps Spiraea alba at Saskatoon, and Phleum pratense at Edmonton are better examples, as each was recorded for 23 years. The spread in each case was 16 days.

The influence of weather conditions on the time of flowering of the species observed was not recorded except in a general way. Bassett et al. (1) found apparent differences in the reactions of different species at Ottawa to average maximum temperatures. As far as our experience goes, it was quite apparent that periods of cool cloudy weather retarded the development of the prairie flora, especially in the first half of the season, whereas excessive warmth hastened flowering. In certain unusually dry periods, when temperatures were high and moisture reserves at a low level in the soil, it appeared as though flowering of some species in June and July was actually retarded or entirely inhibited under specially arid conditions.

The rate of development of wheat at the three stations appeared to be governed by the same factors that affected the growth of native plants. However, an artificial variation was introduced in the case of wheat because the time of planting was not determined entirely by weather conditions each year. At one station, at least, the tendency in recent years has been to sow the wheat at a later date than formerly to allow time to cultivate the land to destroy a crop of weed seedlings and to allow the soil to warm up somewhat before the grain is sown. It was noticeable from the records that early seeding was not always followed by early maturity. The type of weather that prevailed throughout the growing season determined the number of days from seeding to harvest. Usually, early-sown crops took more days to reach maturity because of cooler conditions during the earlier part of spring.

As the result of certain experiments conducted by the Field Husbandry Department of the University of Saskatchewan (unpublished), to ascertain the optimum time to sow wheat, it was concluded that the best time to sow wheat to obtain highest yields of grain, on the average, was about the 8th of May. In relatively early seasons, however, seeding should be done nearer the first of May, and in later seasons about the 15th of May. At Saskatoon the 8th of May coincides very closely with the average date of flowering of *Acer negundo* L., hence it seems reasonble to suppose that farmers in that district could use the commencement of flowering of this species to determine the best time to seed wheat in any particular year.

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PLANT PATHOLOGY IN THE U.S.S.R.

W.E. Sackston[1]

Introduction

The impressions summarized in this article were registered during a visit to the U.S.S.R., which extended from May 15 to July 28, 1961. I was one of the Canadians fortunate enough to take part in the exchange of scientists between the National Research Council of Canada and the Academy of Sciences of the U.S.S.R.

My itinerary included a week in Moscow at the beginning of the trip, and most of a week just before leaving the U.S.S.R.; approximately three weeks in Leningrad; most of a week in Kiev; approximately three weeks at Krasnodar in the Kuban region of the northern Caucasus; a week and a half at the Kuban Experiment Station of the All Union Institute of Plant Production, about three hours drive east of Krasnodar; and most of a week at Tashkent, in the Central Asian republic of Uzbekistan.

As I speak Russian, I travelled without interpreters or guides. Because I had no guide to arrange such formalities, I was not exposed to the numerous long-drawn-out sessions of caviar, vodka, and speeches reported by many other visitors. Because I clearly expressed my desire to concentrate on institutions where plant pathology research or teaching is done, I made only one formal tour of a state farm, and visited a minimum number of institutes which were of only peripheral interest to me.

The absence of formal receptions did not imply a lack of hospitality. I was welcomed warmly by scientists everywhere, and shared their laboratory and office lunches, ranging from bread, cheese and tea; through cold cuts and beer; to plov, exotic fruits, and green tea from bowls. I was treated to meals in institute staff canteens, in a neighborhood "militia" canteen, in good restaurants, and in private homes; and was invited to and advised about theatre, opera, and ballet performances.

MOSCOW

Institute of Microbiology.

Dr. E.N. Mishoustin and his group are doing monographic studies on bacteria, fungi, and actinomycetes in the soil. They are particularly interested in the correlation between soil type and the soil microflora, and in at least one applied problem. They explain the increased yields reported as a result of very deep plowing, by the fact that microbial activity is much greater in the top layers of soil than in the lower ones. When the top layers are turned under in deep plowing, they stimulate greater root growth in deeper layers of soil, enabling plants to utilize nutrients more effectively.

Dr. A.F. Protsenko, who has worked on various problems in plant pathology, now concentrates on electron microscopy of the viruses. He has published a handbook (or electron microscope photographic album) of about 60

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viruses, with a classification based in part on morphology of virus particles and on their manner of spread. The album includes a photograph which on the basis of circumstantial evidence, is thought to be of particles of aster yellows virus from various hosts and dodder.

Main Botanical Garden.

Dr. K.T. Suchorukov and his group in the Laboratory of Immunity at the Main Botanical Garden provided two stimulating sessions, one during the first week that I was in Moscow and the other in the second visit, just before leaving the U.S.S.R.. The emphasis of the whole laboratory is on physiology of parasitism. They believe that many problems in plant pathology can be solved only when plant physiological methods are brought to bear, and conversely, that many problems in pure plant physiology can profitably be attacked using diseased as well as healthy plants.

A great deal of emphasis is placed on biotic factors, or "bacterial vitamins", in relation to resistance and suceptibility, and parasitism and saprophytism. Susceptible plant varieties and plant tissues differ from resistant ones by having a higher content of biotic substances. Highly specialized species or varieties of fungi such as Botrytis differ from the less specialized forms by responding to specific biotic materials present in in their hosts, and not to non-specific substances, whereas the less specialized forms respond to a wider range of bacterial vitamins and are not appreciably benefited by specific plant autolysates.

The germination of spores of pathogens has been found to be favoured by the greater concentration of biotic substances in infection drops on susceptible as opposed to resistant hosts. This relationship has been found for rusts as well as other organisms. The investigators recognize that spores of virulent races can germinate in infection drops even on resistant plants. My most serious criticism of the generalizations reached in this laboratory, as in a number of others in the Soviet Union, was based on their apparent failure to use known physiologic races and appropriate differential hosts giving reciprocal patterns of resistance and susceptibility respectively. Too many generalizations on the nature of resistance have fallen down in work in North America, when either the host variety or race of the pathogen was changed, for this factor to be overlooked with impunity.

Other problems which occupy the workers in this laboratory include: Verticillium wilt of cotton; the biochemical and physiological basis of specialization for parasitism in species of Botrytis, members of the Peronosporaceae, the rusts; and pathological anatomy, and the physiology of necrosis. The investigators I met included L.N. Andreev, Elena G. Kling, U.M. Plotnikova, and M.N. Talieva.

Main Botanical Garden, Plant Protection Section

Professor E.S. Cherkassky, an entomologist, is in charge of this section which includes entomologists and plant pathologists. One of their main responsibilities is to control insect pests and diseases of all the plants in the Botanical Garden and in the greenhouses. To help discharge this responsibility, they do research on various insecticidal and fungicidal preparations, on methods and rates and times of treatment, and related practical studies. They also work on the identification of the pests and disease organisms, and their biology. Staff members present during my two visits to this section included Mme. E.P. Protsenko, a plant pathologist, Mme. C.P. Berdenikova, an entomologist, and Miss Levina, an "aspirant", or candidate for a higher degree, also working on entomological problems.

Academician N.V. Tsitsin, Director of the Botanical Garden and a pioneer worker in the production of "perennial" wheat, is as enthusiastic as Prof. Cherskassky about the effecitveness and value of activated creoline (kryolin?), apparently a mixture of gamma and delta isomers of hexachlorbenzene in "creoline". Mixtures including the delta isomer have pronounced fungicidal effects; they are used as sprays in various concentrations, incorporated into dusts on various inert carriers, etc. The material has been found effective against Plasmodiophora brassicae, against fungi on roses, and, with the gamma iosmer in various concentrations, is effective against a wide spectrum of insects and mites.

Moscow State University, Faculty of Biology and Soils, Department of Lower Plants.

Professor M. Gorlenko, Head of the department, worked as a professional plant pathologist before coming to the university about 1955. Students in the faculty spend two years on basic science subjects, then three years in the specialized faculties. About ten to fiteen students come into the Faculty of Lower Plants each year. In addition, there are six or seven "aspirants" studying for the degree of "Candidate of Science", similar to or perhaps a shade above our Master of Science degree, but not up to the level of our Ph.D.

Professor Gorlenko's associates include Galina D. Uspenskaya, Ludmila M. Lyovkina, P.V. Kuznetzov, and G.A. Chinov. Their major interest seems to be the evolution of parasitism. They are particularly interested in Cladosporium, Alternaria, and Macrosporium, because they feel that parasitism has evolved relatively recently in these groups. They find that parasites as a group use amino acids in larger quantities than do saprophytes, and that the most virulent forms within a species leave less residual amine nitrogen in a peptone medium. This general finding applies also to Verticillium from cotton. They are also comparing the enzyme systems of parasitic and saprophytic forms within various genera and species.

I had quite an argument on physiologic specialization and genetics of pathogenicity with a man trying to distinguish populations in Ustilago zeae. Everybody took part and everybody seemed to enjoy it.

The people in this group are interested in practical problems, but devote most of their time to theoretical questions. It was stimulating to meet them.

Timiryazev Agricultural Academy, Department of Plant Pathology.

Professor M.S. Dunin is Head of the Department; M. Minyaeva is Associate Professor; and Zoe P. Kochalava, Director of the Plant Protection Station of the Department. They have about fifty students in each of the five years in the Plant Protection course. There are usually eight or nine aspirants working in the Department, and about as many working elsewhere in the U.S.S.R. under the guidance of staff members. It takes three years to get the Candidate's degree working "internally", and at least four years "externally". The aspirants in 1961 included students from China and the United Arab Republic.

Professor Dunin and his associates are interested in a wide range of problems, theoretical as well as applied. He has developed a hypothesis of phasic susceptibility of hosts to infection; its practical application consists of using cultural practices which will shorten the susceptible or prolong the resistant phases of host development. The staff and their students have investigated the relationship of rusts to the ontogenesis of their hosts; the variability of fungi as influenced by fungicides; and changes in pathogenicity as the result of transfers on a series of host varieties differing in resistance.

Venturia inaequalis cultures developed increased resistance to various poisons incorporated in the medium on which the fungus was grown; this change was not a permanent one, disappearing in a few generations on a normal medium. The reaction of Phytophthora infestans to fungicides could not be changed. The virulence of Puccinia triticina was not changed in repeated single uredospore inoculations on a range of wheat varieties. One culture which increased in virulence on previously resistant varieties also differed in colour; the variant proved to be stable for many generations.

When fibre flax plants were spaced widely, they produced many branches, with primary, secondary, tertiary and higher orders of branching. It was found that seeds from the higher orders of branching produced plants which bloomed later and were much more susceptible to wilt and to rust than plants from seed produced on the primary branches. They have also found that seed of winter wheat, sown on clean fallow to get higher yields, produced plants which were appreciably more susceptible to leaf rust than those from seed produced under less favourable circumstances.

They spoke of some rather interesting work with wheat bunt (Tilletia tritici). Wheat seed was sown in sand with one half of one percent by weight of smut chlamydospores added; seedlings transplanted from the sand to the field were often free of smut and the plants showed greater vigor than normal. The smut spores apparently produced some active substances, neither auxins nor gibberellins, which stimulated germination of spores of other species, as well as development of wheat plants. Similarly, extremely heavy doses of smut (Ustilago zeae) applied to the silks of corn plants counteracted the adverse effects of selfing, increased seed set on selfed cobs, and gave rise to light or no infections of smut. Similar effects are now being sought from extracts made from smut spores.

They are also working with viruses. One project involves producing active antisera for determining virus infection. They have had success using antisera of very high titre, from 1:1000 up to 1:20,000. They claim that this compares with titres of from 1:60 up to 1:100 used in Europe and the U.S.A. Apparently, the method of preparation of the sera is vital in attaining this high level of efficiency. Another line of work is to try to determine "pro-virus" comparable to "pro-phage". Tests of potatoes with antisera at harvest time have shown them free of virus; in the spring, tests with the same sera indicate the presence of virus. As they were not able to prove infectivity of the antigenic materials, they may have found the "pro-virus" they were seeking. They could not confirm the "de novo" origin of virus in plants reported by colleagues.

Professor Dunin is a veritable dynamo of energy and ideas, and is apparently appreciated by his colleagues at other institutions as well as his own. There was a large and elaborate celebration of his sixtieth birthday, to which I was invited. Unfortuntely, my arrangements had already been made to leave Moscow the night before the celebration, so I was not able to attend.

LENINGRAD

Botanical Institute of the Academy of Sciences.

The people I met at this Institute were all specialists on the taxonomy of various groups of plants. Dr. A.S. Bondartsev, well over 80 years old, is an authority on wood-destroying fungi. His daughter, Margarita A. Bondartseva, is working for a higher degree on the polypores and related forms, and handles the correspondence and much of the work for her father. Vasilkov works on Agaricales; Tomilin works on the Ascomycetes; Nikolayeva works on the Thelephoraceae; Dr. P.N. Golovin is currently working on a monograph of the Erysiphaceae, but his interests embrace most of the groups of fungi, and his experience includes a great deal of work on plant diseases, including Verticillium wilt of cotton in Uzbekistan. He has written a book on the fungi of sand deserts of Central Asia. He found tens of species of Peronosporaceae in the desert sand, and believes the area to be an evolutionary center for this group.

Dr. Golovin works with herbarium material. His distinctions of species and higher categories are based on morphology, ecology of the fungi and their hosts, and distribution. He has students working on various groups of fungi in scattered regions of the U.S.S.R. Like him, they are interested in evolution of the fungi, their phylogeny, geographical relations, and ecology. Presumably, they also follow his lead in being "splitters".

All Union Institute of Plant Protection (VIZR).

This Institute, which operates under the direction of the Academy of Agricultural Sciences, has about twenty specialized stations scattered over the Soviet Union, varying in size from two to three people up to four hundred or five hundred staff members. It sends expeditions to those areas where it has no stations of its own.

The Institute is not a teaching organization, but it has about sixty aspirants in all fields, about twenty of them in plant pathology. They carry on regular work as staff members of the Institute, and defend their dissertations for the Candidate of Science degree at various teaching institutions. The Institute has its own "Learned Council" before whom doctoral dissertations can be defended. The library is large and quite complete in its field, with an exceptionally full and efficient index and catalogue.

The Institute consists of a large number of specialized laboratories, varying in size of staff. The Director of the Institute, I.M. Polyakov, is also in charge of the Laboratory of Phytotoxicology. The Acting Director of the Institute, E. Shumakov, is an entomologist.

The Mycology Laboratory, headed by Professor M.K. Khokhryakov, works on biology of pathogenic fungi, and only incidentally on their taxonomy. It has available an herbarium with over 16,000 species of fungi, with a card index to each accession, which actually works; there are also cultures of about 300 pathogenic fungi and about 300 saprophytes. The laboratory receives a large correspondence and many specimens; its staff is required to do considerable diagnostic work and give advice on disease control to collective and state farms. They also turn out handbooks on diagnosis and control of diseases. Although there is at least one "splitter" on the staff, Professor Khokhryakov is a "lumper" in the best tradition. Current problems include, among others, dwarf bunt of wheat and grasses; Plasmopara halstedii on sunflowers; Fusarium oxysporum on legumes and other hosts.

Various groups within the institute are currently very much concerned about Peronospora tabaci, which has already invaded the western part of the U.S.S.R., near the border of Czechoslovakia. They are very much afraid that it will spread.

S.V. Andreev of the Laboratory of Biophysics had a pilot model of a new small "phytotron" under production in a factory. One hundred similar chambers had already been ordered for distribution to various institutions. It is three metres long, two metres wide, and two and a half metres high. It is an extremely versatile piece of equipment, permitting programming of light intensity up to 40,000 lux; temperature from -5° to +60°C; relative humidity from 23 to 98%; all regulated by studs which can be set in any of a large number of holes on the surface of a revolving disk. It is expected that the factory models will cost approximately 25,000 rubles (between $27,000 and $28,000).

It is quite possible that the cabinets will work and will do what their designer expects of them, but they seem unduly elaborate and expensive for most uses. There may be some point to so versatile a cabinet for someone studying the design of growth cabinets. In most research applications, however, it would be simpler and cheaper, and at least as satisfactory, to have a series of cabinets, each with a much more limited range, to cover the various possibilities included in this one extremely expensive machine.

G.M. Shkarlat of the Laboratory of Biological Methods (Biological Control) has small growth cabinets about 30" by 30" by 30", with no control of relative humidity, weak light, and controlled temperature (for entomological use, not for growing plants). Six new cabinets are being set up with much more elaborate control of temperature, relative humidity, and photo period, although not light intensity.

The Plant Pathology Laboratory, headed by Professor S.M. Tupinevich, is particularly concerned with diseases of vegetable crops and of potatoes. Cultural controls for these diseases are worked out in detail by the Laboratory of Agrotechnical Methods. According to one of the pathologists, in some greenhouses producing cucumbers on a small scale, Fusarium wilt is controlled by seeding cucumbers in the same pots with pumpkins or other resistant cucurbits, and grafting the cucumber onto the resistant species. This method is too laborious to be used in the larger greenhouse enterprises, some of which are large indeed! Plasmopara halstedii on sunflowers is sufficiently important that both a mycologist and a plant pathologist are working on the disease.

The Laboratory of Phytotoxicology tests chemicals which it gets from VIZR's own Laboratory of Organic Chemistry, from the Institute of Insecticides and Fungicides, the Institute of Organic Chemistry, and the Institute of Applied Chemistry. They are particularly interested in apple scab and late blight of potatoes. Promising chemicals selected by screening under laboratory and greenhouse conditions go to experimental fields at Pushkin, not far from Leningrad, and to experimental stations at various other points. There are 45 stations distributed throughout all zones of the U.S.S.R. where toxicological tests are made. The laboratory also investigates all new agricultural pesticides on behalf of a government commission.

The Director of the laboratory is trying to confer chemical immunity on plants by the use of various seed treatments and spray applications. Work is also being done with soil fungicides and fumigants, to control Plasmodiophora brassicae, Rhizoctonia aderholdii on cabbage, and Fusarium oxysporum. They are interested in the effect of the soil treatments, including fumigants, on useful microflora, such as Trichoderma; in minimal effective dosage; and the influence of soil type, moisture, and temperature (some sterilization in cold frames has to be done when day temperatures are 18°C and night temperatures 2°C).

The Laboratory of Immunity, headed by Professor Fedotova, works on diseases of interest to the whole country, such as rust of wheat, loose smut of cereals, late blight, wart of potatoes, and wilt of cotton. Disease problems of local concern are studied in local institutions. The laboratory has its own stations in various zones of the U.S.S.R., and cooperates with similar laboratories in institutes of plant protection in the various republics.

One objective in the work with late blight is to find new rapid methods for evaluating resistance, to be used at plant breeding stations with limited facilities. Tests are made on etiolated shoots, permitting selection of tubers before planting without loss of planting material. Differential effects corresponding to the effects of various races of the blight have been obtained with toxins produced by Phytophthora, which are stable, give quick results, and can be sent to outside stations.

Professor Fedotova believes that resistance in many cases is a property of the host protein; susceptible varieties have weak protein structure. She and her many associates have worked out serological tests which permit clear cut determination of the resistance of varieties to late blight. She claims that she can predict the reaction of varieties of cotton by using antisera prepared from various races of Verticillium, and the globulin fraction from cotton seeds; susceptible varieties produce a precipitate, resistant ones do not. She has also found that the leaf temperature of susceptible varieties is higher than that of resistant varieties in the absence of infection; when plants are infected, their temperatures increase.

Potato wart was brought into western U.S.S.R. by the German armies. Every effort is being made to keep it quarantined, and also to develop resistant varieties. By law, no new variety of potato may be released unless it is resistant to wart. Many apparently resistant varieties with no external symptoms carry Synchytrium in the cells. When the organism was isolated from such tubers and inoculated to a series of weakly resistant varieties, it began to produce symptoms even on the varieties formerly thought resistant.

The Laboratory of Prognosis, headed by A.E. Chumakov, is one of the largest in the Institute. It is responsible for predicting the areas and expected degree of infestation with such general pests as rodents and other warm-blooded animals, grasshoppers, and insects and diseases of various crops such as cotton, cereals, sugarbeets, and the other important field, forage, vegetable, and orchard crops. Tentative forecasts are made half a year in advance for the benefit of the Ministry of Agriculture of the U.S.S.R. and of the fifteen republics. The laboratory is also supposed to recommend new ideas in cultural practices and new chemicals to be used in control, as reported in the literature. It has about one thousand regional reporting stations scattered throughout the Soviet Union. There are usually two or three people, an entomologist, a zoologist, and a pathologist, at each point. In the drier zones there may be only one person sending data to the central laboratory. The fifteen hundred crop variety testing stations operating under the Ministry of Agriculture also send data on diseases and pests to the Laboratory of Prognosis. Full reports are made in October, and short reports every two weeks if anything unusual develops. The laboratory prepares a detailed prognosis for release in late winter. The forecasts are used by planners to decide what equipment and chemicals will be needed in various areas. Booklets giving the prognosis are published for the U.S.S.R. and also by the Russian S.S.R. Other republics hope to start publishing their own prognoses fairly soon.

The recommendations are worked out in greater detail for specific regions in the respective republics, sometimes bringing them down to specific state and collective farms. Detailed short term forecasts are made at the approximately one thousand prognosis points throughout the Soviet Union. They provide spray warnings, etc.

The central laboratory is concentrating on better methods of making short term and also long term forecasts for the rusts. The mathematics involved is fairly complicated, as they are attempting to reduce all the factors involved to a single numerical index.

One interesting method of control for Puccinia glumarum in the foothills of the Caucasus, which I heard about in this laboratory, is to use seed of the same variety produced in the steppes, about 200 kilometres away. The conditions under which the seed is formed are believed to be vital in determining the reaction of plants to the rust.

University of Leningrad, Department of Mycology.

Professor V.Y. Chastukhin, is a specialist in industrial mycology. He is primarily interested in the decomposition of forest vegetation, and in the physiology of pure cultures of wood and leaf decaying fungi. He has managed to get 90% utilization of leaf material by using an appropriate succession of fungus species in lab cultures. He is also trying to produce protein from industrial wastes, in order to get animal feed proteins. His big problem now is to produce spore material for "sowing" the tanks used in the continuous deep tank process for large scale production. Students in this department work on systematic mycology, on algology (Professor V.S. Shetukova-Poretskaya is an algologist who has published monographs on fossil diatoms); the undergraduate students do their "diploma work" and the aspirants do their theses in systematic mycology and algology, ecology, and physiology.

All Union Institute of Plant Production (VIR)

Academician S.M. Bukasov, potato breeder, and Dr. V.S. Lekhnovich, specialist in systematics and history of potatoes, have a tremendous worldwide collection of potato species and varieties. They have the German differentials for distinguishing Phytophthora infestans races 1; 2; 3; 4, singly and in all combinations, but none for race 5. They were very interested in obtaining Canadian differentials.

PUSHKIN

Agricultural Institute, Faculty of Plant Protection, Department of Plant Pathology.

Professor T.L. Dobrozrakova and her five associates in Plant Pathology have about fifty students in each of the five years of the plant protection course. They also teach plant pathology to students in other courses. They expect to accept about 75 students per year in future. They also have a large extra-mural enrolment, of students who work throughout the Soviet Union, and come to the Institute for about one and a half months per year to do very intensive laboratory work and to take examinations. Their investigational work is on plant diseases important in the Leningrad area, particularly diseases of small fruits, and of greenhouse and field vegetables. Plasmodiophora brassicae is still a problem on cabbage, which is grown on a large scale, sometimes hundreds of hectares in one field. Most of the studies are practical, such as the effect of fertilizers and of resistant varieties on the development of the disease. They also do some basic biological work, such as trying to determine the biochemical basis for the tolerance of some varieties of cabbage to clubroot.

I was permitted to attend an all day examination in which eight students in the fifth year of the Plant Protection Faculty "defended their diploma work". The respective topics, which may or may not have been completely representative, were as follows: (1) A report on the synthesis of six different phenolic compounds, using various methods; their purification and characterization; and a study of their effectiveness as insecticides on various orchard insects, relating their insecticidal properties to their chemical structure. (2) Studies on the control of Phytophthora on potatoes and tomatoes, using new fungicides, determining effects on infection and yield, and toxicity to spores. (3) Control of Phytophthora of potato, using micro doses of copper materials mixed with the insecticidal sprays which are compulsory for potatoes in the Leningrad area, where Colorado potato beetle is present. (4) Tests of fungicides to control powdery mildew of gooseberry. (5) A study of several new antibiotics against eight plant-pathogenic fungi, including leaf pathogens and also storage rot organisms. (6) Control of Sclerotinia or greenhouse cucumbers, using various chemicals and cultural practices, and studying the ability of the pathogen to survive in soil free of vegetable debris. (7) The taxonomy and biology of several rootfly maggots (8) Studies on the control of cabbage fly.

With one exception, each of these projects had been carried on for two summers, as well as taking a large part of the student's final year. Each was criticized and "attacked" by an examiner appointed for the purpose, and each was defended by the professor who directed the work as well as by the student concerned.

Virology Laboratory of VIZR

The Virus Station of the Leningrad VIZR had been established only a year and a half earlier. Two additional stations were started in 1961. Main objectives include working out quick chemical methods of diagnosis for two virus mosaics of cucumber, and the production of virus free potato seed stocks. They are trying to develop a quick method of diagnosis, using serology. One of the problems is that early varieties give non-specific reactions. Apart from some classic studies on virus, very little work on viruses has been done. A great deal of attention is now being paid to viruses, and intensive work is being started on many problems.

Laboratory of Immunity of VIR

This group working at Pushkin has objectives different from those of the Laboratory of Immunity of VIZR at Leningrad. They make intensive, large scale studies on varieties which appeared resistant in the various plots of the

Plant Production Institute (VIR). The Pushkin group uses artificial infection to determine varietal reactions under severe conditions. They work on methods to be used in large scale inoculations, as well as trying to find materials which can be used as resistant parents in the production of new varieties. They are investigating the inheritance of resistance, and are trying to determine the nature of dominance of resistance where it occurs. They are working on leaf and stripe rusts of cereals (stem rust is important only in the far eastern portion of Siberia). They are also interested in smuts of corn and cereals, and Phytophthora of potatoes and tomatoes.

KIEV

Institute of Microbiology of Ukrainian Academy of Sciences

Academician Drobotko, in charge of the Laboratory of Pathogenic Microorganisms (Human Diseases), is Director of the Institute, which is a complex one with many specialized laboratories.

Laboratory of Variation of Microorganisms, Professor T.I. Vizir

The current work of the laboratory is on bacterial transformation by DNA, and efforts to see if other cell constituents can also act as transforming agents. A group is working on variants induced by radiation; they will soon become a separate laboratory. A biochemist working in the laboratory isolates the DNA they use in their transformation studies, and also investigates the specificity of DNA in various species of bacteria and transformed isolates. She has found variation in the DNA. The work is largely with intestinal bacteria.

Bacterial Diseases of Plants, Dr. Beltikova.

This laboratory concerns itself primarily with new bacterial diseases, and those in which new work is needed. One of their main problems is to develop control by antibiotics. Their requirements include not only control of the pathogen, but also stimulation of plant growth and yield. Dr. Beltikova is particularly interested in seed treatments. She believes that antibiotics improve the physiology of the plants, and increase their resistance to disease and winter killing even in the second and subsequent generations. She is also interested in naturally occurring antibiotics of higher plants, and believes that resistant varieties have higher contents of such antibiotics than do susceptible ones.

Apparently, tomato seed for several thousand hectares (quick mental calculation, subject to error), was treated with antibiotics for the control of disease and stimulation of plants. One of their main difficulties is the production of appropriate quantities of material on a factory scale. The production of the antibiotic for the treatment takes most of the time of her laboratory staff, so that they have to neglect their studies on the nature of resistance, etc.

The requirement that a new antibiotic should stimulate plant growth as well as kill pathogenic bacteria seemed to me to be an unrealistic criterion. When I discussed this problem in another laboratory, it was suggested that the stimulation observed was possibly the effect of secondary substances in the crude preparations of antibiotics used in agriculture, and was not necessarily an effect of the antibiotic itself.

Plant Virology, Professor S.N. Moskovetz

The laboratory is concerned with general virology, the properties of viruses, and their effects on plant physiology. They are starting to work on virus diseases of potatoes, which are attracting increasing attention throughout the Soviet Union. Sugarbeet yellows is also an important problem, which was not known in the Ukraine before 1956.

Professor Moskovetz had previously worked on cotton diseases in Azerbaijan, where he found virus leaf roll attacking only the best varieties of cotton. A large group working on the problem in the Institute of Cotton Research developed antisera for determining varietal reaction, and succeeded in breeding resistant varieties of good quality in six years. They also studied the effects of various cultural practices on the development of the disease and on its transmission by vectors and by seed.

Mycology Division, Professor N.M. Pidoplichko

At one time this laboratory studied the fungus flora of seeds, and pathogenic fungi, and those which were toxic to man and animals. For the last ten years, they have been working on the mycoflora of soils. Currently, they are working on forest soils and the relation of the mycoflora to agricultural crops. Professor Pidoplichko is a systematist who uses ecology and physiology as well as morphology in his systematic work. In addition to his work with plant pathogens and toxicogenic fungi, he has studied antibiotics. Together with Dr. V. Bilai, they found microcidin, which is effective against both gram negative and gram positive bacteria, including the TB organism.

Division of Fungus Physiology, Section of Biologically Active Substances, Professor Vera I. Bilai

Professor Bilai, recently elected a Corresponding Member of the Academy of Sciences, an authority on taxonomy of *Fusarium*, is studying antibiotic substances isolated from rhizosphere fungi, for their effectiveness against plant pathogens. They are also checked for medical uses. She is now interested in the taxonomy of *Trichoderma*, and in some volatile materials which it produces that are antibiotic. Trichodermin has been used against several plant pathogens.

She has found that many strains of *Fusarium moniliforme* produce gibberellins, particularly when extracts of corn plants in the five to six leaf stage are added to the cultures. She has isolated pure cultures of *F. moniliforme* from vessels of healthy corn plants. These isolates produce gibberellins, particularly when isolated from corn plants in the younger stages. They may have some role in the normal growth of corn.

Dr. Bilai attended the International Botanical Congress in Montreal in 1959, where I acted as interpreter for her and Dr. W.L. Gordon when they discussed *Fusarium*. I was greeted like a long lost friend when we met in her laboratory!

Agricultural Academy of the Ukrainian S.S.R., and Ukrainian Institute of Plant Protection.

The Institute works on such general problems as control methods, and also on particularly important and dangerous pests and diseases. It does not work on diseases and pests of specific crops; the various specialized crop institutes all have their own divisions of plant protection. The Institute has ten specialized laboratories, organized on much the same basis as the laboratories of VIZR at Leningrad. Problems of particular importance in the Ukraine are the sugarbeet weevil, and Peronospora tabaci.

The Plant Pathology Laboratory works on wheat leaf rust, corn smut, Peronospora tabaci, and potato viruses, among other problems. The virus problem on potatoes is particularly severe. The "super elite" stocks have up to 80% virus infection. They are trying desperately to clean up the elite stocks, which have several different viruses in them. They have already developed an antigen for a local strain of virus X, and are now working on sera for two more viruses; they hope to have them within a year. They also hope to develop polyvalent sera in the next year or two.

The visit to this Institute was particularly rewarding because I met Maria Zelle, who worked on sunflower diseases up to 1939, and whose work I had seen only in abstracting journals before coming to the Soviet Union. She had encountered many of the problems on sunflowers which still interest me, and we were able to discuss in detail work which each of us had done and which neither of us has yet published! She has worked on forest pathology, and on diseases of vegetables, since 1940. Although she is about 75 years old and retired, she comes to the laboratory quite frequently.

On my last day in Kiev, I spoke about "Plant Pathology in Canada" to a joint meeting of the Microbiological Society, and the Mycology and Plant Pathology Sections of the Botanical Society. The meeting sent greetings and best wishes to the Canadian Phytopathological Society, which I transmitted by telegram to the Annual Meeting of the C.P.S. in Regina.

KRASNODAR

All Union Institute for Research on Oil and Essential Oil Crops (VNIIMEMK)

The various sections of this Institute work on a wide range of crops. The most important include sunflowers, flax, mustard, castor bean, and on a smaller scale, peanuts and sesame, and essential oils. It has sections on plant breeding, soil management, plant protection, and other specialized activities. The breeding program on sunflowers, under Academician V.S. Pustovoit, has been phenomenally successful; the results with flax have also been very good. In 1912, when sunflower breeding was started at the Institute, the best sample of seed collected from the whole country yielded 33% oil on a whole seed basis. A variety with 35% oil was released in 1925. The best selections, not yet released, now contain well over 50% oil in the whole seed; commercial seed at the factories yields over 40% oil.

The present varieties are resistant to broomrape (Orobanche cumana), seed maggot (Homeosoma nebulela), and are reasonably resistant to rust (Puccinia helianthi).

Hybrids resistant to downy mildew (Plasmopora halstedii), a disease which has appeared in the Soviet Union since 1950, are being produced from crosses with Helianthus tuberosus, which also contributes immunity to rust. Crosses have also been made with the wild Helianthus annuus of Texas, (which is used as a source of rust resistance in Canada), but the progenies have not yet been released as varieties.

The main disease of flax in the area is wilt (Fusarium oxysporum f. lini). Some new selections, not yet released, are resistant to wilt and contain up to 48% oil.

The sunflower and flax breeders use the standard disease nursery techniques to test their materials for reaction to broomrape, downy mildew, and flax wilt, respectively, although their actual breeding methods are different than those used in North America. They depend on natural infection for rust.

The Plant Protection Laboratory of the Institute was established fairly recently, and is staffed by young people. They have started work on a range of problems, but have not yet had time for any major contributions.

All Union Tobacco Research Institute

This Institute has as its objectives the raising of yields and quality, and lowering the cost of production of tobacco (*Nicotiana tabacum* and *N. rustica*). Plant breeding is the main method used to achieve these objectives. Although the breeding is based on Michurin genetics, the plant breeders use inter-specific crosses and other classic approaches in their work. The genetics of resistance to disease, cytology, and other theoretical aspects of plant breeding are also studied. Accomplishments include the production of varieties immune to powdery mildew and to tobacco mosaic virus; about 30% of the tobacco area is sown to such varieties. Some varieties resistant to *Thielaviopsis basicola* have also been produced.

The Plant Protection Section works on many of the 25 plant diseases, mostly viruses, which affect either seedlings or field plants or both in the tobacco regions of the U.S.S.R. They are concerned with identifying the viruses and their vectors, and working out cultural or chemical controls until such time as resistant varieties can be produced. They study races of *T. basicola*, and soil treatments to control it and other diseases in seed beds. They have worked out methods of inoculation for various viruses in order to test the reactions of selections, and to determine disease effects; they also inoculate soil plots with *T. basicola*, broomrape, and other pathogens to study the respective troubles which they cause.

The Institute has experimental stations scattered throughout the tobacco growing region of the U.S.S.R. Each of these stations has its own plant protection laboratory, working on diseases important in its area.

Agricultural Research Institute

Academician P. P. Lukyanenko breeds winter wheat for yield, quality, and disease resistance. Stem rust has not been severe since the war, although there was a destructive outbreak on winter wheat in 1936. Stripe rust is severe about three times in ten years on the average. Leaf rust is a limiting factor in winter wheat production. He obtains resistant varieties for his crossing program from the world collection. Soviet wheats were not resistant to leaf rust. All the Argentine varieties were resistant to leaf and stripe rust in his area. Unfortunately, there seems to be a negative correlation between leaf rust resistance and quality, so he has used back crossing to incorporate resistance in varieties with desirable quality. He is using the western Canadian variety, Selkirk, in his breeding program, because it combines high quality with resistance to leaf and stripe rust, and powdery mildew. It was free of mildew the previous year in a very heavy outbreak.

The winter wheat varieties released retain ther rust resistance for a relatively short time. Selection for rust resistance is based on natural infection in the field, and apparently tests are not made with specific physiologic races of the rust. One of the major difficulties recognized by the wheat breeder is that the limited studies on rust races which have been made helped only to explain the breakdown of previously resistant varieties. He envied western Canadian wheat breeders the service given them by pathologists who keep a close check on the occurrence of rust races, and warn them of changes in the race pattern which may necessitate the incorporation of new sources of rust resistance in the breeding program.

Kuban Experiment Station of the All Union Institute of Plant Production

The main work of this station is to maintain for the All Union Institute (VIR) the varietal collections of those crops which grow well in this area. There is also a limited amount of breeding work done with flax, corn, chick-peas (*Cicer arietinum*) and one or two other crops. There is no pathologist permanently located at the station, although an effort is being made to obtain one. A wilt nursery is being used in the flax work, apparently in spite of opposition some years ago. Disease resistance of other crops has been determined exclusively on the basis of natural infections, with the almost inevitable result that varieties selected in years with little disease have proven extremely susceptible when conditions were favourable for disease development.

My main interest at this station was the work on *Plasmopara halstedii* done by N.N. Novotelnova, a pathologist from VIZR at Leningrad, who does her field work with the disease here. I was favourably impressed by her studies on the biology of the organism, although I questioned the basis of her taxonomic treatment of the pathogen.

By coincidence, my room mate in the guest house at the station was Dr. P.A. Lubenetz, who was one of the Soviet scientists who visited the Winnipeg Plant Pathology Laboratory in 1957. He was completing two weeks work in the station plots of forage legumes, which are his main interest.

TASHKENT

Tashkent Agricultural Institute

The Institute has a Faculty of Plant Protection, with Departments of Plant Pathology and of Entomology. The major crops of the area include cotton, fruits, and forage. Fusarium wilt of cotton appeared in Uzbekistan in 1938, and rapidly spread throughout the whole area. Control was achieved by the development of resistant varieties, from crosses between the local fine cottons and resistant Brazilian and Peruvian types. Resistance is determined in a wilt nursery which contains a mixture of virulent races. Verticillium wilt of cotton, earlier brought under control by the distribution of resistant varieties, is again becoming severe where monoculture is practised. A new law requires that cotton be grown for only five or six years, followed by alfalfa for three years.

Uzbek Institute of Plant Protection

The Institute started as a laboratory devoted to cotton diseases and pests in 1912. Since then it has variously been the Uzbek station for Plant Protection, a Cotton Disease Research Station, and a section in the Cotton Research Institute, until it assumed its present role under the Uzbek Ministry of Agriculture in 1957. It is now responsible for work on all crops in the area, but the main effort is still on cotton. The Institute has the usual series of specialized laboratories and sections; because of its special problems, these include a Wilt Laboratory, and a Laboratory of Immunity, which concentrates on breeding for resistance to wilt. There are about two hundred people working in the Institute, and at its experimental station in Ferghana Valley, where field work is done on cotton wilt.

Fusarium wilt is the main problem on Gossypium barbadense, and Verticillium wilt on G. hirsutum. Projects of the two-year-old Wilt Laboratory include studies on the distribution of wilt; the variability of the causal organisms; the possibility that Verticillium may begin to attack G. barbadense, and Fusarium, G. hirsutum; studies on the biology of the pathogens and development of the disease; methods for early recognition of resistance of cotton to wilt; and methods of cultural and chemical control of wilt.

General Comments

There is a great amount of descriptive work being done in plant pathology and mycology in the Soviet Union, and there are monographs and handbooks on an impressive list of subjects. The research work at the universities and at institutes and laboratories under the Academy of Sciences includes such topics as the physiology of parasitism, the evolution of parasitism, the systematics of non-economic groups of fungi, as well as of plant pathogens. The quality of the work varies from place to place and from person to person, as might be expected anywhere. The research at the institutes of the Ministry of Agriculture, and at the institutes and faculties of agriculture, tends to be applied to a greater extent, more so than in some of the laboratories of the Canada Department of Agriculture. The applied work helps to produce more food for more people on a smaller area, and its role is recognized and appreciated.

Most of the laboratories I visited were located in old buildings and were extremely crowded. In several cases, they expected to move to new buildings which were either under construction or were soon to be built. The equipment I saw was fairly standard in most cases. Some had been imported from Germany, Czechoslovakia, or other countries. Most of it was made in the U.S.S.R. One piece of equipment which I had not previously seen used by mycologists, was a comparison microscope which made it possible to examine two preparations simultaneously in one field of view. My previous knowledge of this equipment was confined to reading of its use in ballistics and fingerprint work. Although laboratory space was restricted in most places, the area in field plots was often very extensive. Facilities for making chemical determinations, such as the oil content of sunflower and flax seeds, and the quality of linseed oil, are available to plant breeders on a scale not matched in Canada.

The universities train relatively few students in plant pathology and mycology, and there are also relatively few graduate students in these departments of the universities. Large numbers of students are trained in plant pathology and plant protection at the institutes of agriculture and the faculties of agriculture. There are approximately 250 graduate students in the faculties of plant protection at the Timiryazev Academy in Moscow and also at the Agricultural Institute at Pushkin near Leningrad. The fifty or so students graduated at the end of the five year course at each of these institutions are not plant pathologists in our sense, but agronomists trained in plant pathology or other phases of plant protection. They are trained to take over any one of a number of duties on a state or collective farm.

A significant number of the graduates from the agricultural faculties return to work as "aspiranti" to qualify for the degree of "Candidate of Science", something between the levels of our M.Sc. and Ph.D. degrees. It involves no course work, but the students do have to pass a certain number of examinations, and must prepare and defend a dissertation in public after about three years work. A small proportion, between 1 and 2% of the Candidates, go on to do research for a dissertation which also must be defended in public, for the degree of Doctor of Science, comparable to the British D.Sc.

Undergraduate training takes five years, both in the universities and in the institutes of agriculture. Students compete very intensively for admission to institutes of higher education. Education is prized in its own right, but it also gives prestige and social and financial advantages. The entrance examinations are very stiff; once accepted, however, students receive a stipend, pay no fees, and pay only a nominal price for board and room.

The first two years of the course are devoted to such basic subjects as general biology, zoology, botany, chemistry, physics, mathematics and a foreign language. In the final three years, the students work intensively at specialized courses. They are required to spend part of each summer at biological field stations, teaching and research stations operated by the institute or faculty, and on collective or state farms, all in a definite sequence, and according to a prescribed plan. In the last two summers, they start to accumulate materials and data to make experiments for the "diploma work" which they have to write up and defend in an oral examination at the end of th of their final year.

The course work is more theoretical and the diploma projects and examinations are even more difficult in the universities than at the institutes.

The organization of the system of higher education is such that the students can be required to work hard. The method of admission into the universities and institutes is such that the students are in most cases capable of fulfilling the academic demands made of them. It would be very interesting to arrange an exchange of graduate students in plant pathology between institutions in the Soviet Union and in Canada, if there were Canadian graduates in plant pathology with an adequate knowledge of Russian and Russian graduates with an adequate knowledge of English for such an exchange. I suspect that the Soviet students just starting graduate work would be better prepared than Canadian or American students at the same stage.

The people in the institutes, faculties, departments, and laboratories I visited, without exception, were extremely friendly and hospitable and eager to discuss their work and to compare their problems with ours in Canada. They were also very generous with their gifts of books and reprints. They have been very helpful in sending publications which I have requested since returning to Canada and have been extremely appreciative of the reprints of Canadian publications which I have arranged to have sent to them.

One of the objectives of an exchange of scientists between Canada and the U.S.S.R. is to establish personal contacts between people in related fields of work. In furtherance of that objective, I will be pleased to provide any additional detailed information I may have, and to establish direct contact between any interested Canadian plant pathologists with their opposite numbers in the U.S.S.R.

DEPARTMENT OF ENTOMOLOGY AND PLANT PATHOLOGY,
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