DOMINION OF CANADA
DEPARTMENT OF AGRICULTURE
DOMINION EXPERIMENTAL FARMS

DIVISION OF BOTANY

REPORT OF THE DOMINION BOTANIST

H. T. GÜSSOW

FOR THE YEAR 1925

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DIVISION OF BOTANY

REPORT OF THE DOMINION BOTANIST, H. T. GÜSSOW

The present extensive report of the division, comprising contributions from the Central Laboratory at Ottawa in its divers phases of economic botany and plant pathology, as well as from the individual branch laboratories throughout Canada, speaks well for the progress that is being made in Canada in crop disease investigations. Were it possible to estimate in dollars and cents the value of the work done by the staff of this division, perhaps a still more impressive argument might be presented in favour of every possible support relating to disease control. In many instances certain diseases were kept under thorough and complete control, adding many thousands of dollars to the value of Canada's crops. In other instances losses have been reduced perhaps to a smaller percentage only; but if even to an extent of only two per cent of the total estimated annual losses, our services will have cost the general public not a single cent, but will have constituted a very valuable asset to Canadian agriculture.

The work of the division, hardly ever better and more satisfactorily constituted than at present, with a full and well-trained staff at work in many laboratories, the members of which are thoroughly aware of their opportunities, has made most satisfactory progress, as is witnessed by these pages.

The new Dominion Rust Research Laboratory at Winnipeg is in full working order, and the new premises are now being occupied. The equipment in regard to laboratory buildings as well as thoroughly up-to-date pathological greenhouses, leaves little more to be desired; and every facility has been afforded us by the Department, for which we hereby make grateful acknowledgment, for research along the line of grain rust control.

Uniform Rust Nurseries (Eastern Canada)

In pursuance of our researches in connection with grain rust, uniform rust nurseries of wheat and oats were established at a number of Experimental Farms and Stations in Eastern Canada in co-operation with the United States Department of Agriculture, for the purpose of locating the distribution of prevalent biologic strains of rust in this section of the Dominion. These nurseries were conducted throughout the United States and Canada at fifty different points, of which five were located in Eastern Canada at Ottawa, Ontario; Ste. Anne de la Pocatière, Quebec; Fredericton, New Brunswick; Kentville, Nova Scotia; and Charlottetown, Prince Edward Island. Determinations of rust infestation were made by Dr. E. C. Stakman, of the University of Minnesota, and Dr. H. B. Humphrey, of the Office of Cereal Investigations, United States Department of Agriculture. The following are the results obtained at the different nurseries:—

WHEAT RUST—STATION AND ESTIMATED PERCENTAGE OF INFECTION*

Variety	Ottawa, Ont.	Ste. Anne de la Pocatière, Que.	Fredericton, N.B.	Kentville, N.S.	Charlottetown, P.E.I.
Durum—					
Kubanka 1440	T*	0	0	0	0
Kubanka 2094	5	0	0	0	0
Nodak 6519	0	0	0	0	0
Arnantka 1493	T†	0	0	0	0
Arnantka 6236	3	0	0	0	0
Akrona 6881	T†	0	0	0	0
Mindum 5296	T†	0	0	0	0
Acme 5284	0	0	0	0	0
Monad 3320	0	0	0	0	0
Pentad 3322	0	0	0	0	0
Hard Red—					
Haynes 2874	T	0	T	0	0
Marquis 3641	0	T	0	0	0
Power 3697	T*	0	T	0	0
Ruby 6047	T	5	5	0	0
Marquillo 6887	0	0	0	0	0
Preston 3081	0	T†	0	0	0
Kota 5678	0	T	T	0	0
Progress 6902	0	T	T	0	0
Kota x Marquis 6898	T	0	T	0	0
Marquis x Kanred 7370	T	0	0	0	0
Ceres 6900	0	0	0	0	0
Parker 2222	0	0	T	0	0
White—					
Quality 6607	T*	0	T	0	T
Little Club 4066	T†	T	T	0	T
Dicklao x Sevier G. H. 40	0	0	0	0	0
Dicklao x Sevier G. H. 149	0	0	0	0	0
Emmer—					
Vernal 3686	0	0	0	0	0
Khapli 4013	0	0	0	0	0

T = trace (less than 1 per cent); T† = fairly conspicuous trace; T* = bare trace.

OAT RUST—STATION AND ESTIMATED PERCENTAGE OF INFECTION*

Variety	Ottawa, Ont.	Ste. Anne de la Pocatière, Que.	Fredericton, N.B.	Kentville, N.S.	Charlottetown, P.E.I.
Iowar 847	0	0	0	0	0
Richland 787	0	0	0	0	0
Fulghum 708	0	0	0	0	0
Burt 2043	0	0	0	0	0
Rustless 724	0	0	0	T†	0
Heigira 1001	0	0	0	0	0
Silvermine 659	0	0	0	T†	0
Iogren 2024	0	0	0	T	0
Ruakura 2025	0	0	0	0	0
Red Rustproof 1815	0	0	0	T	0
White Tartar 551	0	0	0	0	0
Swedish Select 134	T	0	0	T	0
Green Mountain 1892	0	0	0	0	0
Joanette 1880	0	0	0	0	0

T = trace (less than 1 per cent); T† = fairly conspicuous trace; T* = bare trace.

PLANT DISEASE SURVEY

In place of the usual mimeographed report on the plant diseases prevalent in Canada during 1924, which would be the fifth annual report, a summary of the years 1920 to 1924 inclusive, was prepared, and is being printed as a bulletin. In this the host plants are grouped; these groups and the number of hosts and diseases dealt with in each are as follows:

—	Host plants	Diseases
1. Diseases of cereal crops	4	55
2. Diseases of forage and fibre crops	16	55
3. Diseases of fruit crops	13	100
4. Diseases of vegetable and field crops	22	136
5. Diseases of forest and shade trees	19	61
6. Diseases of ornamental plants	23	44
7. Diseases of miscellaneous plants	106	131
Total	203	582

Under each disease its reported distribution by provinces is given, together with its comparative importance in each province and in each of the five years. Any observed difference in varietal susceptibility or resistance of hosts to each disease is recorded, and when dates of first appearance have been reported, these are included also.

In addition to the above, two appendices are included in the publication as follows:—

No. 1. An annotated list of anthracnose diseases of the order *Melancoliales*, including the genera *Gloeosporium, Colletotrichum, Marssonia, Septogloeum,* and *Cylindrosporium,* found in the open and under glass in Canada and the adjoining United States. This was prepared by one of our collaborators, Dr. John Dearness, of London, Ontario.

No. II. A list of pathogenic fungi found in Manitoba, prepared by three of our collaborators, Dr. G. R. Bisby, Dr. D. L. Bailey, and Mr. I. L. Connors.

A sixth annual mimeographed report covering the diseases prevalent during 1925 has also been prepared for distribution.

Diseases of Ornamental Plants

As time permits a study is being made of certain diseases of ornamental plants, which are of economic importance to the commercial as well as to the amateur flower grower. A brief description of the year's work with these follows:—

Gladiolus Dry Rot.—This disease is responsible for much loss in that it is responsible for the premature death of plants and the decay of corms in storage.

The causal fungus has been isolated and a study of its life history and the measures necessary for its control was undertaken. A full description of the symptoms, pathogen, and control measures has been published in "Scientific Agriculture," Vol. VI, No. 6.

An article on the diseases of gladioli and their control was also prepared for the Canadian Gladiolus Society for publication in their Bulletin No. 3.

Separates of these articles may be obtained by application to the Division of Botany.

ASTER WILT *(Fusarium conglutinans Callistephi* BEACH).—Badly infected land in the ornamental flower garden of the Division of Horticulture was placed at my disposal and asters grown in the greenhouse were transplanted into this area and subjected to drenches of the following materials:—

1. Uspulun 25 per cent, 2 and 3 waterings.
2. Bayer Compound 25 per cent, 2 and 3 waterings.
3. Kalimat 25 per cent, 3 waterings.
4. Kalimat 5 per cent, 2 waterings.

Seed planted in this area was subjected to similar treatment. Six varieties of asters were used in the experiment.

In no case was there any reduction in the amount of the disease, as compared with the check plots; infections ranging from 17 per cent to 93 per cent being obtained. These experiments will be continued in 1925.

Another experiment with this disease was made to determine whether the plant was susceptible to this disease at the time of transplanting only or throughout its growth.

Six rows containing forty transplants consisting of five varieties and a check were employed. These were divided into five blocks. The plants in each block were artificially inoculated with a crushed pure culture of the causal fungus, starting with the first block on the same day they were transplanted and the other blocks in turn one week apart. This was done in soil in which asters had never been grown. Infections were obtained throughout with the check row remaining healthy, showing that the plants are susceptible to infection at any time of their growth up to blooming time.

EXAMINATION OF PLANT-IMPORTATIONS

Under the Destructive Insect and Pest Act an inspection of all plant-importations at the ports of entry is conducted by inspectors of the Division of Foreign Pests Suppression of the Entomological Branch. All diseased material, other than that caused by insect injury, is submitted to this division for examination.

During the year a large number of these specimens were examined and recommendations made for the disposal of the shipments concerned. The bulbs, etc., of ornamental plants, such as tulip, hyacinth, narcissus, peony, iris, gladiolus, and begonia, constituted the bulk of this material.

It has been difficult in many instances to give definite diagnoses of these troubles and well-based recommendations for disposal, for the following reasons:

1. The more or less decayed condition in which some of the material arrives for examination makes it impossible in some instances to determine the original cause of the trouble.
2. The deterioration may have arisen during the growth of the plant in the foreign country, or during the curing, storage, or transportation of the material.
3. Most of the diseases concerned are of foreign origin, are not always found in locally-grown stock, and have therefore never received any attention by this division.
4. The study of the diseases of ornamental plants as a whole has, up to the present, received little or no attention as compared with that given to the diseases of other economic plants.

This whole subject requires painstaking research by someone who has sufficient time to make a thorough investigation which could form the basis of a guide to inspectors at the ports of entry. Such a guide should contain detailed descriptions of the symptoms and causes of these troubles, with accompanying photographs and instructions as to the method of dealing with the shipments having such troubles.

This leads to a discussion of a system of standardization of what should be admitted, and we are confronted with a difficult problem. The Destructive Insect and Pest Act is wide in its application, and under its regulations admittance may be refused to any material showing any form of deterioration which renders it worthless, but the difficulty is to define the standards for such rejection.

Bulbs and other ornamental plant stock are imported by two classes of customers, viz.:—

1. Those who grow bulbs for immediate bloom or sale in bloom.

2. Those who import various types of bulbs and planting stock, notably gladiolus, peonies, and iris, for propagation and later sale.

In the former case we could perhaps be more lenient, for suppose that a standard for rejection of three per cent was established, and that a shipment of tulips, narcissi, and hyacinths was rejected. The firm exporting these bulbs may or may not make good this loss, but in any case there is never time to replace the bulbs in the same season, and the importing firm is faced with a loss of business and revenue from their failure to obtain the shipment. This loss would be laid at the doors of the Department of Agriculture.

In the latter case, however, we cannot afford to be so lenient. We are faced with the responsibility of admitting diseased material, which may become established in Canadian nurseries and from there spread to various parts of the Dominion.

Our recommendation is that not more than two per cent of disease should be permitted entry in the case of stock for propagation, and not more than five per cent in the case of bulbs for bedding and forcing. In addition the consignee should be notified of the presence of any disease in the shipment and instructions sent covering the recognition and removal of the diseased specimens.

The inspector's statement could be used by the consignee in lodging a complaint with the shipper, not only for the purposes of compensation, but also for education, so that the growers and shippers would take greater care in the choice of material for shipment to Canada.

FOREST PATHOLOGY

White Pine Blister Rust

In Eastern Canada.—As was the case last year interest in blister rust in the east was centred in Ontario, especially in that part of the province adjacent to the Ottawa river. Here for the first time in any section of the province, excepting the Niagara peninsula, rust was found on native pines. Infection on *Ribes* is common enough throughout that part of the province south of the Ottawa river, lake Nipissing, and the French river, and during the present year it has been found even as far north as Haileybury. At the latter point it was on cultivated black currants which are the most susceptible of all species of *Ribes* and which, in any region hitherto free from the rust, are sure to become infected first. This species is, therefore, the most reliable indicator of the presence of rust in any district.

Since 1919 when rust was first found on *Ribes* in the territory mentioned thousands of pines in the neighbourhood of infected *Ribes* have been examined annually for rust, but previous to this year none had ever been found diseased. In September in company with several officials of the Office of Blister Rust Control, United States Department of Agriculture, a trip of inspection was made through this district especially to endeavour to locate infected pine trees or, if these could not be found, to attempt to find an explanation for the apparent anomaly of infected *Ribes* and uninfected pines occurring in close association.

At Pembroke, the first place visited, a small fruiting canker and several younger infections were found in the river valley south of the town. Near the

General Hospital several fruiting and young cankers were found on small trees associated with infected *Ribes*. At the mouth of the Petawawa river no pine infection was observed though *Ribes* were heavily infected. At the Chalk River Forest Experiment Station diseased *Ribes* were abundant but pines were apparently free from rust. Near Chalk River Station, however, a small fruiting canker was found on a large tree near infected black currants. On Allumette Island and the Quebec shore opposite pines were examined at seven points at all of which infected trees were found. At one place on the mainland—School House No. 1— about 25 per cent of the young pines were badly infected and some had already been killed by the rust. At the western end of the island one tree was found which had been killed by the fungus. This infection was at least ten years old.

At Mattawa wild *Ribes* were scarce but one mile east of the town an infected pine was located. At North Bay a limited amount of scouting failed to reveal rust on either host and at Scotia Junction infection on wild *Ribes* was found. At Huntsville pine was scarce but several infections were found. These were about seven years old. At Lindsay there was *Ribes* infection but few pines and none of these were diseased. From Lindsay, Point Pleasant on Sturgeon lake was visited but no rust was discovered on either host. At Port Hope *Ribes* were heavily infected and one pine infection was also found. At Belleville there was rust on *Ribes* but not on pines. Of the wild *Ribes*, *R. Cynosbati* was most common and nearly always bore infection. Others found infected were *R. americanum, R. triste, R. hirtellum,* and *R. glandulosum.*

In general it may be said that rust is widely distributed throughout the important pine-growing sections of Ontario with the exception, for the present, of the Rainy River and Temagami districts. However, it must only be a matter of a short time until the fungus spreads into these two extensive and valuable areas of white pine. Blister rust is not a spectacular disease, except in extreme cases, and because of its insidious character it is all the more dangerous, as the seriousness of the situation is not impressed upon foresters and others until much damage has been done. Rust has been present in the Muskoka district and along the Ottawa river for from seven to ten years, which is longer than had been thought to be the case. But without an adequate field force of well trained men it is not possible to keep a close check upon it because of the obscure nature of the disease. After rust enters any district a number of years may elapse before any considerable infection of pines occurs. This is because there are only certain years in which conditions for the infection of pines on a large scale are favourable although, of course, some infection occurs each year. Rust, therefore, may take several years to spread gradually and become firmly established but after that period much damage will result during the first favourable year for the infection of pines. The disease, then, may be considered as gathering momentum as time passes, if it remains unchecked.

There is but one method by which rust can be controlled, and that is by the eradication of wild and cultivated *Ribes* in the vicinity of white pine. In the United States methods have been evolved by which this work is accomplished at a cost of from 16 to 20 cents an acre. This gives protection for from five to ten years. Were white pine not one of our most valuable tree species it is questionable whether it would be worth protecting it at such an expenditure but under the circumstances there can be no doubt that control measures should be applied in white pine areas and that before it is too late. The whole matter is essentially a problem in forest protection, equally as much so as fire, and, as such, should receive from foresters the attention which it merits.

In British Columbia.—In this province rust probably had its origin in a shipment of 1,000 eastern white pine seedlings imported in 1910 from France and set out at Point Grey. In 1922 but 180 of these trees were alive. Since the date of introduction the spread of rust on the coast has been continuous

until now it more than covers the area in which white pine occurs. In the interior, about Revelstoke, rust apparently first occurred in 1917 and since then has spread north into the Cariboo country and south as far as Nelson. It is becoming more apparent as time goes on that the present widespread occurrence of rust in British Columbia can only be accounted for by long distance spore dispersal from pines. There is much circumstantial evidence in favour of this view. The fact that the original centres of infection must have been very limited in number and that there could have been none of these in many districts where rust is now found is further evidence in support of this theory. Of the pines occurring in this province *Pinus monticola*, the most important species, has proved to be very susceptible. *Pinus flexilis* has not yet been found infected, nor has *Pinus albicaulis* with the exception of a single specimen found diseased and in the fruiting stage in 1924 in the arboretum of the University at Point Grey.

Investigations on Decays of Balsam Fir (*Abies balsamea* Mill.)

During the field seasons of 1923 and 1924 detailed studies of decay in balsam fir were carried out in Quebec on the limits of Price Brothers and Company. The objects and methods of these studies have been dealt with in previous reports and it is proposed to give here a brief summary of the results obtained from an analysis of the field data secured during the course of this work.

The first investigation was made on the Shipshaw river in the Lake St. John district. Here 525 trees were cut and analyzed for decay. The incidence of cull was calculated by 10-year age classes and the results indicated by a graph. Starting from zero in the 51-60-year age class the curve rises steadily until in the 181-190-year age class it reaches 40 per cent, i.e., in this age class 40 per cent of the merchantable volume was discarded on account of decay which in this district is the only cause for cull in pulpwood. The figures show clearly that after a certain age has been reached—in this case sixty years—the amount of decay, and consequently cull, increases steadily with increasing age. This introduces a consideration of the length of time which a stand may be safely left to grow without incurring serious loss from decay as it is only in this way that the problem of decay in forest trees can be successfully dealt with. It is not a matter of controlling this source of loss but of avoiding it by utilizing the crop before much loss has resulted. The results in this particular case indicate that it would be necessary to adopt a rotation of seventy-five years in order to avoid loss of economic importance.

There were but two important types of decay encountered in this work and these have been described previously. In analyzing the trees attention was paid to the means by which the two fungi responsible respectively for red rot and feather rot had gained entrance to their hosts. In the case of red rot it was found that 90 per cent of the infections had come in by way of dead-branch stubs, 8 per cent by means of dead tops, and 2 per cent by miscellaneous means. With feather rot 95 per cent of the infections entered by way of the root-system and 5 per cent by wounds of various kinds.

The second study was carried out at Metis Lake on the south shore of the St. Lawrence and here 634 trees were used. In addition to the decays met with in the previous investigation a third type caused by *Polyporus balsameus* was found to be of fairly common occurrence. This fungus causes a brown butt-rot. An analysis of the figures indicated that the condition of balsam fir in regard to decay in this region was very favourable. For the whole group of trees analysed the percentage of cull was only 11·3 which is probably quite low for this species. Moreover, during the first 100 years the amount of cull is not serious and the stand could be safely left to grow for that length of time if necessary.

There is a general impression prevalent among foresters and others that the present condition of balsam fir in regard to decay is in large measure due to the recent budworm outbreak which has swept over the spruce and balsam fir forests of Eastern Canada. Results obtained from these studies, however, do not support this view. What probably has been an important factor in this connection is the fact that until recently balsam fir was not cut with the other more valuable species—especially spruce—and in this way the proportion of this species became much greater than it was in the original stand. The condition thus created could not but be favourable to the spread of a fungus which is confined to balsam fir, as in many cases practically pure stands of this species were left. In this connection it is significant to note that Moore and Rogers[1] state that "the soundness of fir timber depends chiefly on the percentage of fir in the stand," and they go on to show that the greater the proportion of this species the earlier decay occurs and the more loss it causes.

CULTURAL STUDIES OF WOOD-DESTROYING FUNGI

"Dote" Disease of Sitka Spruce (*Picea sitchensis* Carr.)

It has been found that Sitka spruce *(Picea sitchensis)* which is used in the manufacture of aeroplanes suffers from a defect which, in the factories in England, is commonly called "dote." In the early stages there is frequently little or no discoloration of the wood and it is only when strength tests are made that the presence of decay is realized. Hence it is a very real menace when the spruce is being used in aeroplanes where strength is of prime importance.

A preliminary investigation has been undertaken to determine whether or not this defect is present in aeroplane spruce stock before it is shipped to England. Several of the mills on the Pacific coast which are cutting aeroplane timber were visited. Specimens were collected from freshly felled logs, from freshly cut green timber, and from timber which had been rejected as unfit for aeroplane material. A large number of cultures of fungi were obtained from these specimens but it will take some time to identify the various organisms and to prove whether or not any of them are responsible for "dote" as it occurs in aeroplane spruce stock in England.

"Silver-Leaf" Disease of Fruit Trees

Silver-leaf disease of fruit trees, which was first reported in Canada by Mr. Güssow in 1911, has become very common in the Okanagan district of British Columbia on apples, apricots, and fruit trees generally. The disease is particularly interesting because it is reported that many of the affected trees recover. Brooks reports the recovery of plum trees in England and suggests that perhaps the tree is able to resist the fungous advance. Silver-leaf disease occurs in Nova Scotia as well, but is not as prevalent as in British Columbia.

The fungus *Stereum purpureum* Pers. has frequently been shown to be closely associated with the presence of silver-leaf. Specimens of this fungus have been collected, both in British Columbia and Nova Scotia, from trees which showed the disease. In other cases the mycelium of *Stereum purpureum* has been isolated from the wood of branches bearing silvered leaves. Typical silver-leaf has been obtained experimentally by inoculating young apple trees with spores from the fruit-bodies of *Stereum purpureum* or with mycelium from pure cultures. The whole problem of silver-leaf of fruit trees in Canada requires further investigation to determine its relative economic importance and whether or not *Stereum purpureum* is responsible for the bulk of the damage attributed to this disease.

[1] Moore, Barrington and R. L. Rogers. Notes on balsam fir. For. Quart. 5: 41-50, 1907.

Fomes pinicola (Sw.) Cooke and *Pholiota adiposa* Fr., Two Heterothallic Species of Wood-destroying Fungi

No cytological investigation has been made of the mycelium of *Fomes pinicola* or of *Pholiota adiposa*. The absence of clamp-connections from monosporous mycelia and their presence in compound mycelia, resulting from the pairing of monosporous mycelia, are the only criteria which have been employed in determining heterothallism.

It has been found that *Fomes pinicola* and *Pholiota adiposa* are heterothallic and in all probability bisexual. In both species monosporous mycelia either remain wholly sterile or produce imperfect fruit-bodies which have never shed spores; on the other hand those compound mycelia formed by the union of two monosporous mycelia produce normal sporophores; and monosporous mycelia isolated from the spores of fruit-bodies from different localities are mutually fertile.

Cultures of Wood-destroying Fungi

Cultures of the following wood-destroying fungi are included in the mycological collection at Ottawa. In addition to those listed there are a number of cultures which, for various reasons, have not been included. For example, there are upwards of sixty cultures of *Fomes pinicola* alone, including several series in which inoculations were made from a number of sporophores which grew (*a*) on one tree; (*b*) on different trees of the same host species; (*c*) on different hosts from various localities. There are also a number of cultures of fungi which have been isolated repeatedly from specimens of defective aeroplane spruce from different parts of the Pacific coast. Few of these fungi have been identified so far, either because no sporophores have developed or because we have no type culture with which they agree in microscopic and macroscopic characters.

Collybia velutipes (Curt.) Quél.
Coniophora cerebella (Pers.) Schröt.
Coprinus micaceus (Bull.) Fr.
Fomes annosus (Fr.) Cooke.
Fomes applanatus (Pers.) Wallr.
Fomes igniarius (L.) Gill.
Fomes officinalis (Vill.) Faull
=*F. Laricis* (Jacq.) Murr.

Polyporus Berkeleyi Fr.
Polyporus borealis Fr.
Polyporus Schweinitzii Fr.
Polyporus squamosus (Huds.) Fr.
Polyporus sulphureus (Bull.) Fr.
Polyporus Tsugae (Murr.) Over.
Polystictus abietinus (Dicks.) Fr.
=*Polystictus pargamenus* Fr.
Polystictus hirsutus (Wulf.) Fr.

Fomes pinicola (Sw.) Cooke.
Fomes roseus (Alb. et Schw.) Cooke.
Lentinus lepideus Fr.
Lenzites saepiaria Fr.
Pholiota adiposa Fr.
Pholiota lucifera Lasch.
Pleurotus ostreatus (Jacq.) Quél.
Pleurotus ulmarius (Bull.) Quél.

Polystictus versicolor (L.) Fr.
Poria subacida Peck.
Schizophyllum commune Fr.
Stereum fasciatum Schw.
Stereum purpureum Pers.
Stereum sanguinolentum (Alb. et Schw.) Fr.
Trametes carnea Wettst.
Trametes Pini (Thore.) Fr.
Verticillium albo-atrum Reinke et Berth.

POTATO-INSPECTION AND CERTIFICATION

A comparison between the work accomplished and the results obtained during 1925 and the four previous years indicates undiminished interest and success in the production of certified seed potatoes, the figures of the field inspection for the five years being as follows:—

Year	Number of fields inspected	Number of acres inspected	Number of fields passed	Number of acres passed	Per cent fields passed	Per cent acres passed
1921	2,646	7,900·0	1,634	4,290·0	61·7	54·3
1922	3,283	11,250·0	2,139	6,991·0	65·3	62·1
1923	2,914	9,681·0	2,061	7,099·7	70·7	73·3
1924	5,586	19,238·87	3,868	13,916·64	69·25	72·3
1925	4,542	14,451·51	3,307	10,856·88	72·8	75·1

Included in the two following tables is a summary of the distribution and results of the work in the nine provinces of Canada during 1925, and the average percentage of the principal diseases found in the fields inspected, passed, and rejected:—

SUMMARY OF THE INSPECTION WORK BY PROVINCES

—	Number of applications received	Number of fields inspected	Number of acres inspected	Number of fields passed	Number of acres passed	Per cent fields passed	Per cent acreage passed
Prince Edward Island	1,210	1,880	7,330·5	1,628	6,515·0	86·5	88·8
Nova Scotia	118	155	300·2	113	201·2	72·9	67·0
New Brunswick	476	892	3,745·0	561	2,335·0	62·9	62·3
Quebec	154	253	560·8	97	191·2	38·5	33·9
Ontario	316	470	1,270·0	325	920·0	69·2	72·5
Manitoba	38	70	130·0	56	104·0	80·0	80·0
Saskatchewan	91	115	322·0	81	149·0	70·43	46·27
Alberta	121	157	334·0	90	137·0	41·01	57·32
British Columbia	282	550	459·01	356	304·48	64·7	66·3
Total	2,796	4,542	14,451·51	3,307	10,856·88	72·8	75·1

PERCENTAGE OF DISEASE FOUND—BY PROVINCES

—	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia
Average per cent disease in total fields inspected:—									
Blackleg	0·381	0·87	1·25	1·2	0·69	0·20	0·62	1·08	0·17
Leaf Roll	0·030	0·2	0·18	0·30	0·59	0·19	0·38	0·0	0·16
Mosaic	1·165	0·42	2·33	5·7	0·57	0·14	0·15	0·50	2·51
Wilts	0·068	0·22	0·008	0·003	0·006	0·0	0·0	0·33	0·11
Average per cent disease in fields passed:—									
Blackleg	0·326	0·70	0·57	0·43	0·27	0·20	0·25	0·36	0·04
Leaf Roll	0·004	0·11	0·16	0·12	0·38	0·14	0·10	0·0	0·13
Mosaic	0·251	0·6	0·69	0·41	0·31	0·08	0·20	0·17	0·52
Wilts	0·06	0·22	0·009	0·001	0·001	0·0	0·0	0·02	0·08
Average per cent disease in fields rejected:—									
Blackleg	0·06	1·70	2·41	1·7	1·62	0·87	1·57	2·37	0·29
Leaf Roll	0·058	0·5	0·22	0·40	1·05	0·59	0·83	0·0	0·30
Mosaic	5·24	3·63	5·11	9·2	1·16	0·61	0·74	1·16	5·54
Wilts	0·072	0·0	0·005	0·007	0·017	0·0	0·0	0·55	0·20

FIELD INSPECTION

It will be observed that the acreage inspected this year was considerably below that of 1924, but that it represents a normal and satisfactory increase when compared with the work done in 1923. In 1924 the planting of both seed and commercial potatoes was abnormal, with the result that many growers experienced considerable difficulty in disposing of their crops owing to the intervention of the inexorable law of supply and demand. This had a decidedly stabilizing effect, which was reflected in the certified seed acreage this year for although the number of applications received for inspection was 2,806, as against 2,480 in 1924—an increase of 326—yet they covered an area smaller by 4,787.36 acres, which indicates that the acreages of many growers were considerably reduced. It is safe to predict that the prices being paid this year for all classes of potatoes will induce the growers to plant again more extensively next year, providing they have reserved sufficient seed stock for the purpose.

These fluctuations are not, however, in the best interests of certified seed production, for some growers are tempted, following a year of high prices, to increase their acreages, often by the use of uncertified seed which may contain a quantity of disease, and which, grown alongside certified seed will cause disqualification of whole fields owing to the communicable properties of diseases such as Mosaic and Leaf Roll. However, it is satisfactory to note that the average percentage of acres passing inspection has increased from 54.3 in 1921 to 75.1 in 1925.

Of the 4,542 fields inspected, 1,235 failed to qualify for certification. Of this number, 607 fields, the majority of them planted with uncertified seed, submitted for inspection for the first time, were disqualified owing to the presence of Mosaic. This disease is invariably found to be widespread where uncertified seed is planted, but the gradual progress of inspection and certification is eliminating much diseased stock, and in view of the large amount of certified seed now annually produced and available for reproduction, it is proposed henceforth to insist upon the sole use of such seed as a condition of eligibility for certification. Moreover, the use of certified seed will reduce to a minimum the rejection of fields owing to foreign varieties and non-isolation, which in the past has been far too much in evidence.

The occurrence of misses in the rows is frequently observed in fields apparently free from disease. Hitherto this occurrence has not been taken into account under the standard for field inspection, unless it could be determined as attributable to Blackleg or Rhizoctonia destroying the seed pieces. Under these circumstances, however, it is almost certain that a considerable percentage of such diseases would be found in the growing plants, in which case the fields concerned would be rejected for certified seed.

Mechanical causes may be responsible for misses. The planter may not be functioning uniformly, or the fertilizer distributor may be out of order, causing the application of fertilizer to be too heavy in parts of the field. Care should therefore be taken to have these machines in perfect working order before planting is commenced.

Our experience, however, in the inspection work, notably in some cases the unsatisfactory results obtained from our certified seed, leads us to believe that there exists another reason for the occurrence of misses. During the past few years many growers have become efficient and even expert in the detection of the various diseases and in roguing and other methods of control. This is valuable enough as far as it goes in most cases, but we must now regard it as the frequent cause of the presence of disease in crops grown from certain certified seed. To illustrate this, the following is an outline of conditions which we have observed. A grower secures a supply of potatoes for seed, with the origin and previous behaviour of which the inspection service is not acquainted, and which perhaps contains more disease than is permissible. Being an experienced grower and able to detect diseases, he thoroughly rogues his field, bringing about the "misses," just before the first inspection is made. The inspector, unaware that such roguing has been done, may find the field well within the standard and eligible for second field inspection at a later date. Assuming that in the meantime the grower has continued roguing, the field at this later date is still found to be within the standard and is passed as eligible for certification, subject to tuber-inspection.

As such diseases as Mosaic and Leaf Roll are communicable in the field, the danger of such a situation is obvious; a large percentage of the plants remaining in the field may have become affected by the diseased plants prior to their removal by roguing—and even by the roguing itself, unless carefully conducted—the results of which will reveal themselves the following year, causing loss and dissatisfaction generally.

With these conditions in mind it is felt that in order to protect the growers, the inspection service, and all concerned, misses in potato fields must be taken into consideration and included in the standard for field inspection. It is therefore proposed in future to take this into consideration in fields intended for certification, except in cases where it can be definitely determined that such are attributable to purely mechanical causes.

Considerable difficulty is experienced every year in persuading some growers to make application for field inspection on or before the date which it is imperative to set in order that the work may be performed expeditiously and economically. Many and varied excuses are subsequently forthcoming with requests for acceptance of belated applications, and in the past a certain amount of latitude has been allowed, but often not without additional time and expense being involved. It is therefore being made known as widely as possible, by circularizing all growers on our lists, that in future, applications received after the date set will be accepted only on the understanding that the growers concerned assume responsibility for any expense incurred as a result of such acceptance.

Tuber Inspection

The tuber inspection work this year was more difficult than in almost any year since the service was commenced. This was due to two factors, i.e., the occurrence of Late Blight everywhere in the Eastern Provinces, and severe frosts while the crops were still in the ground. The former caused a considerable number of rejections of otherwise disease-free crops, while the latter were responsible for some very severe grading, particularly in Northern Ontario.

An impression which at times appears to be considerably in evidence is that once potatoes are passed as certified seed and the certification tags placed on the bags, they will retain their excellent quality and vitality regardless of what treatment they may receive, or under what conditions they may be stored. This impression does not prevail among the growers only, as some shippers and buyers are found to disregard essential points, particularly in the matter of storage. We have frequently been called upon to investigate complaints made with regard to the unsatisfactory condition of potatoes which had been certified. Such investigations have almost invariably revealed that the potatoes were kept stored in bags and piled in cellars or warehouses for weeks after date of certification, and under atmospheric and temperature conditions totally at variance with the normal requirements of seed potatoes if their soundness and vitality are to be preserved. It therefore seems imperative to again emphasize as strongly as possible that potatoes, merely because they are certified, are not thereby rendered impervious to injury when made subject to such adverse conditions.

Consideration is being given to the question of providing varietal tags, each with a distinctive colouring, for the certification of Irish Cobbler and Green Mountain potatoes. These two varieties invariably represent from 90 per cent to 95 per cent of the total amount of potatoes certified each year, and it is felt that the provision of such tags with the varietal designation printed thereon would make for greater efficiency during the busy shipping periods, as well as obviate a large amount of work with rubber stamps which at present has perforce to be done by the inspectors.

Markets for Certified Seed Potatoes

The most notable feature in regard to Canadian certified seed potatoes, which becomes more pronounced each year, is the alacrity and even eagerness with which they are accepted in the seed markets of the United States. Up to the end of the year, 367,761 bushels of the 1925 certified seed crop have been shipped to these markets from Prince Edward Island, New Brunswick, and

Ontario, and many more have been purchased for shipment during the winter and early spring. The American markets are the logical ones for this seed, not only from the point of view of adjacency, but also because our northern latitude and a system of suitable localization of different varieties such as is being gradually evolved through the inspection and certification work, enable us to produce vigorous stock, propagated under the most favourable climatic conditions for successful reproduction in the south.

Shipments of certified seed of the Garnet Chili variety from Nova Scotia to Bermuda, amounted to 13,076 bushels, in place of the usual annual shipments of about 20,000 bushels. The reduction was mainly due to the issuance of a warning by the Bermuda buyers early in the year, that owing to the depressed condition of the Garnet Chili trade in the island, only 50 per cent of the normal amount of seed would be required. Bermuda being practically the only market for this variety, the warning naturally led to a reduction of the acreage planted in Nova Scotia. However, the requirements in the fall exceeded the earlier estimate, with the result that more seed would have been purchased had it been available.

A request was recently received through the Dominion Fruit Commissioner from the Government of Czecho-Slovakia, for some samples of certified seed potatoes for testing in that country. Accordingly four samples of one barrel (165 pounds) each, were procured and forwarded, the following varieties being represented: Green Mountain from Prince Edward Island, Irish Cobbler from New Brunswick, Garnet Chili from Nova Scotia, and Dooley from western Ontario.

The work of inspecting, and issuing certificates for, all shipments of potatoes consigned to Cuba, as required by the regulations of the Cuban Government, has been continued. Up to the end of December, certificates have been issued covering shipments of 1,195,637 bushels of the 1925 crop.

Inspection Staff

The number of seasonal and temporary inspectors employed this year was forty-one, including two supplied by the Ontario Department of Agriculture and two by the Department of Agriculture of British Columbia. Thus, with the eight district inspectors—including Mr. C. Tice, Chief Agronomist, Victoria, B.C., who continued to act as district inspector for British Columbia, in co-operation with us—a total of forty-nine men took part in the work for varying periods. The district inspectors also continued to actively co-operate with the provincial departments in delivering addresses on potato diseases at agricultural meetings and short courses, and in acting as judges of potatoes at the various exhibitions.

GENERAL AND ECONOMIC BOTANY

Inquiries concerning the culture of medicinal plants were fairly numerous during the year, of which a large number referred to the propagation of Ginseng. Requests were received also for information dealing with golden seal, seneca snakeroot, cascara sagrada, peppermint, chamomile, and tansy.

Wild rice also received considerable attention on the part of those interested in attracting wild ducks; likewise several inquiries were made concerning Muskrat Potato (*Sagittaria latifolia*) and other plants suitable for the propagation of muskrats.

Other miscellaneous requests for information dealt with chicory, comfrey, teasel, peanuts, broom corn, wild flowers of Canada, insect flowers, plants suitable for checking drifting sand, plants for keeping off mosquitoes, and conditions influencing the flow of sap in sugar maple.

The exchange list of seeds collected in the year 1924 contained the names of 1,303 species and varieties and was mailed to more than fifty of the leading botanical gardens of the world.

Altogether 4,597 packets of seed were received from foreign botanical gardens, while 3,438 packets of seed, 40 cuttings, and 84 rooted plants were sent out to foreign countries as well as to all the provinces of Canada. The largest consignment of seeds despatched to a single botanical garden consisted of 604 packets which were sent to Nantes, France. A consignment of 72 packets of seeds and 27 cuttings was sent to the Experimental Station at Morden, Manitoba, while 50 rooted plants were sent to the Sidney Experimental Station on Vancouver island.

In response to a request from the editor of "Chemist and Druggist", published in England, several photographic prints of views in the Botanical Garden were sent to him for publication.

A paper entitled "Some further experiments on the relation of light to growth" was published in the American Journal of Botany, Vol. 12, July, 1925, and contained the results of further experiments with a number of plants commonly cultivated in field or garden. The scope of these experiments is sufficiently indicated in the opening paragraph:—

"In a previous publication it was stated that 'in summer the higher latitudes have a longer period of daylight, and this greater duration of daylight even with a lower temperature may produce as great an effect on plants as a shorter period of light with a higher temperature in places lying near the equator.' In another and later publication the following statement occurs: 'From the experiments described and from many others the conclusion is drawn that light and heat are to a certain extent interchangeable in a plant's economy.' The experiments of which the details follow were undertaken mainly with a view to confirming, or, at any rate, supplying some further information bearing on, the above statements. At the same time some additional tests were made of the value of electrical illumination as a substitute for or an addition to ordinary daylight; finally an experiment was made out-of-doors to determine the effect on plant growth of the interposition of a screen of ordinary window-glass. The details of the experiments are given in the following order: (1) experiments with electric light; (2) experiments on duration and intensity of light; (3) experiments on relation of growth to duration of light and temperature; (4) effect on growth of a screen of colourless glass."

The results obtained may be summarized as follows:—

"Under a continuous electrical illumination of 700 watts (voltage 110) with daylight entirely excluded, castor-oil bean completed its life history from seed to seed and produced vigorous plants from the seeds ripened under electric light.

"Flowers developed their natural colour under the same illumination, namely, white in wax bean, yellow in tulip, blue in hyacinth, and red (stigmas) in castor-oil bean.

"Plants of wheat, buckwheat, and soybean exposed to daylight alone made greater growth than those exposed to daylight plus electrical illumination at night, while hemp, wax bean, and sunflower showed a slight increase as the result of the nightly illumination. Under the additional illumination at night, earlier flowering occurred in wheat and sunflower and later flowering in hemp.

"Observations as regards height, time of flowering, and weight made on wheat, flax, hemp, buckwheat, white mustard, soybean, castor-oil bean, and sunflower grown both in a green house and in the open air showed that the results were as satisfactory under two hours' exposure to light at midday as under three hours' exposure during the morning or afternoon.

"Experiments in a greenhouse with Indian corn, flax, hemp, castor-oil bean, buckwheat, white mustard, soybean, and sunflower carried out at different times of the year showed as good a growth under an average exposure to daylight for 568 hours 40 minutes at a mean temperature of 60.8°F. as they did with an average exposure to light of 499 hours 53 minutes at a mean temperature of 68.2°F.

"Experiments in the open air with wheat, buckwheat, white mustard, and flax showed as vigorous growth under a glass screen as that of a corresponding set in the absence of such a screen.

"The conclusion is drawn that experiments on the relation of plants to light, in order to be of value, must take into account not only the duration of light but also measurements of its intensity, as well as records of the temperature throughout the period of the experiments."

SYSTEMATIC BOTANY AND WEED STUDIES

Besides maintaining our regular identification service and an extensive correspondence on weed problems which occasionally involved personal visits to farmers, the principal activities under the head of systematic botany and weed studies had to do with the furtherance of the Canadian weed survey and a certain amount of experimental work with weeds. Requests for talks on weeds and wild flowers were acceded to whenever possible, and the more gladly because of the opportunities afforded for carrying out surveys in connection therewith. On such occasions it was usually a revelation to farmers, boy-campers and others addressed, to learn that it was possible to identify a hundred or more species of weedy and poisonous plants in the course of a couple hours' inspection of the locality, and that several dozen kinds of weeds might be detected within a very few steps. This extension phase of our work also made use of the press, radio, etc., to reach a wider public.

In the weed survey the new ground covered this year was principally in the Georgian bay counties of Ontario, and in northern Ontario as far west as Hearst and Sault Ste. Marie, as well as in the parts of Quebec bordering the Ottawa river. Weeds of consequence in newer Ontario were found to be couch grass, perennial sow thistle, Canada thistle, stinkweed, ox-eye daisy, buttercup, etc. The two first named, more particularly, are certain to make serious trouble. The proportion of introduced to native species is still quite low as compared with older settled parts of Ontario, and should be kept so by arousing a live interest in weed matters before it is too late. Interesting extensions of known range were obtained on this trip for perennial ragweed, Russian pigweed, red-seeded dandelion and orange hawkweed.

Satisfactory progress has been made in bringing together and arranging for ready reference data on close to 1,000 species of weeds, poisonous plants and introduced plants aggressive enough to warrant keeping under surveillance as potentially objectionable acquisitions. It is hoped soon to be ready to issue a check list of these plants, more or less annotated, for the use of botanists, farmers and others in a position to furnish us additional records and notes on local occurrence.

Weed Control

Following up the experiments with mouse-ear hawkweed mentioned in last year's report, several acres of badly infested lawn were ploughed up on June 8 after the plants had come fully into bloom. Ploughs were used both with and without skimmers and at furrow depths of from three to seven inches. The soil varied from sandy loam to rather stiff clay, and was in moist condition when ploughed. All lands were double-disked in both directions four days later to settle the furrows and pulverize the surface. It was the intention in the case of the deeper ploughing to keep the weed buried, and in the case of the shallow ploughing to tear the sods to pieces after some rotting, and drag them out to the sun by means of cultivation. It became evident though that even the three-inch furrow, disked to form a close soil mulch, was effectively preventing further growth, so no other implement was introduced all summer. Only where trees prevented the proper turning of a furrow was there any further evidence of hawkweed. Moderately deep ploughing, followed by disking, may therefore be recommended for this, as it has been for other hawkweeds. Eradication without breaking up was tried again with scattered patches, using dry salt, but only with considerable injury to the grass was recovery from the roots prevented.

Common mouse-ear chickweed is another weed of lawns regarding which we have frequent complaints. It is naturally most prevalent where the grass is thin. The obvious remedy is to thicken the stand of grass by sowing in fresh seed, after first raking out as much as possible of the chickweed. The loose sur-

face thus created is favourable to germination, and the seeding may be done in late summer quite successfully, and with less infestation of the seed-bed by dandelion seeds than if done in the spring. A dressing of fertilizers may also be desirable. It will surprise most people to learn how much the chickweed can be thinned out without appreciable injury to the sod, by the use of a bent-toothed rake while the ground is moist.

Poison Ivy Eradication

Efforts were made to determine under what conditions and by what means poison ivy could be uprooted from the neighbourhood of dwellings. The location of such patches seldom admits of the use of the larger implements of cultivation, which otherwise would readily subdue the pest. Chemical methods, such as the use of salt, or sodium arsenite, are frequently asked for, but there is reason to believe that few people persist in applying these remedies until success is achieved. While hand work is generally disliked on account of the risk of poisoning, as well as the labour involved, the fact remains that it is often the surest means of getting the job done. In many cases the amount of the weed present is so insignificant that it is hard to understand its being tolerated. Even larger patches when investigated often prove to be so shallow-growing that they could be easily grubbed out. In wet or in shaded ground especially, it was found possible, using a bent-tined fork or hook, such as many farmers keep for unloading manure or for digging potatoes, to tear up long matted strips of ivy growing superficially under these conditions. On one occasion with some care a strand of rootstock over twenty-five feet long was removed intact. Only a few deeper roots remain to need attention later. In rocky soil however the difficulty of grubbing out by the roots is so increased that applications of hot brine, caustic soda or other chemicals are likely to be more practicable.

Work with hand tools is best undertaken before unfolding of the leaves in spring increases danger from contacts. Gloves should be worn to protect the skin, not only from direct contact with the plant, but also from the virulent oil adhering to the tools, boots, overalls, etc. Persons too susceptible to poisoning should of course leave such work to others. The writer in many years' experience has always regarded himself as immune, and yet the breaking of rootstocks, with wrists somewhat exposed, so that they received the minute oil drops thrown off, resulted once in some inflammation. In every case after discarding work dress, the hands and face should be well scrubbed with a strong soap lather and hot water, either running or changed several times to carry away any poison which might otherwise be washed about on the skin.

REPORT OF THE DOMINION FIELD LABORATORY OF PLANT PATHOLOGY, CHARLOTTETOWN, P.E.I.

(R. R. Hurst, Officer in charge)

Cereal Rust Investigation

A preliminary study of the cereal rust situation was begun in 1925 with a view to finding out what rusts are common on Prince Edward Island and loss sustained therefrom.

Permanent wheat and oat rust nurseries were established. Included in these were differential hosts used in physiologic strain determination.

Barberry and buckthorn surveys were made of the Charlottetown district. One buckthorn hedge and several barberry bushes were located. Aecia of *Puccinia graminis* and *Puccinia coronata* were observed on July 10.

Stem rust of wheat was not a serious factor this year. Infection was only moderate on the varieties most popular in the province. However, Little Club and Marquis, which are congenial hosts, showed heavy infection by August 25.

Spore trapping was undertaken on June 1, but on account of prolonged rainy weather was discontinued and resumed again the latter part of July. A few urediniospores of *Puccinia graminis* were trapped the first week in August.

The viability of *Puccinia graminis* spores is given in the following table:—

1925	Percentage germination		
	Uredinio-spores	Host	Teliospores
March 29....	0	Wheat straw in hay stack	5
April 13....	0	Wheat stubble	6
" 21....	0	*Agropyron repens*	4
" 28....	0	*Phleum pratense*	3
" 28....	0	*Avena sativa* stubble	1

No germination observed after April 28.

Cultures of *Puccinia graminis Tritici* and *Puccinia graminis Avenae* were submitted to Dr. D. L. Bailey, Winnipeg, for determination. This phase of the work was attempted at Charlottetown but was discontinued because of adverse weather conditions.

Leaf rust of wheat did serious injury this year and can be considered of economic importance.

"Browning" and "Stem-break" of Cultivated Flax

This project was first undertaken at Saskatoon, where it was carried on for one year by the present assistant at Charlottetown. In March, 1925, viable spores of *Polyspora Lini* were collected on flax which had wintered-over in the field. The project was then transferred to Prince Edward Island.

Nine varieties of flax were supplied by the Fibre Division and tested for susceptibility. The disease appeared only on Riga Blue and Saginaw, doing very little injury. This was in early August when typical "Stem-break" developed. The "Browning" condition described by Lafferty did not develop under the damp, warm weather which prevailed during the growing season. The marked absence of this organism during the past season under favourable conditions indicates that until flax is more widely grown the disease will not be a serious factor.

Ascospore Discharge in Apple Scab (*Venturia inaequalis* (Cke.) Wint.)

Investigations were undertaken with a view to determining the dates of spore discharge, correlating this with primary infection and arriving at the earliest date on which spraying is necessary on Prince Edward Island.

Observations were made from March 1 to June 10. Spores were first discharged on April 14, continuing until June 1. Greatest activity occurred during rainy weather.

Blight of Tulip—*Botrytis Tulipae* (Lib.) Hop.

This disease of tulips was observed in one bed at the Charlottetown Experimental Station in the spring of 1918. In 1925 it reached epidemic proportions in the same bed where tulips have been grown each year since. Infection was heavy by June 1, one large bed showing as high as 90 per cent. Many bulbs

missed, while a high percentage of plants were destroyed before the buds appeared. On the outer coverings of the bulbs numerous minute sclerotia were observed. These were also found on the roots, stalks, floral parts and leaves. In colour the sclerotia were greyish-white to black, depending upon their age,

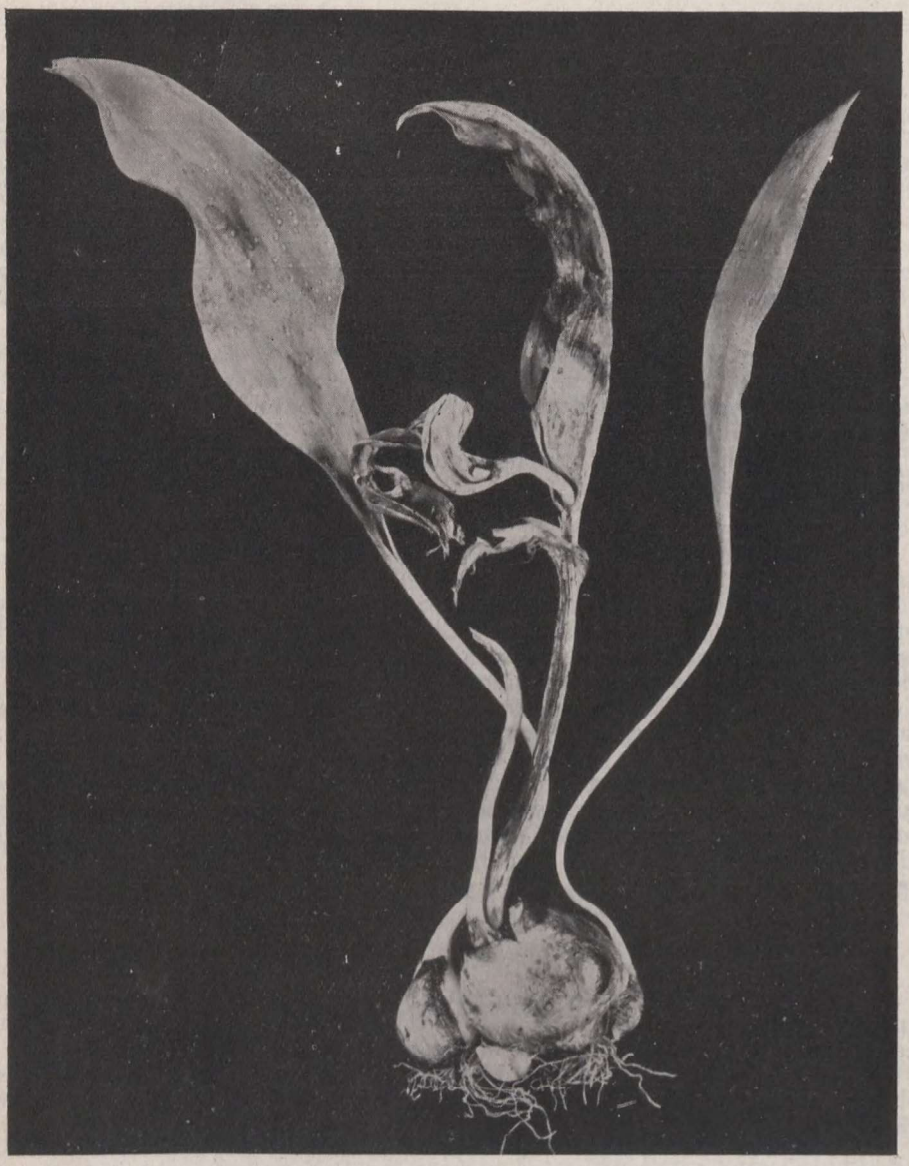

Fig. 1.—BOTRYTIS BLIGHT OF TULIPS
Note twisted leaves and spindling of petioles.

the immature ones being lighter. On the leaves the disease appears first as numerous, small, yellowish spots, which present a speckled appearance, later enlarging and appearing water-soaked. In cases where lesions develop near the margin or midrib the leaves show a marked twisting. Minute light-brown spots

occur on the petals, later causing them to wilt and shrivel up. Typical fructifications of *Botrytis* developed on all parts above ground but on the petals only after they began to wilt.

Fig. 1 illustrates the nature of this disease. Cottage Boy suffered the least, showing but slight infection.

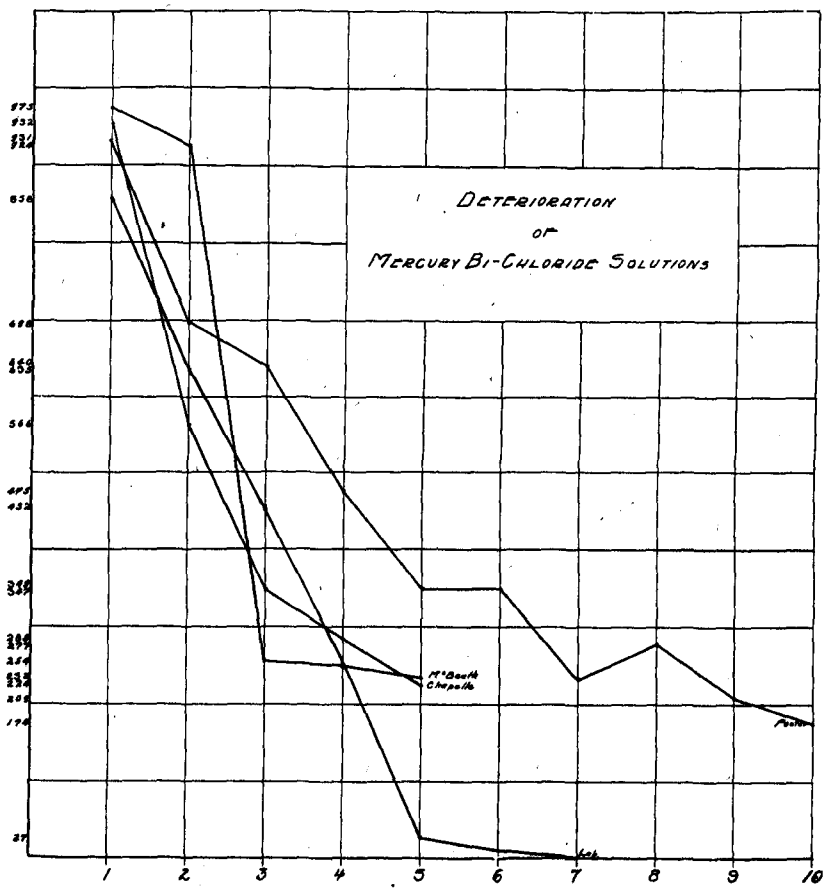

Fig. 2.—GRAPH ILLUSTRATING DETERIORATION IN BI-CHLORIDE SOLUTIONS.
Figures 1 to 10 represent consecutive samples; figures on the left represent percentage bi-chloride in each.

The nature of the disease suggests the following control measures: (1) Remove and burn diseased material as soon as it is found. (2) Examine bulbs before planting and discard those showing sclerotia. (3) Avoid replanting tulips in diseased beds.

Changes in Concentration of Bi-Chloride of Mercury Solutions During Seed Treatment

The Dominion Botanist in his annual report for 1912 was the first to draw attention to the material reduction in strength of mercuric chloride solutions during seed treatment of potatoes. In this report it was pointed out that the amount of bi-chloride removed by the potatoes reduced the strength of the solution 10 per cent for one treatment. To compensate this loss in fungicidal effect the common practice on Prince Edward Island is to dissolve 100 grams of

bi-chloride of mercury in hot water and make up to 22½ gallons. (This covers about four bushels). For each successive four bushels one quarter of an ounce of bi-chloride is added to allow for deterioration in solution, the water being kept up to 22½ gallons.

The doubtful efficiency of this method led to an investigation carried on by Mr. L. J. Howatt. Samples of solutions were obtained from several farms during seed treatment operations. These were taken from the original solutions and again after each quarter ounce of bi-chloride was added, i.e., after treating 4 bushels. In this way nineteen samples were taken and tested for mercury content.

The information obtained from the analyses is presented in the accompanying graph (fig. 2).

It is readily seen that each solution underwent a marked deterioration. This points to the necessity of adding larger amounts of bi-chloride if fungicidal effect is to be retained. It will be seen that the solution used by Mr. Foster weakened more gradually. This may be explained by the fact that after each treatment the liquid was drained into another cask and sediment removed.

The results of one year's work cannot be used as a basis for drawing conclusions. Further tests will be made in the laboratory and all factors controlled as far as possible. The work will be modified to include treating several successive lots in the normal solution and effect noted until the solution becomes too weak to be effective.

It is noteworthy that *Mucor* developed in one lot after the seventh sample, showing that the solution was not sufficiently strong to arrest fungus growth.

Results of Potato Experiments

Powdery scab, *Spongospora subterranea* (Wallr.) Johns

The plot used in 1924 was again planted with the experiment for the control of this disease. As in 1924 negative results were obtained. No disease appeared even in the untreated plots planted with heavily infected seed. The season from the time tubers commenced to form until September 1 was quite warm, and dry in so far as soil moisture is concerned. As this disease is reputed to be more prevalent in wet seasons our results in two dry years apparently bear that out. Very little powdery scab was found by the staff of inspectors while inspecting tubers for seed certification throughout the province.

Rhizoctonia *Corticium vagum* B. et C.

The statement was made in our last report that seed treatment for the control of Rhizoctonia (black scurf) of potatoes is ineffective if the soil already harbours the disease. The results obtained from our 1925 experiments bear out this statement. The plots used were those which have been planted almost continuously to potatoes since the inception of this laboratory ten years ago. The disease consequently has become well established in the soil, much more so than in any part of the province, even where potatoes are grown as a special crop. Crop rotation naturally has the effect of reducing the degree of soil infestation. It was, therefore, considered advisable to use such soil as this for an experiment designed to test the value of seed treatment as a method of controlling the disease.

The seed used was of the Irish Cobbler variety and all tubers were affected with the Rhizoctonia sclerotia. Treatments given included: (1) hot and cold water; (2) hot and cold formalin; (3) hot and cold bi-chloride of mercury; (4) Bayer Dust; (5) Semesan; (6) Uspulun; and (7) Germisan, with untreated check plots, the last four treatments being used as a dust disinfectant. The experiment was conducted in duplicate, planted on June 4 and harvested September 18. Growth was normal in all plots except Germisan which caused considerable injury to the sets so that very few plants came up. One half of the experi-

ments gave positive results when considered from our viewpoint since every treatment produced a 100 per cent diseased crop with the exception of Uspulun and that only produced 1½ pounds of clean tubers from the 60 sets planted. In the duplicate half of the experiment, which was divided into two sections for convenience of planting, the results obtained, while not of so positive a nature, were, nevertheless, of a character to convince one that the treatments given had little effect, if any, in controlling the disease. The results obtained from this plot are shown in the accompanying table.

TABLE 1.—EXPERIMENT TO TEST THE VALUE OF SEED TREATMENT FOR THE CONTROL OF RHIZOCTONIA (BLACK SCURF)

East half		West half	
Treatment	Percentage of crop diseased	Treatment	Percentage of crop diseased
Check (untreated)	73·3	Check	98·8
Hot water	68·0	Cold water	99·5
Hot bi-chloride	72·6	Cold bi-chloride	98·8
Hot formalin	77·0	Cold formalin	99·2
Check	69·9	Check	69·0
Bayer Dust	82·2	Semesan	69·6
Uspulun	74·5	Germisan*	—

*Figures for this treatment not included. Only six plants survived the seed treatment.

That a variation exists in the results obtained between some of the treatments and others does not, in our opinion, necessarily prove the efficiency of the treatment given. The fact should be noted that the check plots in three cases out of four gave better results than treated lots in adjoining rows. Also note in the first four rows of each section, which include the usual seed treatments recommended for the control of this disease, that there exists an unanimity in the results obtained. The chief evidence obtained is that all the plots, regardless of the treatment given, gave a high percentage of diseased tubers. It must be remembered that the experiment was carried out on heavily infested soil. The fact remains, however, that there is in some parts of the Dominion just as heavily infested soil in its virgin state. In other words, the organism causing the disease is widespread but is much more severe in some sections than in others. Seed treatment in such cases would, therefore, be practically valueless. On the other hand, where the soil does not harbour the disease to such a great extent, or not at all, seed treatment is recommended, as it is a wise precaution to kill whatever fungi or bacteria are resting upon the skin of the seed tubers.

A duplicate of this experiment was carried out by the pathologists in charge of the laboratories at Fredericton, N.B., and at Ste. Anne de la Pocatière, Que., the results of which are shown in table 2.

TABLE 2.—CONTROL OF RHIZOCTONIA

Treatment	Percentage of crop diseased at:	
	Fredericton, N.B.	Ste. Anne, Que.
Hot bi-chloride	0·0	6·6
Cold bi-chloride	0·1	0·0
Hot formalin	0·07	22·7
Cold formalin	0·17	18·2
Hot water	3·0	41·5
Cold water	2·6	55·1
Semesan	1·69	47·8
Germisan	2·8	12·7
Uspulun	1·3	23·3
Average of three checks (untreated)	4·5	48·7

The soil at Fredericton apparently is not heavily infested with the fungus. The results obtained at that place indicate the value derived from both the hot and cold bi-chloride of mercury and the formalin treatments. The results obtained at Ste. Anne, however, indicate an unevenness of infestation. Nevertheless, the outstanding feature is the fact that the bi-chloride treatments gave good results over any of the others. As this is only one year's experiment it will be necessary to continue such work at these localities in order to determine the value, if any, that can be expected from seed treatment.

Another factor in the control of the Rhizoctonia disease and one which apparently has considerable influence on the amount of black scurf which eventually develops, is that of the relationship between date of harvest and the percent of disease on the tubers when dug. The laboratories at Fredericton and Ste. Anne also co-operated with us in experimenting on this work. The seed used in each case was infested and not treated prior to planting. The results obtained at the three places are shown in the table following.

TABLE 3.—CONTROL OF RHIZOCTONIA

Date of harvest	Percentage of crop diseased at:			
	Charlottetown		Fredericton; Irish Cobbler	Ste. Anne; Irish Cobbler
	Irish Cobbler	Green Mountains		
Sept. 1	13·2	.....	0·2	37·1
" 8	24·0	.....	0·3	20·1
" 15	74·0	35·6	2·1	30·3
" 22	100·0	73·2	1·9	48·2
" 29	96·8	89·0	4·6	49·0
Oct. 6	97·0	98·0	3·1	56·2
" 13	100·0	100·0	3·0	65·7

The soil used at Fredericton is not heavily infested although sufficient evidence was obtained to illustrate the advantage which obtains from early digging over those dug later on. At Ste. Anne, the results, with the exception of that of the first digging date, certainly prove the value of the earlier harvesting. The results obtained at Charlottetown are somewhat more conclusive.

A comparison of the results obtained in this experiment and that of the seed treatment in table 1 is interesting. In the date of harvesting experiment we have the figures 13.2 and 24.0 per cent of disease respectively for the two early harvest dates with infected untreated seed on heavily infested soil. In the seed treatment plot the best result obtained was with hot water, 68.0 per cent. These plots were harvested at a date corresponding to the third harvest date. Even if that fact is not considered a fair comparison the fact remains that these untreated plots planted and harvested on corresponding dates gave as good and, in some instances, better results than the treated plots shown in table 1. The procedure of digging the potato crop at as early a date as possible either just prior to or immediately after maturity is a practice, therefore, to be recommended where the Rhizoctonia disease is a factor to be considered.

LATE BLIGHT *Phytophthora infestans* (MONT.) DE BARY

The season 1925 proved to be one of the worst for blight which we have experienced for some years. The disease was first recorded on the vines on August 3, and by the 15th of that month was reported as being prevalent in many sections of the province. The remainder of the month proved to be fine and warm with an occasional shower but the nights were cool with heavy dews. The latter feature kept the disease in a fruitful condition. With September

came heavier showers and rains with much cooler temperature which assisted the disease in causing defoliation as well as providing an abundance of spores for the infection of the tubers in the ground. During this period the inspection service was continually called upon for advice on spraying and was able to assist materially in saving many fields. Rot developed very rapidly on unsprayed or poorly sprayed fields, in one or two instances resulting in a total loss. The majority of the Irish Cobblers and Dakota Reds survived the epidemic but the Green Mountains and McIntyres suffered to a considerable degree. It was not unusual to find from 25 to 50 per cent rot in many lots inspected.

An experiment to test the value of dust versus liquid spray was carried out in co-operation with the Fredericton laboratory. The results of this experiment will be found under the report of the pathologist in charge of that laboratory.

EARLY BLIGHT, *Alternaria Solani*, E. & M.

This disease also assumed serious proportions in the province this season, so much so that a number of fields in one section were completely defoliated by the middle of August. Early blight causes considerable losses in some years but is not generally recognized as a serious factor inasmuch as it does not produce a rot in the same proportions as does the late blight fungus. Thorough spraying is the only remedy for controlling this disease and in some seasons it would appear as if the best-made Bordeaux mixture is not as effective as might be expected.

EXPERIMENT TO TEST VALUE OF SMALL TUBERS (WHOLE AND CUT) AS SEED

This project which is carried out in quadruplicate was continued for the second year, on land where potatoes had been the previous year. The yield obtained was a fair average of that produced commercially throughout the province but would have been much better but for the advent of a severe attack of early blight which accounts for the high percentage of small tubers. The results are shown in tabulated form in table 4.

TABLE 4.—COMPARATIVE YIELDS FROM USING SMALL TUBERS, WHOLE AND CUT INTO TWO, AS SEED

Weight and kind of seed used	Yield per acre in bushels			Percentage small	Order of merit after deducting seed used.
	Market	Small	Total		
3 oz. whole tubers	249	132 (76)*	379	34·8	1
2 oz. whole tubers	198	125 (87)	323	38·7	3
1½ oz. whole tubers	190	128 (100)	318	40·2	5
1 oz. whole tubers	211½	97½ (78½)	309	31·2	6
½ oz. whole tubers	174	52½ (43½)	226½	23·1	7
1½ oz. cut set	231	99 (71)	330	30·0	2
1 oz. cut set	225	95 (76)	320	29·6	4
½ oz. cut set	155½	67½ (58½)	223	30·2	8

*Figures in brackets indicate yield after deducting the seed used.

The value of the larger-size seed-piece, whether whole or cut, is evident from a study of the figures. It is also noted that the 1½-ounce cut set, which is a 3-ounce whole tuber cut into two, gave a larger yield than the 2-ounce whole tuber. Similarly the 1-ounce cut set, which is a 2-ounce whole tuber cut into two, gave a better return than either the 1½-ounce or the 1-ounce whole tubers. This indicates that the larger sized tuber when cut into two gives a better yield than the next larger size used. This feature only appeared in the case of the 1½-ounce cut set in the 1924 experiment.

A comparison of the two years results show but little variation one year with the other, the order of merit being changed but very slightly.

An additional plot was planted this year as a check on the small seed. Large (8-ounce) tubers were cut into the five sizes used. These tubers were of the same strain of Irish Cobblers. Only one plot was planted, there being no room for replication. The results, however, are worth recording and are shown in table 5.

TABLE 5.—COMPARATIVE YIELDS FROM USING SEED CUT FROM LARGE TUBERS

Weight of seed used	Yield per acre in bushels			Percentage small	Order of merit after deducting seed used
	Market	Small	Total		
3 oz	324 (268)*	84	408	20·5	2
2 oz	328 (286)	66	394	16·9	1
1½ oz	288 (260)	78	366	21·3	3
1 oz	258 (239)	66	324	20·3	4
½ oz	198 (189)	60	258	23·2	5

*Figures in brackets indicate the yield after deducting seed used.

Further experimentation is needed before any definite conclusions can be drawn.

No rogueing of diseased plants was carried out. A small amount of slight mosaic symptoms developed. Some of this mottling, however, while quite noticeable early in the season had disappeared completely after the lapse of, in some cases, a week to ten days. We question whether this is true mosaic. A number of tubers were saved to determine that point in 1926.

SEED STRAIN DEMONSTRATION

The object of this test is to provide a demonstration plot containing as many different strains of potatoes as possible, so that every seed-producing section is represented. This plot serves as a means of instructing inspectors in the diseases likely to be encountered. It also provides an excellent educational feature for the many growers who visit the Charlottetown Experimental Station, particularly during the farmers' picnic and field days. It provides a centrally located plot where the numbers of seed potato buyers who annually visit the province in search of good seed can obtain, at first hand, information on a large number of representative samples of the seed being grown on a large scale at the number of farms represented and which it would take a considerable amount of time to cover otherwise. The number of people who viewed this plot in 1925 would be well in excess of 1,500.

The experiment on the value of dust versus spray is carried out on this plot. Some fifty-five half-bushel lots of seed were obtained from the exhibition held in conjunction with the meetings of the Potato-Growers' Association, thirty-nine Irish Cobblers and sixteen Green Mountains. Of these, thirty-six showed absolute freedom from field diseases such as black leg and mosaic. The average percentage of the former disease in the Irish Cobblers was 0.24 and of mosaic 0.03 per cent. Green Mountains showed an average per cent of black leg 0.13 and of mosaic 3.7.

Yield counts were taken of every row, the highest in the Irish Cobblers being 337½ bushels per acre and the lowest 219 with an average for the thirty-nine samples of 284 bushels. In Green Mountains the highest yield was 294 and the lowest 220½ with an average of 261½ bushels per acre for the sixteen samples entered.

An idea of the value to the potato-growers of the province of the laboratory may be taken from the fact that ten years ago when the laboratory was built not a single carload of seed potatoes was leaving the province. This year in less than three months, involving the fall shipping season, 350,000 bushels left the province at an excellent price which ranged from $1.10 to $1.75 per bushel, with excellent promise that the trade will continue, providing disease-free and high-yielding stock is put on to the market.

REPORT OF THE DOMINION FIELD LABORATORY OF PLANT PATHOLOGY, KENTVILLE, N.S.

(J. F. Hockey, Plant Pathologist, Officer in Charge)

The year 1925 was exceptionally favourable to the spread of many fungus pests in the apple orchard sections of the province of Nova Scotia. Spraying operations were hindered by wet weather and a considerable area of orchard suffered a total loss of fruit on account of the heavy infestation of apple scab. It is conservatively estimated that this disease alone cost the apple-growers of this province a direct loss of $750,000 without considering the time spent and fungicidal materials used in the efforts to control the disease after it had become epidemic. In parts of the Annapolis valley where spraying operations began before ascospore discharge, and fungicides were regularly and thoroughly applied every two weeks until five or more applications had been made, apple scab was kept under good economic control.

Studies on the seasonal development of the apple scab fungus *Venturia inæqualis* (Cke.) Wint. were the major interests of this laboratory during the spring and early summer. A rather severe type of foliage injury on apples resulting from the use of fungicides containing hydrated lime, necessitated investigation, the conclusions of which are given in this report.

Late blight of potatoes *Phytophthora infestans* de Bary made its initial appearance at Kentville on July 7. This is the earliest recorded appearance in this district.

White pines infected with *Cronartium ribicola* F. de Wald. were found liberating æciospores at Kentville on May 14. Black currants within one-quarter mile were in one-third leaf at this time and subsequently showed the first uredinial stage on June 18. This disease is found on currants in practically all parts of the province.

A severe infestation of onion mildew *Peronospora Schleideni* Ung. occurred locally on experimental onion plots, about the middle of August, and was apparently held in check by liberal applications of sulphur dust. There was no resulting injury from the use of sulphur.

During the past year some twenty-five community meetings were held throughout the valley under the auspices of fruit-growers at which the officer in charge of this laboratory spoke. The average attendance at these meetings was about forty and keen interest was shown in the subjects discussed. An address was also given at the annual meeting of the Nova Scotia Fruit Growers' Association in December, giving the results of investigations and observations made during the year.

Apple Scab, *Venturia inæqualis* (Cke.) Wint.

Little is known of the seasonal development of apple scab under Nova Scotia conditions. Spraying applications have hitherto been made at certain stages in the development of the leaves and blossoms without knowledge of the stage of maturity and time of initial discharge of the ascospores. Some experimenters have found that during occasional years, a spray application at the "mouse ear" or "green tip" stage of leaf development was unnecessary.

Similarly it has been found that a dormant spray or an application of fungicide previous to the "mouse ear" application was unnecessary under practically all conditions as a control for apple scab.

In order to be able to explain the reasons for spraying at definite stages of growth of the tree and at stated intervals, it was found advisable to trace the seasonal development of the apple scab fungus, *Venturia inæqualis* (Cke.) Wint., from early spring throughout the growing season. This necessitated a study of the ascospore stage on the old leaves and also of the conidial stage on the twigs, leaves, and fruit. As the studies progressed it was found that the winter stage was of greater importance than twig lesions to orchardists locally, and hence it received most attention.

DEVELOPMENT OF PERITHECIAL STAGE.—Commencing March 6 leaves were collected fortnightly from under trees which had been used as checks in spraying tests during 1924 and were known to have borne moderately scabby foliage. These leaves were examined for perithecia and freehand sections made to ascertain the approximate average development of the perithecia and time of formation and maturity of ascospores.

The first collection revealed minute perithecia averaging 40μ in diameter and in an apparently pycnosclerotial age. By April 1 the perithecia had enlarged to average 60μ in diameter. The collection in the middle of April showed first signs of asci. These were filled with homogeneous protoplasm and gave no evidence of differentiation into spores. The perithecia averaged 80μ with many 100μ in diameter. Two weeks later, May 1, definite differentiation of the protoplasm in the asci showed the first signs of ascospore formation. Frequent collections of leaves were made from then until May 11, when the first mature ascospores were found. On looking at the rainfall record (fig. 3) for this date, it can be seen that on both May 11 and 12 there was a little rain. This apparently provided the condition most favourable to the rapid maturity of ascospores for at the time of the next rainfall on May 15 the first discharge of spores was recorded at Kentville. Subsequent discharges are shown on the chart (fig. 3) according to time and relative severity. At the time of the last evidence of ascospore discharge, July 13, leaves were again sectioned to note the condition of the perithecia. Many perithecia were examined but in only a very few were any ascospores found.

It was very noticeable when making collections that the perithecia were most numerous on the surface of the leaves uppermost on the ground, irrespective of whether it was the upper or lower surface.

Further studies are under way to ascertain the time of initial development of perithecia and the histology of tissues involved.

THE DISCHARGE OF ASCOSPORES[1].—When it was found that the leaf-collections of April 14 showed the first signs of asci formation, some of the leaves were placed in moist chambers in the laboratory in order to ascertain how rapidly ascospores would be formed under continued favourable conditions. A microscope slide was placed on each leaf and separated from it by two match sticks. The slides were coated with Mayer's fixative which would not only act as a sticker but also provide a medium for the germination of the spores.

Leaves collected April 14 began discharging ascospores in twelve days and one week later were at their maximum discharge and continued to discharge daily for an average period of twenty-five days. Collections of May 1 began discharging in the laboratory in four days, reached their maximum in two weeks, and continued over a period of twenty-four days. Collections of May 8 began discharging ascospores in four days, reached the maximum in two weeks and continued for twenty days. High percentages of germination were obtained throughout these periods.

[1] Compare spore discharge in P. E. I. and Niagara District, pp. 21 and 57, respectively.

From these observations it was concluded that with weather conditions favourable to the fungus, ascospore discharge could be expected following three or four days of wet weather after May 1, and that it would continue with favourable conditions for at least four weeks.

At the time of the sixth recorded rainfall after May 1, i.e., May 15, the first ascospore discharge was observed. The same method of using microscope slides was adopted in the orchard except that the slides were coated with a thin film of white oil, "Stanlox", in place of fixative to obviate washing off during wet weather. Three very heavy ascospore discharges were recorded for the periods, May 31-June 2, June 10-June 11, and June 15-June 18. The last discharge was observed July 13 indicating that it had continued interruptedly over a period of fifty-nine days.

The relative intensity of spore discharge, rainfall in inches, and hours of sunshine for the period May 1 to July 31, 1925, are recorded in diagram form in fig. 3.

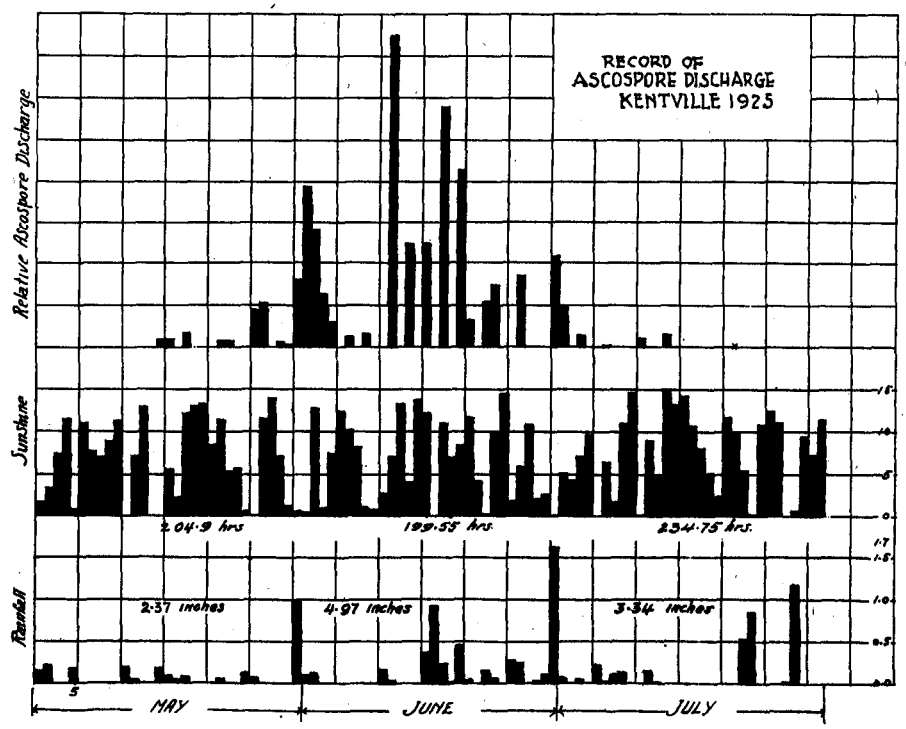

Fig. 3.—Chart showing ascospore discharge, rainfall and sunshine, Kentville, N.S., May to July 31, 1925.

Correlating the ascospore discharges with the stage of development of the trees at Kentville it was found this year that the leaves of Gravensteins were about one-half inch in diameter and had just passed the "mouse-ear" stage at the time of the initial discharge. The first heavy discharge, May 31 to June 2, found the trees past the "pink tip" stage and starting to bloom. By the time of the next heavy discharge of June 10 to June 11 the petals were practically all off and the fruit on some varieties was one-quarter inch in diameter. The third heavy discharge and subsequent ones took place when the fruit was in a rapidly growing and very susceptible stage.

Specimens of leaves received from Berwick, N.S., and Middleton, N.S., on May 9 revealed that an ascospore discharge had already taken place at Middleton and that one could be expected at the next wet period at both Middleton and Berwick. Discharges of spores in the eastern part of the apple section did not occur until after the initial discharge at Kentville.

The prolonged period of ascospore discharge together with the weather conditions which favoured the fungus and hindered spraying operations at critical stages are largely responsible for the very heavy loss from apple scab in Nova Scotia during 1925.

Effect of Lime Sulphur on Ascospore Discharge.—When ascospore discharge was at its maximum in the orchard, several leaves bearing numerous perithecia were collected and cut in half. One half was dipped in lime-sulphur, 1-50 solution and the corresponding half was dipped in water. All leaves were subsequently placed in moist chambers under identical conditions to note the effect of the lime-sulphur solution on the ascospore discharge. Perithecia were apparently equally distributed on corresponding halves of each leaf.

Leaves dipped in water discharged ascospores over an average period of 14.3 days.

Leaves dipped in lime-sulphur solution, 1-50, discharged ascospores over an average period of 6 days.

Poor germination was obtained from spores collected on the slides from the lime-sulphur series. This would seem to indicate that not only does the lime-sulphur spray have a toxic effect on the spores but it also shortens the period of spore discharge. The possibilities of partial control of apple scab by spraying the leaves on the ground have not been tested but from the work of Curtis (2) it would appear that there are practical possibilities in this connection.

Twig Lesions.—Fraser in 1917 (3) reported the twig infections of *V. inaequalis* as severe on Fameuse and McIntosh on specimens sent him from Nova Scotia and Quebec. Similar material was collected at Annapolis Royal on April 1, 1925, from Fameuse trees. Conida were taken from several pustules and placed in hanging drop culture for germination. Spores germinated within twenty-four hours and within thirty-six hours had developed germ tubes 190μ in length. Some twigs were kept in the laboratory and it was found that by the time the leaves began developing on the twigs, the lesions which formerly had the appearance of blisters were now ruptured exposing conidia. These conidia gave a high percentage of germination within twenty-four hours. Similar results were obtained from twigs collected in the Station orchard on both McIntosh and Fameuse when the trees were in the "green-tip" stage.

It would appear that the pustules which contain conidia exposed over winter and having a comparatively low percentage germination are not as liable to cause initial infections in the spring, as the pustules which mature in the spring when growth of the tree has commenced.

In severe cases of infection the twigs are killed outright but when only moderately or lightly infected the twigs apparently recover. The lesions assume a scurf-like appearance the following year. In no case were viable conidia obtained from the two-year-old lesions.

Infection of twigs was found to take place during the early part of the growing season when the twigs were from four to six inches long and still very green and tender. Small areas similar to lesions on petioles were observed on the twigs. These gradually assumed a blister-like appearance 1-3 mm. in diameter. In November when counts were being taken on the spray and dust plots it was found that few scattered pustules had ruptured. On an examination of these, mature viable conidia were found, indicating that viable conidia may be present on the twigs from late autumn to spring.

Twig infections have been found to initiate only on the current season's growth.

CONTROL OF TWIG INFECTIONS.—It is believed that in the average season the possibilities of early infections to foliage from conidia produced on twig lesions are not of sufficient economic importance in Nova Scotia to warrant dormant applications of spray. Thorough applications of spray or dust during the regular schedule will give economic protection from this source of infection and will also protect the growing twigs from new infections. On varieties as Fameuse, McIntosh, and Wagener special attention should be given in severe seasons to the adequate protection of growing twigs by spray or dust.

Counts on the percentage twig infection in the regular spray and dust plots were taken in November, 1925.

TWIG INFECTION

Plot	Treatment	Average percentage twig infection
1	Lime-sulphur, 1-40, 1-50	4·75 on 4 varieties.
2	Bordeaux, 4-8-40	5·20 on 5 "
3	Wet surphur, 30-100	19·40 on 5 "
4	Bordeaux and wet sulphur	14·80 on 5 "
5	Check	88·00 on 5 "
6	Sulphur dust, 85-15	5·00 on 5 "
7	Bordeaux dust, 12-15-73	4·00 on 4 "
8	Bordeaux and sulphur dust	5·60 on 5 "

The varieties used in these treatments were: Fameuse, McIntosh, Gravenstein, Bishop Pippin and Wagener. The first two named were severely infected; Wageners were moderate; Gravensteins were slight; and Bishop Pippins were very slight. The severity of infection used as an index was the frequency and number of lesions per twig. Very slight constituted up to 10 scattered lesions per twig, and the range increased to the severe stage where lesions were very numerous, and averaged 100-200 per square inch of twig surface.

The histology of twig lesions is being studied to ascertain the tissues involved and the possibility of these lesions offering a mode of entrance to host-tissue of canker-producing organisms.

SPRING-INFECTION.—On June 3, 1925, the first infections were observed on unsprayed trees at Kentville. On June 8 counts were made to ascertain the percentage of infection on leaves within three feet of the ground and on leaves eight feet or more from the ground. The majority of these infections were on the under surface of the leaf.

SPRING INFECTION

Variety	Less than three feet from ground	Eight feet and over from ground
	%	%
Bishop Pippin	22·88	3·84
Gravenstein	26·36	9·09
Wagener	21·95	8·23
McIntosh	8·22	2·50.
Fameuse	20·78	6·41
Ben Davis (One spray)	6·87	0·67
Average of 6 varieties	17·84	5·12

In ordinary spraying operations more attention is given to the centre and top of the tree than the lower branches. It would appear from these counts that considerable attention should be paid to the lower branches especially for the first two or three applications while the chances of infection from ascospores are still great.

CONTROL OF APPLE SCAB.—Experiments on orchard-spraying and dusting are conducted in co-operation with the Experimental Station. The early applications were timed by the laboratory in order to give maximum protection at the probable periods of ascospore discharge. With limited spraying equipment at the Station it was difficult to make applications as quickly as desired on the plots on account of the large acreage of orchard demanding attention. Hence there were too long periods between some applications.

Eight plots were used in the testing of seven of the most commonly used spray and dust schedules. The various fungicides used were lime-sulphur, Bordeaux mixture, wetable sulphur, sulphur dust, and dehydrated copper-sulphate dust.

The foliage in each plot was good and very little injury resulted from spray or dust applications. Russeting of fruit was very pronounced in both plots where copper was used throughout the season. This condition was largely prevented in other plots by the use of sulphur fungicide on the " calyx " or after blossom application. Liquid treatments of lime-sulphur or Bordeaux mixture have given better control of scab than dusts this past season. Check trees yielded one hundred per cent spotted fruit, ninety per cent of which was severe. The best plots yielded twelve per cent of slightly scabby fruit. The detailed results from these plots will be found in the Report of the Experimental Station, Kentville, for 1925.

SPRAY INJURY

Not only did apple scab cause a heavy direct loss to apple orchardists this season, but it was a prominently contributing factor to foliage injuries especially in the western part of the Annapolis valley. These injuries first became evident in the early summer in orchards treated with Bordeaux mixture or copper-dust preparations. Orchards treated with lime-sulphur solutions showed some injury increasing in proportion according to the excess of hydrated lime used in the spray. Sulphur dusts gave evidence of practically no injury.

The types of injury causing most alarm were: leaf spotting found to be caused by an excess of water-soluble arsenic in the arsenicals used as poisons; brown spotting and burning of leaf-tissue around scab-areas and insect or other injuries; leaf-spotting and edge or marginal burning on sprayed and occasionally unsprayed trees, not associated directly with any disease or insect. Yellowing was found prevalent later in the season on sprayed trees where scab was severe.

In an endeavour to ascertain some of the factors contributing to these injuries several series of tests were conducted in the laboratory. Materials used in these tests were: hydrated lime from various sources; copper sulphate, commercial and "C.P." grades; calcium carbonate, "C.P."; distilled and tap water. Twigs of apples were taken from unsprayed trees except those infected with aphids which were from sprayed trees having little or no scab on the foliage.

In the first three series of tests, twigs with moderately scabby foliage were used. Duplicate sets of twigs were sprayed with the treatments given below. One set of twigs from each treatment was placed under bell-jars immediately after spraying and while still wet. The others were placed in the open air and sun to dry.

TREATMENTS

Hydrated lime 1:400 by weight using tap water.
Hydrated lime 1: 80 by weight using tap water.
Hydrated lime 1: 64 by weight using tap water.
Calcium carbonate 1:400 by weight using tap water.
Calcium carbonate 1: 80 by weight using tap water.
Bordeaux mixture 4:6:400 by weight using tap water.
Copper sulphate 1:100 by weight using tap water.
Distilled water
No treatment.

The chemical reactions which take place in Bordeaux mixture are more or less complicated but in the final reaction hydrated lime, when present in excess, must be changed to calcium carbonate through the action of the carbon dioxide in the air. Calcium carbonate was used in these tests to ascertain its effect, if any, on apple foliage. The same may be said of hydrated lime in various proportions used. Copper sulphate alone is known to be injurious to apple foliage and was used in order to compare the resulting injury with those from lime and Bordeaux. Distilled water was used merely as a check but under certain conditions the results were very interesting.

In these three series it was found that foliage-injury took the form of leaf-spotting and marginal burning on all twigs treated with hydrated lime, all dilutions, and Bordeaux mixture, where the twigs had been kept in moist chambers after spraying. Duplicate twigs placed in the open showed no injury except on leaves which had taken over one-half hour to dry after spraying. Twigs sprayed with copper sulphate gave a very pronounced reddish-brown-flecked burning on all leaves. The injury was more severe on the twigs kept under moist conditions. After 48 hours this flecking had coalesced and in most cases the entire leaf was burned and curled. The calcium carbonate treatments caused absolutely no injury under any conditions which prevailed.

The action of distilled water was rather interesting. Twigs which had been sprayed with distilled water and subsequently placed in moist chambers showed after 24 hours a slight flecking burn, dark-reddish-brown in colour, which on some leaves gradually assumed a purplish leaf-spot character. These spots could not be consistantly associated with leaf-injuries as was the case with the other burning, when examined histologically. The injury from water appears to be very similar to that recently described by Mann and Wallace (4) as due to the leaching of potash from the leaves under excessively moist conditions. It was not possible at the time these tests were conducted to duplicate tests used by Mann and Wallace to establish this explanation.

Definite burning on aphis-infected foliage was obtained from Bordeaux mixture under moist conditions.

SERIES D.—In some orchards it was found that trees sprayed early in the morning had less injury than those sprayed late in the afternoon, where weather conditions were such that the spray would stay wet on the trees for some few hours following morning applications. This is more or less in accord with the findings of the preceding tests, but where the leaves dried in each case within one or two hours after the application of spray it appeared that there was some other factor influencing the cause of spray injury at night which was not so evident during the day time.

In an attempt to find an explanation for this increased injury from late-day applications, three collections of twigs were made from which representative leaves were boiled in alcohol to remove the chlorophyll and tested with iodine solution for starch.

Series I—Twigs No. 1— 6 collected 8 p.m. July 15, very full of starch.
Series II—Twigs No. 7—14 collected 7 a.m. July 16, very little starch present.
Series III—Twigs No. 15—21 collected 10.30 a.m. July 16, considerable starch present.

The second basal leaf on each twig was given twenty-five needle punctures on one side of the mid-rib and two or three scratches on the other side to note burning on such injuries.

Each of the twenty-one twigs was sprayed with Bordeaux mixture 4:6:10. Part of each series was placed in the moist chamber and the remainder in the open air. At the end of the 1st, 2nd, and 3rd hours' exposure of twig from each lot in the moist chamber was placed in the open and one twig from each series in the open was sprayed with water and placed in the moist chamber. This was done to note any difference in the degree of injury received when trees are sprayed and remain wet for periods up to three hours or when dried within three hours and then wet for periods up to three hours. Frequent notes and observations were taken on the condition of foliage up to the end of 36 hours after treatment.

Summary of Observations on Series D.—1. The ratio of injury in the three series I, II, III was in the proportion 200:100:125, indicating that the twigs collected at night suffered greatest injury and those collected in the early morning had the least apparent injury. The late morning collection was intermediate.

2. Injuries were first apparent at the end of two hours exposure in moist chambers on plants exposed for either one or two hours in the open.

3. Punctures and lacerations on leaves showed the symptoms of injuries earlier than scab areas.

4. Leaves which had been dry, following the applications, for periods up to three hours then wet for one hour or more showed as severe injury as those which were wet for one, two or three hours immediately after spraying.

Freehand sections of many injuries were made and in practically every instance one or more of the following conditions were present in the leaf tissue.

(*a*) Varying stages of infection of apple scab.
(*b*) Insect feeding-punctures.
(*c*) Mechanical injuries.
(*d*) Parasitic leaf-spotting organisms.

Saprophytic organisms were also found on some spots but they appeared to be purely of secondary nature.

(*e*) Copper in the leaf tissue as tested for by the chloriodide of zinc test.

Throughout these entire series the relative humidity in the open varied from 58 to 66.

Discussion of Results.—The spray injuries commonly attributed to lime-sulphur were found on the foliage of sprayed orchards in the form of yellow leaf, burning following scab, scald, and edge-burn as frequently described in the literature and more recently by Young and Walton (5).

A slight amount of leaf-spotting caused by water-soluble arsenics was found in some orchards and the cause established by A. Kelsall, Entomologist in charge Insecticide Investigations, Annapolis Royal, N.S. This leaf-spotting usually has a purplish-brown border in contrast to the reddish-brown burning from Bordeaux or hydrated lime.

Copper sulphate in solution causes a dark-reddish-brown burning on apple foliage, which is comparable to some of the spotting of foliage obtained from the use of Bordeaux mixture without poison.

The injuries caused by hydrated lime either in excess in Bordeaux mixture or alone in solution, vary from light to dark-reddish-brown in colour and may take the form of leaf-spotting, edge or marginal burning or burning following scab, mechanical or insect injury.

The injury resulting from spraying leaves collected at night when photosynthetic activity has stopped, and presumably when the stomata of the leaf

are closed, would seem to indicate that the carbon dioxide activity of the leaves is of considerable importance in completing the chemical reactions necessary in spray solutions or mixtures when hydrated lime is used. Conditions of high relative humidity for periods of one hour or more and which are necessary to this injury would also tend to prevent transpiration and decrease carbon dioxide activity.

The slight leaf-spotting obtained in Series B and C from distilled water, after exposure for 24 to 36 hours to very humid conditions may be attributed to potash-leaching as described by Mann and Wallace (loc. cit.). As this type of leaf-spotting was different in appearance from the injury produced by sprays, and in view of the fact that calcium carbonate in solution gave absolutely no symptoms of injury even after 36 hours' moist conditions, it would apparently disprove any conclusions that the leaching of soluble elements from the leaves was the cause of the burning where the solutions were used.

Orchard Survey

During the month of August a survey was made of about forty representative orchards in scattered sections of the district from Windsor to Kingston in an effort to ascertain the measure of control being obtained by various spray- or dust-schedules and the amount of spray-injury, if any. Orchards were visited which had been treated with dusts, both copper and sulphur, for various applications and with materials from different sources. Similarly, others were visited which had been treated with different combinations of copper and sulphur sprays and some with one or more liquid applications followed by applications of dust. In all twenty-seven different spray schedules were noted in forty orchards, and it is safe to say that there are close to fifty different schedules being used in the Annapolis valley.

It would be a difficult problem to summarize the records from these orchards, hence it is deemed advisable to mention some of the findings made from this survey.

1. The applications generally made were, "mouse-ear," pink, calyx and two weeks after calyx. In many orchards subsequent applications were made from seven to twenty days apart.

2. Liquid sprays of lime-sulphur or Bordeaux mixture are most popular for the first two applications, chiefly on account of their greater adhesiveness and lower initial cost than dusts.

3. The third or calyx application requires sulphur as a fungicide in preference to copper either in spray or dust schedules to eliminate russetting.

4. Fourth and subsequent applications may be either copper or sulphur fungicides. Sulphur is preferred by many on account of the better finish given the fruit. Copper dusts are usually cheaper but do not give as good finish and may cause some russetting.

5. Applications made in advance of ascospore discharges, or dust-applications during a rain, gave best control of apple scab.

6. Spray-injury to foliage on lime-sulphur orchards was slight; on Bordeaux orchards, where the spray dried immediately and remained dry for some hours after, there was no apparent injury.

7. Orchards sprayed or dusted with fungicides using excess hydrated lime or hydrated lime in solution and which were wet for periods of one to six hours within a few hours after treatment showed varying degrees of foliage-burning.

8. Foliage-burning could not be attributed to one brand of materials more than another, but appeared to be linked up with seasonal conditions of excessive moisture together with the scab and insect injuries present.

9. Lack of economic control of apple scab was invariably due to one of the following causes:—

(*a*) First applications too late.

(*b*) Too long a period between applications.

(*c*) No late application to protect fruit where foliage already showed slight spotting.

Apple Rust

During 1924 surveys of orchards it was found that apple rust was a prominent pest in some sections. In the "Survey of the Prevalence of Plant Disease in the Dominion of Canada, 1923," on page 45 occurs reference to Juniper rust, *Gymnosporangium Juniper-virginianae, Schw.*, on apples in Nova Scotia. Efforts have been made to locate this species but so far none of the *Juniperus virginiana* L. has been found in the fruit growing sections.

In the spring of 1925 several barrens containing large numbers of *Juniperus communis* var. *canadensis* Loud. shrubs were examined. Two species of rust were found—*Gymnosporangium clavariaeforme* (Jacq.) DC. and *G. germinale* (Schw.) Kern; the former was found only in two localities whereas *G. germinale* was readily found throughout the Annapolis and Gaspereau valleys. The aecial stage of *G. clavariaeforme* was found on Amelanchier, May 29 and was not observed on any other species of plant. The aecial (Roestelia) stage of *G. germinale* was very prevalent on quinces, leaves petioles and calyces by June 18, and was later found on Crataegus and Amelanchier in different parts of the valley. On apple it was first observed July 15 on Crimson Beauty, Yellow Transparent, Gravenstein, McIntosh, Fameuse and Ribston Pippin. The Roestelia stage has been found fruiting abundantly on quinces, Crataegus and Amelanchier but not on apple. In view of the fact that no rust has been found on red cedar in apple-growing sections of Nova Scotia and that the common bush Juniper—*Juniperus communis*—is the carrier of the rust which is believed to affect apples, it appears that the common apple rust in Nova Scotia is *Gymnosporangium germinale* (Schw.) Kern and not *G. Juniperi-virginianae*, Schw. as has been previously reported.

From observations on the proximity of orchards to common Juniper bushes it is apparent that where the Juniper is not within a half-mile radius of the orchard, rust infections are at a minimum. The regular spraying operations assist to some extent in the control of Juniper rust on the fruit.

Specimens of the above rusts were submitted to W. P. Fraser, Saskatoon, who kindly corroborated the identification.

Winter Injury

Among various types of winter injury reported to this laboratory was one which appeared to be of serious nature in a six-acre block of ten- to twelve-year-old trees, mostly Starks and Baldwins. One or more limbs in each of the affected trees were apparently dying when first examined in June, 1925. The remainder of the limbs appeared to be normal in every respect. The affected limbs showed slight wilting of the bark and when a cut was made in the wood a grayish discoloration was noticeable. Apparently healthy limbs also showed this discoloration to a slight extent. On the majority of trees there was no evidence of old canker or sun scald, but new cankered areas were found on the trunks of several trees.

The owner willingly consented to dig up one of the most severely affected trees. The roots were examined but no evidence of crown gall or hairy root could be found. The trunk to a height of twelve to fourteen inches above the ground was perfectly sound and the wood a good bright colour. Starting at this point on the trunk was a discoloration of the heart wood which gradually became blackened within the next ten inches of wood and the discoloration spread out to newer wood giving it a wedge-shaped appearance in a longitudinal section of the trunk. This greyish discoloration continued throughout the wood of the tree including 1924 twigs. Cultures from various tissues in affected trees have not yielded any organisms consistently. Various canker-producing fungi have been obtained from cankered regions on trunks and limbs but discoloured wood has yielded negative results.

The entire appearance of affected trees was found to correspond to a type of winter injury described by Cardinell (1) as due to killing of some tissues with a secondary invasion of wood-rotting fungi. Treatment of affected trees by cutting back to sound wood and grafting has not been tried but some such treatment may be necessary if the injury continues to develop.

Club-Root of Turnips

Susceptibility tests of varieties of swedes and turnips to club-root (*Plasmodiophora Brassicæ,* Wor.) have been carried on in the Maritime Provinces for some years but no recorded effort has been made to secure pure-line strains of resistant varieties. Several varieties of seed from many sources have been tested from time to time and stecklings selected from resistant stock. The seed from such selections has yielded mixtures of bronze and purple-top varieties indicating mixed strains. An experiment was initiated at Kentville this spring to follow up resistance in turnips through pure-line selection. This is being done in co-operation with Dr. G. P. McRostie, Dominion Agrostologist, who supplied some seed for testing. In addition, seed was obtained by the Dominion Botanist from Dr. Shore Lindfors, of Sweden, and this was also used in the experiment.

Fourteen varieties were tested on heavily inoculated soil in 1925. Notes on the percentage of club-root present were taken at time of thinning and harvesting and are given in the accompanying table. Selections of stecklings were made from three most resistant varieties and will be used to obtain pure-line progeny for further test.

All plots were one one-thousandth of an acre and in triplicate. No absolutely clean roots were obtained from the plots at harvest. Slight to moderate infections included injury to the rootlets and small clubs on the main roots. Severe infections included such as rendered the roots unmarketable. Much secondary infection of Rhizoctonia and soft rot was present.

CLUB-ROOT SUSCEPTIBILITY

Variety	Notes taken	Clean	Club-Root		Yield per acre
			Slight-moderate	Severe	
					lb.
Bangholm, Herning Str...	Thinning, % No.....	98·61	1·39		
	Harvesting, % No.....	.....	82·15	17·84	
	% Wt.....	.....	84·492	15·496	32,500·0
Wilhelmsburger.....	Thinning, % No.....	97·17	2·83		
	Harvesting, % No.....	.....	47·16	52·83	
	% Wt.....	.....	55·646	44·346	18,604·0
Bangholm, Kentville.....	Thinning, % No.....	90·45	9·55		
	Harvesting, % No.....	.....	36·38	63·61	
	% Wt.....	.....	38·59	61·40	17,218·75
Bangholm, Charlottetown	Thinning, % No.....	96·07	3·03		
	Harvesting, % No.....	.....	37·62	62·37	
	% Wt.....	.....	42·726	57·27	16,937·5
Ostgata Kalroe.....	Thinning, % No.....	84·60	11·70	3·37	
	Harvesting, % No.....	.....	29·52	70·47	
	% Wt.....	.....	42·096	57·903	16,718·7
Bangholm, Rennie's Purple Top.	Thinning, % No.....	88·023	7·74	4·236	
	Harvesting, % No.....	.....	40·31	59·68	
	% Wt.....	.....	53·502	46·49	15,510·4
Studsgaard.....	Thinning, % No.....	89·25	9·23	1·516	
	Harvesting, % No.....	.....	11·53	88·76	
	% Wt.....	.....	16·31	83·686	12,161·4
Bangholm, 1029 Trifolium	Thinning, % No.....	87·13	7·2	5·6	
	Harvesting, % No.....	.....	46·66	53·33	
	% Wt.....	.....	49·963	50·016	10,708·3
Bangholm, General Swedish Seed Co.	Thinning, % No.....	68·45	19·093	12·456	
	Harvesting, % No.....	.....	.....	100·0	
	% Wt.....	.....	.....	100·0	5,520·8
Bangholm, A. E. McKenzie.	Thinning, % No.....	68·754	20·63	10·616	
	Harvesting, % No.....	.....	9·72	90·27	
	% Wt.....	.....	56·916	43·08	2,796·8
Bangholm, 1322 Trifolium.	Thinning, % No.....	70·36	18·22	11·353	
	Harvesting, % No.....	.....	.....	100·00	
	% Wt.....	.....	.....	100·0	848·9
Bangholm, Olsgaard H.H.	Thinning, % No.....	66·22	13·313	20·46	
	Harvesting, % No.....	.....	.....	100·0	
	% Wt.....	.....	.....	100·0	802·08
Ditmars.....	Thinning, % No.....	66·51	21·6	11·89	
	Harvesting, % No.....	.....	.....	100·0	
	% Wt.....	.....	.....	100·0	601·56
Bangholm, 8112 Macdonald College.	Thinning, % No.....	70·01	17·76	12·223	
	Harvesting, % No.....	.....	.....	100·0	
	% Wt.....	.....	.....	100·0	177·08

CUCUMBER SCAB

A severe outbreak of cucumber scab caused by *Cladosporium cucumerinum* Ell. and Arth. was found in greenhouses at Falmouth, N.S. The owners were facing the probability of a total loss of their crop if some measure of control could not be established. Accordingly one greenhouse was sprayed with Bordeaux mixture 4:6:40; one with sulphur dust and one with 12:88 copper dust, on June 29. Three houses were left untreated. A week later an examination of the houses indicated that a measure of control was being obtained and

that spread had been considerably reduced in comparison to the untreated houses. Sulphur dust, however, caused a burning and killing of considerable foliage. Bordeaux liquid was applied with difficulty with the available equipment, so at intervals of one week to ten days applications of copper dust were made in all houses by the use of a hand duster (crank type). As all houses were treated in subsequent applications it was impossible to get accurate counts on the final results. It was, however, evident from the results of the first application that Bordeaux dust will lessen the spread of cucumber scab in the greenhouse. The weather was wet and humid at intervals throughout the season and the disease persisted to some extent until late summer. The English forcing varieties (*Cucumis sativus* var. *anglicus* Bailey) were found very susceptible in comparison with the commoner white-spined varieties (*Cucumis sativus* L.).

Pure cultures of the organism *Cladosporium cucumerinum* were readily obtained from the scab spots. On August 7 several vines in the open were sprayed with a spore suspension of the organism and check vines sprayed with water. Two wet days followed. On August 10 several fruits on the sprayed vines were observed with small droplets of exudate on them. Two days later the area around these droplets assumed a water-soaked condition and on August 15 very dense tufts of conidiophores were present on these spots. Cultures inoculated with the water-soaked tissue and with conidia from the fruits all yielded pure cultures of the same organism.

The injury to the fruit is in the form of sunken spots rarely more than 1 cm. and usually averaging 3 to 5 mm. in diameter and not extending much below the first few layers of cells. The diseased spots gain their maximum size by the time the conidia are formed. The saleable condition of the fruits is not affected by one or two spots but where severe the fruits are frequently distorted and curved and so pitted as to render them unmarketable. The flesh of the fruits is not affected by the fungus.

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IMPROVEMENT OF THE GARNET CHILI POTATO

(W. K. McCulloch, District Inspector)

Four years ago the trade in certified seed potatoes with Bermuda was jeopardised. The Garnet Chili, the variety grown, was reported as giving unsatisfactory results, chiefly on account of the amount of leaf roll disease present in the seed stock. In order to remedy this situation several experiments were carried on. These experiments were: an attempt at rejuvenation, by growing the seed in Northern Ontario; selection of seed from the best hills; persistent selection of tubers of ideal shape from the bin or pile. Along with these projects a vigorous campaign of roguing diseased and weak plants from all fields was begun.

The rejuvenation test gave no marked results and has been discontinued. Hill-selection has resulted in the production of plots of vigorous seed from which diseased and weak plants have been eliminated and which have given thirty per cent increased yield over unselected stock. Too little time has

elapsed for persistent selection of tubers from the bin to give definite results, but the improvement of the general run of tubers is so noticeable as to call for remark by the growers.

The whole effect has been to stimulate the seed-growers to greater effort. A steady improvement has taken place in the Garnet Chili stock as a whole, and last spring (1925) the Director of Agriculture for Bermuda reported the seed as being the "best ever imported."

Subsequent to the above work, a start was made to isolate disease-free, high-yielding, pure lines of Irish Cobbler, Green Mountain, Bliss Triumph (fig. 4) and Garnet Chili varieties. The majority of selected units have retained their disease-free character for two seasons. It is hoped to maintain these plots, add other varieties as opportunity occurs, and thus have a disease-free nucleus of as many popular varieties as possible.

Fig. 4.—A Bliss Triumph tuber unit, second season. This unit averaged three pounds per hill. Kentville, N.S., 1925.

REPORT OF DOMINION FIELD LABORATORY OF PLANT PATHOLOGY, FREDERICTON, N.B.

(D. J. MacLeod, Plant Pathologist, Officer in Charge).

The work of this laboratory has been carried on under more favourable conditions than heretofore owing to improved laboratory accommodation provided at the Experimental Station, supplemented by the addition of much new equipment installed during the year. The new quarters occupying the upper story of the administration building comprise offices for the officer-in-charge, the assistant and seed potato inspection staff, a laboratory and a sterilizing room as well as a library co-jointly used with the Experimental Station. In addition there is a storeroom in the attic and a well-equipped darkroom in the basement.

The activities of the laboratory were chiefly restricted to problems relative to potatoes, a crop which continues to enjoy premier economic importance in

this province. Close co-operation with the Experimental Station staff, the Provincial Department of Agriculture and the Forestry Department of the University of New Brunswick resulted in certain information being drawn to our attention with respect to other crops necessitating the initiation of preliminary projects and meriting our detailed investigation in succeeding seasons. A brief taxonomic survey of certain localities in the province resulted in the identification of the following additions to the herbarium—120 species of fleshy and woody fungi, 24 of mosses, 9 of lichens, 14 of marine algae and 91 pathogenic organisms of more or less economic importance. Short addresses were given at the various farmers' field days held at the Experimental Station and a course of six lectures on plant diseases and their control was conducted at the Provincial Agricultural School, Fredericton, during November. A paper was read upon "Problems confronting the Canadian seed potato inspection and certification service" at the meetings of the Potato Association of America held in Kansas City, Mo., in December. It was discovered whilst visiting certain sections of the province that the laboratory did not enjoy the appreciation it really merits owing to the fact that its existence was entirely unknown to a great many people. Therefore, in order to mitigate this condition and enlighten the residents of New Brunswick as to the purpose and being of this office, thereby amplifying its interests, over eight thousand circulars were sent out outlining the activities of the laboratory and the service it purports and attempts to render to the province as a whole.

Optimum Spacing of Potato Plants for the Production of Certified Seed

One of the problems confronting the seed potato inspection and certification authorities in Canada is the necessity of eliminating a great many oversized tubers from the average crop to secure a grade commensurate with the certification standards.

In order to mitigate this condition the following experiment was originated to determine the optimum spacing interval whereby potatoes of such uniformity might be produced that the largest possible quantity of tubers from the average crop so planted may be certified.

The land used for this experiment was ordinary sandy loam of medium fertility and apparently of uniform quality throughout. It was ploughed in the fall and subsequently in the spring given thorough tillage to insure a mellow seed-bed.

The experiment proper consisted of two duplicate plats each planted with certified Irish Cobblers and Green Mountains respectively. Each plat proper included six rows 80 feet 8 inches long by 30 inches wide with an extra parallel or buffer row on both sides of each and every plat. The seed-pieces were placed respectively 6, 8, 9, 10, 12 and 14 inches apart in the rows. The average weight of seed-piece used being 1.5 ounces, it required 54.0, 40.8, 36.3, 32.7, 27.0 and 22.9 bushels of seed per acre for the 6, 8, 9, 10, 12 and 14 inch plantings respectively. The seed-pieces were accurately spaced in the furrow by means of a tape line, and hoes employed to cover them. Five pounds of commercial fertilizer were carefully sown by hand in each furrow. When the sprouts emerged it was found that seventeen seed-pieces had failed to germinate, whereupon these misses were replaced with transplants from the buffer rows, thus obviating the difficulty of making proper allowance for missing hills. All cultivation was done with a hoe in order to preclude any possibility of injuring the plants and the ordinary spray-schedule was applied to protect the crop from diseases and insects.

Favourable weather conditions prevailed throughout the growing season and a good stand was obtained. No damage of any consequence was done by

diseases and insects. At digging-time the product of each row was carefully sorted according to number and weight of tubers, falling into three grades namely: under 3 ounces, 3 to 12 ounces, and over 12 ounces.

FREDERICTON—BEST SPACING FOR PRODUCTION OF CERTIFIED SEED[1]

IRISH COBBLER

Spacing Interval	Yield per Row in Pounds				Yield per Acre in Bushels			
	Under 3 oz.	3–12 oz.	Over 12 oz.	Total	Under 3 oz.	3–12 oz.	Over 12 oz.	Total
6	25·9	58·9	.....	84·8	104·6	212·3	.....	316·9
8	22·0	56·3	.....	78·3	79·4	202·7	.....	282·1
9	22·3	55·0	.....	77·3	89·3	197·8	.....	287·1
10	23·1	54·1	.....	77·2	80·3	194·8	.....	275·1
12	22·1	48·1	.....	70·2	79·5	173·2	.....	252·7
14	25·0	42·1	.....	67·1	90·0	151·6	.....	241·6

GREEN MOUNTAIN

6	17·3	70·5	2·0	89·8	89·5	253·6	7·0	350·1
8	16·6	60·9	2·2	79·7	62·3	219·4	7·8	289·5
9	20·2	44·4	3·0	67·6	59·6	159·7	10·6	229·9
10	15·1	65·9	2·0	83·0	72·7	237·1	7·0	316·8
12	10·1	64·6	4·4	79·1	54·4	232·1	15·8	302·3
14	10·1	51·3	4·4	65·8	36·4	184·5	15·7	236·6

RESULTS OBTAINED AT CHARLOTTETOWN[2]

IRISH COBBLER

Spacing Interval	Yield per Row in Pounds				Yield per Acre in Bushels			
	Under 3 oz.	3–12 oz.	Over 12 oz.	Total	Under 3 oz.	3–12 oz.	Over 12 oz.	Total
6	33·75	72·75	.....	106·5	101·25	230·25	.....	331·5
8	25·0	71·0	.....	96·0	75·0	213·0	.....	288·0
9	27·0	70·25	.....	97·25	81·0	210·75	.....	291·75
10	24·5	69·25	.....	93·75	73·5	207·75	.....	281·25
12	19·0	71·75	.....	90·75	57·0	215·25	.....	272·25
14	17·75	57·75	.....	75·5	53·25	173·25	.....	226·50

GREEN MOUNTAIN

6	23·25	139·5	.....	162·75	46·5	279·0	.....	325·5
8	19·5	125·75	.....	145·25	39·0	251·5	.....	290·5
9	17·5	134·0	.....	151·5	35·0	268·0	.....	303·0
10	15·25	103·75	.....	119·0	30·5	207·5	.....	238·0
12	15·25	125·75	.....	141·0	30·5	251·5	.....	282·0
14	16·5	120·25	.....	136·75	33·0	240·5	.....	273·5

[1] The tabulated data represent the average results from duplicated plots.
[2] This experiment as conducted at Fredericton was duplicated at the Charlottetown laboratory.

Analyses of the foregoing tables show both in the case of the Irish Cobbler and Green Mountain variety that the amount of tubers under 3 ounces, 3 to 12 ounces, as well as the total amount of tubers in these two grades increased, though somewhat irregularly, with a reduction in the interval of planting. A noteworthy feature of the experiment is that the amount of tubers over 12 ounces showed a definite decrease with a decrease in spacing interval. Moreover, in all cases, close spacing produced a much superior crop to that from thin planting, because of the small number of large tubers in the former.

Owing to the fact that many factors, which tend to complicate a problem of this kind, such as weather conditions, soil-fertility, size of seed-piece, time of planting, length of season have been given little or no consideration it is impossible to draw any definite conclusions whereby recommendations applicable to the whole of Canada can be made. Nevertheless, if the results from one year's efforts are dependable, the following recommendations appear in order. In growing seed potatoes of the Irish Cobbler and Green Mountain varieties growers might adopt the practice of planting as close as is consistent with roguing, whereby a greater quantity of tubers grading as Extra No. 1 is likely to be produced as well as the quality of the crop considerably improved, particularly on soil of medium fertility.

The Effect of Various Types of Soil on the Shape of Potato Tubers

It has frequently been the experience of those associated with the growing of potatoes to find that the progeny of a plant grown from carefully selected seed differed considerably in form from that of the parent tuber. Certain constitutional diseases are undoubtedly responsible for many abnormalities found in potato tubers, but variations in form occurring when such diseases are absent must needs be attributed to other causes.

In view of the fact that environmental conditions are known to bring about various changes in the form of other plant structures it seemed feasible to initiate an experiment in a preliminary form to determine the influence of different types of soil on the shape of potato tubers. Healthy, uniform, good-type tubers of the Green Mountain variety were selected and planted in the following types of soils contained in trenches 12 inches by 30 inches by 10 inches.

(1) Fine crushed stone.
(2) Coarse sand.
(3) Fine sand.
(4) Black muck.
(5) Ordinary sandy loam.
(6) Clay.
(7) Clay compacted.

Owing to the fact, that this experiment was conducted on a restricted scale, specific conclusions cannot be arrived at from the results obtained. However, it can be deduced in a slight measure from the following table that there is a tendency for soils such as coarse sand and black muck to produce short round tubers while heavier soils such as ordinary sandy loam and clay produce longer types.

Effect of Soil-type on Shape of Potato Tubers

Type of Soil	Percentage of long tubers	Percentage of short tubers
Fine crushed stone	39·6	60·4
Coarse sand	46·9	53·1
Fine sand	38·9	61·1
Black muck	49·0	51·0
Sandy loam	61·2	38·8
Clay	54·0	46·0
Clay compacted	66·0	34·0

These results, indeterminate as they may seem, are yet sufficiently indicative to warrant the continuance of this investigation on a larger and more diversified scale another year.

Transmission of Certain Constitutional Diseases of Potatoes by Means of Tuber-Grafts

This experiment was incepted in 1924 with a view to ascertaining the possibility of transmitting mild, rugose and leaf-rolling mosaic, mottled and unmottled curly dwarf, leaf-roll and spindle tuber to plants produced from healthy eyes grafted into tubers known to be affected with these diseases.

Carefully selected tubers from plants, grown under caged conditions and known to be affected with but one of the aforementioned diseases, were chosen specifically for the purpose in each instance. The grafting was attempted in the following manner. By means of a large cork-borer previously sterilized two eyes were removed from each of the affected tubers and the cavities thus produced filled by inserting cores each embodying an eye from a known healthy tuber. The remaining eyes in each tuber thus treated were destroyed. To preclude the admission of rot-producing organisms, the ruptured portions of the tuber surfaces were protected with a coat of paraffine wax. The several tubers were planted in individual hills under caged conditions and carefully attended during the growing-season. The Green Mountain variety was used for the experiment.

The following table embodies the results obtained during the season 1924:—

1924—Transmission of Disease by Tuber-Graft

Name of Disease	Number of tubers planted	Number of plants produced	Number of plants showing disease
Mild mosaic	12	6	0
Rugose mosaic	12	5	2
Leaf-rolling mosaic	12	8	0
Mottled curly dwarf	12	6	3
Unmottled curly dwarf	12	7	0
Spindle tuber	12	6	0
Leaf roll	12	0	0

Rugose mosaic and mottled curly dwarf were successfully transmitted, but none of the others showed any visible symptoms of disease. The leaf-roll tubers failed to produce any plants.

In 1925 tubers from each of the various plants used for the experiment the previous year were again planted under caged conditions in order to observe any symptoms developing in the second generation of plants. The results obtained in 1925 were as follows:—

1925—Disease Transmission by Tuber-Graft

Name of Disease	Number of tubers planted	Number of plants produced	Number of plants showing disease
Mild mosaic	24	17	10
Rugose mosaic	24	16	12
Leaf rolling mosaic	24	23	6
Mottled curly dwarf	24	17	11
Unmottled curly dwarf	24	20	4
Spindle tuber	24	15	3

It may be deduced from the aforegoing results that the causal organism of the several diseases experimented with is capable of transmission from diseased to healthy plant-tissues under the conditions provided by grafting healthy eyes

into diseased tubers. A noteworthy feature of these results is that the symptoms did not appear in any specific instance attempted, except rugose mosaic and mottled curly dwarf, until the second generation.

Dusting vs. Spraying

Considering the adverse reports by agricultural experiment stations from time to time upon the comparative efficacy of various dusts as opposed to spray mixtures, which afforded reasonable satisfaction and control for over thirty years, and bearing in mind the very certain distinct and highly desirable virtues possessed by dusts, it seemed not only necessary but imperative that a very thorough comparison test be conducted to determine the respective merits of each.

A field consisting of 4.75 acres on the farm of a grower near Fredericton was chosen for the purpose. This field was divided into three plats of equal area. Each plat proper included twenty-four rows. In addition there were six buffer rows on both sides of each and every plat which served a dual purpose, first to provide transplants for any misses occurring in the plats and secondly to afford a space over which there would be a necessary overlapping of the dust and spray. The land used was of average fertility and apparently uniform throughout. Certified Green Mountains were used for the experiment. The necessary insecticides were applied to protect the crops from insects. The liquid fungicide was applied by means of a power sprayer with a four-row twelve-nozzle boom and the dust mixture by means of a Niagara traction crop-duster provided with a drag-canvas. The fungicides used were ordinary liquid Bordeaux and Bordeaux dust. An attempt was made to apply the dust and spray mixtures in such quantities that equal amounts of metallic copper would be used. The following table embodies an outline of the several applications received by the three plats.

Dust vs. Spray—Applications

Date	Liquid Bordeaux	Bordeaux dust	Copper carbonate dust
July 22..	60 gallons 4-4-40 and 3 pounds arsenate of lime.	50 pounds 20-20-60 poison dust	60 pounds 8-8-84 poison dust.
" 29..	60 gallons 6-6-60 and 2½ pounds arsenate of lime.	50 pounds 20-20-60 poison dust	73 pounds 8-8-84 poison dust.
Aug. 5..	120 gallons 4-4-40	44 pounds 20-80	37 pounds 14-86.
" 12..	120 gallons 5-5-50	48 pounds 20-80	38 pounds 14-86.
" 19..	120 gallons 6-6-60	53 pounds 20-80	70 pounds 14-86. 5 pounds 8-8-84.
" 26..	120 gallons 6-6-60	48 pounds 20-80	90 pounds 14-86.
Sept. 3..	120 gallons 6.6-60	50 pounds 20-80	98 pounds 14-86.

Rainfall was ample during the growing-season and an excellent stand was obtained. Fortuitously, early and late blight were prevalent during the latter part of the growing season. Certain plants were rogued on account of blackleg and constitutional diseases, but, in order to attain uniformity, plants occupying identical positions in other plats were also removed. Digging operations were not performed until four weeks subsequent to the usual date for harvesting owing to the occurrence of a period of wet weather during this interim. Such a condition would undoubtedly predispose to an increase in the amount of rot developing as a result of late blight, but it might be conceded axiomatic that the increase would be uniform throughout all areas under consideration. Designedly, no customary check plat was included in the experiment as planted—because the

owner of the potatoes objected to sacrificing a whole acre of his certified crop—but, to obviate in part this non-inclusion, for the purpose of comparison a third plat was added, which received a dust application of copper carbonate calculated to retard, but not to preclude the spread of early and late blight.

Observations made during the course of the growing-season indicated that there was no apparent difference in the amount of early and late blight appearing on the foliage up to August 26. However, subsequent to that date the number of leaf- and stem-lesions produced by these diseases increased considerably in the plat treated with liquid Bordeaux and the check with the result that the final readings were as shown in the following table, which also includes the results obtained at the time of digging.

DUST VS. SPRAY—COMPARISONS

Fungicide	Number of applications	Amount of metallic copper	Field readings Sept. 3		Percentage of rotten tubers	Total yield per acre in barrels
			Early Blight	Late Blight		
		lb.				
Bordeaux dust	7	24·5[1]	Moderate	Moderate	1·2	97·2
Bordeaux spray	7	24·4[1]	Severe	Severe	3·2	85·4
Copper carbonate dust (Partial check)	7	29·5	Very severe	Severe	10·5	81·7

[1] The approximation of amounts of metallic copper applied as Bordeaux dust and spray was accidental rather than designed.

The results of the experiment as shown by the yields are what might be expected from the appearance of the foliage as injured by early and late blight during the latter part of the growing-season. The loss from rot was slightly greater on the sprayed plat than that treated with Bordeaux dust. Owing to the fact that the experiment was conducted for one year only, it would appear presumptuous to draw any final conclusions. However, the results obtained show in a measure that better production was afforded by the Bordeaux dust than the Bordeaux spray as applied with power machines against such diseases as early and late blight.

A STUDY OF THE DETRIMENTAL EFFECT OF CHEMICALS ON POTATO TUBERS

This preliminary investigation was incepted as a result of the very severe damage to a carload of certified seed potatoes put up in bags previously used for shipping Epsom salts. Consideration of this case revealed that unfortunately it is a practice accorded considerable usage by potato-shippers to bag stock in containers which have not been washed and previously contained certain salts, fertilizer ingredients, fungicides and commodities of general consumption.

That as far as possible, under the necessary restricted scope of the observations, information might be made available for dissemination and reference in the event of damage to shipments, an experiment was conducted where Epsom salts, ammonium sulphate, sodium nitrate, potassium nitrate, coarse common salt, acid phosphate, Bordeaux dust, flowers of sulphur, cane sugar, tea, coffee, cocoa, potato starch, corn meal, and bran were placed in contact with duplicate lots of tubers in burlap containers. Storage of these was effected under dry warehouse conditions and in a root-cellar with earthen floor where the atmosphere was damp—a prevailing state in storage of this type.

Consideration of the anatomy of the potato tuber discloses it to be a thickened plant-stem composed of a delicate corky outer covering, corresponding to the bark of an above-ground stem, and an internal area having cells

mostly filled wth starch as reserve food for new plants. This underground stem is active physiologically, respiring rapidly, absorbing much oxygen, and liberating quantities of carbon dioxide. Simultaneously transpiration takes place, whereby much water is given off, all which physiological actions are made possible through the medium of minute breathing pores or lenticels occurring on the surface of the tuber.

Thus the potato tuber, by virtue of its succulent nature with a fairly thin easily-penetrated outer covering, is predisposed to accelerated infiltration of the tissues by chemical substances. This assumption was most amply corroborated under the conditions obtaining in this experiment.

In the following description is embodied the sequence of the relative and progressive intensity of the type of injury as evidenced from initial to ultimate destruction of the tuber.

Salts, particularly when brought in contact with the moistened surface of tubers, readily dissolve and, gaining admission through the lenticels, infiltrate the surrounding tissues producing necrosis. At first the necrotic areas are very restricted, embracing only tissues surrounding the lenticels, thus presenting a pocked or pitted appearance. Subsequently they enlarge, due to more diffused penetration of the tissues by the salt, and eventually coalesce, involving the major portion of the tuber surface, effecting a soft and spongy texture. Finally this condition becomes aggravated causing a breaking down of the cortical tissues, resulting in a sloughing off of the skin of the tuber exposing the interior portion to the action of rot-producing organisms, whereby, ultimately decomposition of the remaining tissues is effected. This particularly obtains where damp storage prevails.

Considering their individual severity of action Epsom salts, sodium nitrate, potassium nitrate, coarse common salt are analogous whereas ammonium sulphate, while slightly retarded in action in common with them, ultimately produces conditions as outlined above.

Bordeaux dust and acid phosphate produced restricted necrotic sunken areas involving only the tissues adjacent to the lenticels leaving the unaffected portion of the tubers otherwise firm and normal. The former under dry conditions produced no apparent injury.

Under dry storage all the salts produced very much modified conditions as outlined.

Flowers of sulphur effected no change.

Cane sugar exhibited a very slight necrosis of tissue around a few lenticels under damp storage, but no abnormality under dry conditions.

Tea, coffee, cocoa, potato starch, corn meal, and bran do not in themselves produce necrosis of the tissues, but by virtue of their capability to retain moisture, induce an enlargement of the lenticels and in addition provide admirable media for the development of rot-producing organisms which are afforded readier penetration through these orifices.

As far as now known all varieties grown in New Brunswick are susceptible to this type of injury. It might be conceded, however, that all deep-eyed as opposed to shallow-eyed varieties are predisposed to greater ravages by chemicals due to the natural depressions furnished by the eyes as receptacles for these tissue-destroying agents. Varieties possessed of thin skin like the Irish Cobbler were found to be extremely susceptible to the rapid infiltrating and diffusing action of chemicals.

In view of the very manifest deleterious effects exhibited, it seems not only highly advisable but absolutely imperative that all sacks used as containers for potatoes should be thoroughly washed before using, to ensure complete removal of injurious substances clinging to their inner surfaces.

The use of new sacks, however, will absolutely preclude occurrence of this type of injury, a fact which should not lightly be disregarded.

The Overwintering of the Causal Organism of Potato Blackleg in the Soil

Perusal of the voluminous literature relating to the study of blackleg disease of potatoes reveals a very considerable diversity of opinion with respect to the survival of the causal organism during the winter months in the soil.

While bearing in mind the classical work performed by others along similar lines it seemed imperative, however, in view of the different conclusions arrived at from time to time by these investigators, that a thorough study of this problem under New Brunswick conditions should be undertaken.

During the month of October, 1924, in conformity with a definite outline, a quantity of tubers, stems, leaves, etc. from plants known to be affected with Blackleg were placed in the ground at the usual planting depth and so left under the conditions obtaining during the winter months. The land used for the experiment was ordinary sandy loam and apparently uniform throughout—a soil normally occurring in the potato-producing sections of the province.

The following introductions into the soil were made at intervals of 30 inches, in each of six rows, 36 inches apart:—

(*a*) Fifty tubers known to be affected with blackleg and manifesting well-marked rot.
(*b*) Fifty tubers from plants known to be affected with blackleg, but as yet showing no evidence of rot.
(*c*) Fifty cut and abraded tubers, which had been immersed in a virulent broth culture of the blackleg organism.
(*d*) Fifty tubers known to be free from blackleg and treated with corrosive sublimate, serving as a check.
(*e*) Fifty areas containing stems and leaves from "blackleg" plants.
(*f*) Fifty areas where virulent broth cultures of blackleg organisms were poured directly into the soil.

All areas under consideration were staked and numbered to facilitate their identity at subsequent periods. A careful examination of the several staked areas during the month of May 1925 revealed that all the tubers in series *a* and *c*, seventeen in series *b*, and three in series *d* had completely decomposed; twenty-two tubers in series *b*, and nineteen in series *d* were sufficiently injured by frost and the tissues disintegrated to a degree precluding possibility of germination. The remaining tubers in series *b* and *d* were apparently sound and left as located to germinate. The stems and leaves evidenced advanced decomposition in each instance.

A bacteriological examination of samples of soil from all areas under consideration—conducted in accordance with recognized methods—revealed in no instance the presence of the causal organism of blackleg.

Feeling that the ordinary plate method for the isolation of micro-organisms was more or less a futile task in a case such as this—owing to the preponderingly large number of soil organisms present—another mehod for the detection of the organism in question was attempted, as follows: a small amount of soil-solution obtained from representative samples of each series was injected into the stems of healthy potato plants to determine the presence of the specific organism as evidenced by the characteristic necrotic areas produced by it. This method in common with the former furnished negative results.

At planting time healthy seed-pieces were placed directly in contact with the soil formerly surrounding the several affected tubers, stems, leaves, etc., with the exception of the specified areas in series *b* and *d* where apparently sound tubers were left to germinate, as previously indicated.

During the growing season specific observations revealed that healthy plants emerged from all areas under consideration with the exception of three in series *b* emanating from tubers, surviving the winter in the soil which were themselves produced by "Blackleg" plants. These manifested the typical symptoms of blackleg and subsequently died long before the others matured.

Deductions from these observations in New Brunswick, tend to corroborate the contention of others, elsewhere, that the causal organism of Blackleg does not overwinter in the soil itself, or if it does is sufficiently attenuated to render it inffective. However, the results obtained from series *b* seem to indicate that the organism is capable of being carried over in a measure, under the conditions obtaining in the tissues of a tuber, which itself survived the circumstances predisposing to its destruction in the soil during the winter months.

REPORT OF THE DOMINION FIELD LABORATORY OF PLANT PATHOLOGY, STE. ANNE DE LA POCATIÈRE, QUE.

(H. N. Racicot, Plant Pathologist, Officer in Charge)

The work of this laboratory during the past year consisted chiefly in field experiments and in extension work. The field experiments were similar to those of 1924, and mainly on potatoes. The cold weather in May retarded seeding and planting, but June and July were very favourable for growth. The warm, moist weather of July was responsible for a heavy outbreak of diseases on garden and truck crops. This was followed by a protracted drought during August and the first half of September, which checked the progress of disease, but which caused many crops to mature early, and thus reduce the yield. This was especially true of the potato crop.

Late Blight of Potatoes *Phytophthora infestans*, (Mont.) de B.

An addition of two plots was made to the experiment on spraying with Bordeaux mixture to determine the time and number of applications to control late blight of potatoes in this district, and the effect of Bordeaux mixture upon the yield in blight-free years, in order to have a wider range of the time at which sprayings were begun. The sprayings were made every ten days with 4-4-40 Bordeaux mixture. Owing to the drought during August and the early part of September, the yield was considerably lower than last year, especially that of marketable tubers. On this account, it was found advisable to record not only total yield but also the yield of marketable tubers. The potato vines in the plots in which the sprayings continued throughout the dry weather remained green longer than the vines in the other plots. Therefore, when the rains came in September, many of the plants in these plots were still green, and these plots gave a higher yield. It would appear that even in the absence of late blight, Bordeaux mixture helps to keep the plants green during dry weather, and increases the yield.

Spraying Potatoes With Bordeaux

Plot	No. and time of sprayings	Date when Late Blight on vines first noticed	Late Blight		Total yield	Marketable
			Vines	Tubers		
					Bush. per acre	
1	Control, unsprayed	July 20	trace	0	235	134
2	4, beginning June 30		0	0	249	135
3	6, beginning June 30		0	0	253	143
4	4, beginning July 20		0	0	261	151
5	6, beginning July 20		0	0	258	148
6	4, beginning Aug. 10		0	0	255	149
7	6, beginning Aug. 10		0	0	271	161

In order to determine the progress in severity of potato mosaic, as determined by the yield, when diseased plants are not rogued, two plots were planted with healthy seed in 1924. One plot was artificially inoculated with mosaic (by the leaf-mutilation method). The healthy plot is kept as free from mosaic as possible. However, this season, owing to the fact that the nicotine sulphate dust that was being used did not control aphids, the vines in the healthy plot showed about 10 per cent mosaic. The mosaic plot showed about 30 per cent

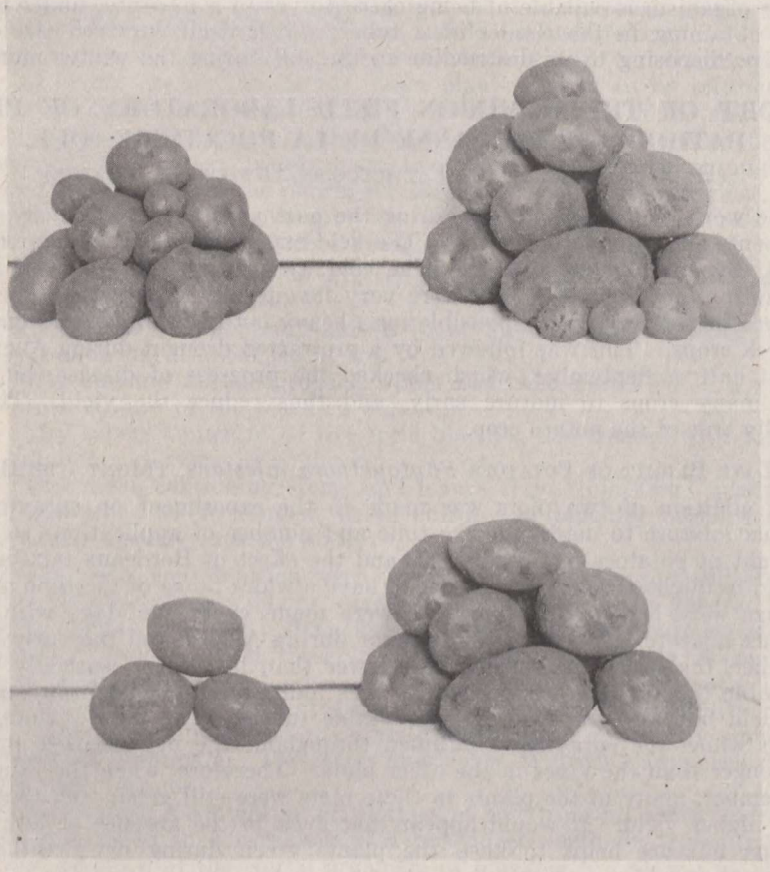

Fig. 5.—The difference between the total yield (upper) and marketable tubers (lower) from healthy (right) and mosaic (left) potato plants.

mosaic. There is a slight decrease in yield due to mosaic and this is more marked in the yield of marketable tubers.

	Bushels per acre	
	Total Yield	Marketable
Healthy plot	274·0	178
Mosaic plot	262·0	162
Decrease in yield	% 4·4	% 9

Demonstration plots, to show to growers in this district who still believe that mosaic does not reduce the yield, were set out at Riviere Blanche, Matane county. One plot was planted with healthy seed and the other with mosaic seed.

Plot	Per cent mosaic	Total Yield Bush. per acre	Decrease	Marketable Bush. per acre	Decrease
			per cent		per cent
Healthy seed	10	109	.....	57	.....
Mosaic seed	97	82	24·8	28	50·9

Observations on mosaic potato plants show that the decrease in yield, compared with healthy plants, is due more to the reduction in the size of the tubers than in the number of tubers produced. It is believed that the accompanying photographs represent a fair average of field condition. Figure 5 shows the difference in total yield and marketable tubers from healthy and mosaic plants. The difference in the percentage of the yield of marketable tubers of the two plants is well marked.

The attention of growers is here called to the fact that the use of small tubers as seed is a very important factor in the increase of mosaic disease in potato fields.

COMMON SCAB OF POTATOES, *Actinomyces scabies*, (THAX.) GÜSSOW.

Soil treatment with inoculated sulphur to control common scab was again carried out. In the case of the experiments at Ste-Anne de la Pocatière, the seed used was scabby tubers. In the other experiments, ordinary seed was used. The results are as follows:—

Locality of experiment	Variety of potatoes	Pounds Sulphur per acre	Per cent clean	Per cent saleable scabby	Per cent unsaleable scabby	Bush. per acre	
						Yield	Marketable
Ste-Anne de la Pocatiere, Que.	Green Mountain	0	0·86	95·72	3·42	114	79
" "	" "	300	0·00	99·25	0·75	136	109
" "	" "	450	1·00	99·00	0·00	145	115
Bic, Rimouski Co.	" "	0	52·0	48·0	0·0	177	.....
" "	" "	300	55·0	45·0	0·0	253	.....
" "	" "	450	54·0	46·0	0·0	207	.....
Sacre-Coeur, Rimouski Co.	Irish Cobbler...	0	63·0	37·0	0·0	206	.....
" "	" " ..	300	52·0	48·0	0·0	219	.....
" "	" " ..	450	84·0	16·0	0·0	194	.....

Scabby tubers were treated with chemicals and commercial seed-disinfectants and planted in 50-foot rows, in duplicate. The results obtained are given below.

Row	Treatment	Bushels per acre		Per cent scabby
		Total yield	Marketable	
1	Mercuric bichloride, 1-1000, 1½ hours	294	231	80·5
2	Formalin, 1 pt. per 30 gals. water, 1 hour	270	172	85·0
3	Semesan, dust, 3 oz. per bush. (60 lb)	269	171	82·3
4	Semesan, liquid, 0·25% solution, 30 minutes	297	162	79·7
5	Control, untreated	265	141	75·8
6	D.D.D. No. 15, dust, 3 oz. per bushel	224	158	63·7
7	D.D.D. No. 12, liquid, 0·25 per cent solution, 30 minutes	246	169	55·1
8	Uspulun, solution, 0·25% solution, 30 minutes	295	185	63·5
9	D.D.D. No. 13, dust, 3 oz. per bushel	258	179	100·0
10	D.D.D. No. 12, dust, 3 oz. per bushel	322	211	100·0
11	Dyol, 2% solution, 2 hours	108	67	100·0

OAT SMUTS, *Ustilago Avenae*, (PERS.) JENS. AND *U. levis*, (K. & S.) MAGN.

In order to determine the value of commercial seed-disinfectants placed on the market, seed oats harvested from fields containing oat smut, were treated with chemicals and commercial seed-disinfectants and sown in 1/300-acre plots, in duplicate. The results obtained are recorded below.

LAUREL HULLESS OATS

Plot	Treatment	Per cent germination soil test	Yield per acre	Per cent smut
			bush.	
1	Control, untreated	71·0	56	0·33
2	Wet Formalin, 1-300, soaked 5 minutes, drained, covered 1 hour	39·0	56	0·00
3	Dry Formalin, 1 pt. to 1 pt. per 50 bushels, covered 2 hrs.	23·0	51	0·00
4	Uspulun, 0·25 % solution, soaked 2 hours	77·5	66	0·00
5	Semesan, Liquid, 0·3 solution, soaked 2 hours	69·5	66	0·16
6	Semesan, Dust, 3 oz. per bush	56·5	57	0·00
7	D.D.D. No. 12, Liquid, 0·33% solution, soaked 2 hours	78·0	70	0·00
8	D.D.D. No. 12, Dust, 3 oz. per bushel	78·5	70	0·16
9	D.D.D. No. 13, Dust, 3 oz. per bush	68·5	51	0·00
10	D.D.D. No. 15, Dust, 3 oz. per bush	77·5	51	0·00
11	Copper Carbonate, Dust, 4 oz. per bush	75·5	49	0·00
12	Sulphur Dust, 6 oz. per bush	67·5	49	0·00
13	Powdered Copper Sulphate and Lime, equal parts, 4 oz. per bush	74·0	54	0·5
14	D.D.D. No. 17, Dust, 3 oz. per bush	73·0	54	0·00
15	Bayer Compound Liquid, 0·25% solution, soaked 2½ hours	76·0	57	0·16
16	Bayer Dust, 2 oz. per bush	54·0	60	0·00
17	D.D.D. No. 16, Dust, 3 oz. per bush	73·0	53	0·00
18	Dyol, 2% solution, soaked 2 hours	27·0	51	0·16

LIGOWO HULLED OATS

Plot	Treatment	Per cent germination soil test	Yield per acre	Per cent smut
			bush.	
1	Control, untreated	88·0	52	1·0
2	Wet Formalin, 1-300, soaked 5 minutes, drained, covered 1 hour	63·0	52	0·0
3	Dry Formalin, 1 pt. to 1 pt. per 50 bushels, covered 2 hours	48·0	52	0·0
4	Uspulun, 0·25% solution, soaked 2 hours	77·5	70	1·33
5	Semesan, Liquid, 0·3 solution, soaked 2 hours	86·5	66	1·22
6	Semesan, Dust, 3 oz. per bush	93·0	71	1·66
7	D.D.D. No. 12, Liquid, 0·33% solution, soaked 2 hours	87·5	73	0·33
8	D.D.D. No. 12, Dust, 3 oz. per bush	84·5	71	1·00
9	D.D.D. No. 13, Dust, 3 oz. per bush	97·5	78	1·66
10	D.D.D. No. 15, Dust, 3 oz. per bush	80·0	82	1·16
11	Copper Carbonate Dust, 4 oz. per bush	73·5	83	1·33
12	Sulphur Dust, 6 oz. per bushel	88·0	86	0·83
13	Powdered Copper Sulphate and Lime, equal parts, 4 oz. per bush	85·0	68	1·00
14	D.D.D. No. 17, Dust, 3 oz. per bushel	72·0	71	1·5
15	Bayer Compound, Liquid, 0·25% sol., soaked 2½ hours	84·5	73	0·83
16	Bayer Dust, 2 oz. per bushel	82·0	77	1·83
17	D.D.D. No. 16, Dust, 3 oz. per bush	89·5	70	0·66
18	Dyol, 2% solution, soaked 2 hours	24·0	78	1·00

BEAN MOSAIC

Observations on the transmission in the field and through the seed of bean mosaic were made during the season. As last year, no current-season symptoms appeared on the plants. But seed from plants that showed no mosaic last year,

and which were in rows adjacent to rows of " mosaic " plants, produced plants showing an average of 12.5 per cent mosaic this year. It will appear that plants that are inoculated in the field with mosaic will not show any mosaic symptoms until the following year. The average germination of both healthy and " mosaic " seeds was 96 per cent, but the healthy plants produced a yield of 20 bushels per acre, while the mosaic plants only produced 15 bushels per acre.

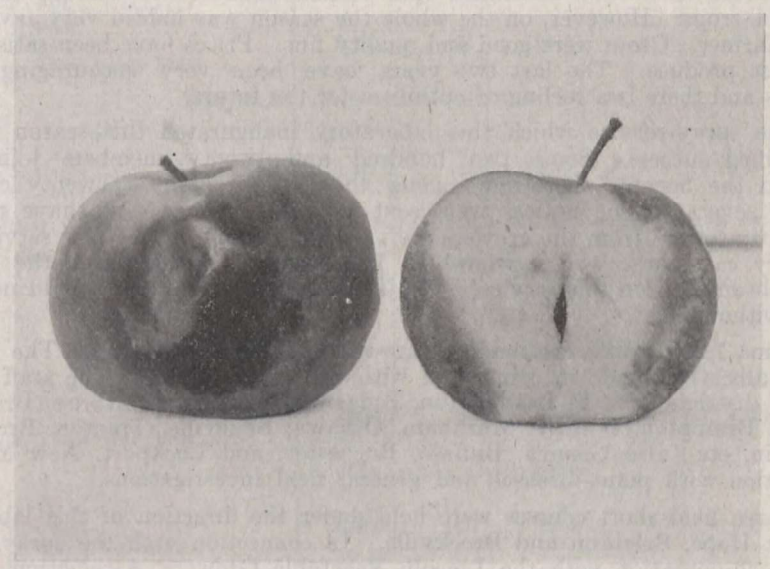

Fig. 6.—A type of frost-injury to apples.

Frost Injury to Apples

A peculiar breaking down of apples in storage, which had never been noticed before, was reported to the laboratory. It was first noticeable by the darkening of the skin in spots. Later these spots became slightly sunken, with a softening of the tissues underneath. On cutting through these spots, the tissues were found to be a light brown (see fig. 6). Attempts, from a total of nineteen apples, to isolate an organism gave negative results. It was further learnt that apples picked prior to the cold and snow storm of October 7 were free from this, while it was only in apples picked after that date that the trouble was found. The varieties most affected are, in order of severity, Fameuse, Scarlet Pippin, McIntosh and McIntosh seedlings and Milwaukee, while there is a good percentage found in all varieties. The loss is estimated at upwards of 25 per cent.

Extension Work

A plant-disease exhibit was prepared, illustrating the common diseases of the district. This exhibit, the first of its kind in the district, was shown at the county fairs of Rimouski, Montmagny and Bellechasse. It created such interest that it is hoped to be possible to have a plant-disease exhibit at a larger number of fairs throughout the province.

REPORT OF THE DOMINION LABORATORY OF PLANT PATHOLOGY, ST. CATHARINES, ONTARIO

(G. H. Berkeley, Plant Pathologist, Officer in Charge)

The early season, which was exceptionally dry, was followed for a time by weather conditions just the reverse. The fall of 1925 was very unusual. Three early severe frosts and continued rain caused considerable damage to apples and root crops. However, on the whole the season was indeed very favourable to the farmer. Crops were good and quality fine. Prices have been satisfactory for most produce. The last two years have been very encouraging to the growers and there is a feeling of optimism for the future.

The spray-service which this laboratory inaugurated this season was an unqualified success. Some two hundred and twenty members joined and received the benefits therefrom during the entire season. Twenty circulars besides several phone notices were sent to each member. We have received some fifty letters from the growers giving their opinion of this new service, and in every case these were favourable. The growers have realized the benefits to be obtained from this service, and after only one year's trial would not want to be without it.[1]

Some 1,200 calls were made to growers on their own farms. The bulk of these calls were made in connection with the spray-service. The staff visited outside districts such as Leamington, Ridgeway, London, Strathroy, Brantford, Milton, Brampton, Whitby, Markham, Oshawa, Belleville, Trenton, Brockville, Brooklin, etc., also Geneva, Buffalo, Rochester, and Lockport, New York, in connection with plant-diseases and general field investigations.

Three field short courses were held under the direction of this laboratory at Port Hope, Brighton and Brockville. In connection with the spray-service and in co-operation with the Lincoln Vegetable Growers' Association, a field trip was held via Buffalo to Geneva, Rochester and Lockport.

Two bulletins, one on Raspberry Wilt, the other on Raspberry Mosaic and Leaf-Curl, have been prepared. Largely due to our efforts, the *Daily Standard*, St. Catharines, has inaugurated an agricultural section on Wednesday of each week. This laboratory has so far submitted about ten articles for this page.

The staff have reported this year three diseases which I believe are new to Ontario, namely *Fusarium* rot of asparagus, blackheart of celery and eastern blue stem (Rosette) of raspberries.

Apple Scab

The accompanying data represent the principal results obtained from a spraying-experiment carried on in the McIntosh orchard of H. E. Maycock & Son, Vinemount, Ont.

A McIntosh orchard comprising 1,280 trees was divided into five blocks. Fifteen trees in the centre were left as a check (unsprayed).

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[1] We also desire to express our appreciation to Mr. Wm. Ross, Entomologist, for acting in the capacity of consulting entomologist.

Number of trees	Spray schedule	Number of apples	Production, in bushels	Per cent clean A 1 grade	Per cent slight scab	Per cent severe scab	Per cent insect injury
	Block No. I. Bordeaux 3 : 9 : 40 for first two applications and lime sulphur 1-40 for last two applications						
15	1. Delayed dormant						
	2. Pink						
	3. Calyx	7,200	51	94·8	3·7	0·1	1·2
	4. Three weeks later						
	Block No. II. Lime-sulphur for all four applications						
15	1. Delayed dormant						
	2. Pink						
	3. Calyx	6,333	42	95·9	3·6	0·04	0·42
	4. Three weeks later						
	Block No. III. Bordeaux 3 : 9 :40 for first two applications and lime sulphur 1-40 for last two						
15	1. Delayed dormant						
	2. Pre-Pink						
	3. Calyx	7,932	54	91·4	7·8	0·07	0·6
	4. Three weeks later						
	Block No. IV. Lime-sulphur for all four applications						
15	1. Delayed dormant						
	2. Pre-Pink						
	3. Calyx	6,801	51	89·8	8·8	0·35	0·92
	4. Three weeks later						
	Block No. V. Lime-sulphur used throughout						
15	1. Pink						
	2. Calyx	8,394	51	97·5	2·7	0·00	0·9
	3. Three weeks later						
	Block No. VI. No spray applications applied						
15	No sprays applied	1,112[1]	6	15·4	34·7	39·9	3·8

[1] Undersize—6·2%; Pink rot–6·2%.

NOTE.—The delayed dormant was applied April 29, the pre-pink on May 10, and pink on May 16, and the calyx on June 1 and 2. The fourth application was applied on June 24.

The outstanding feature in connection with this experiment is the great difference in yield between the sprayed (average 7,363 apples, 93.7 per cent clean) and unsprayed (1,112 apples, only 15.4 per cent clean) blocks, a difference of 6,251 apples. Looking at it from the standpoint of percentage of clean, healthy apples, the sprayed blocks gave from 89.8 per cent to 97.5 per cent (average 93.6 per cent) as compared with 15.4 per cent for unsprayed block. This great difference in yield was due mainly to a severe scab infection of the blossom parts early in the season, which resulted in the blighting of the blossoms and dropping of the fruit pedicles and fruit while still very young. This is a phase of scab injury that many orchardists are not familiar with, or largely overlook. Not only was the crop much lighter on the unsprayed block, but the foliage was also thin and considerably scabbed. From the data collected from a series of spore-traps set out in the orchard, the greatest ascospore dissemination took place on May 16, when the blossoms were in the pre-pink stage. The first recorded ascospore discharge was May 1, and the last June 28.

BORDEAUX MIXTURE ON SOUR CHERRIES

It has been known for some time that when Bordeaux mixture was applied to certain plants there was a tendency to increase the transpiration, i.e., evaporation or loss of water, from those plants.

It has also been reported on one or two occasions that cherries from trees sprayed with Bordeaux were smaller than cherries from lime-sulphur sprayed trees. This dwarfing of the cherries was likely due to the increased evaporation of water from the leaves. In any case the Dominion Laboratory has started an experiment to ascertain if these facts are true for our conditions. This experiment will be carried on for at least three years.

The spraying demonstrations were carried out on Early Richmond cherries at Mr. M. Udell's, Grimsby, and Mr. Geo. Robertson's, St. Catharines. Thirty-six trees in all were used for the experiment, eighteen of which were sprayed with Bordeaux and eighteen with lime-sulphur.

Two applications, the shuck and maggot sprays, were applied on May 16 and June 3 respectively.

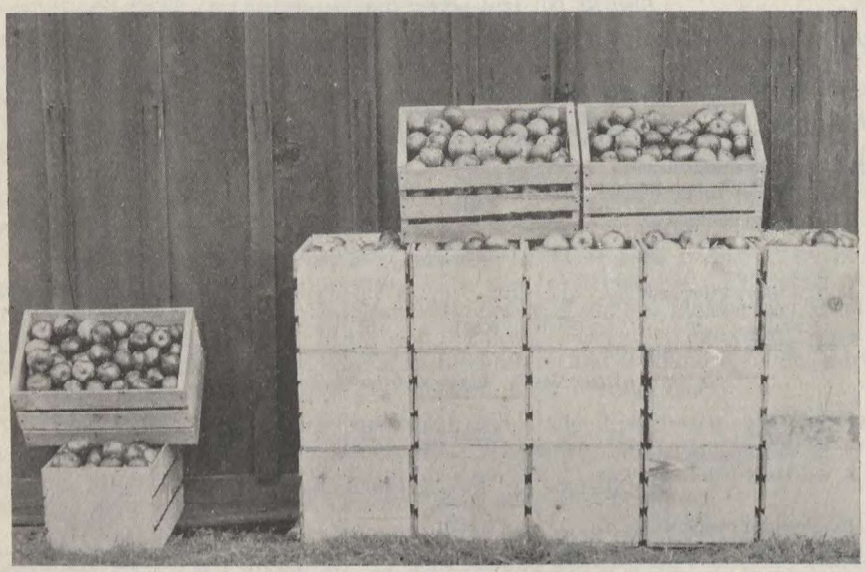

Fig. 7.—The two boxes on the left show the crop from five trees of the unsprayed block, while the seventeen boxes on the right show the crop from the same number of trees of the sprayed block. That is, five trees of the unsprayed block gave two bushels of 15.4 per cent clean fruit, while five trees from the sprayed block gave seventeen bushels of 93.6 per cent clean fruit, a difference of fifteen bushels.

The results for the first year given in the table following were arrived at by taking the total crop for a tree, measuring the diameter of the cherries in groups of one thousand and weighing them.

BORDEAUX ON CHERRIES

—	Nine trees crop given in 6-qt. baskets	Average weight per 1,000 cherries		Average diameter per cherry in $\frac{1}{33}$ inch
		lb.	oz.	
Lime-sulphur	100	5	8	21·75
Bordeaux 3:9:40	90	4	7	20·66
Difference	10	1	1	1·09

These results show that the cherries on Bordeaux-sprayed trees were smaller under the conditions of the experiment than the cherries from lime-sulphur-sprayed trees. The difference of 1 pound 1 ounce between 1,000 cherries from each of the Bordeaux- and lime-sulphur-sprayed trees is considerable and of direct interest to all growers, from the standpoint of financial returns.

This experiment will be continued in 1926.

Spraying for Shipping Qualities of Sweet Cherries

In most seasons it is advantageous, indeed, almost a necessity to spray or dust sweet cherries shortly before picking so as to ensure sound fruit with good shipping qualities. Sulphur dust for this purpose is entirely satisfactory, but there are many growers who do not possess a dusting machine and whose small acreage perhaps does not permit of the expense of purchasing one. Is it possible for these growers to use a spray that is as satisfactory as the dust for this late spray on cherries? At the present time in Ontario lime-sulphur 1-50, or soluble sulphur are generally recommended for a spray-application at this time. However, neither one is entirely satisfactory because the one may mark the fruit severely and the other (soluble sulphur) has been known to cause considerable burning of foliage on some varieties.

This experiment was therefore started in an endeavour to gather more definite knowledge about the utility of the various spray-materials for application a few days before picking. This experiment will run over a period of four or five years. The results obtained in a few orchards in 1925 follow. The spraying was done from three to seven days before picking, as follows:—

Late Spray for Cherries

Place	Variety	Spray used	Degree of marking of fruit	Keeping quality	Percentage of rot showing 1 month after picking when left in ordinary store window
					%
Geo. Robertson, St. Catharines	Sweet cherry	[1]Dry mixture 6–40	Very slight	Good	15·2
" "	"	Soluble sulphur 1½–40	Clean	Good	23·1
" "	"	Unsprayed		Fair	29·6
					Rot shown at time of picking
M. Udell, Grimsby	"	Soluble sulphur	Clean	Good	Trace.
F. Bayne, Vineland	"	[2]Soluble sulphur	Clean	Good	Trace.
Note.—Windsor variety—leaves slighly burned by this application.					
F. Bayne, Vineland	Sweet cherry	[1]Dry mixture	Fairly clean	Good	Trace.
F. Anderson, Grimsby	"	[2]Sulphur caseinate	Clean	Good	Trace.
Wm. Corcoran, Port Dalhousie	"	[3]Soluble sulphur	Clean	Good	2
Note.—No burning in this case of foliage on Windsor variety.					
Wm. Corcoran, Port Dalhousie	Sweet cherry	[1]Dry mixture	Clean	Good	Trace.

Notes.—[1]Dry mixture (lime and sulpbur), also called wettable sulpbur is prepared by mixing thoroughly the following:—

Superfine sulphur	64 lb.
Hydrated lime	32 lb.
Calcium caseinate	4 lb.

This mixture is used at the strength of 12½ pounds to 40 gallons of water.

[2]Sulphur caseinate is a mixture of super-fine sulphur and calcium casenate (spreader) and is applied as a spray. It is really the dry mixture without the addition of lime. The lime is omitted so as to lessen the possibility of marking the fruit. This, therefore, although put on as a spray, is practically a sulphur dust since once the water dries only particles of sulphur remain as is the case with sulphur dust.

It is essential in the use of both these sprays that the particles of sulphur be kept in suspension and therefore the agitator should be kept going during the mixing and until the spray-material is out of the tank. It is often necessary to turn the rod or gun into the tank (with the engine running) and thus forcibly agitate the contents.

[3]Solubls sulphur is a sodium compound of sulphur and comes in dry form but is mixed with water and used as a spray. It is *not* a lime-and-sulphur mixture.

Many growers are confusing soluble sulphur with wettable sulphur, and therefore the term "dry mixture" in place of "wettable sulphur" seems preferable for the dry lime-and-sulphur mixture.

Peach Scab or Black Spot

During the last three years peach scab has been on the increase in certain localities. As this fungus disease can be very severe under certain conditions and may spoil the appearance and saleability of the fruit it must be given some attention by the peach-grower. It is not, however, one of the major troubles. For the last two years we have projected experiments towards the control of this disease. For both these years we have had almost perfect control from one application of dry mixture about four weeks after the blossoms have fallen.

Control of Peach Scab

Place	Variety	Spray material	Time	15 sprayed trees	15 unsprayed trees
1924					
F. Bayne, Vineland.	Yellow St. John	Dry mixture....	Four weeks after blossoms fall.	Trace only of scab.	From 20% to 30% scab.
1925					
F. Bayne, Vineland.	"	"	"	None.....	10%

Several other growers have also used this spray-material at our suggestion with very satisfactory results, but as we were unable to take percentage counts of scab infections we are not reporting them. In every case, however, satisfactory results have been obtained. Our recommendation is that wherever this disease has been bothersome, and has lowered the grade, that an application of dry mixture be applied about four weeks after the blossoms have fallen. This is not a general recommendation, but is only for the grower who has been troubled with this particular disease.

Blossom Blight in Relation to Peach Canker

Every year a certain amount of blossom blight of peaches occurs. Some years this may only reach 2 per cent or 3 per cent while in other years it may reach 5 per cent or 6 per cent. This appears to be a negligible amount. But is it? If only the loss of the blossoms and fruit was involved it would most assuredly be negligible. But is there any direct connection between blossom blight and peach canker? If so, then even such a small infection as 3 per cent would be of great economic value.

It has been shown by McCubbin that (*a*) a canker starts in a dead portion of a tree, and (*b*) this dead portion may be a dead twig, a pruning wound, a *dead bud or flower,* a split crotch, sunscald area, or any other spot where dead tissue is formed. Therefore a dead blossom may be the starting point for peach canker, and since blossom blight results in the killing of the blossom, and often in the brown rot fungus growing down through the blossom into the twig, the possibility of canker formation is at once apparent. It would appear therefore, that even a 2 per cent or 3 per cent blossom blight infection may be of considerable importance from the standpoint of initiating peach canker.

In order therefore that more definite information may be available as to just what percentage of blighted blossoms may result in peach canker, the Dominion Laboratory of Plant Pathology has started a project to ascertain these facts. This experiment will run over a period of four or five years.

In the spring of 1925 four hundred and sixty-eight blighted blossoms were marked. At various times the cankers resulting therefrom will be examined, measured and reported upon.

Strawberry Mosaic

Early in May a plantation of the Eaton variety of strawberry showed the characteristic mottled symptoms of mosaic. This first appeared as a yellowing along the edges of the rows and later the whole plantation, at a distance, had a slightly yellowish colour, in comparison to the green of the Premier variety adjacent. Close examination of the leaves showed a very marked yellowish to green mottling so characteristic of mosaic diseases. Along with this mottling in some cases was a puckering and curling of the leaf. Dwarfing was also quite noticeable in many cases. (Fig. 8.)

Fig. 8.—(*a*) Strawberry plant showing mosaic symptoms.) (*b*) Healthy plant of same variety.

Examination was made for aphids and red spiders, which were found on most plants. The Premier and Cooper varieties lying right alongside were also infested with these insects but showed no sign whatever of the mosaic symptoms. The mottling was not the characteristic grey mottling of the red spider attack and moreover during the dry period of late June when the red spiders became very numerous the mottled appearance began to disappear from the leaves. There was no good reason for believing that either the red spider or aphids were responsible for the mottling.

Several of these diseased plants have been brought into the greenhouse and others have been planted in an experimental plot for further observations.

Raspberry Mosaic

Raspberry mosaic is general throughout Ontario. Although certain sections are fairly free from this serious disease, such as the Waterford and London districts, on the whole throughout the province it is very prevalent and severe. Many thousands of dollars loss are caused yearly by this trouble. This is a disease that must be continually fought if any lasting effect is to result. We are of the opinion that legislation should be immediately enacted that will prohibit the importation and sale in Ontario of any raspberry stock that is not certified as practically disease-free. At the present time we have met with considerable success in the controlling of this disease but until some such legis-

lation is enacted to support our efforts, we are working under great handicaps. In the course of our inspections we come across dozens of cases where the grower has purchased stock from a nursery and in its first year there is a high percentage of mosaic. One particular case will serve as an example. A grower at Brockville set out three acres of the King variety, purchased from one of our largest nurseries. The year it was set out it showed over 10 per cent mosaic.

Some five hundred raspberry inspections were made by the staff of this laboratory. Mr. Tucker and some of his potato inspectors, very kindly assisted us with raspberry-inspection in outlying districts. This assistance was greatly appreciated and proved entirely satisfactory. Our raspberry variety plantation at Port Dalhousie made splendid growth this year. All gaps were filled in this fall and this plantation should be of considerable assistance to us in our mosaic studies. Due to pressure of other work—particularly the spray-service—we had to drop our spraying experiments on raspberry mosaic control. We hope to continue this another year.

Production of Mosaic Raspberry Bushes

To what extent does the mosaic disease cut down the yield of raspberries? The following data are the results obtained from the first year's picking of an experimental plot of thirty mosaic bushes and thirty healthy bushes. A much larger plot for this purpose will come into fruiting in 1926. Crops from mosaic bushes will be studied over a period of four or five years, in comparison with those from healthy bushes.

Effect of Mosaic on Yield

Number of pickings and date	Healthy plot		Mosaic plot	
	Weight in ounces	Number of berries	Weight in ounces	Number of berries
1. July 8	9½	155	32¼	538
2. July 11	19½	343	59¼	1,124
3. July 15	72¾	1,375	124	2,442
*4. July 18	107½	2,079	113¾	2,428
5. July 22	202½	4,144	149¼	3,018
6. July 25	152	3,235	95½	2,091
7. July 30	212	3,968	119¾	2,446
8. August 1	134	2,638	55	1,324
9. August 5	159	3,460	77½	1,657
10. August 10	90	1,937	44½	980
11. August 12	47	1,183	24	616
Total	1,203¾ oz.	24,517 berries	895¼ oz.	18,664 berries

*The mosaic plot out-yielded the healthy plots for the first four pickings in number, weight and volume after which the healthy plots completely out-yielded the mosaic plots. The maximum production was obtained on July 22. In the case of mosaic plants the total crop is reduced and the berries are more crumbly and softer.

The healthy plot produced 24,517 — 18,664 = 5,853 berries, or 310 ounces, more than the mosaic plot. It must be remembered that this difference is based upon thirty three-year-old bushes only. If there is a loss of some 300 ounces from 30 bushes, the loss due to mosaic must be considerable in a one-acre plantation of this age. Taking the number of bushes to the acre as 1,800, (the number required for a 6 by 4 planting) the loss per acre would be 1,125 pounds or 18,000 ounces. This would be in the neighbourhood of some 900 quart boxes, a loss at 20 cents a quart, of $180 per acre. This is of course assuming that the plantation is badly diseased with mosaic. In cases where mosaic is not so

prevalent, the loss would be proportionately less. On the other hand in older plantations, where mosaic has been working for a longer period, the loss per mosaic bush is considerably greater due to the accumulative effect of mosaic.

CONTROL.—Our experience for the last three years with raspberry mosaic has demonstrated time and time again,—

(1) That an old plantation badly diseased with mosaic should either be ploughed up, or let run until a new planting comes into fruit.

(2) A one or two-year-old plantation with a small percentage of mosaic present, may be put in a fairly healthy condition by careful roguing.

(3) It is always advisable in setting out a new plantation to use only healthy certified stock. Never use doubtful stock from a neighbour's plantings just because it costs you nothing. It is false economy. This has been demonstrated time and time again, and therefore we do not hesitate to recommend the purchase of certified stock.

In the control of mosaic, it is absolutely essential to (1) start with clean, healthy, certified stock, and (2) to keep it in that condition by regular inspection and the roguing of diseased bushes that creep in. That this can be done satisfactorily and economically has been demonstrated repeatedly by the purchasers of certified stock themselves, and by the experimental plots maintained by this laboratory.

Mosaic is a serious disease that is causing an annual loss of many thousands of dollars and the only way in which this can be cut down is for the growers to realize this fact and to make use of certified stock that has been made available for them by the raspberry inspection service of the Dominion Laboratory of Plant Pathology at St. Catharines.

Of course the ideal method of control would be the use of an immune commercial variety. We are always on the lookout for a highly resistant or immune variety and in this connection we have under observation a new seedling originated by Mr. Geo. Adams, Smithville, called Adams 87, which has great promise of being highly resistant if not immune. This statement is based upon the following facts:—

(1) Mr. Adams has had more or less of seedling No. 87 on his place for the past ten years and in no case has mosaic been present in it, although nearby Cuthbert or Marlboro plantings have at times been severely diseased.

(2) Several of these bushes were planted three or four years ago on the Vineland Experimental Farm amongst varieties that have considerable mosaic at the present time; Adams 87, however, has not become infected.

(3) Last fall a small block of this seedling was planted at our St. Catharines headquarters and also at Mr. Wm. Corcoran's, Port Dalhousie, and although mosaic Cuthbert and mosaic Viking plants were planted in the same hill along with it no mosaic has as yet been found on Adams 87. We realize of course, that one year is insufficient time for a test of this nature.

(4) We have carefully examined the entire stock of Adams 87 at Mr. Adams's nursery for the last three years and have yet to find the first case of mosaic.

Therefore there may be great possibilities in this new seedling which is a cross between a black and red variety and which is a strong grower, hardy, erect, bears fruit in clusters, and is very productive: the berry is a large, rounded, first class fruit. It does not sucker profusely like the Cuthbert but does so sufficiently for commercial purposes. This berry is not as yet on the market.

A new circular on Raspberry Mosaic and Leaf Curl has just been prepared.

CERTIFIED RASPBERRY STOCK.—There are available again this year some fifty acres of certified stock. This comes from plantations that have been carefully inspected during the past season and which showed no mosaic whatever, or at the most a mere fraction of one per cent before roguing. Such stock can therefore be highly recommended.

Certified stock has proven very satisfactory. Where such stock has been set out and has been kept clean, by the removal of all diseased bushes as soon as they appear, it has been found after three years' experience that only a fraction of one per cent is now present. In many cases no more than twenty-five plants have had to be rogued during this time. Of course where roguing has not been done, mosaic has gradually crept in as it always will. It cannot be too strongly stated that certified stock is just the start, and that this must be followed by careful inspection and the roguing of diseased bushes by the grower himself. If this is carefully and systematically done the grower is assured of a productive plantation for some years.

LEAF CURL

The prevalence of leaf curl in the Niagara peninsula is on the wane. There is of course a yearly occurrence of it in most sections, but the number of such bushes in a plantation is small. However, our inspection service the last two years has demonstrated that in other parts of the province leaf curl is still prevalent to a considerable extent. The symptoms of this disease are so characteristic that control is rendered very easy. Wherever systematic roguing has been continuously carried out from early spring till fall, the disease is of no importance.

RASPBERRY WILT

In our report for 1924 this disease was called "bluestem" but it is now considered more appropriate to use the term "wilt", since the symptoms of the disease are a true "wilting" and since the term "bluestem" is used for another disease of raspberries. Harris[1] in a recent publication uses the term "blue stripe wilt" of raspberries for this disease. But since the blue discoloration may entirely girdle the cane (therefore no stripes) and also since the blue discoloration may be entirely lacking in the field, the use of "blue stripe" does not seem appropriate. We are therefore designating this disease "wilt" since there is no other reported "wilt" disease of the raspberry. Since a circular on this disease is now in the printer's hands nothing further will be added here.

GRAPE CHLOROSIS

In July, 1924, several vines in the grapery of D. Crole, Geneva street, St. Catharines, had become chlorotic, the leaves were stunted and growth was poor. Some of these vines appeared to be early stages of dead arm, while others less stunted were put down as a case of chlorosis.

On August 26, five of these diseased vines were treated with iron sulphate, five with magnesium sulphate and five with a combination of iron and magnesium sulphates. Two teaspoonfuls of the salts were placed on the ground around the main stalk in each case. In July, 1925, a second application was made.

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[1] Harris, R. V.—The Blue Stripe Wilt of Raspberries. Journal of Pomology and Horticultural Science. Vol. 4. p. 221, 1925.

Fig. 9.—(*a*) Chlorotic vines showing sparse foliage and no fruit. (*b*) A previously chlorotic vine, treated with magnesium sulphate. Note the abundant foliage and fruit.

GRAPE CHLOROSIS—TREATMENT*

—	No.	Sept. 22, 1924	June 23, 1925	August 26, 1925
Iron sulphate	1	Improvement	O.K.	Healthy.
	2	"	O.K.	Improved.
	3	"	Pruned back	New growth healthy.
	4	"	O.K.	Healthy.
	5	"	Pruned back	Pruned back (dead)
Magnesium sulphate	1	Chlorotic	O.K.	Healthy.
	2	Improvement	O.K.	"
	3	"	O.K.	"
	4	"	O.K.	"
	5	"	O.K.	"
Magnesium and iron sulphates	1	Improvement	Chlorotic	Chlorotic.
	2	Chlorotic	Improvement	Healthy.
	3	"	Chlorotic	Improved.
	4	"	"	Improved.
	5	Improvement	Improvement	Healthy.

*NOTE.—In the table the following meanings are used:—

Improvement—Vines lost all or almost all of the yellowing and produced a fair crop. In other words they appeared to be on the highroad to recovery.

Pruned back—Vines so badly defoliated and stunted that they were cut back to the ground.

O.K.—Vines appear to be healthy.

Chlorotic—Leaves of vines are yellow instead of green in colour.

Out of the fifteen chlorotic (yellowed) vines which were treated as above, eleven showed improvement and were considered healthy. The remaining four vines were pruned back to the ground on account of severe yellowing and dead arm.

Several chlorotic vines were marked and were left untreated. All these were defoliated by September 22 and no fruit was formed. Treated vines on the other hand produced a fair crop. (See fig. 9.)

In 1925 these untreated vines were either dead or had been cut down to the ground on account of severe chlorosis or dead arm or both.

A similar demonstration was started in graperies at Winona and St. Catharines, September, 1925, and will be reported on next year.

An experiment of this kind to be of any value must be carried on for several years before any definite conclusions can be arrived at. However, the results this first year are significant. (See fig. 9).

REPORT OF THE DOMINION RUST RESEARCH LABORATORY, WINNIPEG, MAN. (CO-OPERATING WITH THE MANITOBA AGRICULTURAL COLLEGE)

(D. L. Bailey, Plant Pathologist, Officer in Charge)

Tests of Rust-resistant Wheats

This phase of the rust investigational work has previously been carried on by Mr. W. P. Fraser (see Report of the Division of Botany, 1924: 65-67). This year also Mr. Fraser planned and carried out the experiment until it was well under way. After his resignation various members of the staffs of the Saskatoon and Winnipeg laboratories co-operated on the collection of the data. Mr. P. M. Simmonds examined the rows at Indian Head, Swift Current and Lethbridge. Mr. G. A. Scott examined those at Saskatoon, Scott, Rosthern, Lacombe, Vermilion, and Edmonton. Mr. D. L. Bailey examined the rows at Morden, Brandon and Winnipeg and correlated the entire data.

The experiment was carried out in the same manner as previously, one sixteen-foot row of each variety was seeded at each Station, the serial arrangement of the rows being the same in each case. The staffs of the western Experimental Farms co-operated most effectively in this experiment.

A heavy epidemic of stem rust occurred in Manitoba but, as it was relatively late in developing, it did not extend very far west or north, hence no data could be obtained from some of the Stations. The rows at Lacombe, Vermilion and Edmonton were examined on August 14, 15, and September 2, respectively and practically no stem rust was present. A heavy epidemic of leaf rust was fairly general. None, however, was reported from Lacombe (August 14) nor from Vermilion (August 15) and only a trace on four varieties from Edmonton on September 2. The rest of the data is summarized in tables 1 and 2.

The Durums as a group were quite resistant to stem rust this year, the varieties Nodak, Iumillo Selection, Mindum, Acme, Monad, and Pentad were highly resistant. The varieties Kubanka C.I. 1440, Kubanka C.I. 2094, and Arnautka C.I. 1493 were decidedly variable in resistance, two distinct types being present in each case. Marquis x Iumillo Minn. II-15-44 was once again the most promising of the common wheats in resistance.

As a class, the Durums were quite resistant to leaf rust. There appeared to be considerable variability in resistance among the common wheats.

In addition to these tests which were scattered throughout Western Canada, notes were taken on the percentage infection of leaf and stem rust on the rust-nursery of the Plant-Breeding Section of the Rust-Research Laboratory at Winnipeg. The results are presented in tables 3 and 4.

Test of Varieties Resistant to Oat Stem Rust

Uniform rust-nurseries paralleling those with wheat were arranged to test several oat varieties which give some promise of being resistant to stem rust. Stem rust of oats, however, was very late in appearing and the final infection was very light. The test at all the Stations was so inconclusive that it does not seem desirable to publish the data collected.

Barberry Survey

The survey of the towns of Manitoba for barberry and buckthorn was completed in 1924. This year, with the exception of some necessary resurvey work, all the surveying was done in rural districts. Mr. R. M. Scott and Mr. J. G. Fletcher were engaged on this work. An informational survey was

planned, designed to cover limited rural areas in various parts of the province so that all the representative soil types and types of settlement might be included. A summary of the various types of country surveyed and the results obtained is included in table 5. It will be noted from that table that although considerable area was covered and a wide variation in environmental conditions met with, not a single barberry planting was located. Inasmuch as the work was carefully and efficiently done it must be concluded that barberries are indeed rare in the rural districts of Manitoba and that they have not tended to become established even in districts where a hedge was introduced and remained for considerable periods.

On the site at Snowflake of the hedge removed in 1923, five seedlings survived last winter and entered on their second year. One additional seedling of this year's growth appeared. One seedling was also found at St. Charles, near Winnipeg, where a hedge was removed last year. In both of these cases, however, it is to be remembered that ideally sheltered conditions exist which are far from natural.

One additional hedge of approximately eighty bushes was reported this year from one of the older sections of Winnipeg.

Buckthorn Survey

This survey was carried on in conjunction with the barberry survey. Four plantings of buckthorn were reported in the districts surveyed. It is gratifying to find that this shrub has not been used more extensively. There is no mistaking the correlation between the buckthorn and Crown Rust of oats in Manitoba. Unfortunately, however, public opinion is not sufficiently enlightened to make it advisable to press for their eradication just yet. In a district near Portage a number of men sent in a protest against a hedge which was located on a property near them and demanded that it be removed. Fortunately it proved easy to persuade the owner to dispose of it.

The Control of Leaf and Stem Rusts of Wheat by Sulphur Dusting

Some preliminary experiments on this subject were carried on this summer in the field. Two series of fortieth-acre plots of Marquis wheat at Winnipeg were dusted fortnightly, weekly, semi-weekly and tri-weekly with sulphur dust. The rate of application of sulphur was 15 pounds per acre in one series and in the second series 30 pounds per acre. The plots dusted once every two weeks were rusted as heavily as the checks. One application per week had some influence, and two applications per week had a very marked influence in controlling rust and increasing the yield. Three applications per week at 15 pounds per acre practically controlled both leaf and stem rust, and the increase in yield was 34 bushels per acre as compared with the average of the check plots. One plot was dusted at the rate of 15 pounds per acre when rain seemed imminent (seven applications). The percentage infection and yield in this plot were about the same as in the plots receiving two applications per week or a total of seventeen applications.

An article including all the details of this experiment and the results obtained appeared in the December issue of "Scientific Agriculture". For further details the following reference should be consulted: Bailey, D. L., and F. J. Greaney: Preliminary experiments on the control of leaf and stem rusts of wheat by sulphur dust. Scientific Agriculture 6: No. 3: 1925.

Epidemiology Studies

(a) Field Studies

Pycnia on barberry were first observed this year on June 4 (R. M. Scott) and æcia on June 15 (Dr. Bisby). The weather in the interval and for some time following was very unfavourable for rust development.

The first collection of the uredinial stage in 1925 was on June 23 at Morden, Man., where Mr. Greaney collected a single pustule on Masters wheat in the varietal test plots at the Experiment Station. At this time rust was extremely scarce in Manitoba, none had been found at Winnipeg and a survey from Winnipeg to Portage and from Portage to Carman failed to reveal a single pustule. Until the middle of July rust developed very slowly although by July 15 scattered primary infections were generally present throughout the south and central parts of the province. In the latter part of July rust developed rather rapidly for a time but conditions early in August checked the development again and it looked for a time as though little if any rust damage would occur. But then for about two weeks the crop seemed to stand still and during this period rust developed rapidly. The final result of this belated epidemic was an extremely patchy development of rust in which local environmental conditions played an extremely significant part. Late crops throughout the province suffered considerably while the earlier ones escaped completely in many sections. Under such conditions it becomes an extremely difficult matter to estimate the loss which occurred from wheat rust this year.

To get some idea of the actual loss occurring in different sections, inquiries were made (September 8 to 19) at a large number of country elevators regarding the grade of the wheat coming in, the average yield for the district and the reduction in grade and yield attributed to rust. A summary of the results is appended in table 6. It will be noted that the yield of Marquis was reduced by six to eight bushels per acre and the grade reduced one or two grades. This would bring the reduction in yield about 17 per cent. It seems certain, however, that if these results were computed on an acreage basis for the province as a whole the percentage reduction in yield would be materially reduced. Twelve per cent seems a fair estimate.

Oat stem rust was late in appearing and was relatively insignificant. This is extremly interesting inasmuch as it seems to indicate a lack of inoculum which is difficult to explain.

(b) Results of Spore-Trapping Experiments—Aeroplane Exposures

(Co-operative Experiment between Royal Canadian Air Force and Dominion Plant Pathological Laboratory at Manitoba Agricultural College, Winnipeg.)

OBJECT OF EXPERIMENT.—To collect all the data possible regarding the origin and spread of black stem rust in Western Canada by studying the spore-content of the upper air over various districts during the season. It was particularly desired to obtain information along the following lines:—

(1) The time when wind-borne urediniospores first appear in Western Canada.

(2) The direction from which the rust spores, which cause the initial infections in Western Canada, appear.

(3) The region over which wind-borne rust spores first appear.

(4) The rate at which the spore content of the upper air increases over various areas. This material is to be correlated with the field studies on the direction and rate of spread of rust.

(5) The viability of air-borne spores; to establish whether the spores caught in the upper air currents are living and capable of causing infection.

(6) The conditions governing the precipitation of air-borne spores. The relation of rain and dew is particularly desirable here.

PROCEDURE.—Microscope slides, lightly smeared with vaseline and secured to wooden paddles, were exposed from hydroplanes. Before and after exposure

the slides were protected from contamination by enclosure in suitably corked bottles.

Exposures were made chiefly on routine flights connected with the regular work of the Air Service.

SCHEDULE OF EXPOSURES.—An attempt was made to carry out the following schedule of exposures in connection with the routine flight of the various patrols and special flights.

SUMMARY OF SUGGESTED EXPOSURES ON ROUTINE FLIGHTS*

Patrol	Paddles exposed per week	Duration of exposure	Section of flight over which exposures should be made
Victoria Beach—Border, etc	2	15 mins.	South-West
" —Berens,	2	"	North.
Berens—Norway House	2	"	North.
The Pas	2	"	South.

*Exposures were made from July to September, altitude approximately 5,000 feet.

SUMMARY OF SUGGESTED EXPOSURES ON SPECIAL FLIGHTS

Area covered	Number and date of exposures	Details
(a) Red River Valley	Weekly from June 15–July 15.	Two paddles per flight; one north, one south; 10 min. exposure.
(b) Around Victoria Beach	1-3, June 20–July 5.	When strong south or south west wind is blowing. May be exposed on any routine flight; 10 min. exposure.
(c) Around Victoria Beach	two; about Aug. 10-20.	One before and one immediately after a rain; 10 min. exposure.
(d) Around Victoria Beach	4; after Aug. 1	One five minute exposure at each of the following altitudes; 2,000, 3,000, 4,000, and 5,000 ft.

DISCUSSION.—The results obtained from first year's work on this project are quite striking. (See table 9). In the first instance the wind-dissemination of rust spores over large areas and for considerable distances is established. Many of the exposures were made over heavily wooded areas widely separated from cereal-growing districts. Take, for instance, the slide exposed at Norway House on August 14. On a surface whose area was only two square inches, 259 spores were caught during a fifteen-minute exposure. This indicated definitely that even at an altitude of 5,000 feet the concentration of spores was surprisingly high. Yet the district in which this exposure was made was upwards of 300 miles from the nearest big cereal-growing region in the direction of the prevailing wind. Moreover, the intervening area is heavily wooded and should be in all respects ideal for screening the spores from the air. So this work indicates quite clearly that rust spores are carried in great numbers over long distances. This could account in large measure for the almost miraculously sudden appearance of rust over large areas. Because, once rust becomes prevalent in the spring wheat area of the United States, the rust spores can very readily be carried north in large numbers by a south wind.

The data obtained from these spore traps, when taken in conjunction with the field evidence collected this year, add further support to the idea that the initial rust-infections in Manitoba each year are caused by wind-borne spores from the south. The earliest report of rust this year came from Morden on June 23. Only a single pustule was found although a very thorough search was made. Even by July 13, there were only scattered traces of stem rust present in Manitoba. Yet it will be noticed that during this period sufficient spores were present in the air over Victoria Beach for one or two spores to be caught on two square inches of a slide during an exposure of fifteen minutes. The only plausible explanation seems to be that these spores were wind-borne from districts farther south where a rust epidemic was by that time well under way.

A comparison of the spore-content of the air over High River in western Alberta with that over southern Manitoba is interesting. It will be noticed that rust spores were relatively very late in appearing in Alberta and until the very end of the season remained few in number. The first large catch of spores occurred on August 27. This indicates that the spread of rust from east to west in the Prairie Provinces this year is not to be explained so much by weather conditions as by the fact that wind-borne rust spores were present much earlier in the east than they were in the west. In Alberta this year the amount of rust was extremely small. On September 2, in the uniform rust-nursery, rust was found only on Little Club wheat—the most susceptible variety—and on it the infection was a mere trace. It is evident that the spores caught on the slides must have originated elsewhere.

(c) *Report on Stationary Slides*

The supposition is quite generally accepted that the source of rust-epidemics in the Canadian wheat-growing belt lies in the United States. Several circumstances lend credence to the assumption. (1) It is quite definitely known that particles of dust are carried long distances by air-currents. Pollen-grains have been collected long distances from their nearest possible source. Infections of white pine blister rust have occurred over 100 miles distant from any known location of the disease. Wind-blown spores seemed to have been responsible for the spread. At this Station during the summer of 1925, slide exposures by aeroplanes have shown that rust spores have been present in considerable numbers in places quite remote from any severely infected area. It sems evident that the possibility of wide lateral spread of black stem rust spores must be admitted. The suddenness with which a rust epidemic appears over extensive areas in the southern parts of Manitoba and Saskatchewan indicates that an abundance of inoculum (spores) is present to infect the wheat whenever conditions are favourable for the development of rust. As far as known, such a quantity of spores could only be furnished by large areas of rusted grain such as are found in the northern wheat-growing States lying south of us. (2) The number of barberry plantings which may possibly remain in the Prairie Provinces is inadequate to explain the initiation of the sudden epidemic. Moreover, the spread of rust from barberry bushes is quite characteristic. The areas infected are at first small and localized although later they may become extensive and finally merge, giving the appearance of a general epidemic. Such localized infected places are very uncommon in Canada. Our epidemics are general and extend over large areas. (3) The evidence furnished by the exposures of stationary slides, as given below indicate that our rust inoculum is not of local origin.

Glass slides coated with a thin smear of vaseline were exposed at the Agricultural College, Winnipeg, in order to ascertain when spores of black stem rust could be detected in air and in what relative numbers they were present. Slides were exposed almost daily from June 22 to September 29. The date of

exposure and the number of spores present on the area examined of each slide are given in table 7. In each case the area examined was two square inches.

The first spore found was on the slide exposed June 25. Five were found on the one exposed June 26. On June 23 one pustule of rust was discovered at Morden, Man. The fact that spores were not found on the slides somewhat earlier than the first pustule was found in the field may mean, as it likely does, that spores appeared earlier in the extreme south of Manitoba than they did at Winnipeg, or that they were not present in sufficient concentration over Winnipeg at that time to be detected by slides. It is quite probable that spores were present in the air over Winnipeg considerably previous to their first appearance on the slides.

From the middle to the end of July spores were found regularly on the slides and in increasing numbers. Up to the 25th of July only traces of rust were found in the field in southern Manitoba. It seems quite improbable that these traces of rust could furnish the quantity of spores which was indicated by the slides as being present in the air. It is much more probable that these spores drifted into Manitoba from more heavily rusted fields farther south. It was during this time that rust was becoming prevalent in North Dakota and northern Minnesota. These in-borne spores most probably furnished the inoculum for the general epidemic which broke out in Manitoba about the first of August.

TABLE 1.—STEM RUST INFECTIONS: UNIFORM RUST NURSERIES, 1925; WHEAT VARIETY TESTS

Examiners:—D. L. Bailey, P. M. Simonds and G. A. Scott.

Wheat — Variety	Experimental Stations											
	Morden	Winnipeg	Brandon	Indian Head	Swift Current	Lethbridge	Saskatoon	Scott	Rosthern	Lacombe	Vermilion	Edmonton
	Percentage Infection—Stem Rust											
Kubanka C.I. 1440	30	85 5	40	tr.	0	0	0	0	tr.	0	0	0
Kubanka C.I. 2094	20	85 20	30	tr.	0	0	0	0	tr.	0	0	0
Nodak C.I. 6519	3	3	3	0	tr.	0	0	0	0	0	0	0
Arnautka C.I. 1493	30	80 10	50	tr.	0	0	0	tr.	tr.	0	0	0
Arnautka C.I. 6236	20	15	20	tr.	0	0	0	0	tr.	0	0	0
Iumillo Selection	3	8	10	tr.	0	0	0	0	0	0	0	0
Mindum C.I. 5296	5	8	5	tr.	0	tr.	0	0	tr.	0	0	0
Acme C.I. 5284	tr.	tr.	tr.	tr.	0	0	0	0	tr.	0	0	0
Monad C.I. 3320	tr.	tr.	tr.	tr.	0	0	0	0	tr.	0	0	0
Pentad C.I. 3322	0	tr.	tr.	0	0	0	0	0	0	0	0	0
Haynes Bluestem C.I. 12874	90	90	90	2	tr.	0	tr.	tr.	10	0	0	0
Marquis Ottawa 15	80	85	80	50	tr.	0	tr.	tr.	10	0	0	0
Power C.I. 3697	85	80	80	60	tr.	tr.	tr.	tr.	20	0	0	0
Ruby Ottawa 623	55	80	60	50	tr.	0	tr.	0	15	0	0	0
Marquis x Inmillo, II-15-44	15	10	15	25	tr.	0	0	2	5	0	0	0
Preston C.I. 3081	70	80	75	25	2	tr.	0	tr.	20	0	0	0
Kota C.I. 5878	60	60	50	20	tr.	0	0	tr.	15	0	0	0
Progress C.I. 6902	65	90	60	15	tr.	0	0	tr.	5	0	0	0
Kota x Marquis N.D. 1656	60	75	65	10	tr.	tr.	0	0	3	0	0	0
Marquis x Kanred B 8-11	85	80	80	20	tr.	tr.	tr.	2	15	0	0	0
Marquis x Kota (N.D. 1658) C.I. 6900	55	75	70	10	tr.	tr.	0	0	10	0	0	0
Parker's Marquis	50	65	60	15	tr.	tr.	tr.	tr.	5	0	0	0
Larcombe's Marquis	60	65	65	5	tr.	tr.	tr.	tr.	8	0	0	0
Early Triumph	70	80	70	10	tr.	tr.	tr.	3	10	0	0	0
Reward	70	90	65	3	tr.	0	tr.	2	10	0	0	0
Garnet	65	75	70	5	tr.	0	tr.	tr.	12	0	0	0
Aurora	65	18	75	20	1	tr.	0	tr.	15	0	0	0
Huron	70	85	95	30	tr.	tr.	tr.	tr.	7	0	0	0
Quality C.I. 6607	70	70	60	50	tr.	0	5	tr.	15	0	0	0
Little Club C.I. 4066	75	90	95	60	2	tr.	20	10	35	0	0	tr.
Vernal C.I. 3686	tr.	tr.	0	tr.	0	tr.	0	0	0	0	0	0
Khapli C.I. 4013	3	3	0	0	0	0	0	0	0	0	0	0
Kanred	10	60	tr.	tr.	tr.	0	0	tr.	3	0	0	0
Date examined	Aug. 21	Aug. 26	Aug. 24	Aug. 22	Aug. 25	Aug. 26	Aug. 18	Sept. 1	Aug. 19	Aug. 14	Aug. 15	Sept. 2
Examiner	D. L. B.	D. L. B.	D. L. B.	P. M. S.	P. M. S.	P. M. S.	G. A. S.	G. A. S.	G. A. S.	G. A. S.	G. A. S.	G. A. S.

From the data it appears that there were two distinct stages in the development of the epidemic. The first characterized by few spores which were most probably blown in from the south, and a second phase characterized by a sudden and large increase in the number of spores on the slides. This sudden increase is exceedingly significant and striking. Taking the number of spores caught on the slides at Winnipeg as indicative of the number of spores in the air over southern part of the province, although in the extreme south the number was probably much greater, an average of 18 spores fell daily on each square inch of land between July 14 and July 28; or during the whole period approximately 270 spores alighted on every square inch of surface. These spores, as already intimated were most probably in-borne from the south and during that period they initiated the general epidemic which broke out about the first of August. In this second phase, approximately 1,100 spores fell daily on each square inch of surface. The number no doubt was much greater, for on several occasions rains washed the slides to some extent so that the number of spores was considerably reduced. But accepting the figures for calculation purposes, we see that during the month of August, the daily spore shower was sixty times as heavy as it was during the 15 days prior to July 29. Both in the first and second phases of the epidemic, the spores caught on the slides were viable. Whenever heavy dews or light rain furnished sufficient moisture, many of the spores germinated on the slides during the time of exposure.

TABLE 2.—LEAF RUST INFECTIONS: UNIFORM RUST-NURSERIES, 1925: WHEAT VARIETY TESTS

Wheat — Variety	Experimental Stations									
	Winnipeg	Indian Head	Swift Current	Lethbridge	Saskatoon	Scott	Rosthern	Lacombe	Edmonton	Vermilion
	Percentage Infection—Leaf Rust									
Kubanka C. I. 1440	tr.	10	tr.	tr.	0	tr.	tr.	0	0	0
Kubanka C. I. 2094	tr.	10	tr.	0	0	tr.	tr.	0	0	0
Nodak C. I. 6519	5	5	tr.	0	0	tr.	tr.	0	0	0
Arnautka C. I. 1493	tr. (90)	15	0	0	5	0	20	0	0	0
Arnautka C. I. 6236	0	10	0	0	5	0	5	0	0	0
Iumillo Selection	0–35	5	0	tr.	0	0	tr.	0	0	0
Mindum C. I. 5296	tr.	3	0	0	0	tr.	tr.	0	0	0
Acme C. I. 5284	tr.	3	0	tr.	tr.	0	tr.	0	0	0
Monad C. I. 3320	tr.	3	0	0	tr.	0	tr.	0	0	0
Pentad C. I. 3322	tr.	tr.	0	0	tr.	0	tr.	0	0	0
Haynes Bluestem C. I. 2874	20	60	tr.	tr.	55	10	50	0	tr.	0
Marquis, Ottawa 15	35	60	tr.	0	20	5	60	0	tr.	0
Power C. I. 3697	70	70	tr.	tr.	50	25	80	0	0	0
Ruby Ottawa 623	90	60	tr.	0	10	20	50	0	0	0
Marquis x Iumillo II-15-44	26	60	tr.	tr.	5	10	75	0	0	0
Preston C. I. 3081	75	60	tr.	tr.	10	30	85	0	0	0
Kota C. I. 5878	90	60	5	tr.	35	20	70	0	0	0
Progress C. I. 6902	50–75	70	tr.	tr.	20	20	40	0	0	0
Kota x Marquis N. D. 1656	35–65	70	tr.	tr.	20	15	10	0	0	0
Marquis x Kanred B 8-11	5–15	50	tr.	tr.	20	10	20	0	0	0
Marquis x Kota N.D. 1658 C.I. 6900	30–40	50	tr.	tr.	30	10	30	0	tr.	0
Parker's Marquis	50–60	60	tr.	tr.	10	20	25	0	0	0
Larcombe's Marquis	50–75	60	tr.	tr.	10	15	35	0	0	0
Early Triumph	90	60	tr.	tr.	10	10	30	0	0	0
Reward	65	50	tr.	0	tr.	10	20	0	0	0
Garnet	55	30	tr.	tr.	5	5	30	0	0	0
Aurora	0–30	50	tr.	tr.	15	tr.	55	0	0	0
Huron	75	70	tr.	tr.	35	25	75	0	0	0
Quality C. I. 6607	90	65	tr.	0	30	tr.	60	0	0	0
Little Club C. I. 4066	85	70	tr.	0	90	80	90	0	tr.	0
Vernal C. I. 3686	10	70	tr.	0	20	tr.	20	0	0	0
Khapli C. I. 4013	15	5	tr.	tr.	0	0	5	0	0	0
Kanred	75	90	10	tr.	10–50	40	20	0	0	0
Date examined	.....	Aug. 22	Aug. 25	Aug. 26	Aug. 18	Sept. 1	Aug. 19	Aug. 14	Sept. 2	Aug. 15
Examiner	F. J. Greaney.	P. M. Simmonds	P. M. Simmonds	P. M. Simmonds	G. A. Scott	G. A. Scott	G. A. Scott	G. A. Scott	G. A. Scott	G. A. Scott

One would think that while a south wind was blowing more spores would be deposited on the slides than when the wind blew from some other dircetion. From the data collected such a conclusion could not be established, but this is not surprising. The direction of the wind on the earth's surface is usually not the same as that at greater elevations. Moreover, there is more or less a continual interchange of air between these two currents. Spores blown north by an upper air-current might be brought back and deposited on the field by a wind from the north. As the upper currents are more constant than the lower ones, the far-distant spread of spores would depend more on these than on the more variable surface ones. Meteorological observations indicate a fairly constant northward flow of the upper air during the summer months and it is possible that these northward-flowing air currents bring in the spores which cause our primary infections.

It is proposed to continue this phase of the epidemiology study next year. Slides will be exposed at a number of stations in order to determine the limits of the spore spread west and north.—(J. H. Craigie).

Physiologic Forms of Oat Stem Rust

This project has been continued this year. Thirty collections of oat stem rust from various parts of Canada were cultured in the greenhouse. Nine cultures of form 1 were isolated, fourteen of form 2 and twenty of form 3. A summary of the origin of the various collections and the physiologic forms isolated from each is presented in table 8.

The Take-all Disease of Wheat

In view of the wide-spread occurrence of take-all of wheat (*Ophiobolus carieceti*) in the northern park sections of Saskatchewan (see division reports of 1923 and 1924 and elsewhere in this report) it seemed almost inevitable that this disease would be present in similar areas in Manitoba. Unfortunately only a very limited preliminary survey was possible this summer. This survey indicated, however, that this disease was fairly abundant in a considerable section. It was located at the following places: Neepawa, Kelwood, Laurier, Riding Mountain Station, McCreary, Ashville, Dauphin, and Snyder's Crossing. In some cases only a mere trace doing little or no damage was found, while in other instances the outbreak was extensive and serious injury was present. More extensive survey work must be done on this problem next year.

Expansion of the Work

Two new greenhouses, each approximately 60 feet long by 20 feet wide were erected this summer and are being completed at the present time. Each house is divided by cross-partitions into three sections, each of which is independently heated and ventilated. Artificial illumination is being installed to permit rust-culture work to be carried on during the winter months.

A new laboratory building is also under construction and will be ready for occupancy some time in February.

Additional appointments have enabled the work to be considerably expanded and some reorganization has occurred. The project dealing with the identity and distribution of physiologic forms of wheat stem rust in Western Canada is receiving special attention under the supervision of Dr. Newton. The newer phases of the work are only well begun, and no progress report can be made on them until next year.

TABLE 3.—WINNIPEG RUST-NURSERY-1925: PERCENTAGE INFECTION OF LEAF RUST ON VARIOUS WHEAT VARIETIES

Wheat Variety	Percentage Infection		Remarks
	Series 1	Series 2	
Chelsea	25	15—50 30	Pustules small; flecking pronounced.
White Fife	20	30	Pustules small.
Kubanka	2	0—5 5	
O.A.C. No. 85	15	5—35 20	Flecks.
Alberta No. 3	75	70—95 80	Heavy infection; pustules large.
Hy. - 19-967	.....	85—100	
Kubanka x 345 EA	90	95	
Iumillo	1	0	No pustules found.
Prospector	35	20—60 40	Some plants quite susceptible.
Pioneer	20	20	Variable.
Swedish	40	40—75 55	
Tartan	30	50	A few quite susceptible plants.
Ruby	90	95	
Major	1	tr—10 5	
Brownie	60	65	
Garnet	25	25	
43 H	tr	0—1 tr	
Red Quality C	4	tr—20 5	*Septoria*.
Aurora	4	5—15 2	Pustules small; hyper.
Early Russian	25	5—20 5	Pustules small; some hypersensitive.
Huron	55	60—90 75	
Crown	35	20—90 50	Very variable.
Red Fife	10	50—90 50	Considerable hypersensitiveness.
96 B	75	(1) 95 (2) 15 (3) 0—5	About 10 per cent of plants. About 5 per cent of plants Majority of plants.
Forward	10	5—30 5	Much hypersensitiveness.
Prelude	80	85	
395 A	35	10—75 35	Variable; different types present.
Bobs Wylers	65	85	
Master	98	95	
55 A	25	40—95 50	
Producer	70	10—70 45	Some hypersensitiveness.
45-F	1	tr	
928 AA	5	15—95 25	Very variable.
939 D	75	95	
928-L-3	8	10—60 25	Variable
928-L-6	10	10—50 30	
737 B 2 B 2	40	5—95 35	Some susceptible plants and some quite resistant.
928 C.I	30	20—60 35	Hypersensitiveness present.
642 A	3	0—5 3	
928 TT 1	15	30—85 45	
935 A	50	50—95 65	Variable.
930 E	80	95	
662 A 2	15	20	
943 A	35	70—95 80	Pustules small: hypersensitiveness.

TABLE 3.—WINNIPEG RUST-NURSERY-1925: PERCENTAGE INFECTION OF LEAF RUST ON VARIOUS WHEAT VARIETIES—*Continued*

Wheat Variety	Percentage Infection		Remarks
	Series 1	Series 2	
928 A	90	90	
Marquis (McKay)	6	70	
745 A	75	95	
Minburn (Larcombe)	1	15	
686 A	35	70	
White Russian D	10	20	
928 W.L.D	95	80	
482 B	80	5—85 70	Variable
Marquis x Kanred, B—2—5	55	75	
Marquis x Kanred, B—9—14	40	15—85 40	Variable S to R—hypersensitiveness marked.
Kota x Ruby II—19—18	65	40 80	Pustules small.
Kota x Ruby II—29—29	45	95	
Kota x Ruby II—19—19	90	95	
Marquis x Iumillo II—15—51	25	10	Occasional and susceptible plants.
Marquis x Iumillo II—15—44	4	tr—5 2	
Kota Natural Cross II—18—35	65	85	
Kota Natural Cross II—18—17	60	95	
Kota Natural Cross II—18—34	55	55	
Marquis x Iumillo II—15—55	5	5	
Duchess	10	10	
Red Fife Sask. 73	35	20—80 35	Variable S— to R—
446—G	25	20—75 35	Variable S— to R—
936 D	50	5—100 15	S plus to R.
Huron Cap Rouge 7	70	50—85 70	Some hypersensitiveness.
Red Quality A	5	tr—20 5	Flecks.
Kitchener, Sask. 34	20	tr—30 8	Flecks.
Marquis—Parker's	25	10—40 15	Flecks.
Quality A	75	30—80 55	Variable.
372 A	15	3—20 8	About 3 per cent mixture of susceptible plants.
Marquis 10 B	5	tr—10 3	
Axminster	5	tr—15 5	
Kota	80	98	
Supreme	60	3—95 40	Very variable; from 3 plus to R—
Swedish 0-880 D	80	35—75 55	Variable S plus to moderately resistant.
Reward	75	40	
45 B	tr	0—tr 0	
Bishop	50	20—60 45	
Early Red Fife	80	85	
Piper	40	75—95 80	Variable.
Marquis, Ottawa 15	5	15—35 30	Hypersensitiveness.
932 A	50	95	
Blue Ribbon	15	15	Also a few susceptible plants.
932 C.I	85	98	
682 B	40	55	
928 P	25	80	
928 E	20	25—65 45	Variable.
928 Q.Q. 2	40	90	
Marquis-Criddle	tr—5	tr—15 5	
940 A	20	50—85 75	Variable.

TABLE 3.—WINNIPEG RUST-NURSERY-1925: PERCENTAGE INFECTION OF LEAF RUST ON VARIOUS WHEAT VARIETIES—*Continued*

Wheat Variety	Percentage Infection		Remarks
	Series 1	Series 2	
Early Triumph	80	85	
Topaz	35	50	Hypersensitiveness.
Marquis M.A.C	tr—5 5	20—30 25	
944 A	5—10 10	65	
928 Z	90	95	
553 A	5	5	
Ruby B	75	98	
Kitchener-Wheeler	tr—5 tr	10	
687—A	25—70 60	85	Variable.
517—A—1	95	98	
Calcutta D2 B—	10	20	
929 D	20	30—75 35	
720 D	75	90	
932 C2	40—90 70	95	
Red Russian 1030	10—40 30	80	Variable.
Kahla (Stewart) 1033	0—tr tr	0—tr tr	
Early Prolific 1010	80	98	
Golden 731	tr—10 5	5—25 15	
Pusa 1031	tr—20 5	60	Very variable.
Brownhead 1017	tr—10 5	40—75 50	
Early Emmer 792	0—tr 0	tr—10 5	
Acme 450	tr—5 tr	0—tr tr	
Emmer 674	0—tr tr	0—tr 0	
Pusa 1032	tr—15 10	10—30 20	
White Head 1018	2—75 25	20—60 45	
Kota 673	65	95	
T 161	50—90 75	10—90 70	Variable R—to S.
T 102	70—90 80	5—80 60	Very variable S plus to R—; Flecks.
T 164	98	5—95 70	Very variable S plus to R—; Flecks.
T 167	80	40—70 55	
T 166	95	80	
Kubanka 45	0	0—tr 0	
N.D. 1656	tr—30 15	5—15 5	A few plants 30%.
Ceres	35	5—20 5	Flecks.
Marquis x Iumillo II—15—59	25	tr—10 3	
Marquis x Iumillo II—15—55	tr—5 5	tr—3 tr	
Marquis x Iumillo II—15—43	tr—15 10	tr—5 tr	
Marquis x Iumillo II—15—51	5—45 25	tr—15 5	
Marquis x Iumillo II—15—44	0—5 5	tr—10 2	
Quality	70	30—85 40	Variable S— to R—
Alberta 222	90	30—90 60	
Renfrew	10—50 25	tr—5 3	Flecks.

TABLE 3.—WINNIPEG RUST-NURSERY-1925: PERCENTAGE INFECTION OF LEAF RUST ON VARIOUS WHEAT VARIETIES—*Concluded*

Wheat Variety	Percentage Infection		Remarks
	Series 1	Series 2	
T 163	60	5—65 40	Variable.
Kubanka 6	0—tr 0	0—5 tr	
T—165	15—70 30	3—35 5	Plants unhealthy.
T—168	95	60—95 80	
T—160	80	5—60 30	Variable.
T—153	80	5—90 20	Variable S plus to R—; mostly moderately R.
T—121	98	80	
T—150	60	5—50 35	Very variable.
T—154	0—100 30	5—70 10	Very variable S— to R.
Pelessier 41	0—tr tr	0—tr 0	Very resistant.
T 152	10—95	20—80 35	Variable S— to R.
T 158	85	60	Hypersensitiveness.
T 155	70	5—50 20	Hypersensitiveness.

TABLE 4.—WINNIPEG RUST-NURSERY—1925

Percentage Infection of Stem Rust on Various Wheat Varieties

Wheat variety	Percentage Infection Stem Rust		Type of pustule	Remarks
	Series one	Series two		
Chelsea	80			
White Fife	85	98	4	
Kubanka	65			
O.A.C.	90	98	4	
Alberta No. 3	95	95	4	
Hy.—19—967 Kubanka x 345 EA	90	90	4	
Iumillo	0—5	0—3	1	
Prospector	90	85	4	
Pioneer	85	70	4	
Swedish	85	98	4	
Tartan	95	95	4	
Ruby	75	75	4	
Major	90	85	4	
Brownie	80	85	4	
Garnet	95	95	4	
43.H	70	50	3 to 4	Hypersensitiveness present.
Red Quality	90	95	4	
Aurora	70	60 (50—80)	3 to 4 plus	Some hypersentiveness on some plant
Early Russian		75	4 plus	
Huron	75	85	4—	
Crown	90	90	4	
Red Fife	90	95	4	
96 B	70	60	4—	
Forward	95	95	4	
Prelude	90	90	4	Chlorosis.
395 A	95	95	4 plus	
Bobs Wyler's	80	90	4 plus	
Master	90	95	4 plus	
55A	60	75	4	
Producer	95	95	4	
45-F	15	10	1 plus and) 4	hypersensitiveness present.

TABLE 4.—WINNIPEG RUST-NURSERIES—1925—*Continued*

Percentage Infection of Stem Rust on Various Wheat Varieties

Wheat Variety	Percentage Infection Stem Rust		Type of pustule	Remarks
	Series one	Series two		
928AA	65	50	3—	"
939 D	90	40	3 to 4—	"
928—L—3	75	85	4	Chlorosis.
928—L—6	95	90	4	
737 B2B2	65	75	4—	
928 C.I	55	50 (40—70)	3 — to 4	Hypersensitiveness present.
642 A	50			
928 TT I	60	45 (30—70)	3— (4)	Hypersensitiveness present.
935 A	85	90	4	
930 E	85	90 (80—95)	4	Chlorosis.
662 A2	70	60	3 to 4	Chlorosis.
943 A	90	75	4	"
928 A	75	80	4	
Marquis (McKay)	85	80	4	
745 (McKay)	85	80	4	
745 A	80	90	4	
Minburn (Larcombe)	95	100	4 plus	
686 A	85	65 (50—75)	3 plus minus	Chlorosis.
White Russian D	75	90	4	
928 W.I.D	85	90	4	
482 B	65	75	4	Chlorosis.
Marquis x Kanred B2—5	65	90	4—	
" II—17—4	85	95	4 plus	
" B—9—14	90	90	4	
Kota x Ruby II—19—18	55	70	3 plus	
" II—29—29	70	75 (60—85)	4—	
" II—19—19	50	50 (50—75)	3 to 4	Some hypersensitiveness.
Marquis x Iumillo II—15—51	25	tr—80 15 (tr—10)	1 plus 1 plus	15 aver. of Resistant type; very variable. Occasional susceptible plant.
" II—15—44	10	5		
Kota Natural Cross II-18-35		55	3 plus minus	
" II-18-17		50 (50—65)	3 plus minus	Reaction like Kota.
" II-18-34		50 (40—65)	3 to 4	"
Marquis x Iumillo II—15—55	75	75 (70—95)	4—	A few plants fairly resistant.
Duchess	98	85	4	Chlorosis.
Red Fife Sask. 73		98	4	
446—G	90	95	4 plus	
936 D	85	90	4	
Huron Cap Rouge 7	85	85	4	
Red Quality A	90	85	4	
Kitchener, Sask. 34	95	95	4 plus	
Marquis—Parker's	85	50 (30—85)	3 to 4	Some resistance
Quality A	75	82	4 plus	
372 A	85	85	4 plus	
Marquis 10 B	90	95	4 plus	
Axminster	60	45 (45—75)	3 to 4	Much hypersensitiveness.
Kota	62	45	3 plus minus	
Supreme	95	90	4	
Swedish O—880 D	70	50 (50—75)	4	Root-rots stopped development.
Reward	95	55 (55—75)	3 plus minus	Hypersensitiveness.
45 B		2 tr—5	1 plus and 4 plus	"

TABLE 4.—WINNIPEG RUST-NURSERY—1925—*Continued*

Percentage Infection of Stem Rust on Various Wheat Varieties

Wheat Variety	Percentage Infection Stem Rust		Type of pustule	Remarks
	Series one	Series two		
Bishop	97	75 (60—80)	4	
Early Red Fife	90	90	4	
Pipee	75	90	4	
Marquis Ottawa, 15	90	90	4	
932 A	97	85	4—	Chlorosis.
Blue Ribbon	80	90	4	
932 C. I	97	90	4	
682 B	60	25	3	Occasional susceptible plant.
928 P	85	70 (60—90)	3 to 4	Variable; hypersensitiveness.
928 E	74	50 (50—90)	3 to 4	" "
928 Q.Q. 2	60	40 (30—90)	3—to 4	Variable. Some resistance.
Marquis—Criddle	80	98	4	
940 A	60	55 (50—70)	3—to 4	Variable: 3-type predominate.
Early Triumph	90	65	4 plus	
Topaz	90	75	4	
Marquis M. A. C. 114	95	75	4	
944 A	50	40	4	Chlorosis.
928 Z	65	35	4	"
553 A	55	20	3	Variable: Some resistance.
Ruby B	80	65	4	
Kitchener—Wheeler	95	90	4	
687—A	70	70 65—75	4—	
517—A—1	85	85	4	
Calcutta D2 B	75	80 75—95	4	
929 B	95	95	4	
720 D	75	90	4	
932 C2	90	90	4	
Red Russian 1030	65	50	3—	Small pustules; appears to have some resistance
Kahla (Stewart) 1033	35	15	3 plus minus	
Early Prolific 1019	85	90	4	
Golden 731	85	95	4 plus	
Pusa 1031	75	65 (50—80)	4	
Brownhead 1017	95	98	4 plus	
Early Emmer 792	.....	5 (3—10)	5	Hypersensitiveness.
Acme 450	.....	tr 0—tr	3	
Emmer 674	.....	tr tr—3	1 to 3	
Pusa 1032	95	85	4	
White Head 1018	90	80	4	
Kota 673	65	48	3 plus	
T 161	85	75	4—	
T 102	75	70	4—	
T 164	90	75 (60—90)	4—	
T 167	85	25 (10—50)	3 to 4	
T 166	97	75	4	
Kubanka 45	.....	30—85	3—to 4	Variable. 3 predominates.
N.D. 1656	35 (20—65)	55	3—	Reaction like Kota.
Ceres	55 (30—65)	70	3—	"
Márquis x Iumillo II—15—59.	35 5—95	40	1 to 4	Very variable.
" II—15—55.	65	55 (10—95)	1 to 4	Very variable: more susceptible than others.

TABLE 4.—WINNIPEG RUST-NURSERY—1925—*Concluded*

Percentage Infection of Stem Rust on Various Wheat Varieties

Wheat Variety	Percentage Infection Stem Rust		Type of pustule	Remarks
	Series one	Series two		
Marquis x Iumillo II—15—43.	45	tr—98	1 to 4	Very variable: Aver. of resistant type 15%.
" II—15—51.	35	5—75	1 to 4	Very variable: Aver. of resistant type 10%.
" II—15—44.	30	5	1 plus	Uniform: only a few plants in row
		tr—15	to 3	mod. suscept.
Quality	80	20	4—	Poor stand in series 2.
		(10—50)		
Alberta 222	92	80	4	
Renfrew	85	85	4	
T 163	70	85	4	
Kubanka 6	5	5	1 to	Hypersensitiveness present.
		(3—5)	4	
T—165	45	90	4	
T—168	75	90	4	
T—160	80	65	4—	Variable: some hypersensitiveness.
		(50—85)		
T—153	90	85	4	
T—121	75	55	4	Chlorosis.
T—150	80	75	4	
		(75—90)		
T—154	90	90	4	
Pelissier 41		5	1 and	A few completely susceptible plants.
		(3—10)	4	
T—152	90	80	4	
T—158	90	85	4	
T—155	92	85	4—	

Examined by.....(F. J. Greaney) (D. L. Bailey).

TABLE 5.—SUMMARY OF THE 1925 BARBERRY SURVEY IN RURAL DISTRICTS IN MANITOBA

District	Approximate area surveyed	Character of district	Barberries found
Stonewall-Stony Mountain	21 sq. mi.	Limestone outcrops ridge about 48 feet above surrounding prairie	None
Gimli	6 sq. mi.	General neighbourhood of established hedge removed in 1924; district low-lying; boulder till.	None
Emerson	78 sq. mi.	Red River Valley; old settlement; well-established wind-breaks; small bluffs of willow and poplar.	None
Carman	65 sq. mi.	Sandy loam; old settlement of prosperous farm homes; sloughs and creeks bordered by thickets of scrub oak, poplar, cherry, dogwood, etc.	None
Snowflake	89 sq. mi.	Sandy loam to clay; old-settled district with many large windbreaks. An established hedge removed in 1923.	None
La Riviere	3 sq. mi.	Pembina Valley; fairly heavily wooded with hazel, oak, cherry, poplar, hawthorn, etc.	None
Boissevain	11 sq. mi.	Turtle Mountain Forest Reserve	None
Virden	79 sq. mi.	Sandy loam to clay loam; scattered bluff and windbreaks	None
Russell	46 sq. mi.	Rolling park country on southeast slopes of Riding Mountains. Natural bluffs abundant.	None
Emerson	4 Mennonite village communities.	Abundant shrubbery	None

TABLE 6.—ESTIMATE OF RUST LOSSES IN 1925 FROM VARIOUS LOCALITIES IN MANITOBA

Town[1]	Estimated average yield; bush. per acre	Estimated reduction in yield; bush. per acre	Estimated reduction in grade
Portage	16	4	1-2
Macdonald	20	0	1
Gladstone	20	0	2
Neepawa	18	3-4	1-2
Minnedosa	25	10	1
Shoal Lake	20	10	.....
Binscarth	20	5	1
Inglis	25	5-10	0
Virden	10	10	1-2
Oak Lake	20	0	0
Boissevain	14	4-6	3
Killarney	12-14	5	1
Crystal City	12-14	6	1-2
La Riviere	18	10	1
Darlingford	22	10	1
Morden	20	0	0
Altona	20	0	0

[1] Estimates were obtained from men in charge of elevators in the towns mentioned and refer to Marquis wheat in the surrounding district.

TABLE 7.—RESULT OF STATIONARY SLIDE EXPOSURES AT WINNIPEG, MAN., FOR THE YEAR 1925

Date	Spores	Date	Spores	Date	Spores
June 22	0	July 25-27	41	Aug. 28	703
23	0	28	46	29-30	7,220
24	0	29	346	31	326
25	1	30	258	Sept. 1	504
26	5	31	813	2	769
27	1	Aug. 1-4	7,827	3	694
28	1	5	31	4	224
29	1	6-7	1,230	5-6	1,390
30	3	8-9	6,842	7	62
July 2	0	10	367	8	99
3	0	11	3,360	9	292
4	3	12	2,441	10	2,019
6	0	13	306	11-13	184
7	0	14	1,440	14	101
8	0	15-16	879	15	1,052
9	0	17	1,813	16	286
10	1	18	12,844	17	222
11	Lost	19	1,975	18	150
12	4	20	2,640	19-20	23
13	0	21	6,046	21	178
14-15	14	22-23	2,285	22	454
16	21	24	1,964	23	140
17-20	221	25	1,614	24	212
21	.....	26	710	25	68
22-23	.....	27	2,542	26	48
23-25	.....			27-29	97

TABLE 8.—PHYSIOLOGIC FORMS OF *Puccinia graminis Avenae* IDENTIFIED IN 1924–1925

Origin of collection	Collected by	Physiologic forms present
Winnipeg, Man.	D. L. Bailey	5
Darlingford, Man.	F. J. Greaney	1
Athens, Ont.	D. L. Bailey	2 & 5
Sault Ste. Marie, Ont.	"	1
Ste-Anne de Bellevue, P.Q.	W. L. Gordon	1
Mountain, Ont.	D. L. Bailey	5 (& 1?)
Brandon, Man.	"	2 (& 5?)
Lachute, P.Q.	W. L. Gordon	2
Lethbridge, Alta.	E. C. Maguire	2 (& 5?)
Englehart, Ont.	W. L. Gordon	2 & 5
Edmonton, Alta.	E. C. Maguire	5
Carman, Man.	F. J. Greaney	5
Morden, Man.	"	5
Fredericton, N.B.	W. L. Gordon	5
Portage, Man.	D. L. Bailey	5
Rosthern, Sask.	W. P. Fraser	2 & 5
Morden, Man.	D. L. Bailey	5
Kapuskasing, Ont.	W. L. Gordon	2
Indian Head, Sask.	P. M. Simmonds	2 & 5
"	"	2
Williamsburg, Ont.	D. L. Bailey	5 & 1
Winchester, Ont.	"	1, & 5?
Neepawa, Man.	F. J. Greaney	1
Port Arthur, Ont.	D. L. Bailey	2
Norway House, Man.	G. R. Bisby	2
Oakville, Man.	D. L. Bailey	5 & 1?
Poplar Point, Man.	"	5 & 1?
Saskatoon, Sask.	W. P. Fraser	2
Winnipeg, Man.	D. L. Bailey	5 & 2?
Rosthern, Sask.	W. P. Fraser	2 & 5

TABLE 9.—RESULT OF SLIDE EXPOSURES BY AEROPLANES DURING SUMMER OF 1925 AT VARIOUS R.C.A.F. STATIONS IN WESTERN CANADA

Victoria Beach, Man.						The Pas and Norway House, Man.					High River, Alta.				
Date	Patrol	Altitude	Duration	Wind	Spores P. gr.	Date	Altitude	Duration	Wind	Spores P. gr.	Date	Altitude	Duration	Wind	Spores P. gr.
July 2..	A	2,000	15	S.W. strong.....	1	July 3..	3,000	15	10 M.P.H.....	1	July				
4..	A	5,000	10		0										
4..	F	2,000	15	S.W. 15 M.P.H.	2										
6..	D	4.500	15	W. strong.....	0										
9..	A	5,000	15	W. strong.....	0										
9..	C	4.500	15	S.W.....	1										
12..	A	3,500	15	(?)	0										
13..	D	3,000	15	S. Mod.....	1	13	4,000	15	(?)	0					
17..	A	4,200	15	S.S.W.....	0	20..	4,500	15	(?)	3	17..	5,000	15	(?)	0
22..	A	3,000	15	S. 2 M.P.H.....	0	22..	5,200	15	(?)	0	18	4,500	15	(?)	0
23..	A	3,500	15	(?)	0	24..	4,000	15	N.E. 15 M.P.H.	8	24..	3,500	15	(?)	2
23..	C	4,000	15	(?)	4	29..	3,500	15	.....	4	31..	5,000	15	(?)	0
Aug. 1..	A	5,000	15	S.W. 8 M.P.H..	13	Aug. 1..	4,200	15	S.W. 10 M.P.H.	9	Aug. 1..	4,000	15	(?)	3
3..	A	4,000	15	(?)	826	4..	4,500	15	(?)	4	2..	5,000	15	(?)	3
5..	A	4.000	15	S. 10 M.P.H....	3,568	7..	3,000	15	(?)		10..	2,000	15	N. cloudy.....	0
11..	A	4,000	15	S.W. 15 M.P.H.	211	13..	5,000	15	S.W. 6 M.P.H..	1	19..	12,000	20	N. 4 M.P.H.....	0
20..	T	4,000	15	(?)	2	14..	3,000	15	W. 12 M.P.H....	6·7	25..	5,000	15	S.S.W.....	4
28..	A	4,000	15	S.W. 15 M.P.H.	283	14..	5,000	15	(?)	259	25..	7,000	15	N.N.E.....	4
31..	E	5,000	15	N.W. 15 M.P.H.		24..	2,900	13	N.E.....	5	25..	6,000	15	S.E. 10 M.P.H..	
Sept. 3..	A	4,000	15	W.....	190	25..	3,000	15	N.....	6					2
8..	B	3,500	15	S.....	258	Sept. 1..	5,000	15	S.W. 6 M.P.H..	116	26..	5,000	15	S. 15 M.P.H....	2
8..	A	4,000	15	S.W. 6 M.P.H..	156						27..	5,000	15	S.E.....	102
11..	G	4,200	15	S.W.....	0						28..	5,000	15	S.W.....	58
14..	A	4.000	15	S.W.....	21						31..	4,500	15	S.S.W.....	19
19..	A	3,000	10	N.N.E. 2 M.P.H.	113	15..	4,500	15	S. 20 M.P.H....	181					
25..	A	?.500	15	W. 15 M.P.H...	769										

Smut Investigations

(Pathologist in Charge, I. L. Conners)

Control of Bunt in Wheat

Experiments in the control of bunt in wheat were carried out in co-operation with the Dominion Experimental Farms at Brandon, Man.; Indian Head, Rosthern, and Scott, Sask; and Lacombe, Alta. The seed was treated and germination tests were made at the laboratory and the estimates of the smut percentages were taken by the writer. The actual conducting the experiments and the collection of all other data were done by the Experimental Farm Staff at each place.

Since copper carbonate seems to be the best substance for the control of bunt in wheat in these experiments, the copper carbonate dust treatment was compared with the standard formalin treatment under a number of different conditions. The conditions investigated were the influence of (*a*) the variety (*b*) the machine used in the application of the copper carbonate (*c*) the spore load which the seed carried and (*d*) the physical condition and chemical character of the copper carbonate.

Experiment 1—Bunt in Wheat.

This experiment was carried out at Indian Head, Rosthern and Scott, Sask., and at Lacombe. Alta.. so that widely different soil and meteorological conditions might be encountered.

The seed used was Marquis and Kota wheat of good quality grown in 1924 at the Dominion Experimental Station, Morden, Man., and at the Agricultural College, Winnipeg, Man., respectively.

Bunted heads were collected in 1924 from the thoroughly mature plot of Prelude wheat and carefully preserved. The heads were ground in a meat chopper or broken up in a mortar. The spores were separated from almost all débris by passing through a 200-mesh sieve. Microscopic examination of the spores showed that they were of the bunt fungus *Tilletia Tritici*. Fifty bunted heads of the resulting crop from the Marquis plots at Rosthern were all smutted with *Tilletia Tritici*.

The seed was artificially smutted with the bunt spores obtained as described above at the rate of 1 part of bunt to 500 parts of seed by weight.

The plots were one-fortieth-acre each in duplicate. Germination tests were made at the laboratory and notes on the germination, temperature, soil-moisture and stand were taken by the Experimental Farm staff. The yields were also recorded in bushels and pounds per acre.

Treatment and Methods of Application.—Formalin solution, 1-320, seed dipped five minutes, drained, covered for one hour and then dried by spreading out in a thin layer in the laboratory. The formalin was tested by the Chemistry Department, Manitoba Agricultural College, Winnipeg, Man., and the solution was made up to proper strength.

The two copper carbonates used in this experiment were "Corona Coppercarb" manufactured by Corona Chemical Division, Pittsburgh Plate Glass Co., Milwaukee, Wis., and a sample marked "Agricultural Copper Carbonate" manufactured by M. Ewing Fox Co., New York City, New York. These dusts were applied at the rate of 2 ounces per bushel. Chemical analysis showed "Corona" copper carbonate contained approximately 20 per cent copper and the "Fox" sample over 50 per cent copper.[1] Both samples were fine and fluffy so that the seed became readily covered with these dusts.

[1]Kindly analyzed by S. G. Lipsett, formerly in the Chemistry Department, Manitoba Agricultural College, Winnipeg, Man.

A small hand-machine was used in most of the treatments. The machine consists of a rotating drum mounted like that of a cement-mixer and provided with suitable baffles to give a thorough mixing of the dust with the grain. In one treatment the smallest duster manufactured by Calkins Machine Co., Spokane, Washington, was used. It is of the continuous type. The grain feeds into the machine from a hopper. There is an independent feed which is adjustable for the copper carbonate and when properly adjusted the grain appears well dusted. Care must be taken to maintain a rather slow constant speed otherwise more copper carbonate is used than is required for a given adjustment.

The amount of smut present was estimated by selecting 100 heads from ten different places in the two plots, five from each plot. The percentage of smut in each treatment was based on the number of the smutted heads in the 1,000. Where only a trace or no smut is reported the whole plot was carefully examined.

TABLE 1.—PERCENTAGES OF BUNT IN SEED TREATMENT EXPERIMENT FOR THE CONTROL OF BUNT IN WHEAT

Variety	Treatment	Indian Head	Rosthern	Scott	Lacombe
Marquis....	Formalin dip	0·0	0·0	0·0	0·0
	Copper carbonate dust:				
	Corona hand-machine	0·0	0·9	0·4	0·1
	Corona Calkin's machine	0·1	0·1	0·0	0·0
	Untreated	3·3	17·4	15·2	6·6
Kota.....	Formalin dip	0·0	0·3	0·0	0·0
	Copper carbonate dust:				
	Corona hand-machine	0·0	0·5	0·1	0·2
	Fox hand-machine	0·0	0·0	0·0	0·1
	Untreated	0·8[1]	16·9	25·7	8·5

[1] One plot only.

In table 1 are given the percentages of bunt in Experiment 1. The percentages of bunt that developed in the untreated plots varied considerably at the different places. Generally Marquis was less affected than Kota and any treatment was about equally effective whether the bunted wheat was Marquis or Kota. The Formalin dip eliminated the bunt almost entirely. A small percentage of bunt (0 to 0.9 per cent) developed when the seed was dusted with Corona copper carbonate in a small hand-duster. Using the Calkin's machine or Fox copper carbonate (50 per cent), bunt was almost completely eliminated.

About three weeks elapsed before the germination of the treated seed was tested. Formalin depressed germination while the copper carbonate treatments showed a tendency to increase the germination over the untreated seed. The effect was most marked when the seed was germinated in soil in the greenhouse. These belated tests show that seed may be treated with copper carbonate sometime before it is sown without injurious effects.

As it is recommended that seed treated with formalin should be planted immediately after treatment, lots of smutted Marquis were treated with formalin, Corona copper carbonate and Semesan. Portions of the treated seed with an untreated lot were sown the same day and after intervals of three, seven and fourteen days.

Semesan is an organic mercury compound manufactured by I. E. du Pont de Nemours Co., Wilmington, Del. The seed was soaked for one hour in a 0.3 per cent solution of Semesan and then dried. The formalin dip and copper carbonate dust treatments have already been described. One hundred seeds from each treatment were germinated in soil in the greenhouse.

It will be readily seen from table 2 that the formalin depressed germination not only to a marked degree when the treated seed was planted after interval of a few days, but even to some extent when planted the same day. The copper carbonate and Semesan stimulated germination, especially the latter.

Field data were carefully collected on the effect of seed treatment on germination and the subsequent development of the crop in Experiment 1 by the Experimental Farm staff at Scott, Sask. The results are given in table 3. Since the data from duplicate plots were so nearly the same, the figures reported are the average for both plots. About a week elapsed from time the seed was treated until it was sown. Formalin delayed emergence three days and reduced the stand and the vigour of the stand about 40 per cent. The copper carbonate treatments reduced the stand from 10 to 20 per cent but the vigour and the time of emergence were not impaired. The formalin-treated plots were somewhat delayed in heading and in ripening also. These treatments had no effect on the development of loose smut. No significant difference can be observed in the yields, but the number of plots is also too small to draw any conclusions.

Experiment 2—Bunt in Wheat

Experiment 2 was conducted at the Experimental Farm, Brandon, Man. Copper carbonate was tested under a number of different conditions especially to study the influence of spore-load. The details of the experiment are essenti-

TABLE 2.—GERMINATION TESTS WITH MARQUIS WHEAT—SEED TREATED JUNE 9

Treatment	Date planted	Number of days after treatment	Germination after					
			Strong	Weak	Total	Strong	Weak	Total
Formalin dip	June 9	0	72	12	84	84	6	90
Copper carbonate, Corona	" 9	92	4	92	96	96	2	98
Semesan, soak	" 9	0	95	4	99	95	4	99
Untreated	" 9	0	92	4	96	94	4	98
Formalin dip	" 12	3	10	34	44	50	13	63
Copper carbonate	" 12	3	90	5	95	93	5	98
Semesan soak	" 12	3	95	4	99	98	1	99
Untreated	" 12	3	85	3	88	91	4	95
Formalin dip	" 16	7	.....	.....	.....	37	5	42
Copper carbonate	" 16	7	.....	.....	.....	84	4	88
Semesan soak	" 16	7	.....	.....	.....	88	2	90
Untreated	" 16	7	.....	.....	.....	79	3	82
Formalin dip	" 23	14	.....	.....	.....	36	17	53
Copper carbonate	" 23	14	.....	.....	.....	86	6	92
Semesan soak	" 23	14	.....	.....	.....	89	2	91
Untreated	" 23	14	.....	.....	.....	77	6	83

TABLE 3.—MORE DETAILED RESULTS OF SEED TREATMENT FOR THE CONTROL OF BUNT FROM EXPERIMENT 1 AT SCOTT, SASKATCHEWAN, 1925[1]

Variety	Treatment	Days to emergence	Plants per square yard average, 10 counts	Vigour of plants on scale of 10	Days to heading	Days to maturity	Percentage of bunt	Percentage loose smut[2]	Yield in bushels per acre
Marquis	(1) Formalin dip	12	165.0	5·3	64·5	113·5	0	0·5	52·0
	(2) Copper carbonate:-								
	Corona hand-machine	9	254·5	9·3	63·0	109·5	0·4	0·3	50·3
	Corona Calkin's machine	9·5	242·5	8·3	63·0	109·0	0	0·6	54·0
	(3) Untreated	9	283·5	9·1	65·5	113·0	15·2	0·5	50·0
Kota	(1) Formalin dip	11	187·5	6·3	65·5	113·0	0·0	19·8	42·5
	(2) Copper carbonate:-								
	Corona hand-machine	8	237·5	9·5	63·5	109·0	0·1	22·6	40
	Fox hand-machine	8	235·5	9·8	63·0	109·0	0	19·8	4
	(3) Untreated	8	300·0	9·8	64·0	109·5	25·7	16·4	

[1]Seed planted May 12, 1925.
[2]Percentages of loose smut not estimated at Scott. These percentsges are from same experiment at Lacombe, Alta.

ally the same as in the previous experiment. The hand-machine only was used to apply the copper carbonate. All the data except yields were collected from 1/100-acre plots in duplicate. Four 1/100-acre plots of each treatment were planted, from which yield-data were obtained. Due to an error in replicating, two plots of the same treatment were adjacent to each other and therefore the yields are taken as if from 1/50-acre plots in duplicate. These plots were planted sufficiently oversize so that after cutting off the two outside drills and one foot at each end just before harvest, there still remained 1/100-acre in each.

The results of this experiment are summarized in table 4. Under any given conditions the spore-load greatly affects the amount of bunt in the resulting crop. Where Marquis seed was smutted at rate of 1 part of smut to 250 parts of seed there was 18.6 per cent of bunted heads developed. The results with Kota are equally definite. This confirms the more extensive results reported last year.

Copper carbonate dust applied at the rate of 2 or 3 ounces per bushel successfully controlled the bunt where the seed was moderately bunted (1-250) but it is highly ineffective where the seed is heavily smutted (1-100). This experiment does not show any advantage in using a 50 per cent copper carbonate over a well prepared 20 per cent copper carbonate.

Formalin delayed emergence and reduced the stand over the check; copper carbonate seemed to have done the same but to a less degree.

Formalin significantly reduced yields when applied to grain that was lightly smutted, but seemed to have little effect on the grain that was heavily smutted. Copper carbonate throughout had no depressing effect on yield when compared with the untreated plot. Of course the bunt itself reduced the yield as is shown by reduced yield of the more heavily bunted plots. The probable

TABLE 4.—RESULTS OF SEED TREATMENT FOR THE CONTROL OF BUNT. SEED GROWN AT BRANDON, MAY 16, 1925

Variety	Spore-load	Treatment	Time of emergence, in days	Plants per 3 sq. ft.	Percentage, bunt	Percentage, loose smut	Yield in bushels per acre
Marquis.....	1–250	(1) Formalin dip.....	11·0	21	0·0	1·4	20·6—0·4
		(2) Copper carbonate:					
		Corona, 2 oz. per bush.	10·0	26	1·3	1·1	26·5—0·6
		Corona, 3 oz. per bush.	10·0	29	0·5	1·1	27·1—0·6
		Fox, 2 oz. per bush.	10·0	27	0·5	1·4	27·1—0·6
		(3) Untreated.....	9·0	33	18·6	0·8	26·1—0·6
Marquis.....	1–100	(1) Formalin dip.....	11·0	22	0·0	1·4	25·0—0·5
		(2) Copper carbonate:					
		Corona, 2 oz. per bush.	10·0	27	12·5	1·3	27·3—0·6
		Fox, 2 oz. per bush.	10·0	26	10·1	1·3	27·5—0·6
		Corona, 3 oz. per bush.	10·0	30	5·9	1·1	26·7—0·6
		Fox, 3 oz. per bush.	10·0	30	9·6	1·4	26·7—0·6
		(3) Untreated.....	9·0	28	46·8	0·9	21·3—0·5
Kota.....	1–250	(1) Formalin dip.....	10·5	28	4·4[1]	13·1	15·6—0·3
		(2) Copper carbonate:					
		Corona, 2 oz. per bush.	9·5	29	0·4	13·3	17·7—0·4
		Corona, 3 oz. per bush.	9·5	30	0·5	16·1	18·1—0·4
		Fox, 2 oz. per bush.	9·5	30	1·1	14·3	19·2—0·4
		(3) Untreated.....	9·5	34	12·9	15·2	15·2—0·3
Kota.....	1–100	(1) Formalin dip.....	10·5	26	0·9	13·4	17·7—0·4
		(2) Copper carbonate:					
		Corona, 2 oz. per bush.	10·0	30	10·5	13·9	17·5—0·4
		Fox, 2 oz. per bush.	10·0	28	11·5	14·9	17·7—0·4
		Corona, 3 oz. per bush.	10·0	34	10·3	16·6	17·1—0·4
		Fox, 3 oz. per bush.	10·0	35	5·5	17·1	18·1—0·4
		(3) Untreated.....	10·0	36	51·8	12·3	8·3—0·2

[1] Probably reinfected from the seeder.

error of the experiment was calculated by the deviation of the mean method. A difference of 2 bushels in yield between any two treatments is a significant difference. These conclusions have, therefore, a good mathematical basis.

It will also be noted that loose smut is not affected by these seed treatments.

Control of Covered Smut in Hulless Oats

An experiment in the control of covered smut in hulless oats was also carried out in co-operation with the Dominion Experimental Station, Lacombe, Alta.

The seed was naturally smutted Liberty oats from the untreated plots in last year's experiment at Brandon, Man. The treatments were:—

1. Corona Copper carbonate applied at the rate of 4 ounces per bushel with the hand-machine.
2. "Superfine" sulphur, 95 per cent passing a 200-mesh sieve, dusted on the seed by machine at the rate of 6 ounces per bushel.
3. Semesan. The seed was soaked in 0.3 per cent solution of Semesan for one hour, drained and spread out to dry.
4. Untreated.

The treated seed was sown in 1/40-acre plots in duplicate.

The results are given in table 5. Individual counts varied more than in previous years, so that two plots of the same treatment are strikingly different. However, it is evident that copper carbonate and sulphur are by far the most effective and when considered with the heavy infestation of the untreated plot (79.4 per cent) good control was obtained. A farmer may confidently expect that the smut would be completely eliminated if the treatment was continued for a second season.

Estimation of the Spore-Load on the Seed

The spore-load of bunt on any sample of wheat can be estimated from the colour of the brush and the appearance of the surface of the seed. In clean seed

TABLE 5.—SEED TREATMENT FOR THE CONTROL OF COVERED SMUT IN LIBERTY (HULLESS) OATS

Treatment	Percentage of Smut		Average
	Series I	Series II	
Copper carbonate dust—			
Corona, 4 ounces per bushel	1·0	10·2	5·6
Sulphur dust, 6 ounces per bushel	6·6	1·0	3·8
Semesan soak	18·2	20·3	19·3
Untreated	75·1	83·6	79·4

the brush is white and the surface of the seed has the natural colour of the variety. Seed smutted at the rate of 1 part of smut to 2,000 parts of seed by weight has a very light brush and the surface remains apparently unchanged. A spore-lead of 1-1000 imparts a distinct slate-grey colour to the brush and the surface remains apparently unchanged. With a spore-load of 1-500 the brush is gray black and there is very slightly visible coating of the spores over the seed. A spore-load of 1-250 imparts a black colour to the brush and a visible coating of spores to the seed. With a spore-load of 1-100, the heaviest that has ever been seen on grain smutted in threshing a very smutty crop, the brush is black and filled out with spores and definite specks of spores occur over the surface. A sample of grain may contain many smut-balls, but for the control of bunt with copper carbonate the spores on the seed are the more important.

Of twenty-seven samples of smutty grain from Western Canada (see report for 1924) the spore-load was estimated to be as follows:—

Spore load	Number of samples
1—100	1
1—250	2
1—500	3
1—1000	5
1—2000	21
less than 1—2000	5

All these samples contained bunt-balls; nevertheless, it would seem that copper carbonate could have been used effectively except in one case.

Summary—Copper Carbonate Dust for the Control of Smut

Copper carbonate has now been tested quite extensively for a number of years both in rod-row tests and in $\frac{1}{40}$-acre plots, first by Mr. W. P. Fraser, formerly in charge of the Plant Pathological Laboratory at Saskatoon, Saskatchewan, and for the last two years by the author.

Copper carbonate gives good control of wheat bunt under average conditions. It is not effective against bunt when the seed is very heavily smutted. It has given almost as good control with a very susceptible variety as with a variety of medium susceptibility.

The seed must be coated evenly with a film of dust. An air-tight dusting-machine, either home-made or purchased for the purpose, is necessary. Some of the copper carbonate invariably escapes into air when treating grain in large quantities. Since it is both disagreeable and poisonous, a simple respirator should be worn.

Two ounces of copper carbonate per bushel is sufficient to control bunt in wheat. Larger quantities will not hurt the seed. Hulless oats require from 3 to 4 ounces per bushel to control covered smut.

The copper carbonate must be very fine. Although equally good results have been obtained with copper carbonates containing 20 per cent and 50 per cent copper, adulterating copper carbonates containing a high percentage of copper with inert substances is not recommended.

Formalin reduces the germination and the vigour of the stand while seed treated with copper carbonate germinates about equally as well as the untreated seed. After the farmer cleans his seed which he intends to sow next spring he may dust his seed with copper carbonate a month or two before sowing without injury to the seed. However, treated seed cannot be fed to poultry or stock.

Control of Loose Smuts of Wheat and Barley and Barley Stripe by Seed-Treatments

The organic mercury compounds have been found to give practical control of some seed-borne diseases. Some results have been published that the loose smuts of wheat and barley stripe may be controlled by these substances. An experiment was conducted to test the possibility.

SEED.—Kota wheat grown at the Manitoba Agricultural College, Winnipeg, Man., 1924. The seed was from a crop which showed 10 per cent loose smut in 1924.

Junior (hulless) barley grown at the Experimental Farm, Brandon, Man. Loss of 6 per cent of the heads due to loose smut occurred in 1924.

Minstrudi barley, kindly supplied by Dr. J. J. Christensen, University Farm, St. Paul, Minn., from a field showing a high percentage of stripe in 1924.

SIZE OF PLOT.—Single 18-foot rows in triplicate for wheat and in duplicate for the barleys.

ESTIMATE OF DISEASE.—The amount of disease present was estimated by selecting 100 heads from two different places in each of the two or three rows. The percentage of disease in each treatment was basd on the number of diseased

heads in 400 heads for the barley treatments and 600 heads for the wheat treatments.

TREATMENTS AND METHODS OF APPLICATION.—Three organic mercury compounds were selected, viz., Uspulun, Germisan and Semesan. Uspulun is manufactured by the Bayer Co. Inc., New York City, N.Y.; Germisan by Fahlberg, Liste & Co., Magdeburg, Germany; and Semesan by I. E. du Pont de Nemours & Co., Wilmington, Del.

Tap-water supplied by the Agricultural College water-works dissolved these substances as readily as distilled water and was used in this experiment.

The strengths of solution were: for Uspulun 0.25 per cent, for Germisan 0.25 per cent and for Semesan 0.3 per cent.

The seed was soaked for one, two and three hours in the solutions of these compounds at room temperature and for one-half, one and two hours in the solution held at 45° C. (or 113° F.) with and without previously soaking the seed for one hour in water. Thus there were twelve treatments with each compound. For comparison two lots of seed were left untreated and one was treated by the modified method with hot water.

The results of the experiment are reported in tables 6, 7 and 8. It will readily be seen that the organic mercury compounds reduce but slightly the amount of loose smut when the seed is soaked at room temperature. At 45° C. these compounds were more effective, but it is difficult to maintain the temperature for so long a period. The modified hot-water treatment eliminated loose smut and is an easier treatment to carry out. Germination tests were made for all the treatments. No injury was observed except with the hot-water treatment and with the hot treatments with Germisan on Junior barley. Until more experimental work is done the modified hot-water treatment is recommended for the control of loose smut in wheat and barley.

Barley stripe, however, appears to be effectively controlled by seed-treatment with the organic mercury compounds. Although soaking at 45° C. more completely eliminated the stripe, the control is sufficiently great when the seed is soaked for one to two hours in the fungicide at ordinary temperatures to warrant its use in practice. Germisan seems to be slightly more effective than either Uspulun or Semesan. It should be noted that the hot-water treatment failed to control the disease.

TABLE 6.—RESULTS OF SEED-TREATMENT WITH ORGANIC MERCURY COMPOUNDS FOR THE CONTROL OF LOOSE SMUT (*Ustilago Tritici*) IN KOTA WHEAT

Previous Treatment with Water	Length of soak with fungicide	Temperature	Percentage of Disease after Treatment with:—		
			Uspulun	Germisan	Semesan
	hours				
Soaked	1	Room	19·8	19·2	16·3
"	2	"	20·5	19·7	16·8
"	3	"	16·2	17·3	16·5
Not soaked	1	"	16·2	18·8	19·5
"	2	"	19·7	19·0	20·3
"	3	"	15·8	15·8	18·0
Soaked	½	45° C.	11.5	10·5	5.8
"	1	45° C.	11·3	1·8	5·5
"	2	45° C.	6·8	1·8	0·3
Not soaked	½	45° C.	19·7	18·2	21·2
"	1	45° C.	17·3	18·2	15·7
"	2	45° C.	3·2	16·2	4·5
Modified hot-water treatment (average of 3 tests)					0
Untreated (average of 6 tests)					20·9

TABLE 7.—RESULTS OF SEED-TREATMENT WITH ORGANIC MERCURY COMPOUNDS FOR THE CONTROL OF LOOSE SMUT *Ustilago nuda* IN JUNIOR (HULLLESS) BARLEY

Previous Treatment with Water	Length of soak with fungicide	Temperature	Percentage of Disease after Treatment with:—		
			Uspulun	Germisan	Semesan
	hours				
Soaked	1	Room	8·3	9·5	9·5
"	2	"	5·5	5·0	9·3
"	3	"	5·8	5·8	4·0
Not soaked	1	"	9·8	12·3	6·3
"	2	"	8·5	9·5	1·3
"	3	"	7·3	9·8	9·5
Soaked	½	45° C.	5·5	0	1·3
"	1	45° C.	0·3	0	0
"	2	45° C.	0	1·0	1·8
Not soaked	½	45° C.	8·3	3·0	6·3
"	1	45° C.	2·0	4·3	1·5
"	2	45° C.	0	1·5	0
Modified hot-water treatment (average of 3 tests)					0
Untreated (average of 6 tests)					9·8

TABLE 8.—RESULTS OF SEED-TREATMENT WITH ORGANIC MERCURY COMPOUNDS FOR THE CONTROL OF STRIPE (*Helminthosporium gramineum*) IN MINSTRUDI BARLEY

Previous Treatment with Water	Length of soak with fungicide	Temperature	Percentage of Disease after Treatment with:—		
			Uspulun	Germisan	Semesan
	hours				
Soaked	1	Room	0·8	0·3	0·5
"	2	"	0·5	0	1·3
"	3	"	0·3	0	0
Not soaked	1	"	0·5	0·3	0·5
"	2	"	1·0	0	2·0
"	3	"	1·8	trace	1·0
Soaked	1	45° C.		0	0
"	2	"	0·3	0	0
Not soaked	1	"	trace	0	0·5
"	2	"	0·5	0	0·3
Modified hot-water treatment (average of 3 tests)					3·5
Untreated (average of 6 tests)					8·0

Varietal Resistance of Oats to Covered Smut

A very extensive experiment was undertaken this year to test the varietal resistance of oats to covered smut (*Ustilago levis*). One hundred and twenty-six varieties (1) and selections were grown, a few of which were duplicates. They may be classified as follows:—

Avena brevis—1
A. byzantina—12
A. nuda—2
A. sativa—94
A. sativa orientalis—17

(1) I am indebted to Dr. T. R. Stanton, Agronomist in charge of Oat Investigations, Office of Cereal Investigations, Washington, D.C., for seed of 88 varieties and selections.

Four packets of seed of 120 seeds each were prepared. Two packets were seed with their hulls removed, and the other two with the hulls left on. Each lot of seed was shaken with excess of smut and then the excess removed.

An unhulled and a dehulled packet of each variety were sown in adjacent 18-foot rows. A check of Liberty (hulless) oats was run every six varieties. The experiment was therefore in duplicate with sufficient checks for comparison.

The results will only be briefly summarized for the experiment must be conducted a number of years before conclusive results may be obtained. The dehulled seed generally developed much more smut than the unhulled. Many varieties escaped infection or showed very small percentages of smut when the hull was left on the seed, but on the removal of the hull they showed up to 50 per cent smut.

The one variety of *Avena brevis* was immune. Nearly all the varieties of *Avena byzantina* were immune or highly resistant (0 to 5 per cent). Laurel and Liberty, two varieties of *Avena nuda*, showed 34.9 and 62.0 per cent respectively. The varieties of the common open-panicled oats, *Avena sativa*, varied from complete resistance to high susceptibility (40-100 per cent). The side-panicled oats, *Avena sativa orientalis*, were practically all highly susceptible.

The following varieties of *Avera byzantina* were immune: Coast Black, C.I. 1025, (1) Black Algerian, C.I. 840-1, Red Rustproof C.I. 1039, Fulghum C.I. 708. The following varieties of *Avena sativa*, Hatchett, C.I. 845, Hutcheson C.I. 905 Culberson C.I. 1875, Dwarf Culberson C.I. 748, Black Mesdag C.I. 1877, Early Joanette C.I. 1092, Fergusson Navarro C.I. 966, Aurora C.I. 957, Markton C.I. 2053, and Black Norway, were immune.

These varieties as far as they have been reported by other investigators have proven at least highly resistant. These varieties will supply suitable material from which to develop by crossing a highly resistant variety with desirable agronomic characters.

Experiments to determine varietal resistance of wheat to bunt were continued this year. No results were obtained at Winnipeg since only very small percentages of bunt developed even in susceptible varieties. Thirty-three varieties under test agronomically at the Experimental Farm, Brandon, were tested for resistance to bunt, both *Tilletia Tritici* and *Tilletia lævis*. The present varieties being grown in Western Canada or under test are more or less susceptible.

All other phases under investigation at the present time such as the conditions affecting infection, will be left for later reports when more data have been accumulated.

REPORT OF THE DOMINION LABORATORY OF PLANT PATHOLOGY, INDIAN HEAD, SASKATCHEWAN

(P. M. Simmonds, Plant Pathologist, Officer in Charge)

The Department of Agriculture allowed the officer in charge leave of absence for the winter of 1924-25 in order that he might continue his studies on cereal diseases at the University of Wisconsin. Research work in connection with the root-rot projects for this laboratory was carried on along with other studies, and it is felt that the knowledge and experience thus acquired are of great help in investigating the particular problems of this district. The officer in charge returned to Indian Head district about July 1 and immediately commenced the summer work. Rust epidemiology observations for southern Saskatchewan were made and the reports sent to the Saskatoon and Winnipeg laboratories, also the general plant-disease survey was carried on as in former years. Particular attention was given to a preliminary survey of root-rot conditions in southern

(1) These numbers are the Cereal Investigation numbers under which the strains and varieties are listed by the Office of Cereal Investigations, Washington, D.C.

Saskatchewan. This form of cereal disease appears to be very severe in some districts and a complete survey, starting in 1926, is intended, making note of the methods of cultivation and various rotations on the incidence of disease. In view of the fact that *Fusarium* spp., and *Helminthosporium sativum* P.K et B., are conspicuously associated with this type of root-rot the projects of this laboratory are outlined for the study of these fungi in particular. Extensive field experiments have been planned for next summer and in the meantime the necessary preliminary laboratory and greenhouse work is being carried on at the Saskatoon laboratory. Some very helpful information is being obtained in the greenhouse studies with the large number of *Fusaria* isolated from diseased wheat and oats. Up to the present time the writer has given most of his attention to a study of root-rot of oats caused by *Fusarium culmorum*. Co-operation has been given Dr. J. B. Harrington, plant-breeder in the Field Husbandry Department of the University of Saskatchewan, in a study of the possibilities of plant-breeding in the control of root-rot of cereals.

"Fusarium" Studies

In the Reports of the Division of Botany for 1922 and 1923 notes are given on the work carried on by the writer on studies of root-rot of oats caused by *Fusarium culmorum* (W. G. Smith) Sacc. During the winter of 1924-25 the work was carried on as time would permit at the University of Wisconsin, where the study revolved around the effect of soil-temperatures and moistures on this disease and the use of seed disinfectants as means of control. The investigations are still incomplete, but a summarized report here might be pertinent.

In environmental studies the reactions of the host must be taken into account. Soil-temperatures ranging from 8° C. to 30° C. and soil-moistures of 20, 35 and 50 per cent of the moisture-holding capacity of the soil comprised the soil-variations for the tests. The air-temperature was approximately constant at 22° C. The dry weights of representative samples of roots and tops of the check plants, grown at each temperature and the two low moistures, were taken as indices of the plant growth. The results show in general that the lower soil-temperatures encourage root development, with a decrease in dry weight towards the higher temperatures; conversely the top growth increases with the higher temperatures with the optimum range lying between 21° C. and 27° C., falling off sharply beyond this range. The difference in soil-moisture here was apparently not great enough to change the general trend of growth. Unfortunately data on the 50 per cent moisture test were not obtained. The results here are significant when one considers that in the field the lower soil-temperatures of spring are advantageous for vigorous root development, so necessary for the establishment of the plant and for its support in the top development to follow. Consideration must now be given to the effect of soil-temperatures and moisture when the plant is attacked by *F. culmorum*. The optimum temperature range for this fungus on artificial media lies between 24° C. and 28° C., falling sharply to either side. When this parasite attacks the oat plant, producing a seedling blight disease, the optimum for disease development coincides fairly well with the optimum for the fungus development on artificial media. This is true, however, only with the 20 and 35 per cent soil-moisture, where the temperature seems to be the controlling factor. In the case of 50 per cent moisture, on the other hand, the optimum for disease development was shifted towards the lower soil-temperature, being at 18° C., apparently the limiting effect of the temperature being offset by the increase in moisture.

Preliminary tests were conducted to determine the value of some common seed-disinfectants for the control of this form of root-rot. A soil-moisture of 50 per cent and three soil temperatures, 12°, 24° and 30° C., were used for these tests. The seed was treated with formalin, copper carbonate dust and

Uspulun, according to the ordinary directions for seed-treatments in practical field work. The soil was heavily inoculated so that the conditions for disease were very favourable. Under the conditions of these tests Uspulun gave by far the best control, while the formalin series showed more disease than the checks, which may indicate predisposing influences of formalin. Copper carbonate dust was not satisfactory.

REPORT OF THE DOMINION FIELD LABORATORY OF PLANT PATHOLOGY, SASKATOON

In Co-operation with the University of Saskatchewan

(G. B. Sanford, Plant Pathologist, Officer in charge)

The "Take-All" Disease

The first case of the "take-all" disease in Canada was reported by W. P. Fraser in 1923. This disease is known to be very destructive to the wheat crop in Australia and South Africa. The intensive survey of the present season located 228 quarter-sections, on which the disease appeared in varying severity. Most of the data were taken by Mr. Russell, assisted by Mr. Scott and others.

Table 1.—Distribution and Relative Severity of the "Take-All" Disease as Shown by the 1925 Survey

District	Number of infested quarter-sections			Miles travelled in each district
	Trace	Moderate	Heavy	
Battleford	0	0	0	45
Carlton	8	1	0	300
Duck Mountain	1	2	0	38
Humboldt	40	32	5	460
Nut Mountain	8	3	0	105
Prince Albert (N.)	1	7	0	72
Prince Albert (S.)	27	64	9	390
Pasquia	7	3	1	30
Saskatoon	2	0	0	150
Shell River	2	0	0	63
Touchwood	1	0	0	30
Yorkton	1	3	0	164
Totals	98	115	15	1,847

The "take-all" area seems to be located mainly in the semi-wooded or scrub districts, chiefly lying north of the prairie lands. This area extends in a northwesterly direction from Manitoba through Saskatchewan, chiefly between latitudes 52 and 53° (fig. 10 A and B). The disease has also been found in the Clover Bar district, eight miles east of Edmonton, by Mr. Scott, but an extensive survey has not been attempted in Alberta yet. It has also been found in Manitoba. The causal organism has been identified as *Ophiobolus cariceti* (B. & Br.) Sacc. The organism proved to be very virulent.

The following investigations of the "take-all" disease have been made under greenhouse conditions:—

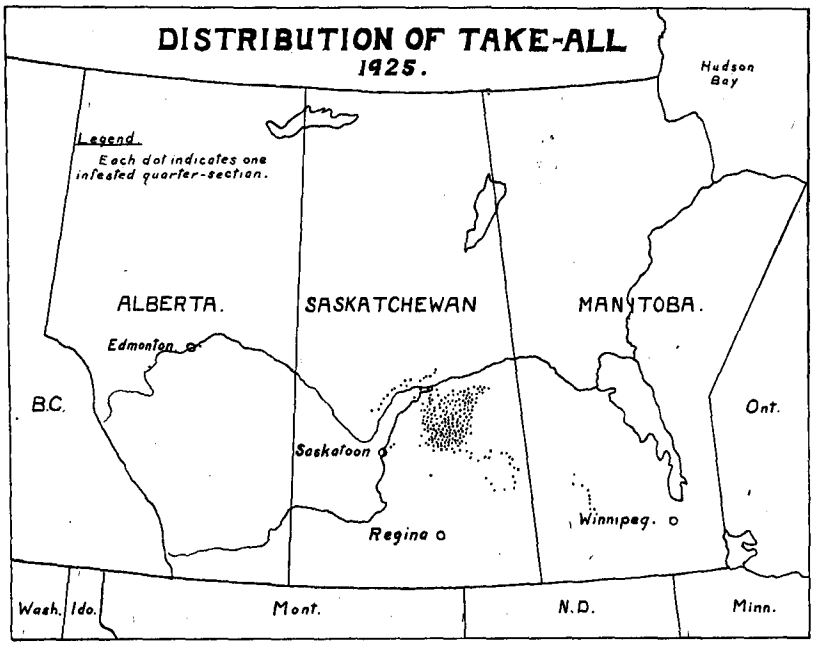
(*a*) Determination of host range, including wild and cultivated grasses, wheat, oats, barley and rye.

(*b*) A comparative study of susceptibility of a number of cereals and grasses.

(*c*) Relative varietal susceptibility of wheat.

(*d*) Preliminary study of the effect of various fertilizers on the development of the disease.

(*e*) Preliminary investigation of the influence of soil moisture and temperature.



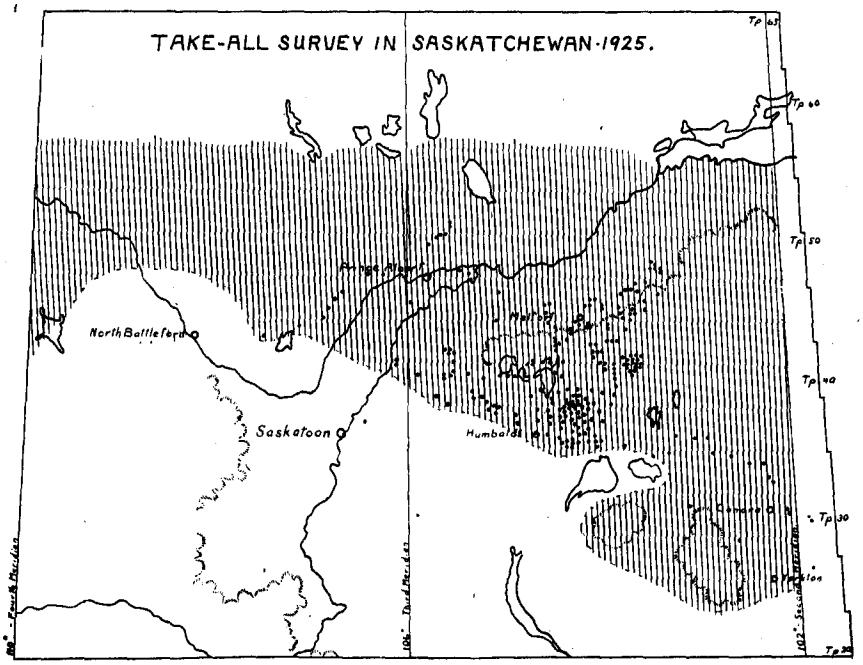


Fig. 10.—The distribution of the "take-all" disease found by the 1925 survey. Each dot indicates, in the lower chart, an infected farm. The shaded portion ipdicates "park" country.

The varieties of wheat found susceptible were: Einkorn, Emmer, Spelt, Polish, Alaska, Acme, Kubanka, Little Club, Marquis, Kitchener and Ruby. Barley and rye were slightly susceptible and oats were not noticeably susceptible. The grasses heavily parasitized were: *Agropyron dasystachyum, A. repens, A. Richardsonii, Bromus ciliatus, B. Porteri, Elymus canadensis, E. innovatus, Hordeum jubatum.* Those of medium susceptibility were: *Agropyron Smithii, A. tenerum, Bromus inermis, B. Pumpellianus.* Those slightly attacked were: *Avena Hookeri, A. striata, Beckmannia erucaeformis, Deschampsia caespitosa, Festuca viridula, Phleum pratense, Torresia odorata.*

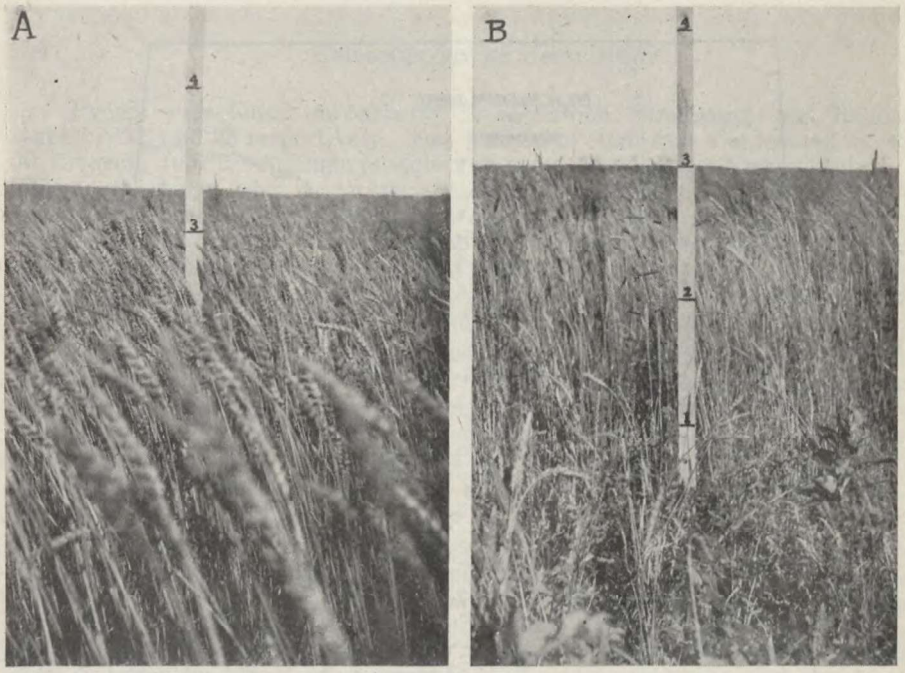


Fig. 11.—(*b*) A typical case of damage in a Saskatchewan wheat field caused by the "take-all" disease. (*a*) Shows the normal growth of the plants nearby.

The information secured from observing the disease under field conditions was: oats were apparently uninjured, but barley was slightly attacked. The injury on wheat varied from slight to 15 to 20 per cent loss (fig. 11). Traces of the disease were found on the first crop after breaking. The data indicated that the second crop was more injured than the first. Severe damage appeared on the third and successive crops. Very little disease was noticed on wheat following summerfallow. Indications were that rotation of crops reduced the disease. Therefore, it would seem advisable to determine by experiment the cumulative effect of continuous cropping to wheat and the possibilities of crop-rotation for control.

It is very probable that the best results would be obtained by properly supervised co-operative experiments located in the infested area. It is also important to determine the relative susceptibility of varieties of wheat under field conditions, as this information is the first step in the process of securing greater resistance to the "take-all" disease by plant-breeding methods.

Buckthorn Survey

During the summer Messrs. Maguire and Bennett were engaged chiefly in locating buckthorn and barberry bushes and the eradication of the latter. Simultaneously with the survey these men collected valuable plant-disease survey data. Two cars were used, principally for this work, and this enabled a much more extensive survey than could otherwise have been possible. Over thirteen thousand miles were travelled by car, and six hundred and fifteen towns and cities surveyed (fig. 12). This includes eight in Alberta which were visited by rail. Three hundred and ninety-nine buckthorn bushes, and 5,472 feet of buckthorn hedge, consisting of sixty-seven separate hedges, were located. Of these,

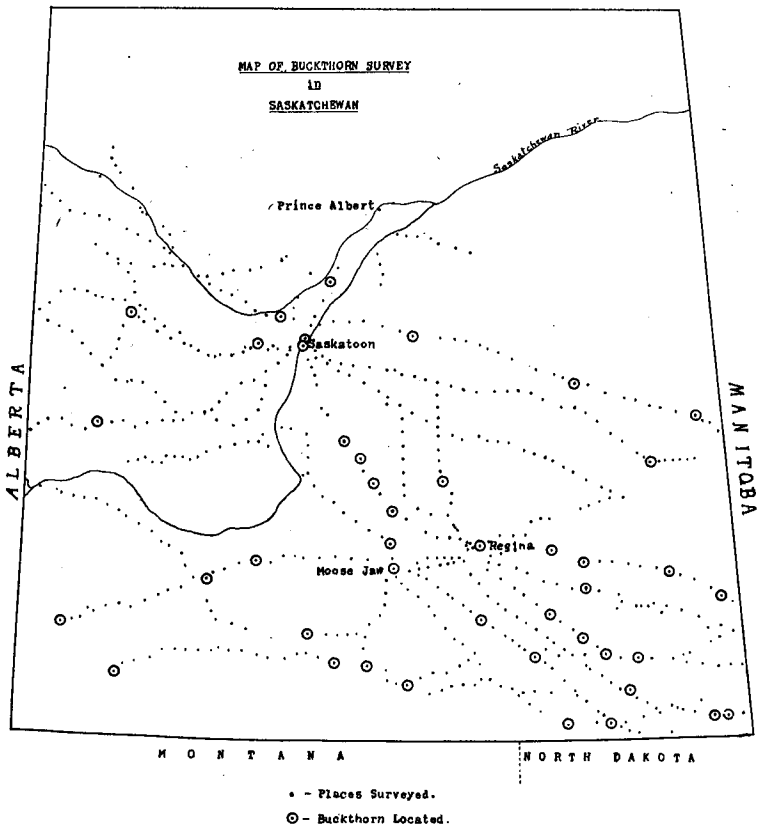


Fig. 12.—Territory in Saskatchewan surveyed for buckthorn in 1925.

three individual bushes and 1,211 feet of hedge, including eighteen separate hedges, were found at Edmonton. There still remain many hedges and bushes to be located in Saskatchewan and Alberta. Most of these should be found by another season's work. The buckthorn (*Rhamnus cathartica*) was rusted only slightly, this and last year, on account of the unfavourable climatic conditions. However, it rusted severely in 1923, when it was an important factor in spreading crown rust of oats (*Puccinia coronata*). Very few of these buckthorn bushes and hedges already located have been eradicated because no pressure has so far been brought to bear on the owners as in the case of the barberry.

Barberry Survey

Simultaneously with the buckthorn survey, barberry bushes (*Berberis vulgaris*) were located and at once eradicated. Ninety-one bushes and thirty shoots (sprouts from roots of previously removed bushes) were found. These were located in Saskatchewan with the exception of four bushes found at Calgary. Other points in Alberta visited by rail were Bremner, Brooks, Didsbury, Edmonton, Lacombe, Olds, and Wetaskiwin. The barberry bushes rusted only slightly (as was also the case with the buckthorns) on account of the unfavourable weather for infection. The data indicate that nearly all the barberry bushes in Saskatchewan have been located and destroyed.

Epidemiology of Stem Rust

Pycnia were found on barberry at Saskatoon, Strasbourg, and Regina on June 17, 22, and 23 respectively. One pustule of stem rust was located on wheat at Estevan, July 2. A single pustule was noted on wheat at Kisbey, July 6, and also one barberry bush moderately rusted at Stoughton. The nearby *Hordeum jubatum* was heavily infected, and *Agropyron tenerum* slightly. By July 14 slight infection occurred in every wheat field examined from Moosomin to Regina and one pustule was observed on wheat twenty-two miles northeast of Saskatoon. By August 8 slight infection became general as far west as Saskatoon, while traces of rust occurred twenty miles northwest of this point.

In southeastern and eastern Saskatchewan heavy losses were suffered from stem rust (*Puccinia graminis Tritici*). An epidemic appeared in many sections in this area. Severe losses resulted on late grain in Saskatchewan as far west as Saskatoon. In the northern parts (Melfort, Prince Albert, Shellbrook, etc.) injury, to any marked extent, occurred only on the latest wheat. Traces of rust were found in western Saskatchewan and Alberta but no appreciable loss was felt.

Beginning July 25 ordinary microscopic slides (one side smeared with vaseline) were exposed each day until September 15 to determine the daily rust spore-load of the air. A weather vane type of spore-trap was used, and this was located on the roof of the greenhouse. Counts were made of the urediniospores of *Puccinia graminis* found on each slide and these are given in table 2. The data were collected by Mr. P. M. Simmonds.

While the results obtained are not sufficiently comprehensive to draw any conclusions, they do indicate that valuable data relative to the aerial drift of rust spores can be secured by well-organized distribution of spore-traps in the Prairie Provinces.

ABLE 2.—THE NUMBER OF UREDINIOSPORES OF *P. graminis* CAUGHT ON A SLIDE DURING A 24-HOUR EXPOSURE AT VARIOUS DATES

Date	Number of spores per slide	Date	Number of spores per slide
July 25	4	Aug. 21	1,468
26	0	22	690
27	0	23	66
28	20	24	30
29	26	25	89
30	7	26	78
31	13	27	85
Aug. 1	30	28	105
2	159	29	243
3	54	30	155
4	1	31	189
5	21	Sept. 1	238
6	7	2	30
7	55	3	590
8	43	4	210
9	32	5	100
10	219	6	4
11	70	7	77
12	31	8	174
13	368	9	96
14	4,000	10	25
15	777	11	12
16	408	12	15
17	73	13	80
18	190	14	100
19	71	15	94
20	549		

DETERMINATION OF PHYSIOLOGICAL RACES OF STEM RUST

The determination of physiological races of stem rust was continued and the following recognized. The work of the determination of stem rust strains was discontinued at Saskatoon in April, 1925, and the cultures forwarded to the Dominion Laboratory of Plant Pathology, Winnipeg, where the work will be carried on in future. The collections were made in 1924.

III—From Treesbank, Minto, Winnipeg, Grebert Plains in Manitoba, and Indian Head, Vonda and Rhyl in Saskatchewan.
XI—From Canora and Moosomin in Saskatchewan.
XXXIV—From Truax and Watson in Saskatchewan, and Lethbridge in Alberta.
XII—From Melfort, Raymore and Estevan in Saskatchewan.
XXI—From Prongua in Saskatchewan.

ROOT-ROT INVESTIGATIONS FOR PLANT BREEDING PURPOSES

A co-operative project was begun last spring with Dr. J. B. Harrington, of the University Department of Field Husbandry, to determine the relative susceptibility to root-rots of a number of wheat and other cereal varieties. This is preparatory to obtaining resistant varieties by plant-breeding.

It was necessary to first determine the best method of inoculation with *Helminthosporium sativum* to secure infection. Therefore, a separate experiment was made by this laboratory on the University plots. The varieties of wheat used were Kubanka and Marquis. Two methods of inoculation were tried:—coating the grains with spores of *H. sativum*, and surrounding them with inoculum, consisting of vigorously growing cultures, at planting time. The percentage of infection was calculated as follows:—When harvested, each plant in the series was given a numerical value, according to the degree of infection as indicated on the basal parts of the wheat plant. These ratings were from one to ten. The final infection rating for the plants was determined by adding

together all the numerical ratings, dividing this sum by ten times the number of inoculated plants involved. This result was then multiplied by one hundred, thus putting the infection rating on a percentage basis.

$$\frac{\text{Sum of all numerical ratings x 100}}{\text{Total number of inoculated plants x 10}} = \text{Infection-rating.}$$

This result is then the comparative infection-rating since ten times the total number of plants (10 being the highest numerical rating) represents the highest possibility for disease under the conditions of the experiment (table 3).

TABLE 3.—THE AMOUNT OF INFECTION OF WHEAT PLANTS SECURED BY TREATING THE GRAINS WITH SPORES ONLY, COMPARED WITH THAT OBTAINED BY PLACING INOCULUM AROUND THE GRAINS

Row No.	Variety	—	Percentage infection
		Kubanka 2094, Rows 14 ft., 83 seeds per row	
1	Kubanka	Check	51·0
2	"	"	53·1
3	"	Grains treated with spores	67·8
4	"	" "	65·6
5	"	Inoculum placed around grains	86·8
6	"	" "	81·4
7	"	" "	84·3
8	"	" "	76·3
9	"	Grains treated with spores	54·6
10	"	" "	56·2
		Marquis, Rows 14 ft., 55 grains per row	
11	Marquis	Check	40·3
12	"	"	56·7
13	"	Grains treated with spores	51·8
14	"	" "	61·2
15	"	Inoculum placed around grains	78·7
16	"	" "	76·5
17	"	" "	93·0
18	"	" "	91·8
19	"	Grains treated with spores	71·6
20	"	" "	75·0

The results obtained from this experiment were quite significant. Where the inoculum was placed around the grain the percentage infection ranged from 76.5 to 93 for Marquis and for Kubanka it ranged from 76.3 to 86.8. But, where the grain was treated with spores only, the percentage infection ranged from 51.8 to 75 for Marquis and for Kubanka from 54.6 to 67.8. Therefore, it appears that inoculum (consisting of mycelium and spores), placed around the grains is preferable to inoculating them with spores only. It is hoped that these results will aid in securing more satisfactory results when applied to the co-operative experiment already mentioned.

STUDIES ON SMUT OF WESTERN RYE GRASS

Experiments to determine the host range and methods for control of smut of *Agropyron tenerum* were begun in 1919 and continued to date. This smut is common in the Prairie Provinces. Besides *A. tenerum* it attacks *A. dasystachyum*. This smut closely resembles *Ustilago bromivora* and is assigned to that species. The smut is controlled by the formaldehyde solution as used for cereals. (Abstract from article awaiting publication by W. P. Fraser and G. A. Scott.)

REPORT OF THE DOMINION FIELD LABORATORY OF PLANT PATHOLOGY, SUMMERLAND, B.C.

(H. R. McLarty, Plant Pathologist, Officer in Charge)

The winter of 1924 and 1925 was, by all means, the chief factor in lessening the fruit crop in British Columbia during this past season. The trouble is attributed to an exceptionally rapid drop in temperature during the middle of December. The daily maximum and minimum records as kept by the Summerland Experimental Station for this period are as follows:—

Date	Maximum temperature	Minimum temperature	Date	Maximum temperature	Minimum temperature
	°	°			
Dec. 12	50	30	Dec. 23	11	3
" 13	54	40	" 24	11	2
" 14	52	41	" 25	15	1
" 15	12	12	" 26	19	6
" 16	− 2	− 8	" 27	23	11
" 17	− 1	− 9	" 28	24	16
" 18	2	− 7	" 29	27	19
" 19	9	− 5	" 30	34	20
" 20	9	− 3			
" 21	7	3			
" 22	11	3			

The above table represents the comparatively moderate weather conditions prevailing at that time. It was, nevertheless, severe enough to cause a complete loss of the peach and apricot crops and considerable loss in other fruits. The rapidity and extent of this change in temperature was, in some districts, much greater than in Summerland and produced a much greater loss.

Injuries produced in the different parts of various kinds of fruit trees are briefly as follows:—

APPLE.—1. Flower buds. The embryonic flowers were browned in varying degrees according to the variety and the district. Heavy killing of these buds occurred in the late maturing varieties in Salmon Arm, Vernon, Creston, and Keremeos. In Creston, where the extremes in weather were more marked, the injury was so severe that there was considerable loss even in the early varieties, and in the later varieties not only the floral parts of the bud were killed, but the leaf parts as well. As indicative of what this type of injury can do, the crop was reduced in this district from 225,000 boxes in 1924 to an estimated 55,000 boxes in 1925.

2. Leaf buds. The killing in the Creston district, of the leaf buds as well as of the flower buds, was so severe that, in many of the late maturing varieties, trees were dependent wholly for their summer foliage on the growth from adventitious buds.

3. Spurs. These were observed to be brown in practically every district. They were injured to such an extent in Salmon Arm, Vernon and Creston that buds above them were unable to develop. It is worthy of note that in some cases, spurs were killed when buds were good, while in neighbouring orchards, buds were killed when spurs were good. Although many hundred spurs and buds were examined, no safe rule was found for judging from the amount of browning, whether or not a spur or bud was killed.

4. Twigs. Killing back of the twigs was especially severe in Creston, but was also present to some extent in Salmon Arm, Vernon, and Keremeos.

5. Main limbs. Many were killed outright in the Creston district, especially on late maturing varieties which had borne a heavy crop the previous year.

6. Crotch injury. Where injury occurred in the main limbs, it was noticed that the injury was most severe at the junction of two limbs. The results indicated very clearly that the tissue around the crotch was less hardy than at other parts of the limb.

7. Trunk. Trees badly trunk-injured during previous winters appeared very susceptible to last season's conditions and as a result, the injured areas were greatly extended. Trees healthy in the trunk came through with very little vital injury, though in many cases considerable browning of the tissues was noted.

8. Crown and main roots. The climatic conditions during the fall of 1924 were such that the trees entered the winter in a very mature condition. As a consequence, very little crown or main-root injury was found.

9. Small roots. A very heavy killing of the small root-system of the tree occurred in practically every district. This type of injury was not confined to any particular variety, but was apparently limited by the type of soil in which the tree was growing, the amount of moisture in the soil, and the cultural practices employed. Factors favourable for this kind of injury were, open gravelly soils, low moisture-content, and clean cultivation. This type of injury has accounted for the death of many trees of even the hardier types such as McIntosh and Wealthy.

Pears.—The pear suffered chiefly in the floral parts, the remainder of the tree coming through in remarkably good condition. As result of the injury in the flower buds, the crop this year was only 14 per cent of last. A few pears of the Bosc variety were killed outright in the Creston district.

Cherries.—Suffered considerably in the flower-buds from Summerland northwards. Some small root-injury as recorded for apple was also found.

Plums and Prunes.—Here the injury varied in the flower-buds with the variety. The estimated crop was 35 per cent of that of last year.

The results of such injury, as briefly outlined, demonstrate once again that one of the chief problems facing the fruit-growing industry of British Columbia is that of winter injury.

The growing-season during the ensuing summer was for the most part favourable. Apple scab, which occurs only in the northern districts, was less prevalent than usual. Powdery mildew was almost entirely absent. Fire blight was less destructive than previously. Physiological disorders in the fruit were considerably more pronounced than in a normal year. Corky core was much more wide spread and caused considerable loss. Drought spot was also severe in many orchards.

The Effect of Fall Irrigation on the Spread of Collar Rot

A two-acre block of eight-year-old trees was selected. This block was planted with six varieties of apples in ten rows—the rows running parallel with the irrigation furrows. Except for rows numbers 5 and 10 the one-half of the orchard was an exact duplicate of the other. These plantings were: rows numbers 1 and 6 to Yellow Transparent; rows numbers 2 and 7 to Duchess; rows numbers 3 and 8 to Wagener; rows numbers 4 and 9 to Jonathan; row number 5 to Cox's Orange, and row number 10 to Wealthy. This plot is fairly uniform in slope and soil with a slight tendency to a better soil in rows 8, 9 and 10. An alfalfa cover-crop is maintained and the plot has received the same cultural treatment throughout, except that in the fall of 1923 and 1924 a fall irrigation was applied to rows 7 to 10 inclusive. In the fall of 1920, the first year that the alfalfa cover-crop was established, this orchard suffered an extreme drought, the effects of which at that time were very marked, and which was, no doubt, the cause of a set-back from which the orchard never entirely recovered.

Examinations were made in the fall of 1924 and 1925 of the complete crown from a point 6 inches above the ground to a short distance out on all the main roots. No attempt at treatment was made; merely the extent of the injury was ascertained and the earth replaced.

The results of the observations are as follows:—

Row No.	Variety	Number of trees	Collar Rot		—
			1924	1925	
1	Yellow Transparent	10	3	7	No fall irrigation.
2	Duchess	10	4	8	
3	Wagener	10	4	7	
4	Jonathan	10	3	6	
5	Coxs' Orange	8	3	5	
			17	33	
6	Yellow Transparent	10	4	5	Fall irrigation.
7	Duchess	9	4	5	
8	Wagener	10	4	5	
9	Jonathan	10	2	3	
10	Wealthy	10	2	3	
			16	21	

Leaving out rows numbers 5 and 10 which are different varieties, we have for rows 1-4, fourteen trees with collar rot in 1924, twenty-eight in 1925. In rows numbers 6-9, fourteen collar-rotted in 1924, eighteen in 1925. Now including rows 5-10, of the seventeen trees in rows 1-5 affected in 1924, seventeen were dead in 1925. Of sixteen trees in rows numbers 6-10, only seven were dead in 1925. In most of the others, the diseases had advanced but the tree was not completely girdled. One tree in the non-fall-irrigated section, healthy in 1924, was dead in the fall of 1925. No trees in the fall-irrigated section, healthy in 1924, were dead in 1925.

These results demonstrate the value of applying a fall irrigation in orchards suffering from collar rot.

The Relation of Small Root Injury to a Physiological Disease Known as Corky Core

An examination of winter-injured trees early in the spring of 1925 disclosed the fact that there had occurred, very generally, an exceedingly severe killing of the small-root systems of the trees. In the small-root system are included roots of one inch in diameter and less. In many cases, no good roots of this size could be found within two feet of the surface of the ground. The remainder of the roots of the tree were usually normal. To gain information as to whether or not this type of injury has any relation to corky core, examinations were made of the root-systems of a number of trees. The method used in making the examination was to dig four holes equally spaced around the tree at a distance from the trunk a little less than the spread of the branches. Each hole was sunk to a depth of two feet and the roots so exposed were examined for injury. Later in the year, an examination for corky core was made on the fruit of these trees. This examination was made by cutting open apples on branches just above the place where the holes were dug.

Districts in which trees were examined were Salmon Arm, Winfield and Kelowna.

One hundred and fourteen trees, including the following varieties, were used: McIntosh 51, Jonathan 14, Wealthy 25, Delicious 8, Winesap 2, Rome Beauty 10, Transcendent Crab 2, Hyslop Crab 2.

RESULTS.—In the 456 holes dug, root-injury was found in 332, and two holes were filled with water. An examination, just before harvest, of the fruit above these 332 holes showed corky core in 123 cases; no corky core in 167; and no crop in 42. An examination of the fruit above the 122 holes where no root injury was found showed corky core in 42 cases; no corky core in 68; and no crop in 12.

It would seem from our results that there is no relation between this particular type of root-killing and the occurrence of corky core.

AN EXPERIMENT TO DETERMINE THE VALUE OF CERTAIN CULTURAL METHODS IN THE PREVENTION OF CORKY CORE IN APPLES

In this experiment, continued from previous year, there are four plots of 16 trees each, placed under four different cultural methods as follows: plot No. 1—a cover-crop of hairy vetch with water; plot No. 2—clean cultivation with the addition of manure and water; plot No. 3—clean cultivation, plus water; plot No. 4—clean cultivation and manure only, no water.

In the spring of 1925, manure was applied to plots numbers 2 and 4 at the rate of 16 tons per acre. During the season, irrigation was applied as needed, there being 17.7 acre-inches put on plot No. 1 in three irrigations; 6.3 acre-inches on plot No. 2 in two irrigations, and 7.32 acre-inches on plot No. 3 in two irrigations.

Examinations were made of the fruit on these plots by cutting apples from four sides of each tree. A summary of the results is as follows:—

Plot No. 1—Water and vetch—1 tree affected on one side only.
" 2—Manure and water—15 trees affected.
" 3—Water—5 trees affected.
" 4—Manure—13 trees affected.

The results of our experiments up to the present would seem to show that a good cover-crop with even moisture-conditions assist very materially in warding off this disease.

AN EXPERIMENT TO DETERMINE WHETHER FIRE BLIGHT IS SPREAD BY PRUNING TOOLS IF THESE ARE NOT DISINFECTED WHEN USED IN CUTTING DURING THE WINTER SEASON

This experiment was continued along the same lines as in 1924. Inoculations were made by cutting into live cankers with shears or saw and immediately cutting off with the same tool, a twig or branch. A Winter Bartlett tree was used and inoculations were made as follows:—

March 25—343 inoculations.
" 26—170 inoculations with shears.
" 26—15 inoculations with saw.

The buds on the trees at this time were showing white over the scales and were quite enlarged.

Careful observations were made during the summer and it was found that of the 528 inoculations, two only caused infection.

THE LONGEVITY OF FIRE BLIGHT BACTERIA IN IMMATURE FRUIT

The following table presents the results obtained on sixty-four apples placed in storage as recorded in this experiment under this title in the 1924 report. Dates of inoculations and the number of fire blight cultures obtained from these apples are recorded.

Date of Inoculation	Number stored Dec. 10, 1924	Number showing F.B. on culture	Date of re-isolation 1925
June 16	5	5	Feb. 3
(all apples inoculated between these dates, rotted and destroyed)			
July 24	6	1	Jan. 28
" 31	9	0	" 31
Aug. 4	7	0	" 31
" 7	2	0	Feb. 2
" 11	6	0	" 2
" 14	1	0	" 2
" 21	3	0	" 3
" 25	7	1	" 3
" 28	9	0	" 4
Sept. 1	7	2	" 7
	62	9	

These cultures were all inoculated into pear twigs during the summer 1925 and caused in them typical fire blight lesions. From these infections the organism was re-isolated to pure culture.

Longevity of Fire Blight in Immature Fruit (Part 1)

To obtain additional evidence, the experiment was carried along the same lines again this year.

On an eight-year-old McIntosh tree ten apples were inoculated every week in a similar manner as last year.

A total of 150 inoculations was made and the results to date are as follows:—

Rendered unmarketable because of rotting due to organism	62
Dropped prematurely slightly rotten along the line of inoculation	25
Dropped prematurely but healthy enough to be stored	25
Picked at the end of the season and stored	26
Missing	12

Observations Nov. 16—Healthy 39, rotted 12.
Observations Dec. 10—Healthy 34, rotted 5.

Isolations for the fire blight organism will be made on these remaining thirty-four apples at the end of their storage-period.

Longevity of Fire Blight Bacteria in Immature Fruit (Part 2)

This was an additional experiment along the lines of the preceding one in order to ascertain if an apple pierced only one-quarter inch in the flesh by the inoculating needle would rot.

On a McIntosh tree, five apples were inoculated every week commencing July 10. A total of forty-five inoculations was made and the results to date are as follows:—

Rendered unmarketable because of rotting due to organism	7
Dropped prematurely but with slight browning in flesh	3
Dropped prematurely but healthy enough to be stored	14
Picked at the end of the season and stored	17
Missing	4

Observations Nov. 17—Healthy 30, rotted 1.
Observations Dec. 10—Healthy 29, rotted 1.

Isolations for the fire blight organism will be made on these at the end of their storage-period.

Longevity of Fire Blight Bacteria in Immature Fruit (Part 3)

An experiment to determine whether fire blight can enter the calyx-cup of an immature fruit and remain alive until the end of its storage period.

On a McIntosh tree, ten apples were inoculated every week during the growing-season commencing May 22. Tested fire blight cultures were used in every case, and the method of inoculation was to spray the calyx-end with distilled water from an atomizer, then by means of a dropping pipette to place on the calyx a drop or two of a water suspension of the organism. A total of 150 inoculations was made and the results to date are as follows:—

Dropped during the summer	14
Dropped near the end of the season but stored	20
Picked off at the end of the season	104
Missing	12

Observations Nov. 16—118 healthy, 6 rotted.
Observations Dec. 10—118 healthy.

Isolations for the fire blight organism will be made on these at the end of their storage-period.

Perennial Canker of Apple Trees

In January of 1924, specimens of cankers on Yellow Newtown apple limbs from Okanagan Centre were sent in to the Farm superintendent and were referred to the laboratory. Cultures were set up from this material, and a fungus was obtained which did not correspond to any recorded in available literature as producing a canker or rot. As a consequence, visits were made to the orchards affected, more material was collected, and an investigation of the trouble undertaken.

Since that time the trouble has been found in several places in British Columbia, and has this year been reported in many of the apple-growing regions of Oregon and Washington. From the evidence in the canker itself (fig. 13), we are certain that this disease has been in British Columbia seven years, but it is because of its rapid spread during the last few years and especially the last season, 1925 (fig. 14B), that so much concern is felt at the present time. In one particular orchard in Winfield, where exceptional care is taken by the grower in watching for unusual developments, four years ago there was reported to be one canker found; to-day the trouble has spread so extensively through a five-acre block of Rome Beauties that the number of cankers has become too numerous to count. A continuance of its spread at the same rate for four more years would make the growing of Rome Beauties in that orchard unprofitable.

Characteristics of the Disease.—All observations up to the present indicate that the fungus producing this canker is only a wound-parasite. The most of the cankers result, as one would expect, from pruning-wounds, but we have observed that cankers result from any abrasion occurring on the bark of the tree. Cankers are found on all sizes of limbs, from those forming the general frame-work to those of only a year's growth (fig. 15A).

The fungus apparently lives over from year to year in the tissue of the host and each spring advances into the healthy tissue around the edge of the canker to a greater or less extent depending upon prevailing conditions. From the records left in the cankers themselves, this yearly advance has been, in the past, usually not more than one inch, commonly one-quarter to one-half inch. In the spring of 1925, however, there were observed invasions extending as much as ten inches into the healthy tissue (fig. 14B). While it is not definitely established, we believe, from our observations, that growth into the healthy tissue takes place only in the spring. Cankers that had been cleaned and cut back to healthy tissue during the summer months of 1924 showed no infection when examined late the following winter. By the end of May, 1925, the healthy tissue around the edge of these same cankers which had been cleaned had been

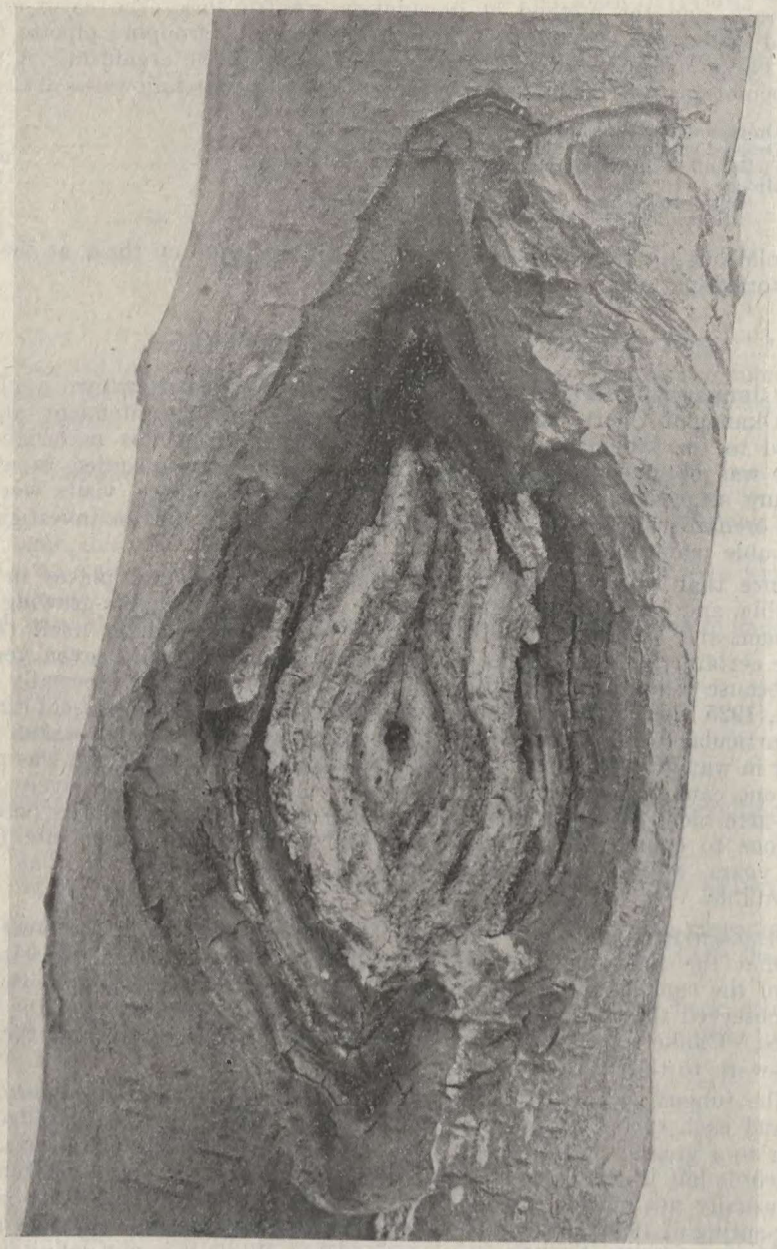


Fig. 13.—A seven-year-old canker; showing the annual rings.

Fig. 14.—(*a*) A canker in Rome Beauty produced by artificial inoculation. (*b*) Illustrating the extent to which the fungus advanced last year. The distance on this branch is between 10 and 11 inches.

killed back anywhere from one-quarter inch to five inches. After this date (the end of May) no further growth of the fungus into the healthy tissue was found. A crack appeared between the healthy and the diseased tissue and healing began quite complete, appearing healthy and normal in every way. This distinct in a normal manner. This fall, the callus formations on these (cankers) are periodicity of growth accompanied by the healing process at the edge accounts for the annual rings in the canker. (fig. 13).

About the time that the growth of the fungus into the healthy tissue is complete, the fruiting bodies appear on the surface of the newly invaded wood. In some cases, these fruiting bodies break through the epidermis and appear as acervuli of the *Gloeosporium* type. In other cases, the epidermis becomes loosened and is raised from the underlying cortex. In the space so formed, fruiting bodies also occur, and by removing the epidermis, we find these as shown in fig. 16B. It will be noticed that these fruiting bodies stand up from the matrix on a pedestal and each has a gelatinous mass in the centre of the top. It is from this gelatinous mass that the spores are produced in great numbers. Later on in the season, the epidermis usually becomes cracked and exposes these fruiting bodies with their spores. On material brought in from the field this year, we have found spores being produced from both kinds of fruiting bodies. Not only are fruiting bodies produced on the tissue invaded in the current year, but acervuli producing viable spores have been found in great numbers on wood killed by a previous year's invasion. Just when these acervuli appear we are not certain, but they did not attract our attention until some time during the summer.

The spores of the fungus are small, 3-4 x 11-13 microns, fusoid, sometimes slightly larger on one end than on the other; hyaline, one-celled, sometimes slightly curved.

Fig. 15.—(*a*) A yellow Newtown badly affected with perennial canker. Several limbs have already been removed, having been practically killed by the fungus. (*b*) Canker on Rome Beauty tree showing the appearance of limbs as cleaned and treated during the summer of 1924.

Germination tests carried on during the summer are presented in the following table:—

Date of Test	Diseased bark collected	Date of Obs.	Approx. Germination[1]
			%
June 10	Keane orchard, May 28	June 11	100
" 22	" " 28	" 23	100
" 29	" " 28	" 30	100
July 1	Goldie orchard, June 29	July 2	100
" 7	Keane orchard, May 28	" 8	100
" 13	" " 28	" 14	100
" 20	" " 28	" 21	100
" 28	" " 28	" 29	100
" 28	" July 18	" 29	100
Aug. 3	" May 28	Aug. 5	50
" 6	" July 18	" 7	90
" 15	" May 28	" 17	50
" 15	" July 18	" 17	75
" 20	" May 28	" 22	50
" 25	" " 28	" 26	90
" 27	" " 28	" 28	70
" 27	" Aug. 21	" 28	75–100
" 31	" " 21	Sept. 2	75
Sept. 3	" " 21	" 4	75–100
	" May 28	" 4	75–100
" 10	" " 28	" 11	90–100
" 10	" Aug. 21	" 11	90–100
" 17	" " 21	" 18	90
" 17	" May 28	" 18	10
" 28	" Sept. 28	" 29	90–100
Oct. 7	" " 28	Oct. 8	90–100
" 13	" " 28	" 14	90–100
" 19	" " 28	" 20	75
" 22	" Oct. 20	" 23	90–100
" 27	" " 20	" 28	90–100
Nov. 4	" " 20	Nov. 5	75
" 10	" " 20	" 11	90–100
" 16	" Nov. 11	" 17	90–100
" 21	" Oct. 20	" 22	90–100
" 26	" Nov. 23	" 27	90–100

[1]Spores were germinated in weak sugar solution at a temperature of 16°–20° C.

This high percentage of germination, when considered with the perennial nature of the fungus in the host, presents to us a problem in control which contains many difficulties.

Susceptibility of Varieties.—Fortunately all varieties of apple do not show the same susceptibility to the disease. Two of our main varieties in the districts in which the disease occurs, namely, Wealthy and McIntosh, have so far shown a very marked resistance. Our observations have shown that, for British Columbia, the most susceptible varieties, in order of notation are:—Rome Beauty, Yellow Newtown, Spitzenberg, Delicious, and Jonathan.

Experiments on Control.—The experimental work that we have been able to carry out up to the present on the control of this disease has not been very encouraging in its results. In the fall of 1924, a very thorough application of Bordeaux was made on a badly cankered five-acre block of Rome Beauty. This spray apparently effected no control whatever.

During the summer of 1924, several hundred cankers on Rome Beauty trees were cleaned by cutting out all the affected tissue, washed with corrosive sublimate and when dry, treated with one of four different kinds of protective coverings, namely, No. 1 solution, 6 per cent potassium bichromate and 6 per cent copper sulphate (fig. 15B); No. 2, creosote and coal tar; No. 3, Bordeaux

paste; No. 4, water-glass. In the spring of 1925, counts made on the cankers treated with the different protective coverings gave the following results:—

Protective covering	Number of cankers counted	Number in which there was no control
Potassium bichromate and copper sulphate	60	56
Creosote and coal tar	67	63
Bordeaux paste	71	56
Water-glass	40	17

As the bichromate and copper and the creosote and coal tar solutions were used on trees where there was a far greater number of cankers than was the case with the other solutions, the better showing of water-glass and of Bordeaux may not mean as much as the counts would suggest. Cleaning and treating of cankers under these conditions did not give a satisfactory control.

During the past summer, 1925, a co-operative spraying experiment was carried on with the Provincial Horticulturist. Mr. Evans, Assistant Horticulturist, under whose directions the actual spraying was done, has furnished the following report of the work:—

PERENNIAL CANKER SPRAYS—1925

Rainbow Ranch Orchard:

Variety sprayed, Yellow Newtown; number of trees in block—30

Formula used:—

Liquid lime-sulphur 1 gallon to 50 gallons.
Hydrated lime 2 pounds to 50 gallons.
Casein spreader 10 ounces to 50 gallons.

Dates of Application:—

First spray, June 30.
Second spray, July 21.
Third spray, August 11.

This was applied with guns attached to a 4-horsepower Bean power-outfit carrying a gauge pressure of 240 to 260 pounds. The complete block was sprayed on each date.

F. H. Keane Orchard:

Variety sprayed, Rome Beauty; 8 rows of trees in block.

Dates of Application:—

(First spray put on by Mr. Keane, June 3).
First spray, July 6.
Second spray, July 21.
Third spray, August 11.

The same formula was used here as on the Rainbow Ranch block. This was applied with guns attached to a 8-horsepower Hardie power-outfit carrying a gauge pressure of 280 to 300 pounds. In this block of trees, two rows of trees were dropped at the 2nd and 3rd sprays giving this result—1st spray, 8 rows; 2nd spray, 6 rows; 3rd spray, 4 rows.

Owing to excessive temperatures at the season when this work was carried out, it was deemed advisable to add the excess of lime to lime-sulphur as a neutralizing agent to prevent spray-burn and russeting.

I am pleased to state this was an absolute success, as no evidence of russeting or spray-burn became apparent throughout the period.

Spray-burn injury had, however, occurred on the Keane orchard previous to our operations from an application of lime-sulphur without added lime put on by the owner.

In applying the spray, care was taken to cover thoroughly every portion of the tree. The amount of spray used per tree per spray on the Rainbow Ranch block averaged 7½ gallons, trees 13 years old.

The Keane block has not been worked out as no actual tree-count was made, but it would closely approximate the amount used on the Rainbow block as the trees, I think, are of the same age.

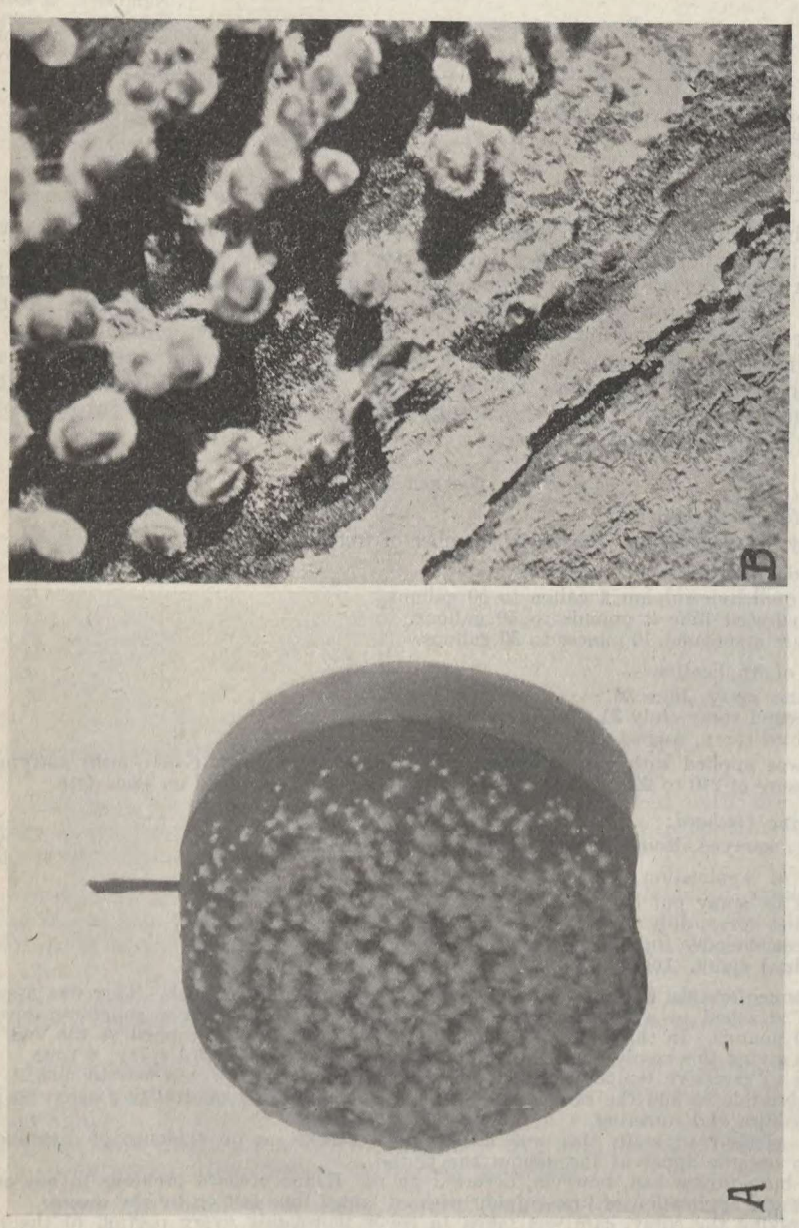


Fig. 16.—(*a*) Rot produced in Wealthy from artificial inoculation. Apple kept in a moist chamber. (*b*) Magnification by twenty, showing the fruiting bodies as they appear underneath the epidermis.

This coming winter we are taking typical trees in each of the sprayed plots and, by marking all the old cankers, we will be able to ascertain what effect the spray-programme has had in preventing the formation of new cankers.

INOCULATIONS OF THE CAUSAL ORGANISM.—Commencing on May 7 and finishing on November 24, inoculations were made on thirty different dates throughout the summer and fall on Rome Beauty trees at the Laboratory with spores taken either from pure cultures or from the canker itself. Inoculations were made by causing an abrasion of the bark with a scalpel or needle and then applying the spores to the wound. Of these inoculations, eight have taken. Re-isolations from these have produced a fungus similar in all respects to that used in the inoculations. Its pathogenicity, therefore, is considered established. (Figure 14 A.)

CLASSIFICATION OF THE DISEASE.—Very recently, August, 1925, a bulletin has been published on this disease by Zeller and Childs of the Oregon Agricultural College. These authors are calling the fungus *Gloeosporium perennans* and the canker the "Perennial canker." Their technical description appears in the Oregon Station Bulletin 217, August, 1925.

FRUIT ROT

So far as we know, this fungus has not been in this respect a serious offender in British Columbia. Apples rotting with this fungus have been collected from storage, but its occurrence is rare. Inoculation tests have shown that the rot is a very slow one; a rot on inoculated fruit kept in a moist chamber was usually not more than one inch in diameter in a month's time. Rots have been produced in the laboratory in five different varieties, namely, Yellow Newtown, Wealthy, McIntosh, Rome Beauty and Yellow Transparent. (Figure 16 A.)

VEGETABLE DISEASES

The importance of the vegetable-growing industry in the Okanagan Valley has increased greatly during the last few years. As indicative of this, the acreage planted to potatoes, tomatoes and onions in 1924 was 5,452 while in 1925 this had increased to 8,179. The importance of the industry is now such as to demand very considerable attention from the pathological standpoint. Reports of many losses in these crops are continually coming to the laboratory, and as a preliminary to entering on a definite series of investigations, a careful survey of the whole district was carried out during the summer.

In all, some thirty-three diseases of economic importance were recorded, and among these, there are several which are presenting a serious problem to the growers, and on which investigations ought to be carried out immediately. Among these might be mentioned the following:—

TOMATOES.—1. Grand Rapids disease (*Aplanobacter michiganense, E.F.S.*). —During the past season this was one of the most serious diseases affecting this crop. It was very widespread, the average infection being between 3 and 5 per cent; in a few particular cases, however, infection running as high as 40 per cent.

From field observations it would seem that the pathogen is seed-borne, although this is not shown by preliminary laboratory tests. The first appearance of the disease in the field is usually at the time when the plants are from ten inches to a foot high. The young, succulent, growing tips and the first flowers wilt and turn brown and about a week later the plant dies. An examination of the stems and petioles even at an early stage shows the characteristic browning of the xylem and in advanced cases, of the pith as well. Ten days to two weeks later, what seems to be a secondary infection shows up. (For

complete description of a diseased plant at this stage, see the Annual Report, 1924.). The symptoms are similar for all later infections. The later the infection, the less the likelihood of the plant dying and consequently less loss is sustained. In most cases of secondary infection, there is a decided tendency to premature ripening of the fruit, which is usually small in size and may be mis-shapen. Fruit set before infection takes place is not as a rule much affected.

To date, no work has been done at this Laboratory with regard to resistant varieties or general control methods.

Soft rot (Bacterial). A bacterial soft rot of tomatoes was quite prevalent in many places. A bacterium was isolated, which preliminary laboratory tests have shown to be different from both *Bacillus carotovorus* Jones, and *B. aroideae* Townsend. Further work should be done to establish its identity. The pathogen seems to be a wound-parasite and causes a colourless soft rot. Green fruits are more susceptible than ripe ones. Losses caused by this rot this year were of commercial importance.

ONIONS.—Botrytis and other storage rots. The onion-growing industry has assumed, in recent years, very considerable proportions in this district. Every year, however, heavy losses are sustained in storage, owing to "shrinkage." The "shrinkage" is due chiefly to losses caused by storage rots, *Botrytis Allii* Munn being the fungus which has been most commonly found. The seriousness of this may be realized when, out of 23,000 sacks placed in storage in 1924 by one selling organization, 9,460 were lost because of this so-called "shrinkage." Investigations to obtain a control over such losses which will be suitable for our conditions are most urgently needed.

MANGELS.—A very serious condition developed in mangels in the district about Kelowna. It was present in a varying degree in almost every field examined, the infection running from 10 per cent up to one case of 80 per cent.

The first symptom is a cracking and wilting down of the outside leaves. Later the young leaves in the centre at the crown turn black and shrivel up, even before they have properly unrolled. When the roots are well grown, large, more or less lateral cracks appear in them. These cracks may be more than half the diameter of the root in depth, and up to two inches in width at the surface. No rotting is apparent at this stage, but the exposed tissue is blackened and dry. The latest stage in the field is a crown rot that sets in about harvesting time.

A species of *Phoma*, as well as one of *Alternaria* and a *Fusarium* were isolated from the cracks and blackened leaves, but which of these, if any, is actually the pathogen has not been established. It seems very probable that the trouble is to quite an extent physiological, brought about by certain conditions of soil and moisture.

In one case where mangels were grown on light land, a good irrigation was applied to a patch which showed about 95 per cent infection, the leaves being cracked and wilted down with the disease. In about two weeks recovery was almost complete. At the time the irrigation was applied, the crown leaves were just beginning to turn black and no cracks had appeared in the roots.

LETTUCE.—Tip-burn (Physiological). This trouble prevents the growing of head lettuce commercially in the dry regions of British Columbia, where the production of this commodity could be, otherwise, a financial success. This disease is, of course, well known throughout the Pacific Northwest, but no satisfactory control measures have as yet been found. Further information on the subject ought to be obtained as soon as possible.

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