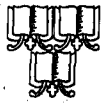
DOMINION OF CANADA
DEPARTMENT OF AGRICULTURE
DOMINION EXPERIMENTAL FARMS

DIVISION OF BOTANY

INTERIM REPORT

FOR THE YEAR ENDING MARCH 31, 1921



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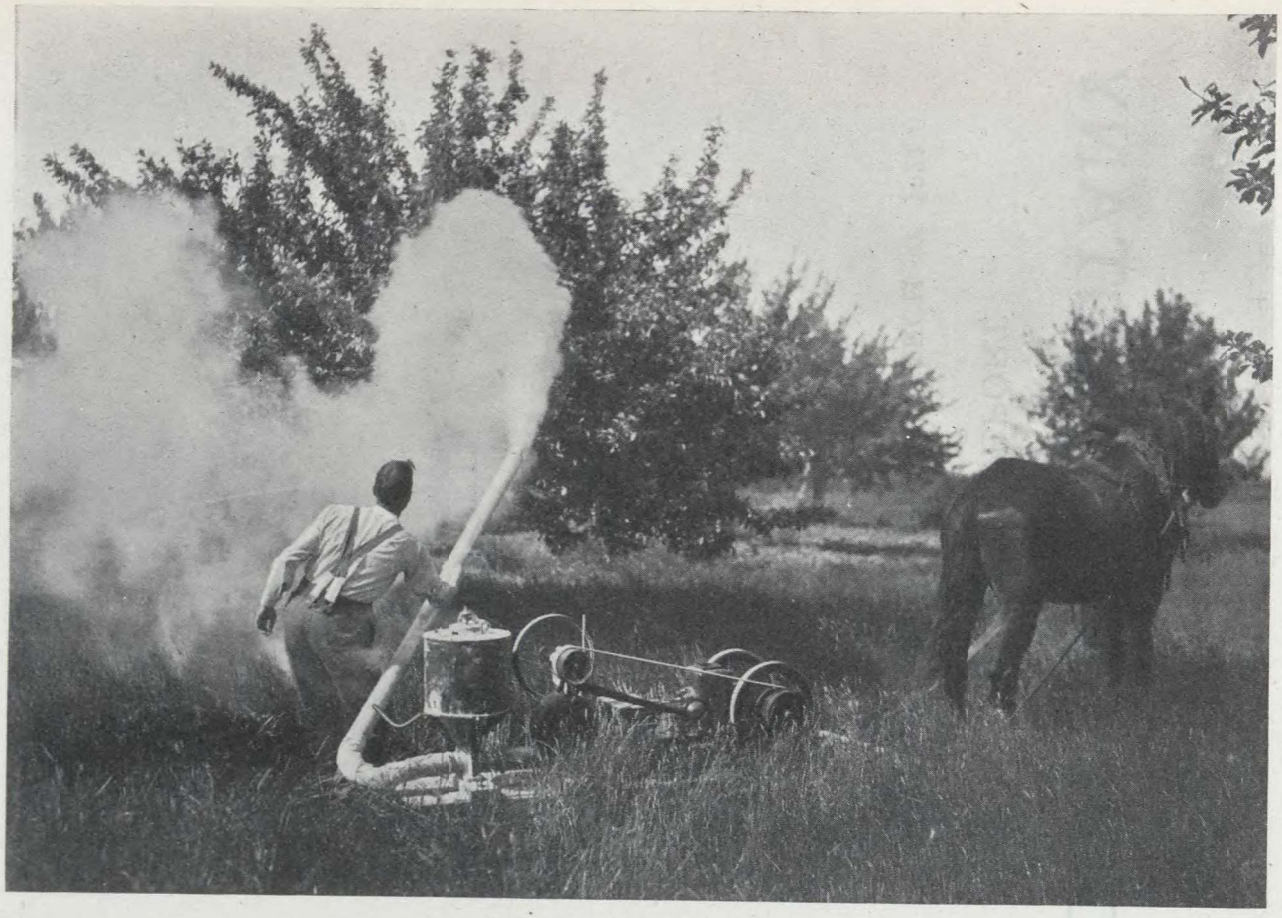

Dusting machine in operation.

(Photo by P. A. Murphy.)

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DIVISION OF BOTANY

Annual Report for the Year Ending March 31, 1921

In the preparation of this report, consideration has been given to the fact that during the past few years considerable experimental and research data have, for economic reasons, remained unpublished. Its pages will therefore be found to contain not only an account of the work of the past year, but also a resumé of the work accomplished during the period in which publication in detail was not practicable. Herein will be found detailed reports prepared by the officers in charge of the several phases of work at the Central Laboratory and from the officers in charge of the Branch Laboratories at Charlottetown, P.E.I., Fredericton, N.B., St. Catharines, Ont., and Saskatoon, Sask. These reports are regarded as bringing the work of the division up-to-date.

During the year a report on the Plant Disease Survey was prepared and published in multigraphed form, and a bulletin on Researches on Potato Diseases was prepared and is now in the press.

The work of the division is directed from the Central Laboratory, the main divisions being

Administrative (Central and Branch Laboratories), Administration of the Destructive Insect and Pest Act (plant disease section) including seed potato inspection and certification,
Economic Botany,
Forest Pathology,
Mycology,
Plant Pathology.

The staff of the division now numbers twenty-six permanent and eighteen temporary and seasonal employees. It is here desired to express appreciation of the satisfactory work and devotion to their duties of every member of the staff. This is the more worthy of note when consideration is given to the fact that many members are located at long distances and are therefore able to get in personal touch with headquarters only very occasionally.

POTATO INSPECTION SERVICE

During the past year, the sixth of its existence, this service, which has undergone gradual expansion since its inception on a small scale in New Brunswick and Prince Edward Island, was further expanded to allow for the commencement of seed certification in Manitoba and for an extensive survey of the more important potato-growing districts of Saskatchewan and Alberta. Also, although seed certification was not generally put into practice in southern Ontario, a considerable amount of tuber inspection was for the first time carried on during the fall and early winter,

with the object of ascertaining the condition of crops harvested from fields which upon inspection during the growing season had been found to come well up to the standard set for field inspection. It may here be mentioned that a considerable quantity of first-class seed of the Dooley variety was thus located in Caradoc township, Middlesex county, a carload of which was subsequently purchased under our certification by the Ontario Department of Agriculture for demonstration purposes.

The expansion of the work referred to above, may be summarized as follows:—

Year	Work engaged in
1915	Limited survey of fields in New Brunswick, Nova Scotia and Prince Edward Island, during the growing season, supplemented by an inspection of tubers in the fall.
1916	Survey continued and extended in New Brunswick, Nova Scotia, Prince Edward Island, and a limited number of crops certified to as reasonably free from disease, including certification of Garnet Chili seed potatoes for Bermuda. Limited survey of fields in Quebec.
1917	Inspection and certification of crops in Prince Edward Island, Nova Scotia (Garnet Chili), and New Brunswick. Survey continued and extended in Quebec. Limited survey of fields in northern and southern Ontario.
1918	Inspection and certification of crops in Prince Edward Island, Nova Scotia (Garnet Chili), New Brunswick, Quebec and northern Ontario. Survey continued and extended in southern Ontario. Limited survey of fields in Manitoba.
1919	Inspection and certification of crops in Prince Edward Island, Nova Scotia (Garnet Chili), New Brunswick, Quebec and northern Ontario. Survey of fields in southern Ontario and Manitoba continued and extended.
1920	Inspection and certification of crops in Prince Edward Island, Nova Scotia, New Brunswick, Quebec, northern and southern Ontario and Manitoba. Extensive survey of fields in Saskatchewan and Alberta.

For three years following its inception this work was conducted in Prince Edward Island and Nova Scotia by the officer in charge of the Charlottetown Laboratory, and in New Brunswick and Quebec by the officer in charge of the Fredericton Laboratory, who were each provided with a separate staff of inspectors, but in 1918, owing to continued expansion and the necessity for establishing uniformity as rapidly as possible, it was found advisable to place the whole under the control of one man, who would assume the duties of chief inspector. Mr. Paul A. Murphy, of the Charlottetown Laboratory, who was at that time in charge of potato disease investigations, assumed these duties and continued them up to the date of his resignation. It had, however, long been felt that the headquarters of the Division of Botany was the logical place for the headquarters of this rapidly growing service; therefore, since the spring of 1920 it has been conducted directly from the Central Laboratory in immediate charge of the writer.

PRESENT METHODS OF INSPECTION

In the early spring, application forms are sent out to the growers individually, together with a letter inviting them, in the event of inspection being desired, to fill in and return the forms by a given date. All applications received are dealt with by provinces and by counties or districts, and the inspectors are assigned territories of sufficient dimensions to keep them employed to the best advantage, but without sacrificing quality of work for quantity.

The first inspection is made of the growing plants in order to ascertain to what extent, if any, such diseases as leaf roll and mosaic, which can only be distinguished by an examination of the plants, are present. It is also made as far as possible during the blossoming period, since, although the prime object of the inspection is from the standpoint of diseases, due attention is also paid to purity of variety, and the presence of foreign varieties is more easily detected at this time. The inspector makes a thorough examination of the field and records his findings from a count and critical examination of one hundred plants at each of three different parts of the field. A copy of these findings is then handed to the grower for his information. Verbal information is also given the grower by the inspector with regard to diseases which

may be in his field, and with regard to recognized measures necessary for their control. In this manner considerable knowledge is disseminated, which the interested grower is always glad to receive.

In the event of a field of potatoes not measuring up to the standard set, owing to the presence of too large a percentage of disease or foreign varieties, it is given no further consideration, the grower being advised to take steps to remedy matters by securing a change of seed from some reliable source, which the inspector is usually in a position to name from his records. Should a field be found to pass satisfactorily, it is classified at headquarters as grade 1 or grade 2, the grading depending upon the percentage of diseases recorded, and a second inspection is made at or after harvest time to ascertain to what extent—if any—diseases affecting the tubers, such as common scab, rhizoctonia, etc., are present. If this second inspection is satisfactory, and the grower agrees to grade his stock so that a shipment of potatoes for seed purposes contains no tubers under two ounces or above twelve ounces in weight, a sufficient number of tags to cover the number of bags or other containers necessary for the shipping of the amount of potatoes inspected, is issued by the inspector and placed by him upon the shipment at the point of loading.

The following particulars which were contained on the field and tuber inspection forms, and also on the tags used in 1920, go to show that in the course of the work a thorough inspection and inquiry into the condition of each and every field and crop is provided for. Some slight alterations and improvements in these forms have suggested themselves, but on the whole they were found to meet all requirements.

Original — DIVISION OF BOTANY — No. B.....

POTATO INSPECTION SERVICE

FIELD INSPECTION REPORT

Name and address of grower.....

.....County

Variety.....Area.....

Seed.....

Was this seed inspected last year?.....

—	Number present in 100 plants in three different parts of field			Average per cent.
Black leg				
Curly dwarf				
Leaf roll				
Mosaic slight				
Mosaic severe				
Wilts				
Weak plants				
Foreign				
Misses				

General condition of crop and other remarks, if any:

Indicate other diseases and insects with an X

—	Absent	Slight	Moderate	Severe
Early blight				
Late blight				
Rhizoctonia				
Tip burn				

Signed..... Date.....

Original — DIVISION OF BOTANY — No.....

POTATO INSPECTION SERVICE

TUBER INSPECTION REPORT

Name and address of grower.....

.....County

Variety.....Quantity.....

Seed.....

—	Number present in 100 tubers from four different parts of bin or pile				Average per cent.
Bacterial rot					
Deep stem end browning					
Dry rot (Fusarium)					
Late blight rot					
Net necrosis and internal spot					
Common scab					
Powdery scab					
Rhizoctonia					
Silver scurf					
Bruised or cut					
Foreign					
Frost injury					
Off type					

General appearance of crop and other remarks, if any:

Signed.....Date.....

TAG (front)—

Dominion of Canada — Department of Agriculture

SEED POTATO INSPECTION SERVICE

NO. 1 GRADE SEED POTATOES

No.....

Variety.....

Grown by.....

Year.....

TAG (*back*)

"This tag is issued for one container of potatoes and is to certify that satisfactory evidence has been given that the contents have been grown by the person whose name it bears, and that they have been inspected in the field and after harvest by an officer of the Dominion Department of Agriculture and have been found to be sufficiently vigorous and free from serious diseases, other pests and foreign varieties to warrant them being classed as No. 1 GRADE SEED POTATOES.

"This tag is issued on the express condition that the person who receives it, and whose name it bears, undertakes to grade the potatoes for which it is to be used so that they shall be practically free from rotted or otherwise seriously injured or blemished tubers, and so that not more than five per cent by weight of the tubers shall be below two ounces or above twelve ounces in weight; and on the further condition that the said person assumes entire responsibility for the contents of any package to which it may be attached by him."

STANDARDS

Until further work is accomplished it has not been found advisable to attempt the setting of permanent standards. The standards are accordingly amended or revised from year to year as conditions seem to warrant. Those set for the 1920 inspection were as follows:—

FIELD INSPECTION STANDARD, 1920

Black leg.....anything up to and inclusive of 3 per cent.
Curly dwarf and leaf roil....percentages added together, and not more than 2 per cent allowed.
Mosaic: slight and severe....percentages added together, and not more than 2 per cent allowed.
Wilts.....3 per cent.
Weak plants..... (*a*) If percentage is given as occurring in one part of the field, same will not be taken into consideration, since for this year it is considered that such occurrence is due to other factors than disease, viz., mechanical, chemical, entomological, etc.
(*b*) If percentage is uniform in two or more parts of the field, no more than 3 per cent allowed.
Foreign.....5 per cent.
Misses.....not taken into consideration.

(1) If black leg and wilt are present alone, 7 per cent allowed.
If black leg and wilt are present combined, 7 per cent allowed.
(2) If leaf roll and mosaic are present alone, 5 per cent allowed.
If leaf roll and mosaic are present combined, 5 per cent allowed.
(3) If a percentage of (1) and a percentage of (2) are present, 6 per cent allowed.
(4) Percentages of weak plants are included when figuring the above percentages, and in no case is a higher figure than a total of 7 per cent allowed in No. 1 grade.
In No. 2 grade, a total of 12 per cent, including weak plants, is allowed.

TUBER INSPECTION STANDARDS, 1920

	Per cent
Bacterial rot and dry rot (Fusarium)	2
Late blight,, stem end browning and net necrosis	3
Common scab; slight, 1-5 spots	10
Common scab; severe	2
Powdery scab	1
Rhizoctonia	3
Silver scurf	3
Bruised or cut	1
Foreign	2
Frost injury	No allowance
Off type	2

No. 1 grade shall not contain more than a total of 5 per cent of all diseases, injuries and impurities.

No. 2 grade shall not contain more than a total of 10 per cent of all diseases, injuries and impurities.

During the year under report, 7,613 acres of potatoes were inspected, of which 2,850¾ acres classified as grade 1, and 1,105½ acres as grade 2; an average of 51·9 per cent. In the following table will be found the figures and averages for each province:

Province	Acreage inspected	Acreage passed as Grade 1	Acreage passed as Grade 2	Percentage passed
Prince Edward Island	886	523	230	84·9
New Brunswick	1,413½	661½	206½	61·4
Nova Scotia	379	298	17	83·1
Quebec	3,868½	837	448½	33·2
Northern Ontario	472	256½	128½	81·4
Manitoba	594	275	75	58·9
	7,613	2,850¾	1,105½	51·9

In addition, approximately 3,000 acres were surveyed in southern Ontario, Saskatchewan and Alberta.

The disparity existing between the number of acres inspected and the number passed in the province of Quebec is not an indication of the presence of a much higher percentage of disease than in other provinces. In many instances it was found that although the crops would pass inspection from this standpoint, the presence of a high percentage of "mixed" or "unknown" varieties disqualified them for any consideration for seed. However, a vigorous campaign was carried on during the year by the Provincial Department of Agriculture, and by the inspection service, with the object of inducing the growers to introduce pure seed of one variety into their fields. The Provincial Department also purchased a quantity of certified seed from New Brunswick for distribution and demonstration purposes, with the prospect that a much better showing will be the result in the course of a few years.

Tuber inspection was commenced as soon as digging became general and, including a final inspection at points where certified seed was shipped, occupied the time of the available inspectors during the fall and well into the winter. The final inspection at the shipping points before tags were attached to bags or containers, was put into practice for the first time during the past season, experience previously gained indicating this to be essential. The amount of tubers inspected and passed, subject to the grading regulations, in bins and cellars, will be found below:—

Prince Edward Island	21,645	bushels
Nova Scotia	41,412	"
New Brunswick	135,065	"
Quebec	86,220	"
Northern Ontario	19,690	"
Manitoba	33,485	"
Total	337,517	"

ADMINISTRATION

The nature of the service and its present wide scope naturally call for the devotion of much time and attention to the many and varied administrative details involved. The office work alone was particularly heavy during the past year. This will be obvious from a study of the inspection figures and also when it is explained that a special filing system is maintained and kept up to date, containing particulars of every one of the many crops inspected, together with the source and history of the seed. This will in time become a valuable bureau of information, and has already proven of great assistance for reference and for checking the work of the inspectors from year to year.

The work of examining and classifying the field inspection reports also assumed considerable proportions during the past year.

STAFF

The inspection staff has in the past been composed mainly of "seasonal" employees. However, during last year it was found possible to have permanent men, who assumed the duties of supervisors, located one in each of the provinces of Prince Edward Island, Nova Scotia, New Brunswick, Quebec, Ontario, and Manitoba. This arrangement proved very satisfactory, the men assigned all being tried and experienced inspectors.

The work of the "seasonal" employees was, on the whole, satisfactory, but greater efficiency would undoubtedly result if the services of men appointed for the season and specially trained in the work, could be secured year after year, or, preferably, if their services, upon being found satisfactory, could be permanently retained. The inspection service will not attain the high degree of efficiency which is expected of it, so long as it is necessary to engage new and inexperienced help each season. This cannot perhaps be wholly avoided until a stage calling for a complete staff of permanent

men is arrived at, but in the meantime it is strongly recommended that as far as possible, men who have proved to be indispensable to the success of the work in a seasonal capacity, be re-appointed from year to year to their former positions, providing they are available.

The inspectors were distributed last season as follows:—

Prince Edward Island—
1 supervisor, 2 inspectors.
Nova Scotia—
1 supervisor, 1 inspector.
New Brunswick—
1 supervisor, 3 inspectors.
Quebec—
1 supervisor, 5 inspectors.
Ontario—
1 supervisor, 6 inspectors.
Manitoba and West—
1 supervisor, 2 inspectors.
Total, 26.

CO-OPERATION

The interest evinced, and the co-operation extended in connection with the work by all the Provincial Departments of Agriculture, who courteously placed at our disposal all available information and in some instances loaned men to assist during the busiest period of inspection, were outstanding features of the past year's work. Three men were loaned by the Ontario Department, three by the Quebec Department, and one by the New Brunswick Department.

In this connection it is desired to specially acknowledge the courtesy and interest of—

Mr. Wilfrid Boulter, Department of Agriculture, Charlottetown, P.E.I.
Dr. M. Cumming, Department of Agriculture, Truro, N.S.
Mr. E. P. Bradt, Department of Agriculture, Fredericton, N.B.
Mr. George Maheux, Department of Agriculture, Quebec, P.Q.
Mr. A. H. McLennan, Department of Agriculture, Toronto, Ont.
Mr. R. S. Duncan, Department of Agriculture, Toronto, Ont.
Mr. F. C. Hart, Department of Agriculture, Toronto, Ont.
Dr. G. R. Bisby, Department of Agriculture, Winnipeg, Man.
Mr. S. T. Newton, Department of Agriculture, Winnipeg, Man.
Mr. J. H. Booth, Department of Agriculture, Regina, Sask.
Prof. G. H. Cutler, Department of Agriculture, Edmonton, Alta.

The chief varieties of potatoes inspected last season were Green Mountain, Irish Cobbler, Early Ohio, Rural New Yorker, American Wonder and Garnet Chili; the latter variety being grown in Nova Scotia mainly for shipment to Bermuda. In every province some very fine fields were inspected, but considerable damage was caused by the general occurrence of late blight towards the end of the growing season. The crops which had given promise of being abnormal were thereby reduced considerably but still remained well up to the average.

SUMMARY OF RESULTS

A number of growers who planted certified seed and whose fields were classified as grade 1, were recently circularized requesting information as to the benefits (if any) which they have derived from the use of certified seed. The replies received to date indicate that an increase in crop, in some cases as high as twenty-five bushels per acre was noted. This, combined with the facts that the grower of seed worthy of certifica-

tion is able to obtain an enhanced price for his stock, and that certified seed is now in general demand in many parts of the country, encourages the belief that the campaign against potato diseases commenced some years ago, and of which the inspection service is the outcome, is proving of considerable value and importance.

An important adjunct to the work is the marketing of certified seed. This is in the hands of the Markets Division of the Seed Branch, and other organizations such as the Ontario Advisory Potato Council, the Prince Edward Island Potato Growers' Association, and the New Brunswick Potato Growers' Association. The Extension Service of the Manitoba Department of Agriculture is also arranging to assist the growers in that province in this way during the coming year. (Geo. Partridge).

FOREST PATHOLOGY

In Canada at present forestry has to do with natural forests in which there is no attempt made to control any of the loss factors, excepting that of fire. It is only a matter of time, however, until these forests will be managed under a system of annual sustained yield. In short, this means that the forest will be so arranged that annually, forever, there may be harvested in the most profitable form, the same amount of timber that is produced throughout the forest. The future forest will necessarily be grown under conditions in which all avoidable loss will be reduced to a minimum. To accomplish this it will be necessary to possess not only a knowledge of the factors which make for loss in the forest, but, in addition, a knowledge of the manner in which the trees and forest as a whole will respond to these factors. As far as forest pathology is concerned the first step in preparation for the time when scientific management will become effective is to take an inventory of the important forest tree diseases and to study them from the botanical viewpoint. While this work is most important, it is not economical when considered in relation to the present, but it is decidedly so when viewed from the standpoint of the future.

During the summer of 1919 some time was spent in the Timagami forest reserve in northern Ontario studying the leaf blight of white pine and various heart-rots of conifers. This reserve, which lies about 40 miles southwest of Cobalt, consists of about 5,900 square miles of virgin forest in which the most important species are white and red pine.

Leaf blight is a disease which seems to be confined to the white pine. It is characterized by the death of the distal portion of the leaf for about half its length, though the entire leaf may be killed. In the early stages of the disease the leaf assumes a characteristic reddish-brown colour which is different from that which results from winter injury. The leaves become affected about the time when they have completed their season's growth. In Timagami in 1919 the leaves appeared quite normal until about June 28, and then within a week hundreds of blighted trees could be seen throughout the forest.

This disease has been known in America for many years now, but in New England where it has been studied it is not considered to be at all serious. In Canada it is apparently present throughout the range of the white pine and in some districts it is undoubtedly doing considerable damage. While trees of all ages are affected, the young ones usually recover, the mortality being confined to mature trees.

The cause of blight is unknown. As a result of studies made in 1908 in New England it was thought that possibly the disease might be due to the extreme climatic conditions which had prevailed during the few preceding winters. This explanation is hardly tenable for a disease which has now been present for so many years. The only clue which was obtained as a result of the work in Timagami was from an examination of the root systems of diseased trees. It was found that most of the root systems of these trees were dead and that mycorrhiza, which were abundant on

the roots of healthy trees, were entirely absent. The cause of the death of the roots and a determination of the ability of such injury to produce the conditions of blight are points for further study.

Heart-rot of various kinds was found to be very prevalent in Timagami. On some of the islands in lake Timagami almost 100 per cent of the trees were found to be so affected. Besides the actual injuries done by heart-wood being destroyed by the responsible fungi, a great deal of secondary damage results from wind-throw. Pine, spruce, balsam, and cedar are all affected in this manner. The fungi which are chiefly the cause of this type of injury are *Polyporus Schweinitzii, Trametes Pini, and Fomes pinicola.* Among the hardwoods white heart-rot caused by *Fomes igniarius* was common in poplars.

The disease caused by *Napicladium tremulæ* was very prevalent on *Populus tremuloides* and *Populus grandidentata.* It is characterized by the death of the young shoots and the shrivelling of the leaves. The tips of the shoots curl up and become dark in colour, while the leaves at first become olive-green, mostly on the lower surface, and later become dried out and very dark in colour. The olive-green colour is due to the felty coating of the leaf with the conidia of this fungus.

WHITE PINE BLISTER RUST

Though this disease was first found in America at Geneva, New York state, in 1906, it was not observed in Canada until September, 1914, when infected currants were found in the grounds of the Ontario Agricultural College at Guelph. A hurried survey was at once undertaken by Mr W. A. McCubbin to determine to what extent the rust was present in the province. It was found to be generally present throughout a large part of the Niagara peninsula, where currant plantations are numerous and close together.

In 1915 inspection of currants was continued in the peninsula and the rust was found present throughout this district. An examination of European white pine nursery stock which had been planted in Ontario was made and the disease was found in six nurseries and private plantations. Rust was also found on native white pines in the vicinity of Fonthill, in the Niagara peninsula. The age of the cankers on these trees indicated that the disease had been present since 1910 at least and possibly since 1908. Small isolated areas of infection were found outside the peninsula, as at Cookstown, in Simcoe county, and at Bowmanville, in Durham county. It is probable that the rust had been present at Cookstown for five or six years previous. Infected currants were found at Macdonald College, P.Q., in this year.

In 1916 the Dominion and Provincial Governments co-operated in the blister rust work and the disease was found in several new localities outside the peninsula. At this time it was believed that the rust could be eliminated, at least from these isolated areas, and a great deal of eradication of both pines and currants was done.

In 1917 eradication was continued on an extensive scale, and in addition to the general work of this nature a strip along the Niagara river, one mile in width, was cleared of all species of *Ribes* both wild and cultivated. The purpose of this strip was to prevent the rust from spreading from Ontario into New York state, though it was known at the time that the disease was already present there. The inspection of pine plantations of European origin was continued and all infected pines found were destroyed. As a result of the scouting done in this year the rust was found to be present in thirty-eight out of the forty-two counties in Ontario.

In 1918 it was realized that the rust could not be eradicated and efforts were made to devise some effective control measures. To this end four control areas were established to be kept under observation for a period of ten or fifteen years. In these areas, which were composed principally of young white pines and varied in size from five to ten acres, all species of *Ribes* were destroyed. Also for a distance

of 500 yards of all sides of the area both wild and cultivated *Ribes* were taken out. The purpose was to ascertain if the young pines, protected in this manner, could be grown free, or comparatively free, from the rust. It was thought that the disease, would not be able to spread across the sterile zone surrounding the pine areas.

In order to ascertain the percentage of infected pines in districts where the rust was known to have been present for a number of years and to determine what damage the disease was doing to these trees a survey of young pines was made in Ontario. This survey covered the trees up to a height of about ten feet in thirty-five woodlots. The trees were counted and a record made of those which were infected. Most of the woodlots were located in Niagara peninsula, where the disease had been present for at least eight years and where conditions for infection and distribution were highly favourable.

Scouting for the rust in New Brunswick, northern Ontario, Manitoba, Saskatchewan and Alberta failed to reveal its presence. The work of the provincial authorities in British Columbia along this line also gave negative results.

In May, 1919, Mr. McCubbin resigned and the work was carried on under the supervision of Mr. P. A. Murphy, who was temporarily transferred to the St. Catharines Laboratory. The control areas which had been established in 1918 were examined and a fifth area was added in Quebec. The pine woodlots were also gone over again. A great deal of scouting was done in the northern counties of Ontario.

In October, 1919, Dr. W. H. Rankin, was appointed to the St. Catharines Laboratory and the work done in 1920 was outlined by him. This work consisted in the taking of records in the control areas and pine woodlots. Following are the records from the control areas for this year:—

Control Area No. 1, Welland county, Ontario. Established in 1918. This area contains 1,378 white pines, one of which was found to be diseased. In addition 36 wild *Ribes* were found within the plot and were eradicated.

Control Area No. 2, Bowmanville, Ontario. Established in 1918. Fifteen diseased trees were found in this area and 22 wild *Ribes* were found within the 500-yard zone. These latter were uninfected.

Control Area No. 3, Carillon, Quebec. Established in 1918. There are about 1,556 pines in this area none of which were diseased. In the 500-yard zone 53 uninfected *Ribes* were found and destroyed.

Control Area No. 4, Berthierville, Quebec. Established in 1918. There were no cultivated *Ribes* near this area. Of the 935 pines none were found to be diseased. No wild *Ribes* were found either within the area or the 500-yard zone.

Control Area No. 5, Lachute, Quebec. Established in 1919. This area contains 900 pines, none of which were diseased. This plantation has been made in a field upon drifting sand for purposes of protection. There were no *Ribes* to be eradicated this year.

It is very doubtful if these control areas should be maintained because, since they were established, it has been shown that under average conditions the dispersal of sporidia is not effective at a greater distance than 200 yards. This fact, of course, nullifies the purpose for which the areas were established.

In the following table, which gives a comparison of the results obtained from the pine survey for 1918, 1919, and 1920, it will be noticed that the percentage of diseased trees found in 1919 and 1920 is the same and represents a negligible increase over that of 1918. It would seem, therefore, that the disease is not progressing very rapidly. Considering that an average of about 2 per cent of the white pine has been infected in a district such as Niagara peninsula, where conditions for infection are extremely favourable, and this, after the disease has been present for ten years or possibly longer, it is difficult to appreciate the viewpoint of those who regard this fungus as such a deadly enemy of white pine forests. It is true that in Europe it has proved to be destructive to our native white pine, but that it will act similarly

here cannot be taken for granted. So far, in this country at least, no data have been gathered to show what effect the rust is having upon the pines which it has attacked. Next year it is proposed to secure information on this question.

In making the pine survey it is evident from the notes taken that three factors are concerned in the infection of pines. These are:—

(1) The proximity of cultivated *Ribes*.
(2) The number of wild *Ribes* present.
(3) The moistness of the situation.

In natural pine forests in Canada the first of these would be entirely eliminated and also the third to a large degree since the white pine is a species which normally occurs on light soils in dry situations. Just to what extent wild *Ribes* occur under these conditions is not known but it is doubtful if they would be present in sufficient numbers seriously to affect the pines, provided that the rust is capable of injuring that host on a large scale. (A. W. McCallum.)

WHITE PINE WOODLOT SURVEY

No.	Total No. Pines	1918			1919			1920		
		No. inspected	No. infected	Per cent infected	No. inspected	No. infected	Per cent infected	No. inspected	No. infected	Per cent infected
1	a 320	320	27	8·4	.....	.....	.....	300	20	6·6
	b 2,200	2,200	0	0·0	607	15	2·5	1,500	0	0·0
	c 420	400	1	0·2	.....	.....	.....	420	1	0·2
2	1,275	1,275	2	0·1	1,200	0	0·0	680	4	0·6
3	833	663	0	0·0	700	0	0·0	650	0	0·0
4	2,700	1,004	18	1·8	1,022	21	2·0	1,025	25	2·4
5	300	260	4	1·5	200	3	1·5	300	18	6·0
6	2,200	2,121	15	0·7	1,800	11	0·6	2,200	22	1·0
7	1,500	763	2	0·3	1,100	4	0·4	1,200	3	0·3
8	385	385	1	0·3		(t	rees all	cut dow	n)	
9	2,500	1,259	0	0·0	1,000	0	0·0	1,250	0	0·0
10	155	155	52	33·5	155	45	30·0	125	37	30·0
11	1,875	875	0	0·0	(not	examin	ed)	875	0	0·0
12	200	100	0	0·0	.....	.....	.....	100	0	0·0
13	260	260	0	0·0	200	0	0·0	260	0	0·0
14	65	57	0	0·0	(not	examin	ed)	62	0	0·0
15	65	58	0	0·0	60	0	0·0	60	0	0·0
16	260	250	1	0·3	.....	.....	.....	260	0	0·0
17	50	50	0	0·0	(not	examin	ed)	50	0	0·0
18	75	70	0	0·0	.....	.....	.....	75	0	0·0
19	504	504	0	0·0	400	0	0·0	380	0	0·0
20	50	50	0	0·0	50	0	0·0	50	0	0·0
21	140	136	6	4·4	136	6	4·4	140	7	5·0
22	98	98	19	20·0	100	20	20·0	50	6	12·0
23	475	160	20	12·5	460	40	8·7	475	57	12·0
24	200	137	16	11·7	150	11	7·3	140	14	10·0
25	330	330	36	11·0	296	21	7·0	300	22	7·0
26	1,000	350	0	0·0	400	0	0·0	350	0	0·0
27	55	50	0	0·0	55	0	0·0	50	0	0·0
28	500	200	0	0·0	350	0	0·0	210	0	0·0
29	many	a 150	11	7·3	60	4	6·6	100	18	18·0
		b 152	34	22·3	60	2	3·3	100	22	22·0
		c.....	.....	.....	107	29	27·1	100	28	28·0
30	300	280	1	0·4	286	0	0·0	300	0	0·0
31	100	85	0	0·0	83	0	0·0	80	0	0·0
32	125	107	1	1·0	111	0	0·0	100	0	0·0
33	1,000	840	1	0·0	440	0	0·0	600	0	0·0
34	100	100	2	2·0	(no	t record	ed)	100	0	0·0
35	300	.....	.....	.....	240	0	0·0	250	0	0·0
36	150				88	0	0·0	120	0	0·0
37	50	(E	stablish	ed)	36	0	0·0	50	0	0·0
38	75		in		60	0	0·0	72	0	0·0
39	85		1919		72	0	0·0	78	0	0·0
40	250				250	0	0·0	250	0	0·0
41	400				350	0	0·0	350	0	0·0
42	many	260	1	0·4	210	1	0·5	250	1	0·4

SUMMARY OF PINE SURVEY

District	Pine Woodlots			Pines examined	Pines diseased	Per cent diseased Pines
	Examined	Diseased	Free			
In 1918—						
Niagara Peninsula	22	19	3	13,590	270	2·0
Oakville	10	1	9	2,274	1	0·04
Simcoe	3	0	3	600	0	0·0
Total	35	20	15	16,464	271	1·6
In 1919—						
Niagara Peninsula	25	13	12	10,283	233	2·3
Oakville	6	0	6	1,310	0	0·0
Simcoe	3	0	3	805	0	0·0
Total	34	13	21	12,398	233	1·9
In 1920—						
Niagara Peninsula	26	14	12	12,485	305	2·4
Oakville	10	0	10	2,772	0	0·0
Simcoe	3	0	3	610	0	0·0
Total	39	14	25	15,867	305	1·9

POTATO COMMON SCAB INVESTIGATIONS

Common scab, while not classed as a serious disease of the potato, causes great financial loss to growers, because scabby potatoes cannot command the top market price and in some cases, where the disease is bad, a large proportion of the crop may be unmarketable. A completely satisfactory method for the control of this disease is as yet unknown, and the author has undertaken this investigation in the hope of being able to throw some light on the subject.

In 1890, Thaxter (1), established the fact that the disease was caused by a parasite organism, which he named *Oospora scabies*. This name was corrected by Güssow (2) in 1914 to *Actinomyces scabies*. This knowledge has opened up the possibility of being able to control the disease either by seed treatment with disinfectants, so as to kill the organisms in the lesions on the tuber, or by soil treatment, to produce conditions in the soil unfavourable for the growth of the organism. A great deal of work has been done on the seed treatment method of control, and a certain amount of success has been obtained, but as a general method of control it has not been uniformly successful. The author has attempted to isolate *Actinomyces* from twenty-three samples of potato soils taken from various parts of the Dominion, and the results will in some measure give an explanation for the frequent unsuccessful application of the seed treatment. In sixteen of the samples there was no difficulty in obtaining a large number of *Actinomyces* colonies, the counts running as high as 968,750 organisms per gram of soil and never lower than 125,000. Also, L. R. Jones and A. W. Edson (3) report that scabby potatoes have been obtained from soil recently cleared of pines and also from land not under cultivation for at least twenty-five years. This evidence goes to show that the *Actinomyces* organism occurs normally in most soils; therefore it is very evident that potatoes grown in these soils would become scabby whether or not the seed had been previously treated, which is borne out in practice. This does not mean that seed treatment of potatoes is to be entirely discouraged, because it is of value in the control of *Rhizoctonia* and black leg, and also there are some soils which have few or none of the *Actinomyces* and planting scabby seed potatoes would be a means of introducing the organisms in close contact with the growing tubers. These soils in which no *Actinomyces* can be found will be referred to further on.

With regard to the other method of scab control mentioned above, that of soil treatment to bring about conditions unfavourable for the growth of the *Actinomyces*

without affecting the growth of the potato plant; there are two conditions of the soil which are the most important and have the greatest bearing on the production of scab, those of temperature and acidity. L. R. Jones and H. H. McKenney (4) have demonstrated that the optimum soil temperature for scab infection is 24°C. (75°F.). This factor, so far, is not one which is alterable economically by any method of cultivation or treatment; but with the acidity, it has been shown that by turning under such crops as rye, buckwheat, or soy beans (5), or particularly by the applications of acid fertilizers, sulphur or bacterized sulphur, it is possible to raise the acidity of the soil temporarily; and H. W. Martin (6) has shown that this condition inhibits the growth of the *Actinomyces,* so preventing potatoes grown in that soil from becoming infected. In artificial cultures also, Gillespie (7) has shown that there is a definite limit to the acid tolerance for the growth of the *Actinomyces.*

W. A. Millard (8), working at the University of Leeds, observed that the scab organism was more virulent on light, sandy or sharp, gravelly soil, appeared to a lesser extent on heavier soils, was practically unknown on peat and was frequently associated with the presence of ashes in the soil. He then carried on some experiments suggested by the conclusion arrived at by Seton and Stewart—that there was a relationship between the virulence of the disease and the moisture holding capacity of the soil. By the addition of green lawn mowings to the soil infected with scab organism he was able to harvest a clean crop where the check plot was badly scabbed. He concludes from this that the organisms are primarily saprophytic, thriving mainly on plant residues and aiding in the early stages of its decomposition, and only when the soil is deficient in the plant residues do the organisms become parasitic on the potato tubers.

It would have been interesting if Professor Millard had tested these soils, to which he had added the lawn mowings, as to the Hydrogen ion concentration of their water extracts, so as not to overlook the effect of this possible changed condition of the soil.

In the isolations of *Actinomyces* made by the author, as stated before, large counts were obtained from the majority of the soils, but in six of the twenty-three samples it was impossible to obtain any *Actinomyces.* These were all found to be of measurably greater Hydrogen ion concentration and were principally peat or mixture of peat and clay, the types of soil which Professor Millard observed did not produce scab. According to this author's interpretation one would reasonably expect to find considerable numbers of *Actinomyces* in these soils, because of the presence of large quantities of organic matter which he claimed was their normal food, but the entire absence of the *Actinomyces* and also the freedom from scab of potatoes grown in these soils, would appear to be better accounted for by the higher Hydrogen ion concentration, which inhibited the growth of the *Actinomyces* in them.

Since writing the above, Professor Millard has addressed the Association of Economic Biologists in London on "Green Plant Matter as a Decoy for *Actinomyces scabies* in the Soil," but unfortunately the text of this address has not yet come to hand.

From two hundred and fifty or more isolations made by the author from soils and scabby tubers, thirty-five distinct types were differentiated by the use of Czapek's agar and chosen for further study, especially with regard to their morphology, acid tolerance in artificial media and their comparative pathogenicity.

It may be premature to venture an opinion, but it is certainly remarkable that throughout the experiments, the presence or absence of *Actinomyces* has appeared to be dependent on the Hydrogen ion concentration as determined in the soils examined. Further research along these lines, it is hoped, may reveal rather interesting factors relative to the control of this widespread disease. (F. L. Drayton.)

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REFERENCES

(1) Connecticut Agricultural Experimental Station Report for 1890.

(2) Güssow, H. T. The Systematic Position of the Organism of Common Potato Scab. Science N.S., 39, p. 431-432.

(3) Jones, L. R., and Edson, A. W. Report of the Botanists III. Potato Scab Experiments of 1901. Vt. Agr. Exp. 14, p. 231-235, 1901.

(4) Jones, L. R., and McKinney, H. H. The Influence of Soil Temperature on the Development of Potato Scab. (Abstract) Phytopathology 10, p. 63. Jan., 1920.

(5) Hill, H. H. A comparison of methods for determining soil acidity and a study of the effects of green manure on soil acidity, Virginia Agricultural Experimental Station Bulletin, No. 19, 1919.

(6) Martin, W. H. The relation of Sulphur to soil acidity and to the control of potato scab. Soil Science, 9, 6, 239-409, 1920.

(7) Gillespie, L. J. The growth of the potato scab organism at various Hydrogen ion concentrations as related to the comparative freedom of acid soils from the potato scab. Phytopathology, 8, 6, 257-269, 1918.

(8) Millard, W. A. Common Scab of Potatoes. The Jour. Min. Agr., 28, 1, p. 49, 1921.

ACETALDEHYDE AS A FUNGICIDE

The experiments here reported were tried as an outcome of a communication from the Canadian Electro Products Company, Limited, asking whether acetaldehyde could be used to replace formalin as a fungicide. The following are the experiments which were carried out in the season of 1920 and the results obtained therefrom.

No. 1.—A comparison of acetaldehyde and formaldehyde solution in their effect on the germination of wheat, hulled and hulless oats, hulled and hulless barley. The commercial formalin being a 40 per cent solution of formaldehyde, the acetaldehyde was diluted to the same strength for convenience, and the following percentage strengths are with relation to this 40 per cent stock solution.

GERMINATION PERCENTAGE

Grain used	Formalin ·25%	Acetaldehyde 2·5%	Acetaldehyde 5%	Check
Wheat, Marquis	66%	83%	78%	83%
Oats, Liberty (hulless)	48%	71%	72%	78%
Oats, Banner	80%	84%	89%	89%
Barley, Manchurian	69%	79%	87%	87%
Barley, Caucasian (hulless)	55%	61%	63%	63%

It will be seen that the acetaldehyde had little or no effect on the germination, though used in strengths ten and twenty times as great as that of the formalin. The formalin caused considerable damage, especially to the hulless oats.

No. 2.—A comparison of formaldehyde and acetaldehyde solutions of one-half per cent to 40 per cent strength in their effect on the germination of wheat, hulled and hulless oats, hulled and hulless barley.

Grain used	40%		30%		20%		10%	
	F.	A.	F.	A.	F.	A.	F.	A.
	%	%	%	%	%	%	%	
Wheat, Marquis	0	3	0	2	0	3	0	25
Oats, Liberty (hulless)	0	4	0	6	0	10	0	39
Oats, Banner	0	45	0	77	0	83	4	90
Barley, Manchurian	0	3	0	1	0	1	0	7
Barley, Caucasian (hulless)	0	21	0	17	0	15	0	39
	5%		1%		0·5%		Check	
	%	%	%	%	%	%	%	%
Wheat, Marquis	0	68	0	83	10·5	76	84·5	88
Oats, Liberty (hulless)	0	48	0	60	1	74	63	72
Oats, Banner	19	84	50	83	65	89	75	93
Barley, Manchurian	0	50	1	85	30·5	85	86	94
Barley, Caucasian (hulless)	0	61·5	0	62	4	67	62·5	68·5

F.—Formaldehyde A.—Acetaldehyde

The formalin in strengths over one per cent killed all the grain except the hulled Banner oats, and this too was killed in strengths over 10 per cent. The acetaldehyde in strengths from 10 per cent to 40 per cent did considerable damage to all the grains except to Banner oats; below this the damage was not great. It would appear that 5 per cent for acetaldehyde and 0.25 per cent for formalin are the maximum strengths of these solutions which can be employed without causing a very great loss to the germinability of the seed.

No. 3.—A comparison of acetaldehyde and formalin in the control of stinking smut of wheat and the covered smut of oats. The following strengths were employed:—

"A"—1,000 cc. water, add 2.5 cc. formalin solution of 40 per cent strength.

"B"—Dilute acetaldehyde (100 per cent pure) to 40 per cent solution (600 cc. water, add 400 cc. acetaldehyde) use 1,000 cc. water, add 2.5 cc. of above dilution.

"C"—1,000 cc. water, add 5 cc. of the 40 per cent acetaldehyde solution.

Immersed wheat, oats for five minutes. Dried and sown. Controlled with check lot.

The following were the results obtained:—

Grain	Variety	Solution Used	Percentage Smut
Wheat	Marquis	Formalin "A"	0·0
Wheat	Marquis	Acetaldehyde "B"	17·6
Wheat	Marquis	Acetaldehyde "C"	20·0
Wheat	Marquis	No treatment (check)	27·0
Oats	Banner	Formalin "A"	0·0
Oats	Banner	Acetaldehyde "B"	21·5
Oats	Banner	Acetaldehyde "C"	20·7
Oats	Banner	No treatment (check)	28·0

The results of the experiments indicate clearly that solutions of acetaldehyde of the strength used are not effective in the control of oat smut or bunt of wheat, and further, the acetaldehyde has an extremely unpleasant and penetrating odour, especially when being diluted with water, which would make its general adoption for practical use unlikely, if even its fungicidal properties could have been demonstrated.

Experiment 3 was conducted at Indian Head under the direction of Mr. W. P. Fraser, and experiments 1 and 2 were carried out at Ottawa by Mr. F. L. Drayton.

It may be of interest to add that the germicidal value of acetaldehyde was determined by the Department of Hygiene at McGill University. This showed that a dilution of 1 to 5 is of the same relative strength as 1 to 100 carbolic acid.

We thus may conclude from the above work that the fungicidal and germicidal value of acetaldehyde is too low to be of any commercial value for these purposes.

NITRO-CULTURE WORK

Free distribution of a limited quantity of nitro-culture to individual applicants is still being maintained, the selected crops for which bacterial isolations of the nodule-forming organism are prepared being alfalfa, clovers, peas and field beans. This service was instituted in 1915, and, during the war years, showed some decline in demand, owing, doubtless, to the magnificent response our farmers made to the call for increased grain production; but the demand is now once more expanding, as the following figures show.

The total number of bottles sent out—each bottle being good for the treatment of a bushel of seed—during the spring and summer of the respective years indicated, were:—

1916	854
1917	510
1918	455
1919	529
1920	1,079

We do not, saving under exceptional circumstances, supply more than three bottles of culture to any one person. All applicants receive with their letter of advice a report form (or forms) with blank spaces for their observations on the crop under treatment. They are likewise advised to sow a small parcel of their crop untreated alongside the treated seed for comparison's sake. We regret to record that comparatively few of these report forms are returned to us; and, even of those returned, less than half show the comparative trial, so that the majority of returns made can only be accepted as expressions of opinion without evidential backing.

With this proviso, the balance of opinion seems to indicate that nitro-culture treatment is productive of some slight benefit to the crop. It is too early yet to draw definite conclusions, but so far, the main emerging factors appear to be crop in relation to locality, i.e. certain crops in certain localities are benefited, others not. There appears to be a "fashion" in crops likewise, but what this indicates is not clear. Possibly a sudden demand from some district for nitro-culture for a particular crop may indicate co-operative buying of seed; yet in other cases references in the letters of application clearly point to recommendations of neighbours, or the success of a particular crop the previous season, setting the "fashion."

In relation to the extent of territory served, the number of cases covered are still far too few to afford satisfactory data. Conclusions drawn above must be regarded, then, as merely suggestions of certain trends of evidence. (R. A. Inglis.)

MYCOLOGY—EDIBLE AND POISONOUS FUNGI

The study of edible and poisonous fungi of Canada is receiving more popular attention each year, and insistent demands are made by the public to the Botanical Department for literature on the subject. Pamphlet No. 22, treating of the cultivation of mushrooms in cellars, etc., is the only information issued so far by the department. What is urgently needed is a bulletin describing the common forms met with in a day's outing. The demand is for information whereby one may distinguish

between edible and poisonous varieties, or as it is commonly expressed, the ability to distinguish between mushrooms and toadstools. Many samples of mushrooms were submitted for identification during the past season, with a request for literature on the subject. It was felt that the time had arrived when it was advisable to add temporarily to the staff an assistant who should devote his time to the study of the fleshy fungi in the district of Ottawa, and if possible identify the commoner forms met with. Some individual work has been done at intervals, but no co-ordinated effort has been possible, nor have the data collected during a number of years been placed on record. The officer, Mr. W. S. Odell, was instructed to make a systematic study of the fleshy fungi in the surrounding district. A record was kept of all the specimens collected and identified, and efforts were made to preserve them in a dried state, so as to be available to the public, or for reference.

During the Central Canada Exhibition week, Mr. Odell provided an interesting exhibit of common fungi of the district; at one period of it, thirty-two varieties of edible mushrooms were on view. Over fifty varieties of edible mushrooms were from time to time shown during the week. Judging from the crowds who thronged the aisles, examined the exhibit, and questioned us concerning it, our efforts to enlighten the public on the amount of valuable food annually going to waste, were appreciated. The astounding ignorance of the public concerning the specimens described was lamentable, and our inability to supply the universal demand for descriptive literature was keenly felt.

Our aim is to obtain and identify specimens of all the prominent varieties of mushrooms, particularly the poisonous kinds, within a radius of forty miles of Ottawa, so that a careful study may be made of them and their occurrence recorded for the benefit of the public; and for the establishment of a Fungus Herbarium, which when catalogued will be available for reference to all interested in the subject.

LIBRARY

We have been able to fill up the gaps left in our series of German technical periodicals, such as the "Centralblatt für Bakteriologie, etc.," "Zeitschrift für Pflanzenkrankheiten," "Annales Mycologici," etc., and to obtain additional volumes of other serial publications, so as to be once more up to date. Certain English publications, namely, "Nature," "Ecology," "The Annals of Applied Biology," "Science Progress," and the "Bulletin of the Imperial Institute," have also been placed on our subscription list.

In round numbers the library now possesses some 1,530 volumes, of which 120 are permanently assigned to Field Plant Pathological Stations, while about 450 of these should be bound, as their paper covers militate against permanency. There are some 4,000 pamphlets on our shelves, of which only one in six is indexed. All incoming works are indexed so far as divisional requirements are concerned, but only slow progress can be made in overtaking the cataloguing of early issues of pamphlets, and that during slack periods in routine duties. We have some 50 periodicals which are regularly filed.

The library's main extent is in the fields of pathological, bacteriological, mycological, systematic and economic botany. We note with satisfaction that our resources are becoming appreciated not only by the divisions on the Central Farm, but by other departments in the service, and we cordially welcome inquiries from, and place our resources of information at the service of, other technical workers. (R. A. Inglis.)

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

(J. B. McCURRY, *Plant Pathologist, officer in charge.*)

In this report are summarized the results of experiments initiated in 1915 and succeeding years by the former officer in charge, Mr. Paul A. Murphy, under whose direction the work was performed until his departure in March, 1920. To these, other experiments have been added from time to time. The principal diseases investigated were those attacking potatoes, turnips, and apples. Minor attention was also given to the diseases of cherries, wheat, beans, begonias, sweet peas, asters, and tomatoes.

LATE BLIGHT (*Phytophthora infestans* (Mont.) de Bary.)

Considerable attention has been directed towards the control of this disease, which, it has been estimated, causes an annual loss of $2,925,000 to the potato growers of Prince Edward Island. In experiments conducted over a period of five years (1915-19) it was found that late blight and rot caused a total reduction in yield of 130½ bushels per acre. Since these experiments have been dealt with at length in Bulletin No. 44, it will not be necessary to give more than a brief summary of the results obtained, and an outline of the more salient facts concerning the prevention and control of this disease. Measures which have been found effective in combating late blight will also control early blight, which, however, is of little economic importance in this province.

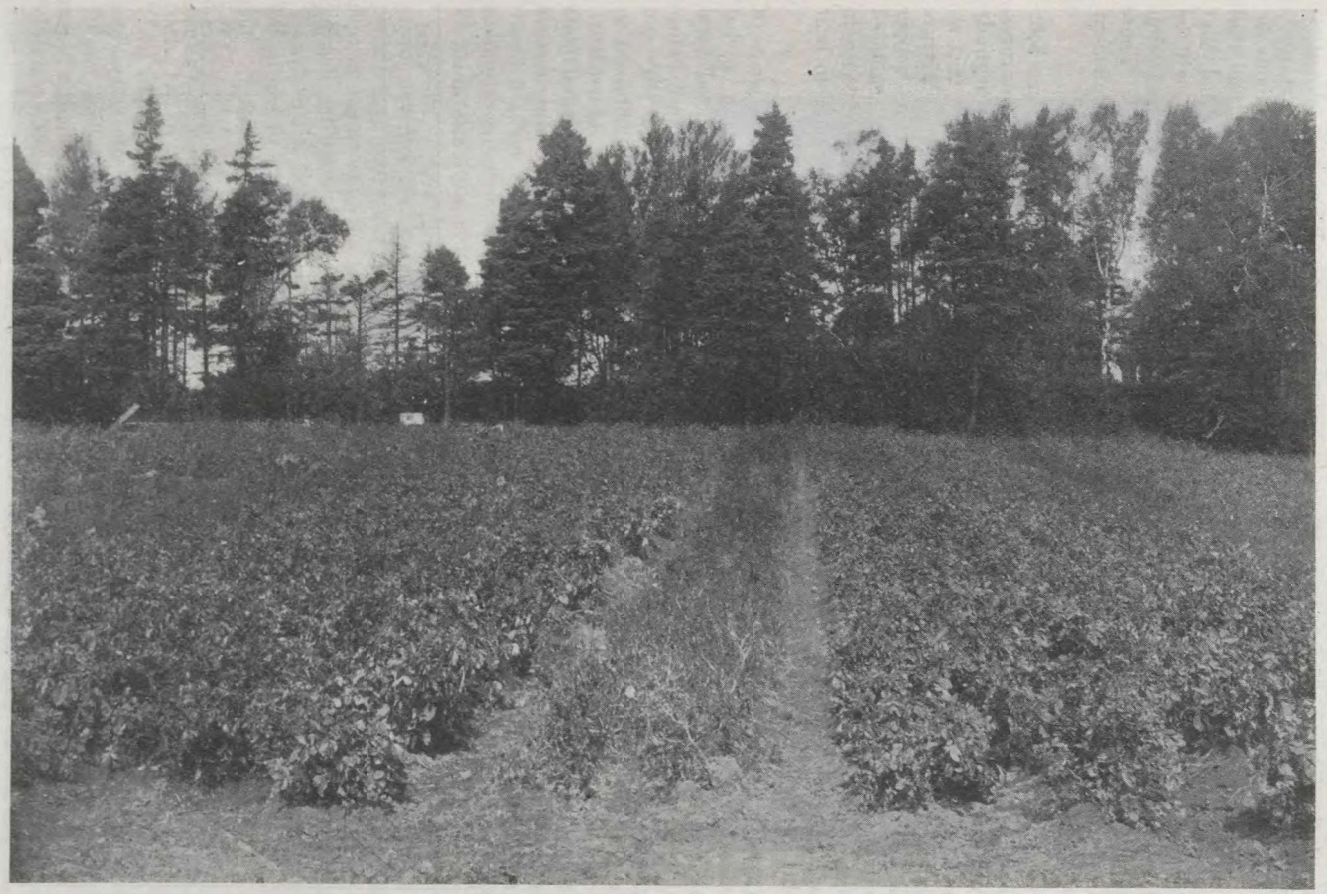
(1) *Number of sprays and time of application.*—It has been found that not less than four sprayings with Bordeaux Mixture in the season are necessary. This number, however, has not proved as effective as five or six applications. Of special importance is the necessity of keeping the foliage well protected toward the latter part of the season whatever number of sprays are given. Neglect of this may render earlier applications useless. In Prince Edward Island in an average season the first spray should be applied about July 25. Should July be wet it may be necessary to commence spraying about July 15. The folowing schedule will usually be found suitable for the average season on Prince Edward Island:—

Spray	Date	Period
First spray	July 25	Last week in July.
Second spray	August 4	First week in August
Third spray	August 18	Third week in August
Fourth spray	September 1	First week in September
Fifth spray	September 15	Third week in September
Sixth spray	September 29	Last week in September

The number of sprays and the dates of application must be adjusted, however, to suit personal conditions. It may be added that four sprays are usually sufficient for Dakota Red, McIntyre, and Irish Cobbler, but not for Green Mountain.

(2) *Spraying outfits.*—The most desirable type of sprayer for potatoes grown on a commercial scale is a three-cylinder horse-power machine with three nozzles to each row. Good results may also be obtained with a two-cylinder sprayer, but the three-cylinder machine maintaining a higher pressure is preferable.

For small areas the disease may be satisfactorily controlled by means of a hand sprayer, provided the rows are sprayed twice in opposite directions at each application.



Potato spraying experiments for the control of late blight.
Plots at right and left sprayed with Bordeaux mixture. Centre—unsprayed check.
(Photo by S. G. Peppin.)

(3) *Weather conditions in relation to time of application.*—Experiments conducted for two years showed that considerably higher yields were obtained when the spray was applied before rain as opposed to spraying after rain, the increase in favour of the former varying from 11 to 47 bushels per acre. When rain threatens the time spray is to be applied, growers will very often delay the operation until after the shower thinking that the material will be washed off, and their labour be lost. The experiments referred to above demonstrate that this is a mistake, and that much better results may be secured by proceeding with the work, provided that sufficient time be afforded for the solution to dry. The advisability of this will be readily realized when it is remembered that it is during moist conditions that infection occurs, and this is the time when the foliage should be thoroughly protected. There will be little danger of the spray being washed off, if, as suggested, it is applied in time to give it an opportunity to dry before the rain.

(4) *Spraying material.*—For several years extensive experimental work has been carried on in order to determine the comparative efficiency of different spray mixtures. The materials tested were Bordeaux Mixture 2:4:40, 4:4:40, 6:4:40, 8:4:40, Burgundy Mixture, and "Kil-tone." The result of these experiments seems to indicate that no compound has yet been discovered which will equal home-made Bordeaux Mixture in efficiency. The tsrength recommended is the 4:4:40 formula—4 pounds copper sulphate (bluestone), 4 pounds quicklime, and 40 gallons of water. It is considered by some that rot is reduced by adding an increased amount of copper sulphate to the later sprays. Though this may be so, we have no experimental evidence to bear out this contention.

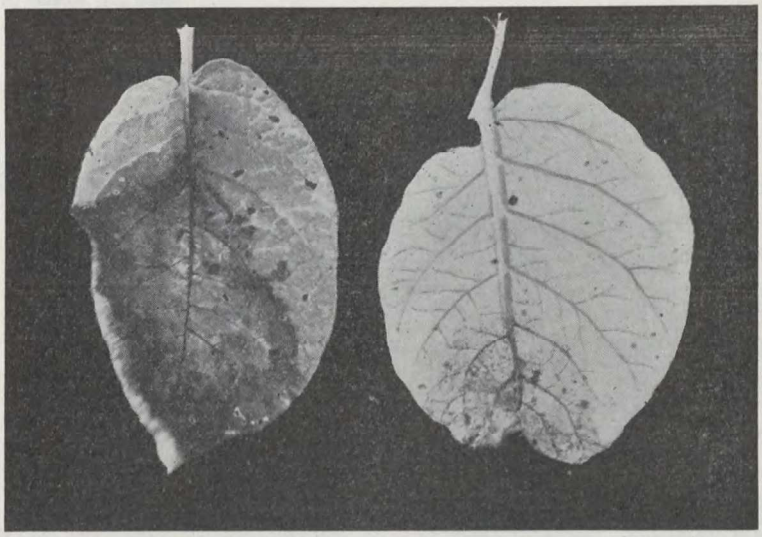
(5) *Experiments to determine the factors influencing late blight rot.*—Series of experiments were conducted in 1918, 1919 and 1920, with a view to determining to what extent the amount of rot may be influenced by such departures from general farm practice as removing the potato tops and allowing certain periods to elapse before harvesting the tubers, treating the tubers, after digging, with formalin (1:240) and powdered Bordeaux mixture, etc. The following table shows the results obtained in 1920 (those of 1918 and 1919 are contained in Bulletin No. 44, previously referred to).

A block of Green Mountains sprayed three times was divided into several plots consisting of two rows each. The various treatments with regard to digging are shown in table.

Plot No.	Treatment of plot	Date of digging	Percentage of crop which rotted			
			In field	To Nov. 24th	To Apr. 15th	Total
1	Dug early	Sept. 11	0·0	6·1	1·3	7·4
2	Tops cut off Sept. 14	" 14	0·01	38·1	0·	38·1
3	Tops cut off Sept. 14	Oct. 1	33·7	13·7	0·	47·4
4	Tops sprayed with copper sulphate 4 : 40 Sept. 14	" 4	8·0	21·5	1·4	30·9
5	Tops and soil sprayed with copper sulphate 4 : 40 Sept. 14	" 4	11·1	7·5	1·2	19·8
6	Dug when dry on sunny day left in sun all day	" 4	14·5	6·5	1·4	21·0
7	Dug when dry on sunny day stored at once	" 4	13·4	21·6	0·	35·0
8	Dug after first killing frost	" 8	7·8	65·4	0·	73·2
9	Tops cut off Sept. 14	" 8	11·6	5·1	0·	16·7
10	Tops cut off Sept. 14	" 13	7·3	0·6	1·2	9·1
11	Dug when wet on sunny day, left on ground all day	" 13	11·8	4·4	0·	16·2
12	Dug when wet on sunny day stored at once	" 13	23·0	10·1	0·	33·1
13	Dug when wet and dusted with powdered Bordeaux	" 13	23·3	0·0	1·9	25·2
14	Dug when wet, check on plot 13	" 13	23·3	11·2	2·9	37·4

The combined results of these experiments prove that much of the tuber infection is initiated at digging time by means of sporeladen surface soil and foliage, particularly

the former, the amount of rot caused by these two agencies exceeding that due to infection before harvesting. A considerable amount of rot may be prevented by removing the tops a sufficient length of time before digging. Just how long a period should elapse has not been definitely ascertained, but in the results given above it will be observed that the plot which was dug on the same day that the tops were removed



Potato leaves showing late blight
right: lower surface
left: upper surface.
(Photo by S. G. Peppin.)

(September 14) produced 38.1 per cent rot in the cellar up to November 24, those dug sixteen days later produced 13.7 per cent rot, those dug twenty-four days later produced 5.1 per cent, while the plot dug twenty-nine days after removal of the tops produced only 0.6 per cent rot. Very little rot developed in any lot from November 24 to April 15, the largest amount (2.9 per cent) being in the check lot No. 14.

Though the question of removing the tops before digging is still in the experimental stage, nevertheless the above results indicate that in certain circumstances this procedure may prove advantageous. It is believed that, when blight attacks the foliage late in the season, the tubers being still free from infection, the amount of rot may be reduced by removing the tops and delaying digging for a period of about three weeks. This, however, is only an accessory factor, and must not be considered a substitute for thorough spraying.

EXPERIMENTS WITH BLIGHT RESISTANT VARIETIES OF POTATOES

During the past year samples of twelve blight-resistant varieties of potatoes were received from Mr. Paul A. Murphy, Royal College of Science, Dublin, Ireland, former officer in charge of this laboratory. These varieties were grown under the usual methods of cultivation practised here, but received no spraying for blight. All varieties showed up well, being remarkably resistant to the disease. Unfortunately mosaic was present in several of the samples, being especially severe in both lots of the Irish Chieftain variety. This will render propagation of the varieties difficult. The yield was comparatively low, the tubers in nearly every variety being more or

less small. It is hoped that in time these conditions will be improved. Tables showing the presence of disease follow:—

FIELD NOTES ON IRISH VARIETIES

Variety	No. of sets planted	No. plants which grew	No. showing mosaic	No. plants weak
Arran Chief (Glasnevin)	9	7	5	2
Irish Chieftain (Glasnevin)	25	22	22	0
Lochar	15	14	0	0
Leinster Wonder	32	32	0	2
Arran Comrade	34	30	0	4
Northern Invincible	32	31	7	0
Shamrock	48	48	2	0
Clifden Seedling	72	70	0	Not very vigorous
Arran Chief (Clifden)	90	78	0	19
Summit	78	71	0	3
Irish Chieftain (Clifden)	120	98	98	10

Up to date*	200 ft. of row	Black leg 2·5%	Leaf roll 13·5%	Misses 17%	Weak 14·5%

*All leaf roll plants rogued out July 19, 1920.

DIGGING RESULTS OF IRISH VARIETIES

Variety	Marketable lbs.	Small lbs.	Rot lbs.	Total lbs.	
Arran Chief (Glasnevin)	43	35	0	78	50% net necrosis and deep stem end browning
Irish Chieftain (Glasnevin)	20	17	0	37	
Lochar	2	13	0	15	
Leinster Wonder	11	14	·5	25·5	
Arran Comrade	19	15·5	·5	35	
Northern Invincible	14	15	0	29	
Shamrock	18	14	0	32	
Clifden Seedling	38·5	29·5	0	68	
Arran Chief (Clifden)	13·5	11·5	0	25	Some net necrosis
Summit	45·5	54·5	0	100	
Irish Chieftain (Clifden)	104·5	52	0	156·5	
Up-to-date	66·5	55	1·5	123	

LATE BLIGHT OF POTATOES, 1919-20

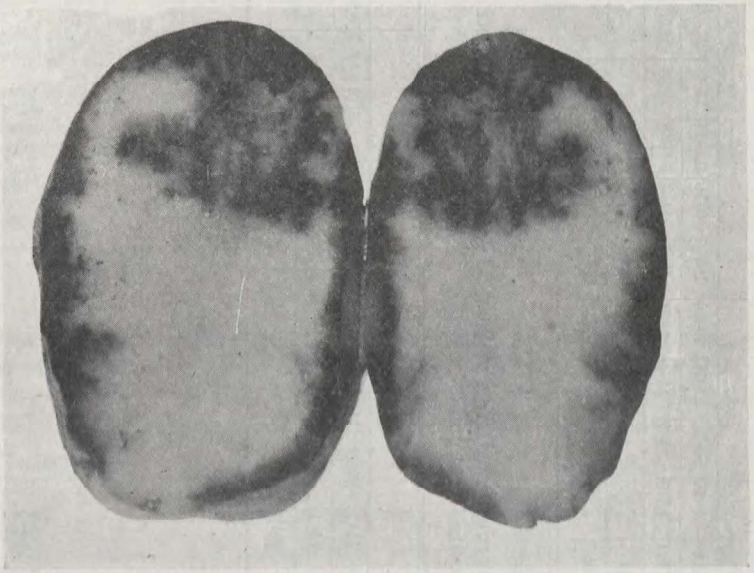
THE EFFECT OF TEMPERATURE UPON THE LATE BLIGHT OF POTATOES

In order to find out how the mycelium of late blight is carried over during the winter, both sound and rotted tubers averaging eight ounces were buried outside in the soil during the winter months, and a record of the air temperature kept. The winter, however, was too severe, being the coldest in many years, with the result that all the tubers were destroyed.

In another experiment conducted inside, it was observed that large tubers in both dry air and soil were frozen when exposed to low temperature, but where the air and soil were kept moist both large and small tubers survived.

This led to a survey in 1920 of the volunteer plants which overwintered safely in the soil, and showed in every case that the tubers were small sound tubers which were buried from four to eight inches deep and which were either those of the McIntyre variety or seedling tubers resembling this type, but in no case was a Green Mountain tuber located. All volunteer plants appearing up to July 15 were removed and transplanted. As diseased Green Mountain tubers failed to keep in the cellar without becoming infected with Fusarium, rotted tubers Empire State and McIntyre varieties were secured and planted. Plants were also produced from potatoes which

had been placed in a discarded place, after sets had been obtained from them. The main plots were planted with Green Mountain sets which had been grown previously under bad blight conditions. When the plants were examined on August 23, 1920, when the blight was appearing on the foliage, it was found that the infection had started in the Green Mountains planted in the main plots, the Empire State and McIntyre being healthy.



Potato tuber affected with late blight rot.
(Photo by S. G. Peppin.)

In another test made in November of the same year some healthy tubers were placed in surface soil, and soil three inches deep, where diseased plants had been grown. Others were placed in clean soil along with dead tops which had been blighted.

A check was kept for each lot and all were kept under warm, moist conditions. All methods, however, failed to produce infection of the tubers.

In order to find out under what conditions of temperature infection occurred on the foliage, a record of the temperature of the soil and air was kept during the growing season. Infected foliage was observed during the last week of August when the temperature was commencing to drop and the rainfall beginning to increase. Where the temperature for June and July ranged over 20° C. with a corresponding decrease in rainfall for the same period, no infection resulted.

According to the weather records at Charlottetown 1919 and 1920 it appears that primary infection would occur on the diseased shoot about the first ten days in July when the temperature was warm (15.1°C.) and the rainfall was reduced (.29″). Secondary infection would occur on the lower leaves to a slight extent during the warmest period until the end of August (17.6°C.). And as the temperature commenced to fall about the first of September until about the middle of the month, when the first signs of rot were visible on the tubers in the soil (September 18), the rainfall was increasing until the maximum amount was registered (·94″).

In 1919 at Ottawa where no blight occurred, the opposite results are recorded in the weather reports, but at Ottawa 1920 where conditions were the same as at Charlottetown in the same year the results were similar, blight occurring at both places.

THE average maximum and minimum daily temperatures for 100 days beginning May 2 and ending August 9. Recorded in five-day periods. Rainfall also noted. (1919).

Temp. C	May						June						July						Aug.	
	2–6	7–11	12–16	17–21	22–26	27–31	1–5	6–10	11–15	16–20	21–25	26–30	1–5	6–10	11–15	16–20	21–25	26–30	31–4	5–9
Av. max. min. daily temp.	7·2	6·1	10·0	11·1	13·7	6·1	12·7	14·1	15·0	15·0	14·4	16·1	16·1	14·4	18·8	20·	20·	18·4	17·	19·4
Av. 4 periods				8·6				11·5				15·1				17·3				18·7
Rainfall				·38″				·55″				·29″				·47″				·63″

THE average maximum and minimum daily temperatures for 95 days beginning August 15 and ending November 17. Recorded in five-day periods. Rainfall also noted. (1919).

Temp. C	Aug.				Sept.				Oct.								Nov.			
Av. max. min. daily temp.	15·5	17·2	19·4	18·3	18·8	14·4	13·3	11·1	16·6	11·4	9·4	10·0	6·1	9·4	5·0	7·7	2·7	2·7	4·1	2·7
Av. 4 periods				17·6				14·4				11·9				7·1				3·1
Rainfall				·48″				·94″				·70″				·71″				·47″

THE average daily temperatures for 50 days beginning June 26 and ending August 14, recorded in five-day periods. Temperatures recorded 12 inches above surface, surface, and 6 inches below. Also maximum and minimum temperatures. (1919).

Temperature C.	June	July						August		
	26-30	1-5	6-10	11-15	16-20	21-25	26-30	31-4	5-9	10-14
12" above surface	17·7	25·1	20·1	25·2	25·7	26·5	23·2	22·1	20·8	19·6
Average 5 periods					22·8					22·4
Surface	22·0	26·8	21·0	25·7	26·0	26·6	22·3	20·6	23·5	20·1
Average 5 periods					24·3					22·6
6" below surface	18·2	20·9	17·7	19·1	20·9	22·5	19·9	18·6	20·5	19·7
Average 5 periods					19·4					20·2
Maximum	21·1	21·6	18·3	24·4	25·0	24·4	22·2	21·6	25·0	20·5
Average 5 days					22·1					22·7
Minimum	11·1	10·0	10·0	13·3	15·0	15·0	14·4	12·2	13·8	10·5
Average 5 days					11·9					13·2

THE average daily temperatures for 50 days beginning August 15 and ending October 3, recorded in five-day periods. Temperatures recorded 12 inches above surface, surface, and 6 inches below. Also maximum and minimum temperatures. (1919).

Temperature C.	Aug.			Sept.						Oct.
12" above surface	21·0	20·0	20·5	21·0	18·4	16·6	17·0	23·0	18·0	17·6
Average 5 days					20·2					18·4
Surface	20·0	20·0	21·2	21·2	18·0	16·2	17·4	22·2	18·4	19·0
Average 5 days					20·1					18·6
6" below surface	19·3	19·0	18·0	18·2	15·4	14·6	14·2	18·6	16·8	15·4
Average 5 days					18·0					15·9
Maximum	21·1	23·7	21·5	22·2	17·7	16·1	14·4	21·6	16·1	15·0
Average 5 days					21·2					16·6
Minimum	13·3	15·0	14·4	15·0	10·5	10·5	7·7	11·5	7·2	3·8
Average 5 days					13·6					8·1

THE average maximum and minimum daily temperatures for 100 days beginning May 2 and ending August 9 as recorded at Ottawa. Recorded in five-day periods. Rainfall also noted.

Temp. C	May				May		June		June				July				July		Aug.	
Av. max. min. daily temp....	8·3	10·5	14·4	12·2	16·6	19·4	29·0	19·4	22·7	29·0	21·6	16·6	25·5	20·0	20·2	22·7	22·5	22·0	19·6	20·0
Av. 4 periods.....				11·4				21·1				22·7				22·1				21
Rainfall.....				·88″				·51″				·48″				·31″				·10″

THE average maximum and minimum daily temperatures for 80 days beginning August 10 and ending October 28, as recorded at Ottawa. Recorded in five-day periods. Rainfall also noted.

Temp. C	Aug.				Sept.				Sept.		Oct.		Oct.			
Av. max. min. daily temp.....	19·3	19·3	21·8	16·3	18·6	17·2	14·1	13·1	17·5	12·3	10·0	11·2	9·8	9·8	6·2	8·1
Av. 4 periods.....				19·2				15·8				12·8				8·7
Rainfall....				·35″				·45″				·68″				·35″

Green Mountain sets which had produced shoots a quarter of an inch in length were inoculated on the cut surface with mycelium and placed under moist air conditions. Rot developed within five days, while the mycelium fruited on the shoots when dry air conditions were produced. Diseased sets were planted in soil and kept under greenhouse conditions in order to determine if dry conditions of soil coupled with a check given to the plant would have any effect on producing infection. The sets were grown for thirty days at an average temperature of 15.5° C. and on two sets shoots were produced about one inch in length. The sets were then removed to the laboratory and potted, being kept under a bell jar with ventilation provided, and were grown at an average temperature of 21.8° C. for twenty days. The shoots grew rapidly until they were about eight inches long, when they collapsed half an inch above the soil. Microscopical examination revealed the presence of conidiophores and conidia of the Late Blight fungus on the surface of the shoots. The dry soil conditions, warmer temperature and the check given to the plants by transplanting had apparently induced the mycelium to fructify.

By placing sheets of paper on the surface of the soil under the plants, it was found that no infection of the tubers was prevented. Where the tops were removed from the plants or where a fungicide was placed on the soil under the foliage the amount of infection occurring on the tubers was reduced. In each case the check showed an increase in the amount of rot. Where seaweed was used as a fertilizer the amount of rotted tubers increased. The same applied in the case where manure was used. Where the foliage had been sprayed with Bordeaux mixture the amount of rotted tubers was reduced as compared with the check. An experiment conducted to see under what conditions infection took place of tubers in soil and in air showed that infection occurred on a few tubers placed in a warm, moist chamber kept at 20-25° C., while no infection took place where tubers were kept in moist soil, either warm or cool. As the inoculations were made through lenticels, this might possibly show the method of infection occurring after digging.

As regards infection of the tubers before harvesting, the results seem to indicate that this is brought about by the spores being carried from the infected foliage into the soil onto the tubers.

27482—3

THE soil was treated with different materials. Results given in ounces. Examined in field October 18.

No.	Treatment	Total	Sound	Rot	Per cent
1	8 plants with oiled paper 1 ft. square covered with powdered Bordeaux. Cotton wool tied on stem. Soil hilled	176	176	0	0
2	8 plants same as No. 1, but no cotton. Soil level	144	144	0	0
3	8 plants same as No. 1, but soil level	104	104	0	0
4	8 plants cotton on stem, but no paper. Soil hilled	122	120	2	1·6
5	Check. Soil level	279	117	162	58·1
6	8 plants. Sulphur on soil in June. Soil hilled	370	358	12	3·2
7	8 plants. Sulphur on soil in June. Soil level	340	293	47	13·8
8	8 plants. P. Bordeaux on soil in August. Soil hilled	381	342	39	10·3
9	8 plants. P. Bordeaux on soil in August. Soil level	344	308	36	10·4
10	Check. Soil level	214	87	127	59·3
11	8 plants. Seaweed in soil in June. Soil hilled	472	280	192	40·6
12	8 plants. Seaweed in soil in June. Soil hilled	340	204	136	40·0
13	8 plants. Seaweed in soil in June. Soil level	316	228	88	27·8
14	8 plants. Seaweed in soil in June. Soil level	296	200	96	32·4
15	Check. Soil level	196	76	120	61·2
16	8 plants. Nitrate of soda, July 4; Potato fertilizer July 14	305	161	144	47·2
17	8 plants. Nitrate of soda July 14; Potato fertilizer July 4	224	107	117	52·2
18	8 plants. Potato fertilizer July 4	268	188	80	29·8
19	8 plants. Potato fertilizer July 14	289	162	127	43·9
20	8 plants. Check. Soil level	209	77	132	63·2
21	8 plants. Sets treated in solution nitrate soda 4 oz., sodium bicarbonate 1 oz. in 1 qt. water for 15 minutes	201	150	51	25·3
22	8 plants. Sets treated in solution nitrate soda 4 oz., sodium bicarbonate 1 oz. in 1 qt. water for 15 minutes	152	111	41	26·3
23	8 plants. Sets treated in solution nitrate soda 4 oz., sodium bicarbonate 1 oz. in 2 qts. water for 30 minutes	183	98	85	46·3
24	8 plants. Sets treated in solution nitrate soda 4 oz., sodium bicarbonate 1 oz in 2 qts. water for 30 minutes	157	69	88	56·0
25	8 plants. Sets. Soil level	181	119	62	34·2
	32 plants. Sets treated with solution nitrate soda and sodium bicarbonate for 15 minutes produced 183 shoots. 32 plants. Check. Produced 82 shoots.				

PLANTS were treated in different ways and the results noted. Examined in field October 18.

No.	Treatment	Total	Sound	Rot	Per cent
1	8 plants. Tops cut off 6″ from surface on July 30. Soil level	228	164	64	28·1
2	8 plants. Tops cut off 6″ from surface on July 30. Soil level	161	100	61	37·8
3	8 plants. Tops cut off 6″ from surface on July 30. Soil level	244	116	128	53·2
4	8 plants. Tops cut off 6″ from surface on July 30. Soil level	194	104	90	46·3
5	8 plants. Check. Soil level	144	84	60	41·6
6	8 plants. Tops tied up on July 30. Soil level	272	176	96	35·2
7	8 plants. Tops tied down to surface July 30. Soil level	230	122	108	46·9
8	8 plants. Soil hilled July 30	344	212	132	38·3
9	8 plants. Soil hilled July 30	256	176	80	31·2
10	8 plants. Check. Soil level	220	132	88	40·0
11	24 plants. Blossoms removed July 30. Soil level	824	389	435	52·7
12	24 plants. Blossoms on. Check. Soil level	920	576	344	37·3
13	4 plants. Grown under inverted V shaped box. Openings plugged with cotton	46	44	2	4·3
14	4 plants. Grown in high box above soil. Soil dry	22	21	1	4·5
15	4 plants. Grown in high box half in soil. Soil moist	39	39	0	0
16	4 plants. Grown in box placed in soil. Soil moist. Check	38	28	10	26·3

TRENCHES dug twelve feet long including one foot for check, separated by two feet of soil. Fifteen pounds of tubers in trench and one pound in check. Results given in ounces.

Trench	Depth of potatoes below surface	Height of drill above surface	Treatment	Trench		Check	
				Rot	Per cent	Rot	Per cent
	Inches	Inches					
1	1	0	Ground level	28	11·6	0	0
2	3	0	Ground level	4	1·6	0	0
3	6	0	Ground level	4	9·2	0	0
4	8	0	Ground level	22	27·5	0	0
5	0	3	Potatoes on surface	66	48·3	0	0
6	0	6	Potatoes on surface	116	2·5	0	0
7	0	8	Potatoes on surface	6	6·6	0	0
8	2	3	Potatoes below surface	16	3·3	0	0
9	2	6	Potatoes below surface	8	3·3	2	12·5
10	2	8	Potatoes below surface	8	3·3	0	0
11	2	3	Potatoes above surface	8	0	0	0
12	2	6	Potatoes above surface	0	0	0	0
13	2	8	Potatoes above surface	32	13·0	0	0
14	2	10	Potatoes above surface	112	46·7	0	0
15	1	0	Manure below potatoes	0	0	4	25·0
16	3	0	Manure below potatoes	102	42·5	6	37·5
17	6	0	Manure below potatoes	194	80·8	0	0
18	1	0	Ground sprayed with Bordeaux before infection	32	13·0	0	0
19	3	0	Ground sprayed with Bordeaux before infection	33	13·7	0	0
20	6	0	Ground sprayed with Bordeaux before infection	38	15·8	10	62·5
21	1	0	Ground dusted with powdered Bordeaux before infection	16	6·6	0	0
22	3	0	Ground dusted with powdered Bordeaux before infection	8	3·3	0	0
23	6	0	Ground dusted with powdered Bordeaux before infection	8	3·3	0	0

DIFFERENT tests were made with paper, sulphur, powdered Bordeaux and liquid Bordeaux placed on the soil. Also results of sprayed and unsprayed foliage are given.

No.	Treatment	Soil	Total	Sound	Rot	Per cent
			oz.	oz.	oz.	
1	Paper	Hilled	176	176	0	0
		Level	104	104	0	0
					Aver...	0
2	Sulphur	Hilled	370	358	12	3·2
		Level	340	293	47	13·8
					Aver...	8·5
3	P. Bordeaux	Hilled	381	342	39	10·3
		Level	344	308	36	10·4
					Aver...	10·4
4	L. Bordeaux	Hilled	263	170	93	35·3
		Level	259	177	82	31·6
					Aver...	33·5
5	Check	Hilled	298	166	132	44·2
		Level	253	142	111	43·4
					Aver...	43·8
6	Sprayed		268	210	58	21·6
	Unsprayed		229	148	81	35·3
					Aver...	28·5

According to results obtained by digging tubers under different weather conditions, it was found that more infection occurred on tubers which were dug during and after rain than before rain. This points to the possibility that if the foliage were removed before heavy rains came, considerable tuber infection might be prevented.

FOUR diggings of potatoes were made, one before rain, two during rain, and one after rain, and examined in cellar one month later.

Plot	Rain	Date	Field lbs.				Storage lbs.			
			Total	Sound	Rot	%	Total	Sound	Rot	%
1	Before	Sept. 30	367	367	0	0	151	145	6	3·9
2	During	"	345	345	0	0	158	102	56	35·4
3	After	Oct. 1	513	513	0	0	156	93	63	40·3
4	During	Oct. 6	618	614	4	·1	614	314	300	48·6

Potatoes dug during rain showing about 25 per cent rot in the field treated with formalin (40 per cent formaldehyde) and weak copper sulphate showed that infection had either previously occurred or the materials used were ineffective. These tubers were dug on a rainy day in September when the blight was at its height.

THREE bags of potatoes placed in boxes without bottoms. Three bags of potatoes kept in bags on wooden platform. Treated with formalin and copper sulphate and kept in cellar one month.

No.	Treatment	Total	Sound	Rot	%
1	Contents of bag in covered box on ground. (Check)	90	40	50	55·5
2	Contents of bag in covered box on ground. Potatoes sprayed con. formalin	89	42	47	52·8
3	Contents of bag in covered box on ground. Ground sprayed con. formalin	88	47	41	46·5
4	Contents of bag stored in bag on platform. (Check)	87	41	46	52·8
5	Contents of bag stored in bag on platform. Tubers dipped in $CuSO_4$ (1-1000) 10 min.	88	58	30	34·1
6	Contents of bag stored in bag on platform. Tubers dipped in formalin (1–500) 10 minutes	87	53	34	39·1
7	Contents of bag stored in bag on platform. Tubers sprayed with con. formalin	85	33	52	61·2

Tubers dug on sunny day and showing 25 per cent rot in field, sprinkled with water and then dusted with powdered Bordeaux, showed that either the treatment was effective, that no secondary infection occurred, or else all the infected tubers were discarded in the field. These tubers were dug in October when the blight was light, and the weather dry.

In an experiment to determine the difference in the amount of rot developing in potatoes dug early and late in a wet season, the most rot developed in the tubers which were dug early. These tubers showed very little rot in the field, but rotted badly in storage, averaging 40 per cent. This would indicate that infection occurred after digging and that the infection and rot occurred in storage. The tubers dug late rotted more in the field, which would show that all infection did not occur in storage.

POTATOES harvested at different dates, under different conditions, and grown in different fields, were dug and examined for rot in field and storage.

Plot	Dug early	Date dug	Total	Sound	Rot	%	Examined cellar	Total	Sound	Rot	%
6	Sept. 19–30..	Sept. 19..	425	424	1	0·2	Nov. 10....	162	105	57	35·6
6	" 19–30..	" 26..	314	314	0	0·0	" 10....	233	146	87	33·0
5	" 19–30..	" 30..	893	893	0	0·0	" 12....	309	247	62	20·1
5	Oct. 1–9.. ..	Oct. 1.....	1,045	1,045	0	0·0	" 12....	295	137	158	53·5
5	" 1–9.....	" 4....	1,050	1,050	0	0·0	" 12....	325	146	179	55·1
5	" 1–9.....	" 7....	1,002	1,002	0	0·0	" 13....	326	217	109	33·4
3	" 1–9.....	" 7....	618	614	4	0·6	" 13....	614	314	300	48·9
*5	" 1–9.....	" 8....	391	387	4	1·0	" 13....	161	137	24	15·9
Total Sept. 19-Oct. 9.....			5,738	5,729	9	0·0		2,425	1,449	976	40·0

Plot	Dug late	Date dug	Total	Sound	Rot	%	Examined cellar	Total	Sound	Rot	%
3	Oct. 10–19...	15	258	184	74	28·6	.....	.....	.....	.....	.....
4	" ...	16	625	411	214	34·2	.....	.....	.....	.....	.....
3	" ...	16	.....	.....	.....	.....	Nov. 14.....	840	506	334	39·7
3	" ...	16	.....	.....	.....	.....	"	472	295	177	37·5
3	" ...	16	.....	.....	.....	.....	"	832	434	398	47·8
5	Oct. 20–22...	21	504	367	137	27·2	Nov. 15.....	158	131	27	17·1
5	" ...	21	476	366	110	23·1	"	167	131	36	21·5
*6	" ...	22	955	905	50	5·2	"	241	232	9	3·7
*6	" ...	22	879	775	104	11·8	"	177	170	7	3·9
Total Oct. 10–22.....			3,697	3,008	689	18·7		2,887	1,899	988	34·2

*Blight was light.

Where sound and rotted tubers are brought in contact with each other, as would occur in field conditions before digging, it was found that the healthy tuber remained sound.

TUBERS treated and untreated placed in moist soil in contact with each other. The temperature was raised and lowered in ten-day periods. Experiment done in pots.

Plot	1	2	3	4	5	6	7	8	9	10
Sound	4	4	4	1	1	4	4	4	1	1
Rot	1	1	1	1	1	1	1	1	1	1
Sound—Bordeaux	.....	.....	.....	3	3	.....	.....	.....	.....	.....
Sound—Oiled paper	.....	.....	.....	.....	.....	.....	.....	.....	3	.....

The result of placing sound and rotted tubers in contact with each other, as would occur in storage conditions, showed that it was impossible to increase the amount of infection.

TUBERS treated and untreated, placed in bags in contact with each other. The temperature was raised and lowered in ten-day periods in order to stimulate the mycelium. Experiment done in bags.

No. of bags	1	2	3	4	5	6	7	8	9	10
Sound	4	4	4	1	1	4	4	4	1	1
Rot	1	1	1	1	1	1	1	1	1	1
Sound—Bordeaux	.....	.....	.....	3	3	.....	.....	.....	.....	.....
Sound—Oiled paper	.....	.....	.....	.....	.....	.....	.....	.....	3	3

It would appear, therefore, that tubers are mostly infected before digging and at a time when the rains are heavy and foliage infection severe. If, however, they are dug during rainy weather or when the tops are badly infected, the tubers can be infected after digging. Tubers are not infected in storage, but the infected tubers in the soil or the tubers infected when dug produce rot when brought under favourable cellar conditions, warmth and humidity prevailing.

Considerable rot can be prevented by digging the tubers under dry conditions, drying sufficiently before storing, and by properly regulating the temperature and humidity of the cellar. Infection of the tubers can be largely controlled by dusting the soil with powdered Bordeaux Mixture, removing the tops before a heavy infection of foliage and dusting the tubers after digging with Bordeaux Dust.

BLACK LEG

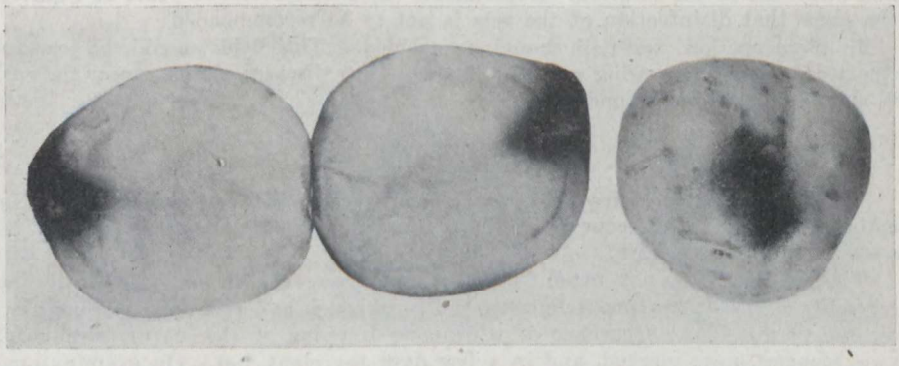
This is a very destructive disease of the potato, usually causing the premature death of the entire plant, with the production of little or no crop. The disease is due to a bacterium which has been variously described as *Bacillus atrosepticus* van Hall, *B. solanisaprus*, Harrison, etc. Diseased plants usually become conspicuous in July because of their yellowish-green foliage and pronounced rolling of the leaves. This latter characteristic may lead one not well versed in the symptoms of the various diseases to diagnose it as leaf roll. In this disease, however, the plant presents a

Potato plant affected with black leg.
(Photo by P. A. Murphy.)

wilting appearance and the harsh leathery condition of the abnormally thickened leaflets so characteristic of leaf roll is entirely absent. On pulling up a plant affected with Black Leg, it will be observed that the plant comes easily and that the underground portion of the stalk is black and rotten. The diseased set which gave rise

to the infected plant will also be found to be decayed, and in addition one or more of the young tubers may show the disease progressing from the stem end, where it gained entrance from the underground stem or "rhizome."

Potato plant affected with black leg. Note the disease starting along the rhizome.
(Photo by S. G. Peppin.)



Potato tuber affected with black leg. Note the decay commencing at the stem end interior and exterior views.
(Photo by S. G. Peppin.)

In the tubers the disease causes a soft rot, which, as noted above, always commences at the stem end. On being cut transversely, the tuber exhibits a black cavity

which often contains a mass of white slime in the centre. Once the tuber becomes infected it decays very rapidly, especially should the land be low-lying and wet. Moisture and a moderately low temperature are conducive to the rapid development of the causal organism, and the disease is, therefore, much more severe during a wet season. Another factor which influences the extent of the damage from this disease is the date of planting, affected plants being more numerous in potatoes planted early than in a later plot, the same stock of seed being used in each case.

So far as is known the disease is produced only through the use of infected seed, and the organism does not winter over in the soil. Healthy sets which were treated with formalin (before cutting) and planted in infested soil immediately following the removal of diseased specimens all produced healthy plants. Similarly healthy tubers planted in soil which had been infected the previous year also gave rise to a healthy crop.

When a diseased tuber is planted the organism produces a soft rot of the tissues which progresses towards the stem end entering the stem of the young plant. The injury to the stem by the organism causes a partial cutting-off of the water supply of the plant, which results in the characteristically rolled leaves and unhealthy colour of the foliage. The parasite gradually spreads along the underground stem and enters the young newly formed tubers.

Should conditions of moisture and temperature be favourable to the rapid development of the rot early in the life of the plant, the young shoots may be killed before they reach the surface of the ground. This is often a common cause of "misses" in the field.

CONTROL

Since the disease has been proved to be propagated only by the use of infected seed, the logical and surest means of control is to use if possible only seed from a healthy crop. Treat the seed before cutting with a solution of corrosive sublimate 1:2000 (two ounces corrosive sublimate in 25 gallons of water) for three hours, or a solution of one pint of formalin in 30 gallons of water for two hours. In cutting the sets any tuber which on being cut across the stem end shows any conspicuous discoloration should be discarded. The knife which has been used to cut such a tuber should be thoroughly disinfected before being used again. For this purpose it will be found convenient to have a vessel at hand containing a formalin solution, and one or more spare knives, so that a clean knife may be used while the other is being sterilized in the solution. Experiments conducted over two years at Charlottetown show that disinfection of the sets is not to be recommended.

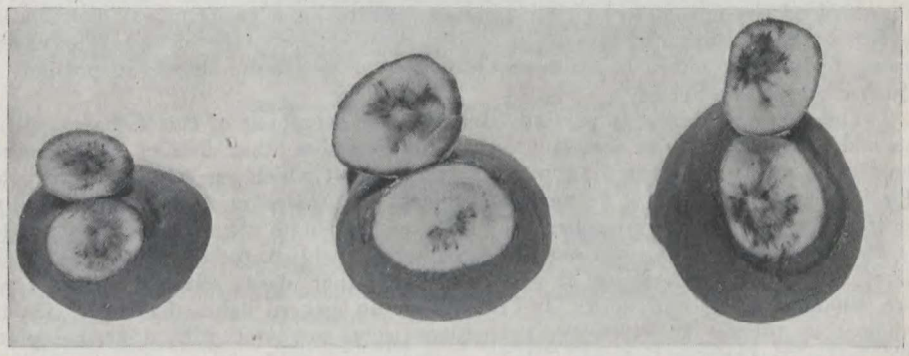
In planting, low, wet soil should be avoided. The field should be carefully inspected during the growing season, and should any diseased plants appear the entire hill should be removed at once.

WILT

This disease is not of frequent occurrence in Prince Edward Island, nor in Nova Scotia. Whatever does occur is of the *Verticillium* type. *Fusarium* wilt, if it is present at all, is very rare.

The disease does not usually appear under our conditions here until about September. The leaves turn a light or yellowish green and roll up conspicuously all over the plant. The appearance of wilting or drooping of the leaves from lack of water becomes quite marked, and in a few days the plant dies. On examination of the stem the vascular system will be found to be discolored as well as the under ground portions leading to the tubers. If an affected tuber is cut across the stem end the presence of the organism will be indicated by a brown discoloration of the tissue.

Potato plant affected with wilt.
(Photo by P. A. Murphy.)



Tubers from a wilted hill cut open at the stem end to show the browning in the flesh.
(Photo by S. G. Peppin.)

EXPERIMENTS TO DETERMINE IF SEED END CARRIES WILT INFECTION

Seed-End Sets				Stem-End Sets			
No. of tubers with stem-end browning	Disease	No. tubers	Weight in oz.	Disease	No. tubers	Weight in oz.	No. of tubers with stem-end browning
0	*	5	34	*	8	22·5	5
4	*	5	38	.....	miss	.....	.....
4	*	4	30	.....	miss	.....	.....
5	*	8	39	*	7	36	1
3	*	5	28	*	8	45	5
2	*	6	46	*	6	25	6
2	*	5	35	*	11	45	9
Average 3·3	.....	5·4	35·7	.....	8	34·7	5·2

*Wilt present in summer.

The disease has persisted in wilted stock here for three years. The majority of the tubers from these plants carry the infection at the stem ends and give rise to wilted plants, though there have been some exceptions.

Records were made of the reduction in yield due to the disease. Two small plots were planted with the same number of sets of uniform size of the variety of Cumming's Pride. The seed used in one plot was from healthy plants while that from the other was cut from tubers which showed deep stem end browning and were the progeny of wilted plants. The plot in which the healthy seed was used yielded 48 pounds, while the yield of the diseased plot was 33 pounds. This would be a reduction of about 60 bushels per acre in a field of 100 per cent diseased stock.

LEAF ROLL AND MOSAIC*

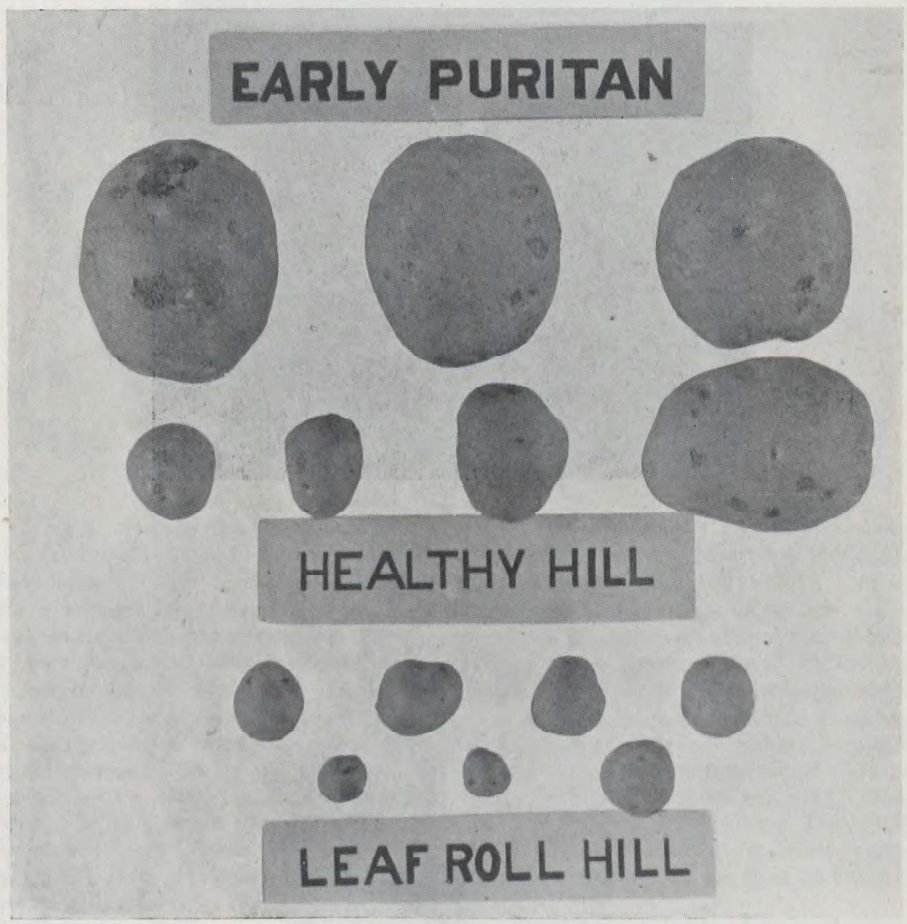
LEAF ROLL

This disease causes a great deal of damage to the potato growing industry whenever present in any quantity, the yield of diseased plants being reduced to about one-third of the normal crop. Fortunately, however, the geographical distribution, so far as the Dominion of Canada is concerned, is somewhat restricted. The trouble seems to be most severe in southern Ontario, and to a lesser degree in portions of Quebec and Nova Scotia.

The term leaf roll only partially describes the symptoms of this disease. It has an added disadvantage in that it also partially describes other diseases and abnormal conditions which are quite distinct from leaf roll but which are sometimes mistaken for it. Among these may be mentioned black leg, *Rhizoctonia*, and wilts. Rolling of the leaves produced by mechanical injury to the potato stem such as that caused by hail, cultivator teeth, etc., has also been erroneously diagnosed as leaf roll. On careful examination, however, it will be observed that plants affected with leaf roll are usually dwarfed and stocky, and often have an upward habit of growth. On the whole they present an unhealthy appearance when compared with a normal plant. The leaves in addition to being rolled are coarser and thicker than normal, and have a distinctly stiff feeling when bent between the fingers. These symptoms are much more marked on the lower leaves although the upper leaves may be similarly affected.

*For a detailed discussion of these diseases the reader is referred to Bulletin No. 44.

The cause of this disease so far remains undiscovered. It has been definitely established, however, that the disease is carried in the seed and that loss can only be prevented by using seed from a field in which little or no leaf roll was present. Experiments also indicate that the disease spreads to neighbouring plants in the



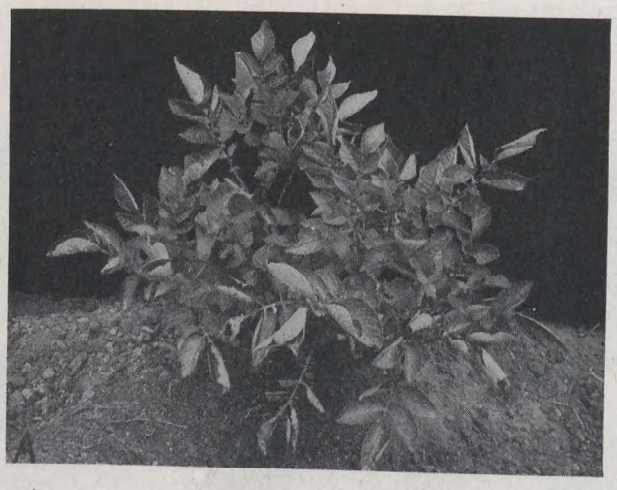
Reduction in yield as a result of leaf roll.
(Photo by S. G. Peppin.)

field, and that infection is also carried over in the soil. Though the yield from diseased plants may vary from year to year according to season, soil, and other local conditions, nevertheless, once the plants develop pronounced leaf roll symptoms, no progressive decrease in yield can be observed, nor is there any recovery from the diseased hills. Careful hill selection should be practised and all diseased hills should be removed as soon as observed.

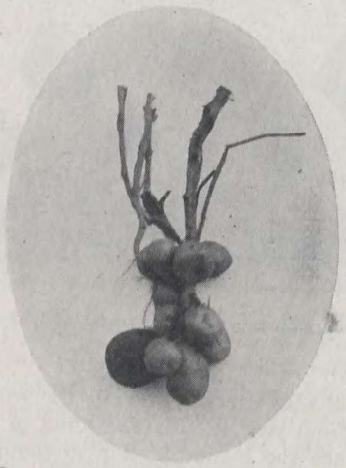
Recent Experiments.—In 1918 and 1919 one hundred hills, each of two strains of Garnet Chili potatoes, were planted in four rows in the same relative position. The amount of leaf roll increased from 17·6 per cent in 1918 to 31·5 per cent in 1919.

In the spring of 1920 it was found that the seed had suffered badly from rot in storage. It was planted, however, using extra cuts from *healthy* hills to replace the

rotted tubers. Owing to the amount of rot, only 172 sets were obtained. Of the 172 plants produced only 26·6 per cent developed symptoms of leaf roll. This decrease in the amount of disease was, of course, due to using a greater proportion of seed from healthy hills. The experiment has been discontinued in favour of a more elaborate one in which the same work has been incorporated.



A.

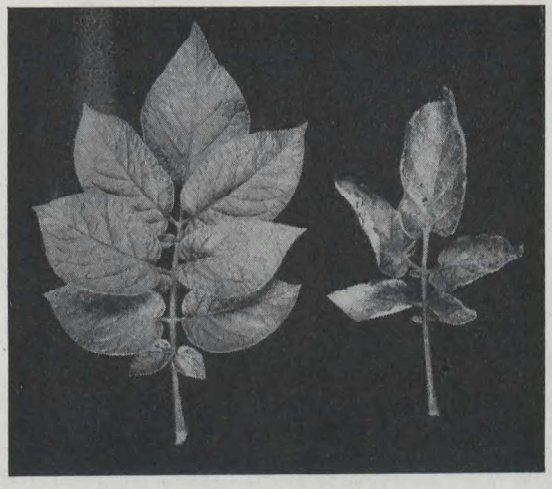


B.

A. Potato plant affected with leaf roll. Note the rolling of the lower leaves. The average of 9 plants similar to this was 3 ounces.
Variety—Early Puritan.

B. A hill of Early Puritan potatoes affected with leaf roll dug to show the characteristic arrangement of the tubers around the stem.
Note the sound seed piece.

(Photos by S. G. Peppin.)



Leaf roll of potatoes.
left: healthy leaf
right: diseased leaf.
(Photo by S. G. Peppin.)

MOSAIC

This is another disease the cause of which is still unknown. The disease seems to be fairly well distributed throughout Ontario, Quebec and the Maritime Provinces. Practically the only disease-free fields which have been found so far have been in Prince Edward Island, and Eastern New Brunswick. As in the case of leaf roll it produces no visible manifestations on the tubers and is, therefore, only discernible in the growing plant, usually becoming conspicuous about growing time. Mosaic, as the name suggests, appears on the leaves as a mottling of light green irregular spots. This mottling is often accompanied by a distinct puckering, and in severe cases the leaves may have a tendency to curl downwards around the edges. Where the plants are only slightly affected the reduction in yield may be only about 8 per cent, whereas, in more severe cases, the yield of diseased plants may be rduced 40 per cent. This, however, will be found to vary with the locality and seasonal conditions. The Green Mountain variety is especially susceptible. In addition to the infection being carried over in the seed, the disease is also spread from plant to plant in the field by sucking insects.

The most reliable control measures are: the use of disease-free seed, isolation from diseased fields, and the systematic removal of diseased plants (including the entire hill) as soon as observed.

Leaf Roll and Mosaic Experiments

The co-operative leaf roll and mosaic experiments were continued for the third year. The original healthy seed of the Garnet Chili variety retains its health, although only isolated from adjoining plots in which there was a small percentage of leaf roll plants by a space of three rows. Only one plant in the 153 which grew in the experiment developed leaf roll in 1920. This would indicate that possibly insects are not the agency by which this disease is spread. Experiment No. 2 was a failure from a leaf roll point of view; less leaf roll developed than in the previous year and mosaic developed to an extraordinary degree, there being very few plants which remained

healthy. In experiment No. 3, to determine the rate of increase of leaf roll, there was less leaf roll than in either 1919 or 1920. This fact is impossible for us to explain except on the assumption that the plot being harvested in bulk, the better and probably healthier tubers were selected for planting. In experiment No. 4, to see if mosaic will appear, 8.8 per cent of the plants were mosaic, which is accounted for by the fact that it was found impossible completely to isolate this plot in 1919 when 2.5 per cent of mosaic was present. It, however, proves that isolation is an important factor in the control of this disease. In experiment No. 5, to study the spread of mosaic, it was found that plants originally healthy, when grown for two years between mosaic plants, contract the disease to the extent of 100 per cent. Plants growing one row away from diseased plants had 90.0 per cent; two rows away, 67.5 per cent; three rows away, 66.2 per cent; four rows away, 73.3 per cent; five rows away, 48.7 per cent. The results obtained from this experiment show rather conclusively that even under the best climatic conditions such as prevail on Prince Edward Island for growing potatoes, mosaic spreads very rapidly in the field. In experiment No. 6, to study the spread of mosaic when insects are not controlled, the original healthy seed broke down to mosaic from 24 per cent in 1919 to 86 per cent in 1920. It should be noted here that in the control of insects on the other experiments, the Colorado beetle and flea-beetle were the only ones that we attempted to control. No effort was made to control the potato aphid which it is believed is the one really responsible for the spread of mosaic in the field. In experiment No. 7, to determine the rate of increase of mosaic, the figures for the three-year period 1918, 1919 and 1920 are: 51.0 per cent, 68.3 per cent and 85.0 per cent respectively, which again bears out our statement as to the spread of this disease under favourable conditions.

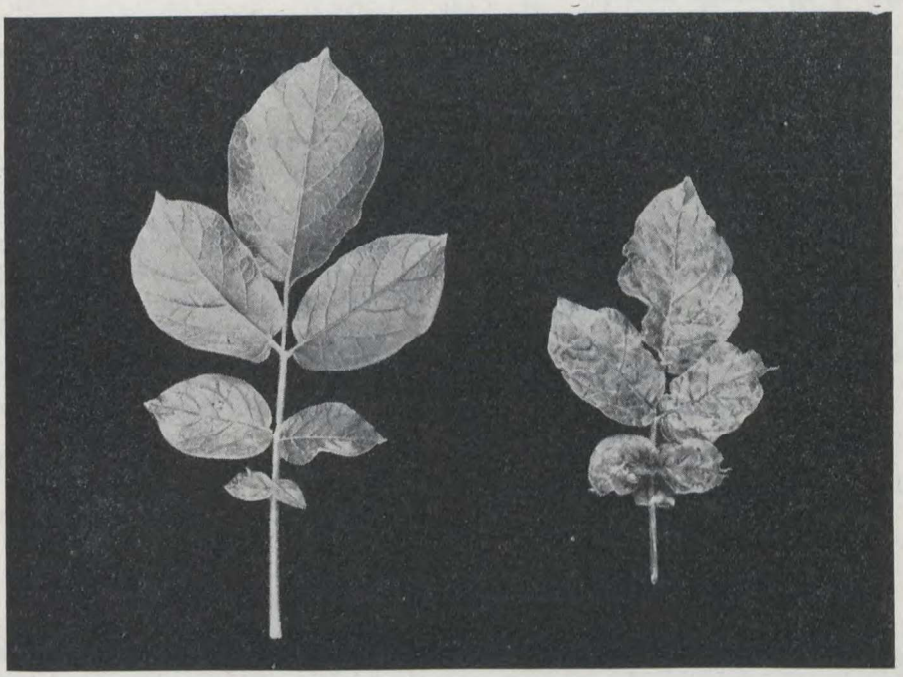
An experiment with the Green Mountain variety was started in 1919 to obtain information as to the value of early and late rogueing by introducing various percentages of diseased plants among healthy plants, viz., 2, 5, 10, 25, and 50 per cent in each of three plots, one plot being rogued of the diseased plants as soon as the disease became apparent; one plot rogued of diseased plants two weeks before the regular digging date, and the tubers discarded; and one plot unrogued as a check. The results of one year's work, while not at all conclusive, indicate that early rogueing reduced the possibilities of the spread of the disease in each plot when compared with the late rogueing, and that the late rogueing was apparently only beneficial in so far as it eliminated the diseased tubers from being planted the following year. The results are given in table I below.

TABLE I.—Early and Late Rogueing Experiment for the Control of Mosaic in the Field.

	Per cent mosaic introduced in 1919				
	2	5	10	25	50
Early Rogued	6	9	27	8	4
Late Rogued	6	23	30	48	47
Not Rogued	17	34	57	69	60

The figures show that in spite of the early rogueing more mosaic developed in the 2, 5 and 10 per cent plots than was originally introduced, while in the 25 per cent and 50 per cent, it would appear that early rogueing was beneficial. Further work along these lines will be necessary before any accurate conclusions can be drawn. The experiment is to be continued for a period of years in order to ascertain this information.

An exact duplicate of the mosaic experiment was done on the Garnet Chili variety with the leaf roll disease. The results obtained in 1920, after rogueing out the various percentages of diseased plants in each plot in 1919, are given in table II.



Mosaic disease of potatoes

Above—diseased plant (Photo by S. G. Peppin.)

Below—left: healthy leaf
right: diseased leaf.

(Photo by P. A. Murphy.)

TABLE II.—Early and Late Rogueing Experiment for the Control of Leaf Roll in the Field.

	Per cent leaf roll introduced in 1919				
	2	5	10	25	50
Early Rogued	0	2	0	2	27
Late Rogued	1	6	19	31	54
Not Rogued	5	7	13	56	68

The figures as shown in the above table indicate that early rogueing was apparently responsible for the control of leaf roll to a very satisfactory degree in the 2 per cent, 5 per cent, 10 per cent and 25 per cent plots, and to a less extent in the 50 per cent plot, whereas in the late rogued plots more leaf roll had developed in the remaining healthy plants than was originally introduced in every case except the 2 per cent plot, which demonstrates that the late rogueing out of diseased plants is not to be recommended in comparison with early rogueing. However, further work will have to be done in this as in the mosaic experiment before any definite conclusions can be drawn.

TESTING POTATO TUBERS FOR LEAF ROLL AND MOSAIC DISEASES BY MEANS OF HEAT

The aim of these experiments was to discover, if possible, a method whereby a sample of seed potatoes could be tested in a laboratory for such diseases as leaf roll and mosaic. It was hoped that by heating tubers for a certain length of time, a combination of time and temperature could be discovered that would destroy the vitality of the diseased tubers.

Two treatments were used: hot-water and hot-air. The greatest care was exercised in selecting, weighing, and marking the material used in the experiments. The work was performed by Mr. W. K. McCulloch under Mr. Murphy's directions.

HOT-WATER TREATMENT

A hot-water chamber was devised in which uniform temperature could be maintained throughout, and held constant for a given time.

Potatoes of the same variety were arranged in a wire basket, so that each diseased tuber was paired with a healthy one of the same size and weight, and immersed in the hot water. After treatment the tubers were taken out, allowed to dry off, placed under conditions as favourable as possible for germination, and examined at frequent intervals. The results of the experiments are shown in tabular form. Untreated potatoes which were placed under conditions similar to the treated began to sprout, more or less vigorously, ten days after the first experiment was done.

In the case of experiment 31 the difference in vigour of the diseased and healthy tubers was very marked.

The sprouts on the diseased and healthy tubers in the other experiments showed little or no difference.

As will be seen, the results are of a negative nature. The experiments have been discontinued for the present, owing to the lack of suitable material.

HOT-AIR TREATMENT

This treatment was carried out in a "Thelco" incubator. After the tubers were arranged, the temperature was allowed to rise to 50° C., and held there with little variation. The duration of treatment was reckoned from the time the tubers were placed in the chamber. For example, in the first experiment in this series, the lowest temperature after immersion was 41° C., and three and one half hours elapsed before the temperature rose to 50° C.

Unfortunately, before we had proceeded far with this treatment it was discovered that the incubator was defective; that, proceeding from left to right of the chamber, an increase of temperature occurred, reaching a maximum increase of 10° to 12° C. on the extreme right.

However, a few tests were continued, an endeavour being made to arrange the tubers so as to balance the unequal conditions.

In most of the cases where the tubers survived this treatment, germination took place in from ten to twelve days after treatment. At this time the healthy were sprouting vigorously, while the surviving mosaic tubers showed only faint signs of growth.

However, after a further period of about seventeen days the difference in vigour was not marked—the diseased having caught up with the healthy.

HOT WATER TREATMENT

LEAF ROLL DISEASE

No. of Expt.	Variety	Temp.	Time in hours	Date of treatment	No. of days before growth appeared	Percentage of tubers sprouting to date	
						Diseased	Healthy
1	Garnet Chili	50°C	1	Jan. 16	48	50	50
2	"	50°C	1	" 16	48	60	—
3	"	50°C	1	" 16	48	70	14
4	"	50°C	1	" 19	45	60	80
5	"	50°C	1	" 19	45	50	50
7	"	50°C	1½	" 20	44	—	20
14	"	50°C	1½	" 26	38	40	40
12	"	50°C	1¾	" 22	42	14	71
15	"	50°C	1¾	" 27		0	0
8	"	50°C	2	" 20		0	0
23	"	50°C	¾	Feb. 6	26	60	40
28	"	50°C	¾	" 13	19	25	50
22	"	50°C	¼	" 5	27	75	75
27	"	50°C	¼	" 13	19	66·67	33·33
30	Empire State	50°C	½	" 17	15	50	50
33	"	50°C	½	" 18	14	50	50
32	"	50°C	¾	" 18	14	—	50
31	"	50°C	¼	" 17	15	100 (weakly)	100 (vigorously)

MOSAIC DISEASE

6	G. Mountain	50°C	1	Jan. 19	45	100	33·33
34	"	50°C	1	Feb. 19		—	—
9	"	50°C	1½	Jan. 21	43	20	0
16	"	50°C	1½	" 28		0	0
10	"	50°C	1½	" 21		0	0
11	"	50°C	2	" 22		0	0
25	"	50°C	½	Feb. 11	21	100	100
29	"	50°C	½	" 14	18	60	60
26	"	50°C	¾	" 12	20	50	50

— = no sign of life
O = tubers killed (soft)

TO DETERMINE IF LEAF ROLL AND MOSAIC INFECTION LIVES OVER IN THE SOIL

Two small plots which grew 100 per cent diseased leaf roll and mosaic plants in 1919 were planted with presumably sound seed in 1920 to determine if the infection lived over in the soil. Fifty-two tubers of the Green Mountain variety were each cut in halves, one half planted in the mosaic infected soil, and the corresponding halves planted in clean soil in the same order. The plants grew normally in both plots and showed corresponding degrees of disease, plant for plant. There was 25 per cent of

mosaic in each Green Mountain plot, that grown on the infected soil was not more severe in type than that grown on clean soil, which would indicate that mosaic does not infect and live over in the soil from year to year. In the leaf roll experiment 52 tubers of the Garnet Chili variety were planted similarly to the Green Mountain in leaf roll soil and clean soil. All the plants in both plots came healthy, indicating that no infection took place from planting in soil in which leaf roll plants had grown the previous year, thus bearing out the results obtained from previous experiments carried on here by Murphy, and in Bermuda by Wortley.

To Note the Effect of Planting Presumably Healthy Tubers in Leaf Roll and Mosaic Pulp

Fifteen presumably healthy Irish Cobbler tubers were cut in halves, one half of each being planted in direct contact with inoculum which had been made up by grinding leaf roll tubers, the other half of each tuber was planted in the same order in an adjacent row, no mush being used. All the plants grew normally, and corresponded exactly as regards disease, there being one plant, No. 6, in each row with leaf roll; the remainder were healthy, there being no apparent difference between the two rows.

In a similar experiment with mosaic there were four plants Nos. 7, 8, 9 and 10 in each row which were diseased. The remaining eleven plants were correspondingly healthy.

CURLY DWARF

In the year 1915 several dwarfed plants were diagnosed as curly dwarf. These have been grown in our plots every year since that time, and it was not until our investigations of mosaic in 1917 and 1918 that we decided these dwarf plants were

"Curly dwarf" of potato
left: Healthy plant
right: Diseased plant showing severe mosaic accompanied by pronounced dwarfing.
(Photo by S. G. Peppin.)

more of the type we are now calling severe mosaic. An endeavour was made in 1916 and 1917 to reproduce the disease in healthy plants by fastening together a healthy and diseased set. It is very unlikely if any organic union took place between the cut surfaces as they were merely pinned together. All eyes in both sets were left intact. The plants grew normally, the diseased set producing a diseased plant, and the healthy set produced a healthy plant in which there were no apparent symptoms of the disease. Unfortunately the progeny of these healthy plants were not saved for planting in successive years to determine if infection had taken place through the plants. In 1918 healthy and diseased sets of the same variety "Irish Cobbler" were planted alternately and the hills saved in separate bags. These were planted in 1919 but no symptoms of disease were found on the leaves in that year. They were planted in alternate rows with diseased plants. In 1920 after being grown for two years among diseased plants the healthy plants broke down to the extent of 53·3 per cent mosaic. It is also interesting to note that 33⅓ per cent of the plants showed no intermediate stage of disease such as we diagnose as "slight mosaic," but developed "severe mosaic" symptoms.

In 1918 we received from Mr. Macoun some of his best strains of Green Mountain, Irish Cobbler, Dalmeny Hero, Dalmeny Regent and Table Talk. These were all planted in our plots and every plant without exception proved to be dwarfs, which produced less than the set originally planted. We also planted some of our own healthy seed in alternate rows with the Ottawa seed the same year. No disease became apparent in this seed until 1920, when the Green Mountains broke down to mosaic to the extent of 52·6 per cent, 50 per cent of which was of the severe type and 5·3 per cent were leaf roll. The remaining 42·1 per cent were healthy. In the Irish Cobbler home grown seed in 1920, 53.3 per cent were mosaic, 85.7 per cent of which was severe, and 46.7 per cent healthy. It is presumed that the diseases which appeared in the Ottawa seed infected the originally healthy home-grown seed.

HILL SELECTION

In 1915 several large and small hills of the variety Garnet Chili were saved separately to determine if each would give rise to similar sized hills in subsequent years. In 1916 the varieties Green Mountain and Cumming's Pride were added to this experiment. It was shown that the largest hills in any one year did not of necessity spring from the largest hills of the previous year and similarly the same argument applied to the small hills since it was found in some instances that small hills one year gave the largest yield in the following year. No definite conclusions can be drawn from this work since it was found impossible to isolate these various lots from the possibility of neighbour infection by mosaic and leaf roll, which fact we were not aware of at the time this experiment was started. The experiments on hill selection were discontinued when the above fact became apparent to us.

IMMATURE SEED EXPERIMENT, 1920

A start was made in 1920 to test out the value of immature versus mature seed. Two lots of the same variety were harvested on different dates, the so-called immature seed being dug on September 14, 1919, and the mature seed on October 4, 1919. Two rows were planted in 1920 from each lot and harvested on the same date, having received the same cultural conditions throughout the growing season. The yield received from the immature seed was 291½ bushels per acre against 246 from the mature seed, a gain of 45½ bushels per acre in favour of the immature seed. There is another factor in testing out the relative values of seed in experiments of this kind which is not generally taken into consideration, and that is the amount of disease

which is present in each lot. In this particular experiment mosaic was present to the extent of 32 per cent in the immature seed, and 50 per cent in the mature seed. The relative weights of 500 healthy hills compared with 156 mosaic hills of the same stock averaged 24 ounces and 17 ounces respectively. By computing the figures of each lot so as to make them 100 per cent healthy we find that the immature seed would yield 331 bushels per acre against 308½ bushels per acre for the mature seed; a difference in favour of the immature seed of 22½ bushels per acre. This evidence is not at all conclusive, but the experiments are to be continued over a period of years. It emphasizes the fact, however, that good clean disease-free seed is necessary in order to make accurate tests of this nature.

COMMON SCAB EXPERIMENT

Owing to the fact that common potato scab (*Actinomyces scabies* (Thax.) Güssow) is a serious trouble to the potato growing industry in Prince Edward Island, a series of soil treatment experiments have been arranged with the object of devising suitable control measures. The materials which will be used are varying quantities of ammonium sulphate, flowers of sulphur, and a commercial bacterized sulphur called "Bac-Sul." In addition a mixture of ammonium sulphate, acid phosphate, and muriate of potash is being tried also in varying amounts per acre.

A "Seed Source Test" was conducted in 1919 by Green Mountain growers at Riverhead, Long Island, N.Y., to determine the most desirable localities from which to obtain their supply of seed. This was intended for American growers only. However, through the efforts of this laboratory, permission was obtained to enter six Canadian samples, three being chosen from Prince Edward Island, and three from eastern New Brunswick. There were eighty-four entries in all, most of which came from New York, Maine, Vermont and Wisconsin.

At the time of the field inspection, the Canadian samples could be easily picked out by even a casual observer because of their greater vigour and freedom from disease. The growers and dealers of Long Island were greatly impressed, so much so that the three contestants from Prince Edward Island received orders for all the seed they could supply. An excellent price was obtained amounting to over 70 per cent above the market price.

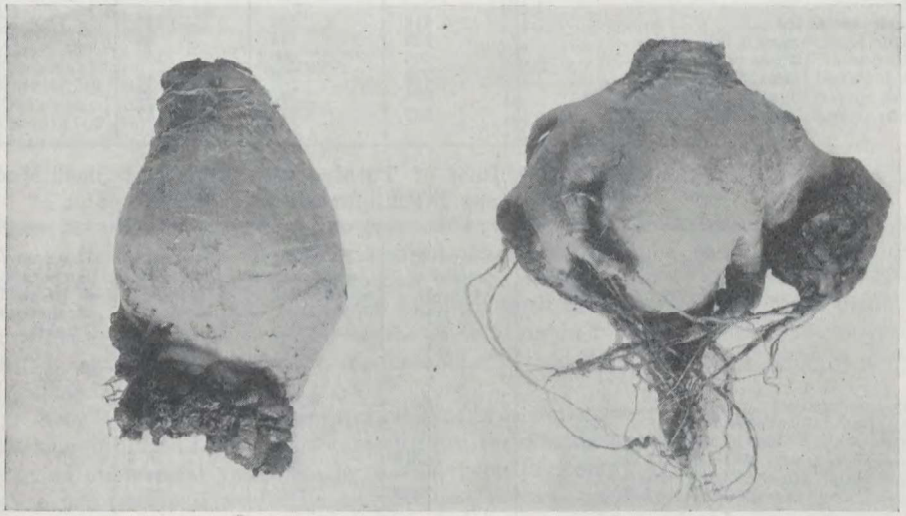
At the second annual "Seed Source Test" held at Riverhead, Long Island, N.Y., in 1920, four of the six Canadian samples of Green Mountains entered were sent from this province; while all these did remarkably well from a freedom from disease standpoint, they did not yield up to those sent in from New York and Vermont, which had 13·4 per cent and 12·5 per cent disease respectively. Our growers are being urged to practise hill selection methods to produce high yielding disease-free strains in an endeavour to overcome this disadvantage. In the Irish Cobbler test conducted at the same place, the one sample sent from here gave the highest yield in the test, namely, 531 bushels per acre.

For the coming season five lots of Green Mountain and two of Irish Cobbler seed have been entered from Prince Edward Island. These include all the Canadian seed in the official tests. Several additional lots of both varieties from Ontario and New Brunswick have been included in a supplementary test.

CLUB ROOT

This disease, which is caused by a myxomycete (*Plasmodiophora Brassicae* Wor.) attacks various cruciferous plants among which may be mentioned turnips, cabbage, cauliflower, Brussels sprouts, and shepherd's purse. It is by far the most destructive disease of turnips and is in fact among the most destructive of all diseases in Nova Scotia and Prince Edward Island. Experiments have been carried out in both provinces with a view to finding a satisfactory remedy.

The control of club root in Prince Edward Island is a difficult problem since there are no deposits of limestone in the province. Though some limestone is imported from Cape Breton and burned for use on the land in districts where shell mud is not available, the chief source of calcium carbonate for agricultural work is found in deposits of shells of oysters, mussels, and other shellfish which are found in varying quantities in most of the river estuaries and bays. It is this which must be relied on to control club root, and if it fails no other material appears to be available.



Typical cases of club root.
(Photo by S. G. Peppin.)

A number of co-operative experiments were carried on in Prince Edward Island to determine the effect of shell mud when applied to the soil in the autumn previous to sowing the land with turnips. The value of lime in the control of club root being well established, applications of freshly slaked lime in varying quantities were made at the same time to serve as a basis by which to judge the efficacy of the shell mud. Unslaked lime was also included for comparison. In one experiment club root developed to such a small extent that no definite conclusions could be drawn. In the other two cases, however, there was a considerable amount of the disease. The lime and shells were applied in the fall and were fairly well worked into the soil before frost came, except in one case in which shell mud was put on an extra plot in the spring. The plots were each one-fiftieth acre in area and were separated from each other by a distance equivalent to the width of two rows. Further experiments were conducted in Prince Edward Island and Nova Scotia to test the efficiency of slaked and unslaked lime, applications of slaked lime and marl in spring compared with fall applications of slaked lime.

EXPERIMENT on the Control of Club Root of Turnips with Lime and Shell Mud, New Perth, P.E.I., 1916

Treatment of plot per acre	Average total weight of turnips per acre in bush.	Average weight of sound turnips per acre in bush.	Average weight of diseased turnips per acre in bush.	Average percentage of diseased turnips by weight
Check: untreated	718	593	125	17·4
Mussel mud: 6 tons in fall	808	715	93	11·5
Mussel mud: 12 tons in fall	766	660	106	13·8
Fresh slaked lime: 25 bush. in fall	772	729	43	5·5
Fresh slaked lime: 50 bush. in fall	824	785	39	4·7
Fresh slaked lime: 75 bush. in fall	862	830	32	3·7

EXPERIMENT on the Control of Club Root of Turnips with Lime and Shell Mud, St. Eleanors, P.E.I., 1916.

Treatment of plot per acre	Average total weight of turnips per acre in bush.	Average weight of sound turnips per acre in bush.	Average weight of diseased turnips per acre in bush.	Average percentage of diseased turnips by weight
Check: untreated	263	212·5	50·5	19·2
Mussel mud: 10 tons in fall	463	404	59	12·7
Mussel mud: 20 tons in fall	605	585	20	3·3
Fresh slaked lime: 25 bush. in fall	588·5	553	35·5	6·0
Fresh slaked lime: 50 bush. in fall	727	702·5	24·5	3·3
Fresh slaked lime: 75 bush. in fall	753·5	726·5	27	3·6

CLUB ROOT

EFFECT of Lime (Slaked) applied in Fall.—Result of two experiments carried out in duplicate, Prince Edward Island, 1916.

Treatment of plots per acre	Average total weight of roots per acre Bush.		Average weight of sound roots per acre Bush.		Average percentage of diseased roots by weight	
	Exp. I	Exp. II	Exp. I	Exp. II	Exp. I	Exp. II
Check—untreated	850·5	553·5	587·5	513	30·9	7·3
Fresh slaked lime: 25 bush	740	668·5	660	660	10·8	1·2
Fresh slaked lime: 50 bush	785·5	672·5	770·5	640	1·9	4·8
Fresh slaked lime: 75 bush	933	611·5	912·5	597·5	2·2	2·3

COMPARISON of Slaked and Unslaked Lime, Prince Edward Island, 1916.—Record of one duplicate experiment

Treatment of plots per acre	Average total weight of roots per acre Bush.	Average weight of sound roots per acre Bush.	Average percentage of diseased roots by weight
Check	850·5	587·5	31·25
Slaked: 25 bush	740	660	10·8
Stone: 25 bush	971	880	9·45
Slaked: 50 bush	785·5	770·5	1·9
Stone: 50 bush	1,024·5	1,022	0·25
Slaked: 75 bush	933	912·5	2·25
Stone: 75 bush	1,049·5	1,036	1·35

CLUB ROOT Experiment at Boulardarie, N.S., 1916.—Plots one-fortieth acre each

Treatment of plots per acre	Average total weight of turnips per acre in bush.	Average weight of sound turnips per acre in bush.	Average weight of diseased turnips per acre in bush.	Average percentage of diseased turnips by weight
Check: untreated	248	112	136	55·0
Fresh slaked lime: 1,500 lbs. in spring	224	96	128	57·1
Marl: 3,750 lbs. in spring	234	125	109	46·6
Fresh slaked lime: 3,000 lbs. in spring	264	168	96	36·4
Marl: 7,500 lbs. in spring	220	168	52	23·6
Fresh slaked lime: 4,500 lbs. in spring	240	72	168	70·0
Marl: 11,250 lbs. in spring	334	118	216	64·7
Fresh slaked lime: 6,000 lbs. in spring	456	244	212	46·5
Marl: 15,000 lbs. in spring	464	176	288	62·1
Fresh slaked lime: 10,000 lbs. in fall	771	759	12	1·5

The results from the use of lime in autumn have been very satisfactory in all cases in which turnips were not grown for two years in succession on the same soil. Very often one will attempt to control the disease when a badly clubbed crop is observed. If this is done poor success will be obtained unless excessive applications are given. If, however, the farmer will wait until the infested land comes around to turnips again (in the ordinary course of rotation in four to six years) good control will be obtained with medium applications of slaked lime, shell mud, marl or ground limestone.

Our work here has demonstrated that it is not necessary to apply more than 50 bushels of slaked lime. This substantiates the conclusions of a club root experiment carried out several years ago by the Division of Botany at Charlottetown. If this were practicable it would be an excellent method of control, were it not for the difficulty in obtaining the material, and the expense incurred thereby. Success has followed the use of shell mud, and there are indications that further trial might prove marl and ground limestone of about equally good value. It is also probable that the length of time which preceded the sowing of the turnips would have an even greater influence on the efficiency of these substances, on account of their more slowly acting nature, than it would have on the efficiency of lime.

The results of experiments and observations as well as practical experience justify the conclusion that club root can be held in check effectively by careful attention to the following points:—

(1) The avoidance of the use of manure for the coming root crop from animals to which any turnips from a clubbed crop were fed raw.
(2) The practice of long rotations and even after a four to six year rotation, the arrangement of the hoed crop in such a way as to put turnips on the part of the field which grew potatoes or mangels previously.
(3) Clean cultivation and eradication of cruciferous weeds.
(4) As heavy applications as possible of shell mud, marl, or ground limestone to infected land as soon as the diseased crop is removed.

LOOSE SMUT OF WHEAT AND BARLEY

In 1917 it was found that some of the wheat and barley grown at the Experimental Station here was badly infected with loose smut. In collaboration with the superintendent in the spring of 1918 we treated several large lots and all the test of variety samples to be grown that year, with the "hot-water" method, with more or less success. Our principal trouble was to secure sufficient hot water, particularly for the final treatment. Owing to this fact the first lot which comprised three samples

of wheat and one of barley did not receive the full heat, and was, therefore, unsuccessful. After this a system was evolved whereby four barrels were so used as to necessitate a minimum of hot water and still keep up a continuous treatment, this proving very successful. In two acres of barley, counts were made which showed an average of 342 smutted heads per acre, and in another acre there were only thirty smutted heads compared with an untreated lot which averaged 20,000 smutted heads per acre. In three lots of wheat grown on two acres there was an average of 1,488 smutted heads per acre. This was no doubt due to having placed too much grain in the bags at one time for treatment. This latter fact was proved to some extent by the results obtained in the smaller lots treated for the test of varieties which was done in small bags. In fourteen varieties of barley treated with formalin in 1917 there were only five which showed freedom from smut, the remaining nine varieties having an average of 83 smutted heads per one-sixtieth acre. This seed treated with hot water in 1918 had no smutted heads.

The wheat varieties were similarly treated in 1917 with formalin, and eight out of thirteen had loose smut averaging 263 diseased heads per one-sixtieth acre. After the hot water treatment in 1918 there were only two varieties, each with one smutted head in the plot, the remainder being clean and free from disease. It would appear that, in order to be successful in treating large amounts, it is necessary to continue the hot water treatment both in the seed plot and the muliplying plots for at least two years, and perhaps longer.

WHEAT SCAB

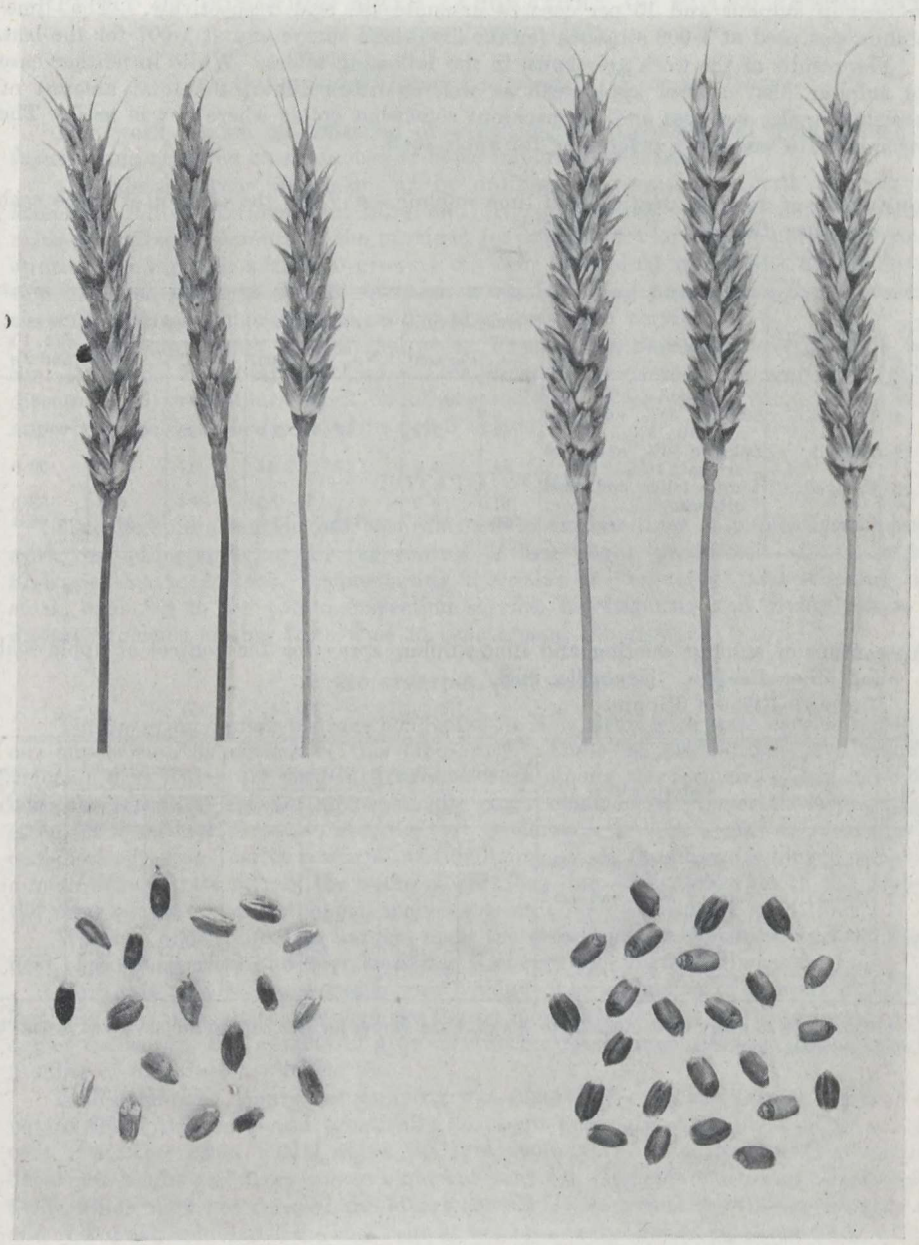
This disease of wheat, caused by the fungus *Gibberella saubinettii* (D. et M.) Sacc., was observed in Prince Edward Island in 1915, and the following year it assumed the proportion of an epidemic. The disease usually becomes conspicuous when the grain is ripening. Affected heads are noticeably smaller and thinner than healthy ones, and turn white prematurely. The glumes become discoloured. Lack of plumpness is emphasized when the heads are passed between the fingers. On examination bright pinkish spore masses will probably be found at the base of the glumes and along the edges. As a rule the disease does not appear on all the spikelets, but it may attack some or all the grains at the base, middle, or top of the head. Spikelets are wholly or partially empty, whatever grain is present being very much shrunken.

Since the disease is carried over by internal infection of the seed, control measures should be directed towards eliminating all shrunken grains by a very thorough cleaning, or by obtaining seed, if possible, from a crop which has not been attacked by scab.

SULPHUR DUSTING FOR APPLE SCAB AND OTHER APPLE DISEASES

A series of experiments was conducted in Nova Scotia in 1916 by Mr. Paul A. Murphy to test the use of sulphur dust as a means of controlling apple scab. While there were several agencies at work on the control of insect pests there were at that time no systematic investigations being carried on to work out the control of the more important plant diseases. Apple scab, or spot, as it is generally called in Nova Scotia, seems to be particularly favoured by the moist climate, and it stands out above all other enemies of the apple in a position of paramount importance. It was with a view to seeing if sulphur dusting would prove a safe treatment for this disease under Nova Scotia conditions that these experiments were begun.

Lime sulphur spraying was used as a basis of comparison for the dust and both applications were made on the same day with one exception. This happened at the time of the third spray in the Tully orchard when the dust was put on contrary to instructions three days before the spray, and to this fact the unusually poor showing



Wheat scab caused by *Gibberella saubinettii*
left: diseased ears and produce of a diseased ear
right: sound ears and produce of a sound ear.

(Photos by S. G. Peppin.)

of the lime-sulphur is to be attributed. Two strengths of dust were used, one containing 85 per cent of sulphur and 15 per cent of arsenate of lead, and the other 50 per cent of sulphur and 15 per cent of arsenate of lead respectively. The lime-sulphur was used at 1·008 strength for the first three sprays and at 1·007 for the last.

The results of the work are shown in the following tables. While in neither case did sulphur dust control apple scab as well as lime-sulphur, the total amount of blemished apples was less and the pack-out somewhat better where it was used. The season of 1916 was not a severe one for apple scab.

COMPARISON of sulphur dusting and lime-sulphur spray for the control of apple scab and other diseases. Berwick, N.S.
Variety—Stark.

No. of plot	Treatment of plot	Materials used	Blemished fruit		Apple Scab		Insect Attacks		Per cent No. 1's and 2's
			No.	Per cent	No.	Per cent	No.	Per cent	
1	Dusted. ...	Sulphur 85%, and lead arsenate 15%.....	49	5·2	19	2·0	29	3·1	93·8
2	Dusted	Sulphur 50%, and lead arsenate 15%.....	34	4·9	17	2·45	17	2·45	90·6
3	Sprayed....	Lime sulphur and lead arsenate.....	87	6·9	2	0·2	84	6·6	88·6
4	Check.....	.....	303	28·3	149	13·9	153	14·3	66·4

COMPARISON of sulphur dusting and lime-sulphur spray for the control of apple scab and other diseases. Kentville, N.S.
Variety—Ribston Pippin.

No. of plot	Treatment of plot	Materials used	Blemished fruit		Apple Scab		Insect Attacks		Per cent No. 1's and 2's
			No.	Per cent	No.	Per cent	No.	Per cent	
1	Dusted.....	Sulphur 85%, and lead arsenate 15%.....	97	2·1	23	0·5	53	1·2	* .....
2	Dusted.....	Sulphur 50%, and lead arsenate 15%.....	206	5·5	42	1·1	158	5·4	.....
3	Sprayed....	Lime-sulphur and lead arsenate.....	1,188	16·0	28	2·4	157	13·4	.....
4	Check.....	.....	840	19·1	180	4·1	651	14·8	.....

*There were so many unblemished No. 3's that the figures for this column are not given owing to their misleading character.

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

G. C. CUNNINGHAM, *Plant Pathologist, Officer in Charge.*

The work carried on consisted of extension or demonstration work among the farmers and research on a number of more important diseases.

Considerable time was taken up by ordinary correspondence with farmers and attending fall exhibitions, seed fairs, and diverse meetings. In addition, visits were made to different sections of the province for the purpose of taking notes on demonstrations and giving advice to growers on their individual problems. Special attention has been given to potato extension work, including potato spraying demonstrations, potato seed improvement, and potato inspection service.

Experimental work was carried on at Fredericton, N.B., Lennoxville, Que., and Ste. Anne de la Pocatière, Que. This included researches on bean and potato diseases, and preliminary work on other problems. Progress on some of the more important problems is discussed in detail below.

POTATO WORK

Considerable attention has been devoted to various lines of potato improvement work, including spraying for the control of late blight, production of disease-free, high yielding seed stock, demonstrating the value of "rogueing" and selecting seed stock, assisting in the potato inspection service, investigating and giving advice on disease problems arising from time to time among the growers.

POTATO SPRAYING DEMONSTRATIONS

The spraying demonstrations conducted in New Brunswick were carried on under our supervision by officers of this laboratory. These demonstrations have supplied valuable data which are used in extension work among the farmers. They have also been the means of convincing practically every commercial grower that spraying is essential to successful potato growing. It is common to hear a grower state that he considers spraying just as essential as fertilizing. It is therefore no longer our chief aim to demonstrate merely the value of spraying, but to demonstrate to the growers the most efficient and economical methods to suit New Brunswick conditions.

We have endeavoured to impress upon the grower that carefulness and thoroughness pay, but careless and poor spraying is energy and materials wasted.

With this in view, experiments were conducted by a number of growers in various localities. As a result the growers are taking more interest and get considerably more out of the work. The number of growers who purchased machines was limited by the number of machines available.

In Restigouche county the spraying was supervised on seven farms. Fire of the potato fields used developed practically no blight and only about one-half to one per cent rot. Two other fields, where the late applications of spray were not applied, developed blight and from one to eight per cent rot. In fields or sections of adjoining fields, which were not sprayed, the blight completely destroyed the foliage towards the end of August, reducing the yield from 25 to 50 per cent followed by from 25 to 75 per cent rot before and after digging. As a result of the success of this work many growers who were able to convince themselves of the value of spraying on their neighbour's field, and who lost their own crop because it was not sprayed, are in the market for sprayers this year, and others wish to replace their cheaper sprayers with larger and more powerful traction power sprayers carrying three nozzles to the row. Spraying was conducted on farms in other sections with equally good results.

No spraying experiments were conducted on the Experimental Farm in New Brunswick or Quebec by the Fredericton Laboratory, for two reasons: (1) The Entomological Laboratory wished to conduct certain tests, and (2) we consider spraying for this section now beyond the experimental stage, and that the aim should be to place the information already obtained before the grower in the form of demonstrations or supervision of his own efforts.

RESULTS OF SOME SPRAYING EXPERIMENTS CONDUCTED ON FARMS IN NEW BRUNSWICK

Location of test	No. of applications of spray	Yield in bushels per acre				Increase of marketable potatoes
		Total	Marketable	Small	Rot	
Scotch Lake	4	213·3	204·2	5·5	3·5	64·1 Bus. per acre
"	6	259·6	249·2	7·8	2·6	109·1
"	Control—0	182·6	140·1	11·0	31·3	
Spring Hill	6	130·5	120·0	10·5	0·0	12·0
"	Control—0	118·6	108·0	10·6	0·0	
Tracy Station	4	302·0	234·0	64·6	3·4	63·0
"	6	299·5	229·0	70·0	0·2	58·0
"	Control—0	237·4	171·0	64·0	1·0	
Florenceville	6	180·6	165·0	3·1	12·5	55·0
"	Control—0	148·5	110·0	5·5	33·0	
River Charlo	4	362·5	334·5	22·0	5·8	156·2
"	Control—0	201·5	178·3	16·9	6·3	
"	5	378·0	352·0	24·2	1·8	122·6
"	Control—0	269·0	229·4	15·2	24·4	
Up. Sackville	4	467·0	461·5	5·5	0·0	115·5
"	6	405·0	397·0	8·0	0·0	51·0
	Control—0	364·0	346·0	17·5	0·5	

The average increase in yield in the ten tests recorded over 80 bushels of marketable potatoes per acre, the lowest 12 bushels and the highest 156 bushels per acre. The stock on the north shore sold for $1.50 per bushel; thus the grower gained by spraying to the extent of $234 per acre.

DISTRIBUTION OF HIGH GRADE SEED POTATOES TO NEW BRUNSWICK FARMERS

When the Dominion Field Laboratory of Plant Pathology was established in 1915 at Fredericton, N.B., the province held a high reputation for the quality of the seed potatoes it produced and shipped large quantities of seed stock to the other Canadian provinces, and to a lesser extent to the United States. A survey of the condition at that time showed that numerous diseases of the potato were becoming established and unless steps were taken for their control and elimination the quality of the stock would be so reduced as to injure the reputation which the growers had already built up. The chief diseases present were: late blight, black leg rhizoctonia, mosaic, leaf roll, powdery scab, and to a lesser extent wilts, common scab, silver scurf, and other minor troubles.

There were several ways of attacking the problems:—

(1) By practising rogueing and selection for the elimination of disease and impurities combined with selection for high yielding strains.
(2) By distributing pure, disease-free, high yielding strains of desirable varieties.
(3) By developing new districts with the best seed available.
(4) Or by a combination of all three methods; that is taking the best seed available to a comparatively virgin district or where the diseases did not occur, or at least rarely, and did not spread rapidly, there to practise rogueing and selection until good strains were developed and multiplied for distribution on a large scale to various sections of the province.

Unfortunately there was no information available or precept to be followed, and the problem had to be solved slowly with many mistakes and delays. At that time rogueing and selection was considered the cure-all. It was not believed that the diseases had become so common and well established that rogueing and selection would not finally eliminate them, or reduce their occurrence to a very low degree. Experience has shown, however, that selection and rogueing are of value, but that the natural agencies for spreading diseases such as mosaic and leaf roll are so active that little can be accomplished in the way of reducing their occurrence or of building up a better strain in districts where the diseases have already a firm foothold. This condition existed and still exists in the greater portion of the present intensive potato growing section. Rogueing and selection in this section have been of great value in the elimination or reduction of black leg impurities, and in a few instances of leaf roll. Mosaic, on the other hand, has steadily increased.

The distribution of disease-free stock was impossible, as there was none to distribute,—certainly none that was known sufficiently well to justify carrying on a vigorous campaign towards having them multiplied.

Certain districts were recognized as being freer from disease than others, but in these sections the stock was badly mixed, and the crop considered only of minor importance.

The problem, therefore, was more difficult than expected. Fortunately, however, the several possible channels for improvement were being developed simultaneously. At present a combination of all three methods is giving results, although pushed with least energy. Two strains are now available—one developed in Sunbury county, on the St. John river, and the other in Restigouche county, on the southwestern shore of the bay of Chaleur.

In the fall of 1919 there were available in Sunbury county approximately 500 bushels of pure and practically disease-free stock of the Green Mountain variety. This was distributed under our supervision to five growers, and proved of excellent quality. One lot of 60 bushels was lost by accidentally mixing with a diseased strain. The crop from the balance has been sold to farmers in New Brunswick, Maine, and New York state. The yielding quality of this strain is proven by the fact that the different growers, even under last season conditions, obtained from 275 bushels up to 517 bushels per acre under field conditions. The yield varied in accordance with the care and fertilization; 275 bushels being obtained with a light dressing of barnyard manure, and 517 bushels with barnyard manure and commercial fertilizer. The quality and type of this strain is exceptionally good.

In 1918 small quantities, varying from 5 to 10 bushels, of another high yielding strain were placed in the hands of several growers in Restigouche county. This strain contained a small percentage of impurities, black leg, and from 3 to 5 per cent mosaic. The fields were rogued in 1919 and in 1920. In 1920 there was present in the stock one-half per cent foreign varieties, one-half per cent of black leg, and 1½ per cent mosaic. These fields were rogued twice during the summer of 1920, consequently we anticipate only a trace of disease next season. In all, fourteen farmers in Restigouche county produced approximately 4,500 bushels. Unfortunately 900 bushels were lost by rot in storage, following late blight in the fields, and 375 on two farms due to severe attacks of common scab. About 500 bushels of this stock will be distributed to other growers in the district; the balance, 2,500 bushels, was sold to New York growers for seed purposes. Last season 700 bushels of this strain were shipped to Presque Isle, Maine, and were reported to be the best grown in that district. Many orders could have been filled this season had the stock been available.

There are three reasons for letting this stock go out of the province:—

(1) To prove to the grower that there is a market for high-grade stock at almost double the price of table stock.

(2) To develop a permanent seed trade and reputation simultaneously with the multiplication of the stock in the province.
(3) To obtain for the grower a good price for his stock so as to enable him to increase his acreage the following year.

So far, the market demand for this stock has exceeded the production.

Survey work conducted in the province during the last few years proved beyond doubt that the district along the bay of Chaleur and the gulf of St. Lawrence is relatively free from disease, and also relatively free from the agencies which spread mosaic and related troubles. Greater attention has therefore been paid to the improvement and multiplication of high-grade stock in this district than in the western counties where diseases spread rapidly. The present indications are that this district will become an élite seed producing centre for supplying foundation stock to the seed growers of the western counties of New Brunswick, Maine and New York state. Certain American authorities are closely watching the development in this section and recommending the stock produced to their growers.

Steps have already been taken towards developing varieties other than the Green Mountain in the district and it is expected that several hundred acres of exceptionally good seed will be produced there next season.

ROGUEING AND SELECTION

In former years considerable rogueing and selection have been done in Carleton, Victoria, and York counties. In some cases this has been in co-operation with the growers and in others independent. Good results have been obtained with the Irish Cobbler variety, which shows a higher resisting power towards mosaic and leaf roll; consequently several pure, high yielding, relatively disease-free strains of Cobblers have been developed. Selection and rogueing with the Green Mountain variety has not been successful for the reason that it is very susceptible to mosaic. The disease increased as rapidly as, and in many cases more rapidly than our selection decreased it. This was particularly noticeable in seasons following heavy infestations of aphis. The aphis is now recognized as the chief agent in spreading mosaic in northeastern sections. Selection and rogueing, however, have greatly reduced the amounts of black leg, wilts, and impurities, which a few years ago were very common. This is noticeable in the potato inspection service reports for various years.

Selection and rogueing of the Green Mountain in the north shore districts and in isolated districts in York and Sunbury counties, where the aphis is not common, have given good results. In several cases the diseases have not only been checked, but greatly reduced, and the yielding power of the strains apparently increased.

A demonstration test to show the importance of planting disease-free stock as compared to healthy stock was conducted at Florenceville, N.B. The healthy stock originated in northern Ontario, and 100 per cent mosaic stock from the Experimental Farm, Fredericton. Each lot was planted on the same date side by side and under as nearly uniform conditions as possible.

The plots were examined on July 26, August 1, and August 11, and records made on the amounts of diseases present. In the fall the crops were harvested, weighed, and the yields computed per acre. The data obtained are tabulated below.

RESULTS OF HEALTHY AND DISEASED POTATO SEED TESTED AT FLORENCEVILLE, N.B.

Condition and source of seed	Field notes on disease and vigor of plants	Yield per acre in bushels			
		Total	Large	Small	Rot
Healthy seed stock from northern Ontario.	13% slight mosaic, 5½% severe mosaic (total 18½% mosaic), 7½% weak plants, 6% misses, no other disease; medium growth of plants but not vigorous.	210·0	129·0	63·7	17·1
Diseased seed stock from Fredericton, N.B.	27½% slight mosaic, 62½% severe mosaic (total 90% mosaic), 8⅓% weak plants, 6⅔% misses; medium growth of tops but not as vigorous as Northern Ontario stock.	67·4	32·4	32·0	3·0

The plants recorded as weak were probably advanced stages of mosaic.

The above data show that even the healthy stock developed 18½ per cent distinct mosaic and 7½ per cent weak plants, making a total of 25⅔ per cent inferiors. The diseased stock known to be practically 100 per cent mosaic developed 90 per cent distinct mosaic and 8⅓ per cent weak plants, making a total of 98⅓ per cent inferiors.

The total yield from the northern Ontario stock was over three times as large as that from the Fredericton stock while the yield of marketable potatoes from the former stock was four times as large. Had the northern Ontario stock remained actually disease free and vigorous the difference would have been even more marked.

OTHER POTATO WORK

A series of eight experiments on potato mosaic, leaf roll, and related problems was carried on at Fredericton and Lennoxville for the pathologist in charge of potato diseases. Considerable attention was also given to the potato inspection service. Reports on these will appear elsewhere in the divisional report.

INVESTIGATIONS ON PARTIAL FAILURE OF POTATO CROP IN SECTIONS OF NEW BRUNSWICK, MORE PARTICULARLY IN VICTORIA COUNTY

During May and June growers from various sections of the province, particularly Victoria county, reported that their potato crop had been injured by fertilizer. An investigation was immediately commenced by the laboratory on instructions from headquarters to determine the cause if possible, and particularly to determine whether or not the trouble was of a pathological nature. The investigation was continued at intervals throughout the season and information collected on numerous points which might possibly throw light on the question. The investigation included the following points:—

(1) *Seed*. . . . . Quality of seed.
Treatment before planting.
Conditions of storing before and after cutting.
Date of cutting in relation to date of planting.
Size of seed piece.

(2) *Soil*. . . . . Type of soil—old or new land, etc.
Preparation seed bed.
Cultivation after planting.

INVESTIGATIONS ON PARTIAL FAILURE OF POTATO CROP—*Concluded.*

(3) *Planting*	Date of planting.
	Depth of planting.
	Type of machine used.
(4) *Fertilizer*	Manufacturers.
	Analysis.
	Quantity applied per acre.
	Method of applying.
(5) *Weather Conditions*	Temperature and rainfall during May, June and July.

The earlier investigations showed the trouble to be more common in Victoria county than elsewhere, but poor fields were noted in different sections of the province and even in Maine. Poor fields were characterized by misses or skips in the rows and weak spindling plants. Under ordinary circumstances we expect to find from 5 to 10 per cent misses in even good fields, and the same percentage of weak plants. However, many fields showed from 25 per cent to 75 per cent misses, and in a few cases even to 90 per cent. In fields with a high per cent of misses the plants which did come were usually weak and spindling and with a few exceptions remained so throughout the season. A few of the poorest fields were re-planted to other crops before the investigation started.

Examination of the seed in the soil showed it to be usually in a rotting or completely decomposed condition, the spindling plants coming from partly decomposed seed. In some cases there were signs of injury to rootlets where they came in contact with the fertilizer. This injury is not uncommon any season where the seed piece comes in direct contact with the fertilizer and more particularly so if a high grade has been used. It should also be noted that parts of individual fields were poor and other parts were medium to almost good.

There was nothing observed in any field to indicate that the trouble was of a pathological nature, when using the term in its more restricted sense; certainly there were no indications of the presence or activities of parasitic organisms. The only pathological condition noted was the rotting of the seed, probably by saprophytic organisms favoured by conditions of the soil. The rotting of the seed in turn caused misses or weak plants. There, however, was evidence of a true pathological condition existing in the base of the stem where the stem came in contact with rotted seed. There was no evidence of more than the normal quantities of black leg, wilts, *Rhizoctonia,* or other types of damping-off diseases.

Seed.—There was nothing brought out by examination of the fields or by questioning the growers to indicate that the quality of the seed was at fault or below the average. Nor could any evidence be obtained to show that the condition of storage, before or after cutting the seed, the date of cutting in relation to the date of planting, the size of the seed piece, or the treatment of the seed before cutting caused the trouble.

Soil.—Poor fields were found on old and on comparatively new land. Soils naturally moist showed less injury than dry soils. A few fields in Carleton county, reported to have received less than the average amount of cultivation, showed an abnormal amount of misses and weak plants. Since the trouble was apparent by the time the plants came up or should have come, there is no ground for attributing the poor stand to lack of cultivation.

Planting.—Fields planted early or late, by the 17th of May or after the 5th of June, were almost invariably normal, while fields planted during the interval were frequently poor, and furthermore, practically all, if not all the poor fields examined, were planted during the latter period. In large fields which required several days to

plant, it was noted that some sections were poor and some normal or nearly so. In such cases it was repeatedly noted that the sections planted before the 17th of May were usually normal or nearly normal, while the sections planted a few days later were very poor showing many skips and a greater percentage of weak plants. As the date of planting approached the 5th of June or later, the percentage of misses and weak plants decreased.

These periods seem to conform with the periods the soil was (1) moist and (2) dry. In Victoria County particularly, the month of May was unusually warm and dry, which condition prevailed until about the 8th of June. Thus the seed planted early found sufficient moisture left in the soil from the early spring to enable it to germinate and become established, and the seed planted after the 5th of June did not rot or dry up before the rain came in June; while the seed planted during the latter part of May and early June, when the soil was exceptionally dry and hot, dried up and failed to germinate, and when moisture became abundant, rot commenced. No information was obtained to show that the various types of machines used caused the misses; the seed piece was there, but rotted.

Fertilizer.—Poor fields were found with practically every brand of fertilizer used in the district, irrespective of both low and high grade material used.

There was a marked effect where varying quantities of fertilizer were applied. This was indicated by more uniform stands where small quantities were used, and poor stands where larger quantities were used in the same field. Furthermore, observations on sections of rows, where the fertilizer failed to be distributed by the machine, disclosed normal stands, whereas the adjacent rows and sections of the same row, where the fertilizer was applied, frequently showed large percentages of misses. These observations indicate clearly that the presence of fertilizer emphasized the effects due in the first instance to drought.

Inquiries as to the types of machines used for distributing the fertilizer did not supply any explanation as to the cause.

Weather Conditions.—There was practically no rainfall during the month of May nor until on or after the 8th of June. The temperature was exceptionally high, for the district and for the period of the year. This condition undoubtedly left the soil dry and warm so that the seed planted during the period found conditions unsuitable for germination.

Poor preparation of land, resulting in a failure to conserve the early spring moisture, was partly responsible for injury in a few cases. Shallow planting which is usually practiced in this district may also have contributed to some extent.

In reviewing above investigation reference is made to records in United States literature relative to the presence of borax in certain grades of fertilizer, which has proved decidedly injurious to a number of crop plants, including potato. In the course of investigation, samples of the fertilizers used were submitted to the Dominion Chemist, who, on analysing same, reported that "in no instance did the content of anhydrous borax exceed 0.01 per cent. The chemical evidence, therefore, may be taken as satisfactorily and conclusively showing that the failure in question was not caused by borax in the fertilizer applied."

ROT OF TURNIP STECKLINGS

In 1916 and 1917 it was foreseen, as a result of the war conditions, seeds of various kinds, including turnips, were going to be difficult to obtain and steps were taken to produce turnip seed to supply the demand. One of the problems connected with this new industry was rotting of the stecklings in storage and in the field after being set out the second year. In some cases as high as 85 per cent of the stecklings rotted in storage, and practically as large a percentage of the stecklings rotted in the field, thus causing a serious loss and making turnip seed growing almost impossible.

In order to obtain information on the question a large number of men who were attempting to grow turnip seed were visited and information obtained concerning their methods and results. In addition, close observations were made on the methods followed on the various experimental farms. These preliminary observations indicated that most of the trouble arose through storage conditions and late planting. This led to a series of experiments being conducted to determine the best conditions of storage. Turnip stecklings were stored under various conditions in an underground root cellar as follows:—

(1) In bins three to four feet deep.
(2) In bins two feet deep.
(3) On shelves one foot deep.
(4) In open crates containing three barrels.
(5) In barrels.
(6) In an ordinary pit without ventilation.
(7) In an ordinary pit with ventilation below and above stecklings.

Early in January it was found that the stecklings in the field pits and in the bins three to four feet deep were heating and rotting badly. This condition was also present where they were stored in bins 2 feet deep but not to the same extent; whereas those stored on shelves one foot deep, in crates, and in barrels were keeping in almost perfect condition. However, in April after the outside temperature rose to a growing point, the stecklings commenced forming new rootlets which apparently induced a further increase in temperature, resulting in rot and premature growth. This probably would not have taken place to the extent that it did had not the heat from the large and deeper bins been developed. The observations thus made indicate that stecklings can be successfully stored on shelves, in crates or barrels, or in a thin layer on the floor of the root cellar. It was also found that the growers who were successful in growing turnip seed stored their stecklings by placing them one layer deep on the floor. Those who stacked them deeply, or pitted them, usually had trouble with rot and over heating. Since the heating developed late in the season, it became quite evident that considerable injury could be eliminated by planting as early in the spring as possible. One successful grower in Nova Scotia followed the practice of removing his stecklings from the cellar to the open just as soon as danger of severe frost was past. This kept the stecklings in a dry condition and eliminated rotting. His fields showed an almost perfect stand of excellent plants when examined early in July.

A series of experiments were planned and conducted in the field to determine:—

(1) The best size of stecklings to be used.
(3) The distance apart in the rows.
(3) Different dates of planting.
(4) Different types of ground.

All stecklings were planted in the field on April 29 except in the experiment on dates of planting.

Size of Steckling.—Four different sizes of stecklings were selected and planted in rows three and a half feet apart and the stecklings two feet apart in the row. The following results were obtained:—

YIELD OF SEED FROM LARGE AND SMALL STECKLINGS

Row No.	Size of Steckling	Yield of seed in pounds per acre
1	1–2″ in Diameter	590 lbs.
2	2–3″ "	1083 "
3	3–4″ "	1236 "
4	4–5″ "	1436 "

Almost a perfect stand of plants was obtained and no difference could be noted in resistance to rot by the different sizes of stecklings. However, it is perfectly evident from the yield of seed obtained that the larger stecklings were more vigorous, and would prove more profitable. The four-fifths-inch stecklings produced over twice as much seed per acre as the small size (one-half inch in diameter).

Distance apart in the row.—The test conducted to determine the distance apart at which the stecklings should be set was carried out with three different sizes: one-half-inch, two-thirds inch, and three-quarter-inch, in diameter. These were planted in rows 3½ feet apart and the stecklings one foot apart, two feet apart and three feet apart in the row. The results obtained are tabulated below:—

YIELD OF SEED FROM STECKLINGS SET AT DIFFERENT DISTANCES APART

Row No.	Size of stecklings	Distance a art in the row	Yield of seed in lbs. per acre
5	1–2″	1 foot apart	734 lbs.
6	1–2″	2 feet apart	871 "
7	1–2″	3 feet apart	428 "
8	2–3″	1 foot apart	1,234 "
9	2–3″	2 feet apart	879 "
10	2–3″	3 feet apart	508 "
11	3–4″	1 foot apart	2,214 "
12	3–4″	2 feet apart	1,097 "
13	3–4″	3 feet apart	1,169 "

With each of the three different sizes used in the experiment the largest yield was obtained where the stecklings were placed one foot apart in the row, with the single exception of row 6, where one-half-inch stecklings were placed two feet apart. The difference here, however, was not very marked. This experiment further confirms the data obtained with the experiment on different sizes of stecklings, showing that the larger steckling, up to a certain point at least, produced the larger yield. There was no disease condition noted which could be attributed to the method of planting.

Different dates of planting.—Observations made on various fields and conversations with growers indicated that the date of planting had considerable influence on the amount of rot which developed; late planting resulting in a large amount of the stecklings rotting in the cellar and in the field. Our experiment differed from the ordinary handling of stecklings from the early planting to the dates of late planting, in that the stecklings for the experiment were selected early and left in small heaps of a couple of bushels each until planted, whereas with the ordinary grower they are not selected but left in the original pile until planting time, which gives an opportunity for heating and for rot to develop, whereas the experimental stock did not heat and practically no rot developed. The dates of planting were April 29, May 3, May 9, May 15 and May 21. Plantings on the various dates were made with three different sizes of stecklings; the sizes selected being one-half inch, two-thirds inch, three-quarter inch in diameter. The results obtained are tabulated below:—

EARLY VERSUS LATE SETTING OF STECKLINGS

Row No.	Size	Date of planting	Yield of seed in lbs. per acre
1	1–2″	April 29th	590 lbs.
2	2–3″	"	1,083 "
3	3–4″	"	1,436 "
27	1–2″	May 3rd	242 "
28	2–3″	"	847 "
29	3–4″	"	896 "
30	1–2″	May 9th	580 "
31	2–3″	"	*282 "
32	3–4″	"	815 "
33	1–2″	May 15th	*1,227 "
34	2–3″	"	718 "
35	3–4″	"	*234 "
36	1–2″	May 21st	403 "
37	2–3″	"	602 "
38	3–4″	"	677 "

*The crop from this experiment was harvested from time to time as the seed matured, and stored in small quantities. A few tags were lost and samples misplaced, and it is probable that some of the seed from rows 31 and 35 were included with the crop from row 33, which explains the low yield in rows 31 and 35 and the high yield in row 33.

The above yields indicate that a much larger yield may be expected from stecklings planted early than from those planted late. Those planted late did not appear as thrifty from the beginning as did those which were planted early, and many plants seemed to wither to some extent.

Accepting the data from one year's work, the results from the combined experiments are positive in indicating that the larger stecklings, even though contrary to the usual accepted theory, are much superior to small stecklings in producing large yields per acre. New growth commenced early and vigorously, producing quite large, strong plants which filled the space allotted to them, while the smaller stecklings produced small plants.

Where the stecklings were planted closely in the rows, the yield was large and the plants stood upright, supported by each other, while those planted from two to three feet apart spread out to a greater extent and later in the season broke down. The more erect growth of the closely placed plants was noted quite early in the season as also was the vigor of the larger stecklings.

A small experiment was planted to get information on the loss or injury caused from setting stecklings which showed injury to the crown, including those cut too short, showing slight rot of the new growth, or where the main shoot appeared dormant. The results were as follows:—

YIELD OF SEED STECKLINGS WITH INJURED CROWNS

Row No.	Type of Crown	Yield of seed in lbs. per acre
23	Crown cut so as to injure main shoot	650 lbs.
24	New growth of crown slightly rotted	226 "
25	Crown developing one strong shoot	807 "
26	Crown showing main shoot dormant but lateral shoots developing	1,153 "

It is therefore evident that stecklings showing slight rotting of the new growth should be discarded. Fifty per cent of the stecklings showing slight rot at time of setting failed to mature and many of the others produced only weak plants. Where

the crown was cut too short approximately 25 per cent of the stecklings failed to produce vigorous plants. The results from one strong shoot as compared to several shoots was rather surprising in that over 300 pounds more seed were obtained from the crown throwing several strong shoots.

It would therefore seem as if medium size to large stecklings or stecklings from three-quarter-inch in diameter should be selected in the fall, stored under conditions giving good ventilation such as found on shelves, on the floor of the root cellar, in ventilated barrels or in open crates. These should be examined from time to time during the winter and any showing rot removed. Planting should be commenced as early in the spring as possible, and if planting is delayed the stecklings should be removed to the open air until time for setting, and any showing signs of rot discarded.

REPORT OF THE DOMINION FIELD LABORATORY OF PLANT PATHOLOGY, ST. CATHARINES, ONT.

W. H. RANKIN, *Plant Pathologist, Officer in Charge*

COMPARATIVE TESTS OF THE MORE PRACTICAL SPRAYING AND DUSTING SCHEDULES FOR APPLES ON A COMMERCIAL SCALE

CONDUCTED AT SIMCOE AND COLLINGWOOD, ONTARIO

The apple spraying and dusting experiments were conducted in co-operation with Mr. W. A. Ross, of the Entomological Branch, who has previously carried on such work in the same orchards. The plan of the co-operation for this year was as follows:—

(1) The orchards used were demonstration orchards leased and managed by the Ontario Fruit Branch. Complete freedom was allowed us as to schedules tried, time of application, etc. (2) The schedules tried were the same as have been used previously by Mr. Ross and were planned entirely by him; also the initiative as to time of application, and the field direction of the spraying and dusting outfits were largely in his hands. (3) Our part in the co-operation was to give advice during the season on the fungous problems, to interpret the results on fungous control and to give such other assistance as was necessary to carry out the operations. The Division of Botany furnished the sulphur-arsenate of lead dust. The other materials were furnished by the Fruit Branch (Ontario) and the Entomological Branch (Dominion).

Either Mr. McCurry or myself was present at the Simcoe orchard at the time of all applications and when the counts were made at picking time. The applications at Collingwood were made by the Fruit Branch representative in charge of the orchard. The results there were determined by Mr. Ross and Mr. McCurry.

The plan of the experiment did not include any of the details of accurate weather data or life history studies which, if time and personnel had permitted, would have been very desirable. As carried out the experiments involved the following factors only:—

(1) Trial of the "seemingly" most practical apple-spraying schedules, which either already had shown promising results in Ontario, or were recommended in other apple-growing sections, such as Nova Scotia, New York state, etc.

(2) Supervision by an entomologist and pathologist as to time of application, method of application, etc.

(3) The same supervision in determining the comparative effectiveness of the various schedules as they showed in the crop.

Unfortunately from the pathologist's standpoint appl[e] scab was so scarce this season that conclusions on the comparative effectiveness of the different schedul[es]

were not possible. For that reason many of the points on which records were made during the season will not be included here as they serve no purpose. No scab was found in the Simcoe orchards at the time for the fourth application and weather conditions up until that time did not indicate that a fourth application was necessary. For that reason a fourth application was put on only one-half of each of three plots, i.e., the outer three rows of plots 1, 7 and 8. An inspection in August was made to determine the amount of scab present at that time. Of about 100 trees carefully examined throughout the orchards, scab was found only on 7 trees (6 of these were unsprayed check trees), and the maximum amount found was 4·5 per cent. Scab was found at that time only on two apples on one tree outside the check blocks.

A chart of the orchards is given herewith indicating the varieties. As will be seen the most abundant varieties are Spy, Baldwin and Greening. The orchards were in excellent condition and were on the whole well adapted to the experiments.

A table is appended showing the results of the counts made. Each count included in most cases the entire crop of the tree.

RESULTS

1. The percentage figures on both scab and russeting are much too small and the probable error too large to warrant any conclusions whatever on comparative effectiveness of the different schedules.

2. The fact that all the schedules held scab to a minimum in about the same degree is no indication of what would have happened in a "scab year," since a comparison of the amount of scab on the different sprayed blocks with the two best check trees shows little difference when the large probable error is considered.

SPRAYING AND DUSTING SCHEDULES USED IN THE GILBERTSON AND NEFF ORCHARDS, NEAR SIMCOE, NORFOLK COUNTY, ONT.

Plot 1—(Nova Scotia schedule) 75 trees.
First—Delayed dormant—Bordeaux mixture 3-10-40 and arsenate of lime one pound.
Second—Pink spray—Bordeaux mixture 2-10-40 and arsenate of lime one pound.
Third—Calyx spray—soluble sulphur 1-40, arsenate of lime ½ pound and hydrated lime 5 pounds.
Fourth—If June is wet—Bordeaux mixture 2-10-40 and arsenate of lime one pound.

Plot 2—(Straight lime sulphur and arsenate of lead schedule) 75 trees.
First—Lime sulphur 1-7 or 1-20 (if no scale or blister mite).
Second—Lime sulphur 1-40, arsenate of lead 2½ pounds.
Third—Lime sulphur 1-40, arsenate of lead 2½ pounds.
Fourth—Lime sulphur 1-40, arsenate of lead 2½ pounds.

Plot 3—(Straight lime sulphur and arsenate of lime schedule) 75 trees.
First—Lime sulphur 1-7 or 1-20 (if no scale or blister mite).
Second—Lime sulphur 1-40, arsenate of lime ¾-pound.
Third—Lime sulphur 1-40, arsenate of lime ¾-pound.
Fourth—Lime sulphur 1-40, arsenate of lime ¾-pound.

Plot 4—(Ross schedule) 75 trees.
First—Lime sulphur 1-7 or 1-20.
Second—Bordeaux mixture 3-10-40, arsenate of lime one pound, or arsenate of lead 2½ pounds.
Third—Lime sulphur 1-40, arsenate of lead 2½ pounds, and hydrated lime 5 pounds.
Fourth—Lime sulphur 1-40, arsenate of lead 2½ pounds, and hydrated lime 5 pounds.

Plot 5—(Ordinary Bordeaux mixture and lime sulphur schedule) 70 trees.
First—Bordeaux mixture 3-4-40.
Second—Bordeaux mixture 3-4-40, and arsenate of lead 2½ pounds.
Third—Lime sulphur 1-40, arsenate of lead 2½ pounds.
Fourth—Lime sulphur 1-40, arsenate of lead 2½ pounds.

Plot 6—(Straight lime sulphur and hydrated lime schedule) 70 trees.
First—Lime sulphur 1-7 or 1-20.
Second—Lime sulphur 1-40, hydrated lime 5 pounds, and arsenate of lead 2½ pounds.
Third—Lime sulphur 1-40, hydrated lime 5 pounds, and arsenate of lead 2½ pounds.
Fourth—Lime sulphur 1-40, hydrated lime 5 pounds, and arsenate of lead 2½ pounds.

Plot 7—(Sulphur—arsenate of lead dust (90-10) schedule) 95 trees.
First—Sulphur and arsenate of lead dust 90-10 mixture.
Second—Sulphur and arsenate of lead dust 90-10 mixture.
Third—Sulphur and arsenate of lead dust 90-10 mixture.
Fourth—Sulphur and arsenate of lead dust 90-10 mixture.

Plot 8—(Nova Scotia Bordeaux—arsenate of lead dust schedule) 96 trees.
First—Bordeaux dust.
Second—Bordeaux dust.
Third—Sulphur and arsenate of lead dust 90-10.
Fourth—Bordeaux dust.

SCHEDULE USED IN THE COLLINGWOOD ORCHARD

Plot 1—Nova Scotia schedule, as above, 6 rows.
Plot 2—Lime-sulphur and arsenate of lead, as above, 6 rows.
Plot 3—Lime-sulphur and arsenate of lime, as above, 6 rows.
Plot 4—Ross schedule, as above, 6 rows.

PLAN OF GILBERTSON'S ORCHARD, SIMCOE

—	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	S	S	S	S	S	Y	Y	B	B	Y	R	B	B	B	Y
2	Y	S	S	S	Y	B	B	B	Y	Y	B	B	Y	B	B
3	S	S	S	S	S	S	B	B	B	B	B	B	B	B	B
4	S	S	S	O	S	S	Y	B	B	B	Y	Y	O	B	B
5	Y	S	S	S	S	S	B	B	B	Y	B	B	Y	B	B
6	S	S	S	Y	S	B	Y	Y	B	B	B	R	R	Y	B
7	P	S	S	S	S	B	B	B	O	B	B	Y	R	Y	R
8	S	S	S	S	P	B	Y	B	B	Y	X	Y	R	R	Y
9	S	S	S	P	S	O	B	B	B	B	B	R	B	B	B
10	S	S	S	S	S	B	B	O	B	B	B	B	B	Y	Y
11	S	S	S	S	S	B	B	B	B	O	O	B	B	Y	B
12	S	O	S	S	S	B	Y	B	B	B	B	B	Y	B	Y
13	S	S	S	P	S	B	B	B	B	B	B	Y	Y	Y	Y
14	S	S	S	S	S	B	B	B	O	B	B	B	Y	B	B
15	Y	Y	E	O	Y	X	P	Y	Y	B	O	X	X	X	B
16	Y	—	B	O	X	B	B	W	B	Y	Y	Y	Y	T	T
17	D	B	E	E	B	Y	Y	X	Y	B	T	T	T	T	T
18	Y	X	K	Y	X	T	P	T	Y	T	M	Y	M	Y	Y
19	X	Y	Y	Y	X	R	R	R	R	R	X	O	O	X	X
20	Y	X	X	Y	X	Y	X	X	X	X	Y	T	X	O	T
21	K	B	Y	K	Y	K	K	Y	Y	Y	Y	Y	Y	Y	X
22	S	S	S	Y	S	S	S	S	Y	S	B	S	Y	Y	Y
23	S	Y	Y	S	S	Y	X	X	P	B	B	T	X	X	X
24	Y	K	Y	R	O	P	S	P	P	B	Y	B	P	B	Y
25	X	K	Y	Y	B	Y	S	B	A	B	Y	Y	B	Y	B
26	Y	A	Y	B	B	A	A	Y	X	Y	Y	Y	B	T	T
27	X	G	Y	Y	B	B	K	B	B	Y	B	B	Y	G	Y
28	Y	Y	S	S	S	S	S	Y	S	S	Y	S	Y	S	S
29	G	G	Y	G	G	S	S	S	S	S	S	S	S	Y	S
30	B	B	B	B	B	G	G	G	Y	G	Y	G	G	G	G
31	Y	Y	O	Y	Y	R	G	Y	Y	G	G	G	G	G	G
32	Y	Y	Y	R	Y	Y	G	G	G	Y	Y	G	G	G	G
33	—	—	—	—	—	—	—	G	—	G	—	—	—	—	—
	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

LIST OF ODD VARIETIES IN THE GILBERTSON ORCHARD

Row 1—R is Rock Russet.
Row 7—P is American Pippin.
Row 8—P is American Pippin, X is Canadian Red.
Row 9—P is American Pippin.
Row 13—P is American Pippin.
Row 15—Tree 6 is Strawberry, 7 is Holland Pippin, 12 is Snow, 13 is Holly, and 14 is unnamed.
Row 16—Tree 2 is unnamed, 5 is Honey Sweet.
Row 17—Tree 8 is St. Lawrence.
Row 18—Trees 2 and 4 are Jennette, P is Newton Pippin.
Row 19—Trees 1 and 5 are St. Lawrence, 11, 14 and 15 are Culbert.
Row 20—Trees 2, 5, 8, 10 are Stone, 3 is Red Astrachan, 13 is Holly.
Row 21—Trees 11 and 15 are Cabashea.
Row 23—Trees 7 and 8 are Seek-no-farther, P is Newton Pippin; trees 13, 14, 15 are Canada Red.
Row 24—Tree R is Fall Russet, and P's are Holland Pippin.

Row 25—Tree 1 is Ben Davis.
Row 26—Tree 9 is Cabashea.
Row 27—Tree 1 is Twenty Ounce.

A—Alexander.
B—Baldwin.
D—Duchess.
E—Early Harvest
G—Greening.
K—King.
M—Mann.
O—Blanks.
P—Pippin (see above).
R—Russets (see above).
S—Spy.
T—Tolmans Sweet.
W—Wealthy.
X—Odd varieties.
Y—Young trees not bearing.

PLAN OF NEFF'S ORCHARD, SIMCOE

S	S	O	O		O	Y	O	S	B	O		O	O	O	O	O
S	S	S	O	O	S	S	S	S	O	B	B	B	B	O	B	B
S	S	S	O	S	S	S	S	S	B	B	B	Y	B	B	B	O
S	S	O	S	S	S	S	S	S	B	B	B	B	B	O	O	O
S	S	S	S	S	S	B	S	S	B	B	O	B	B	B	B	O
S	S	S	S	S	S	S	S	S	B	B	B	B	B	B	B	B
G	G	G	G	G	G	G	G	G	G	G	G	G				
G	G	G	G	G	G	G	G	G	G	G	G	G				
G	G	G	G	G	G	G	G	G	G	G	G	G				
G	G	G	G	G	G	G	G	G	G	G	G	G				
G	G	G	G	G	G	G	G	G	G	G	G	G				
G	G	G	G	G	G	G	G	G	G	G	G	G				

SPRAYING AND DUSTING EXPERIMENTS ON APPLES, SIMCOE, ONTARIO

Block	Treatment	Variety	Total No. Counted	Per cent Sound	Per cent Scab	Per cent Russet	Per cent Side worm	Per cent other insect injury
1	Nova Scotia	Baldwin (4t)	2,383	83·9	0·0	1·4	0·1	14·6
	Bordeaux	Spy (4t)	1,199	80·1	0·2	0·3	1·8	17·6
	Sol. sulphur	Spy (3t)	2,195	76·6	5·3	0·1	0·7	17·2
	Arsenate lime							
2	Lime-sulphur	Baldwin	2,067	97·5	0·0	0·5	0·1	1·9
	Arsenate lead	Spy	1,193	86·1	0·2	0·0	0·6	13·1
3	Lime-sulphur	Baldwin	2,045	97·6	0·0	0·1	0·3	2·0
	Arsenate lime	Spy	1,613	81·0	0·1	0·0	1·1	17·8
4	Lime-sulphur Bordeaux Arsenate lime Lime-sulphur Arsenate lead Hydrated lime	Baldwin	1,943	87·4	0·0	6·8	0·3	5·5
5	Bordeaux	Baldwin	2,044	88·2	0·1	3·3	0·3	8·1
	Lime-sulphur	Spy	1,403	89·5	0·5	0·3	0·8	8·9
	Arsenate lead	Greening	1,664	92·9	0·4	4·0	0·5	2·2
6	Lime-sulphur	Baldwin	2,397	89·4	0·3	1·0	0·0	9·3
	Hydrated lime	Spy	1,407	91·6	1·6	0·0	0·3	6·5
	Arsenate lead	Greening	1,110	94·6	0·3	0·7	0·3	4·1
7	Sulphur	Baldwin (3t)	2,092	94·6	0·2	0·1	0·4	4·7
	Arsenate	Spy (3t)	2,567	90·0	0·6	0·1	0·3	9·0
	Lead dust	Spy (4t)	221	88·6	0·0	0·5	1·4	9·5
		Greening (3t)	1,497	89·8	2·8	1·1	1·4	4·9
		Greening (4t)	4,628	88·3	4·7	0·5	0·8	5·7
8	Bordeaux	Baldwin (3t)	2,642	88·6	0·1	0·1	0·4	10·8
	Arsenate	Spy (3t)	1,705	85·0	0·8	0·1	1·0	13·1
	Lead dust	Spy (4t)	1,702	59·4	1·3	0·4	1·7	37·2
		Greening (3t)	3,055	84·7	1·3	1·7	1·7	10·6
		Greening (4t)	4,158	80·0	10·8	0·9	1·0	7·3
Check	Delayed	Baldwin	1,318	76·1	1·8	0·2	0·4	21·5
	Dormant only (Bordeaux)	Spy	577	64·1	8.5	0.0	3.3	24 1

SPRAYING AND DUSTING EXPERIMENTS ON APPLES, COLLINGWOOD, ONTARIO

Block	Treatment	Variety	Total No. Counted	Per cent Sound	Per cent Scab	Per cent Russet	Per cent Side worm	Per cent other insect injury
1	Nova Scotia	Baldwin	680	69·4	0·2	22·3	4·4	3·7
		Spy	1,033	87·4	6·8	0·0	3·0	2·8
	Bord. L. S.	Greening	1,597	54·1	0·6	36·3	5·5	3·5
2	Lime-sulphur	Baldwin	1,087	94·3	0·4	3·4	0·5	1·4
	Arsenate of lead	Spy	351	91·8	3·7	2·8	1·4	0·3
		Greening	1,648	89·8	0·2	8·0	1·0	1·0
		Ben Davis	531	96·8	1·7	0·0	0·0	1·5
		Snow	1,247	84·0	13·5	0·4	0·4	1·7
3	Lime-sulphur	Baldwin	977	79·7	1·2	5·6	5·2	8·3
		Spy	746	86·2	10·1	0·1	0·5	3·1
	Arsenate lime	Greening	1,612	89·0	1·7	3·5	1·5	4·3
		Ben Davis	973	82·2	13·5	1·3	0·7	2·3
		Snow	1,577	93·1	3·7	0·3	0·4	2·5
4	Lime-sulphur	Baldwin	869	83·1	0·6	12·0	0·9	3·4
		Spy	695	94·8	2·7	0·0	0·0	2·5
	Bordeaux	Greening	1,217	60·6	14·0	20·2	1·1	4·1
		Ben Davis	872	52·3	0·6	43·2	0·9	3·0
		Snow	1,174	45·9	10·3	41·4	0·2	2·2

TESTS OF SPRAY MIXTURES AND DUSTS ON PLUMS AND CHERRIES

CONDUCTED AT VINELAND STATION, ONTARIO

This experiment was planned in co-operation with Mr. W. A. Ross, Entomologist, stationed at Vineland. The purpose of the tests was to compare the effectiveness of the four materials used, in the control of brown rot, cherry yellow leaf and insects. A suitable plum orchard was chosen which was owned by Mr. Harry Dodd. The following schedule was carried out except that for the second application bordeaux and lime sulphur were used on the dust plots because the duster was out of commission at the time.

Block 1.—Lime sulphur 1-40 and 3 pounds of arsenate of lead.

Block 2.—Bordeaux 3-10-40 and 3 pounds of arsenate of lead. (Fourth application soluble sulphur 1 pound and hydrated lime 3 pounds.)

Block 3.—Nova Scotia Bordeaux dust with poison.

Block 4.—Sulphur and arsenate of lead dust.

Time of applications:—

First.—Lime sulphur on all trees just before the buds burst.

Second.—Just after the fruit is about free from the shucks.

Third.—Ten days or two weeks later.

Fourth.—Just before the fruit begins to colour.

Although there were no check trees left in this comparative test, it may be stated that brown rot was very scarce this season. In a few isolated cases near the lake where an occasional mist hung on in early morning plums rotted severely. Elsewhere plums were practically free from rot throughout the season. Carried out as this experiment was, for comparison only, there is no assurance expressed or data proving that unsprayed trees would have shown any considerable amount of rot. Likewise, it will be seen from the data given in the table below that there was no

difference shown between the four substances used as to their effectiveness in brown rot control. The results sought in these tests, therefore, were not forthcoming due to seasonal conditions.

PER CENT BROWN ROTTED FRUIT; COUNTS MADE AUGUST 20-24

(p—fruit already picked; x—no fruit or miss; letters and figures show location of the tree in the orchard

—	Lime Sulphur			Bordeaux Mixture			Bordeaux Dust			Sulphur Dust		
Burbank	p	p	1	0	0	p	p	p	p	0	0	0
Burbank	0	0	0	0	0	p	p	p	2	0	3	p
Shropshire Damson	0	0	0	0	0	0	0	0	0	0	0	0
Lombard	0	6	0	0	1	x	x	1	3	x	7	0
Yellow Gage	0	1	2	0	0	0	0	2	0	x	0	0
Reine Claude	2	0	0	0	0	3	0	0	0	5	0	0
Reine Claude	4	5	0	5	x	0	3	2	0	1	0	4
Bradshaw	5	0	0	0	0	0	1	0	0	0	0	0
Black Diamond	0	0	0	6	6	2	0	0	3	0	0	1
Average all varieties	1%			1%			1·2%			1·1%		

A similar set of tests was planned for cherries, but owing to an accident to the duster these were not carried out in full. When the duster was repaired an application of bordeaux dust and sulphur dust was made on blocks of about thirty trees each of sweet cherries which were colouring. A large number of check trees were left in the same orchard. Examinations made of these trees even when the fruit was full ripe showed no brown rot on either the dusted plots or the checks. Therefore, the results sought in this late application of dust were not obtainable. Very little yellow leaf occurred in cherries this year.

EXPERIMENT ON CONTROL BY SURGERY OF PEACH CANKER

CONDUCTED NEAR PORT DALHOUSIE, ONTARIO

This experiment was begun in the spring of 1918 by Mr. W. A. McCubbin, then in charge of the laboratory. Four diagonal rows in a peach orchard on the fruit farm of Mr. Gilleland were treated. The orchard, comprised of three varieties—New Prolific, Garfield, and St. John—lies on level ground and apparently is subject to uniform conditions throughout the orchard. The object of the experiment was to test the feasibility of the control of peach canker by cutting out all cankered tissue and dressing the wounds with white lead paint. It was intended that all cankers, crotch, limb and twig, should be either treated or the limb or twig removed. Operations were carried out in 1918 between May 21 and June 17. All the trees were gone over three times in 1919, at the following periods: June 11-14, July 10-14, and August 12-17. Old cankers treated the previous year which were spreading were again treated as well as new cankers. The following summary shows the number of new cankers found and treated during the course of the experiment:—

—	Total number active cankers found	Average number active cankers per tree
1918—treated	3,916	36·9
1919—1st-treated	1,145	10·8
1919—2nd-treated	189	1·6
1919—3rd-treated	225	2·1
1920—not treated	2,000	18·9
Total treated	5,455	51·6

In order to determine the effectiveness of the two seasons' treatment, careful records were made in the spring of 1920 on the four treated rows and the two adjoining rows on either side which are used as checks. The records consist in, for each tree, the total number of cankers, treated or untreated, number showing healing and the number showing spread recently. These figures were kept separate for wood three years or older and wood less than three years old. A diagram of the orchard showing the orientation of the trees, and tables giving the data for individual trees are appended.

The following table gives a summary of the field data in terms of the average number of cankers per tree for the four treated and four check rows:—

TABLE I.—SUMMARY OF DATA BY ROWS: SAME ARRANGEMENT AS IN ORCHARD

(All figures denote average number of cankers per tree on wood of three years or older).

	Check		Treated				Check	
	Row 8	Row 7	Row 4	Row 3	Row 2	Row 1	Row 6	Row 5
Cankers treated, 1918 (on wood of all ages)	.....	.....	51·4	44·4	25·0	26·4	.....	.....
Cankers treated, 1919 (on wood of all ages)	.....	.....	18·0	11·4	13·8	14·7	.....	.....
Scars present in 1920	.....	.....	17·0	14·4	13·6	17·5	.....	.....
Scars showing no spread	.....	.....	4·7	4·5	3·8	9·8	.....	.....
Scars showing spread	.....	.....	12·3	9·9	9·8	7·7	.....	.....
New cankers, 1920	.....	.....	6·1	7·1	9·7	7·7	.....	.....
Spreading cankers, 1920	26·8	23·6	18·4	17·0	19·5	15·4	29·6	21·7
Same: combining adjoining rows	25·2		17·7		17·6		25·4	

The number of twig cankers on wood less than three years old was very small in 1920 and is not included in table 1 because there was no indication that the treatment had affected this factor. The number of twig cankers in each row is shown below:—

Row 8	Row 7	Row 4	Row 3	Row 2	Row 1	Row 6	Row 5
11	16	20	34	55	18	36	21

A direct comparison of the total number of cankers removed in 1919 and the number which would have had to be removed in the early spring of 1920 is interesting. It is seen that even though there were an average of four to ten cankers successfully treated per tree the number of cankers present in May, 1920, was greater than the number found and treated throughout the summer of 1919 in every row.

	Row 4	Row 3	Row 2	Row 1
Cankers treated, 1919	18.0	11.0	13.8	14.7
Cankers needing treatment, 1920	19.0	18.3	21.5	16.2

Dividing the average number of active cankers per tree in 1920 into the two classes, those in which the treatment had failed and new cankers, we find about an equal number of each:—

	Row 4	Row 3	Row 2	Row 1
Scar showing spread	12.3	9.9	9.8	7.7
New cankers	6.1	7.1	9.7	7.7

This seems to show for wood older than two years that there has probably been no change in the number of new cankers formed this year and the number formed in previous years.

Comparing the total average number of cankers per tree on wood of three years or older in the check and treated rows, we find that the treatment has not reduced the number:—

Row 8	Row 7	Row 4	Row 3	Row 2	Row 1	Row 6	Row 5
27.4	24.2	23.1	21.5	23.3	25.2	30.4	22.6

Comparing the percentage of the treated cankers which are healing, there seems to be no difference shown as to position within the treated block:—

	Row 4	Row 3	Row 2	Row 1
Total scars, 1920	475	375	381	419
Scar healing, 1920	132	117	105	236
Per cent healing, 1920	27.8	31.2	27.6	56.3

A comparison of the average number of cankers per tree for the three different varieties is made in table 2.

TABLE 2.—AVERAGE NUMBER OF CANKERS (SCARS INCLUDED) PER TREE AND PERCENTAGE SHOWING SPREAD ARRANGED BY VARIETIES

—	Average Number Cankers	Percentage Active
New Prolific—		
Check—8-7	15·8	95·0
Treated—1-4	15·0	67·0
Check—5-6	20·0	95·0
Garfield—		
Check—8-7	30·3	98·2
Treated—1-4	28·9	74·0
Check—5·6	30·7	96·5
St. John—		
Check—8-7	28·2	98·4
Treated—1-4	24·7	82·0
Check—5-6	27·6	97·8

It will be seen in the above table that Garfield and St. John showed about twice as many cankers as New Prolific. The percentage of active cankers on treated and check rows by varieties is included in table 2 and shows clearly that after two years' treatment the surgery methods used have failed as a control measure.

The conclusion drawn from the figures presented is that surgery will not control peach canker.

DATA FOR TREES IN ROW 1

No.	Variety	Cankers treated wood of all ages		1920 observations on wood 3 years and older				
		1918	1919	Scars found	Scars healing	Scars spreading	New cankers	Total active cankers
1	New Prolific	20	17	15	10	5	5	10
2	New Prolific	37	5	12	8	4	8	12
3	New Prolific	3	2	2	2	0	1	1
4	Miss							
5	New Prolific	39	9	14	10	4	5	9
6	New Prolific	35	5	11	5	6	11	17
7	New Prolific	29	10	18	13	5	3	8
8	New Prolific	27	4	8	4	4	4	8
9	Miss							
10	Miss							
11	Garfield	19	5	7	7	0	1	1
12	Garfield	41	13	18	8	10	2	12
13	Garfield	46	22	25	8	17	2	19
14	Garfield	48	13	26	16	10	3	13
15	Garfield	21	2	12	10	2	5	7
16	Garfield	60	21	32	24	8	15	23
17	Garfield	29	30	32	18	14	9	23
18	Garfield	47	30	33	17	16	14	30
19	Garfield	14	11	10	6	4	6	10
20	St. John	7	17	16	8	8	14	22
21	Miss							
22	St. John		1	3	0	3	0	3
23	St. John	23	18	25	11	14	14	28
24	St. John	12	16	15	8	7	15	22
25	St. John	20	31	18	7	11	14	25
26	St. John	16	35	13	6	7	10	17
27	Miss							
28	St. John	27	24	30	20	10	20	30
29	Miss							
30	Miss							
31	Miss							
32	Miss							
33	Miss							
34	St. John	14	12	24	10	14	6	20
35	Miss							

DATA FOR TREES IN ROW 2

No.	Variety	Cankers treated wood of all ages		1920 observations on wood 3 years and older				
		1918	1919	Scars found	Scars healing	Scars spreading	New cankers	Total active cankers
1	New Prolific	31	8	23	14	9	9	18
2	New Prolific	18	14	14	6	8	4	12
3	New Prolific	3	0	0	0	0	1	1
4	New Prolific	27	7	14	7	7	8	15
5	New Prolific	27	8	9	2	7	5	12
6	New Prolific	29	7	10	2	8	8	16
7	New Prolific	26	3	10	5	5	10	15
8	New Prolific	16	4	8	1	7	3	10
9	New Prolific	9	0	3	2	1	2	3
10	Miss							
11	Garfield	28	11	15	5	10	11	21
12	Garfield	48	13	22	7	15	10	25
13	Garfield	53	13	18	6	12	15	27
14	Garfield	46	17	14	3	11	14	25
15	Garfield	15	27	14	5	9	6	15
16	Garfield	36	26	25	5	20	7	27
17	Garfield	29	22	22	6	16	12	28
18	Garfield	13	25	11	3	8	16	24
19	Garfield	57	24	28	5	23	26	49
20	St. John	23	13	23	5	18	14	32
21	Miss							
22	St. John	17	10	12	2	10	12	22
23	St. John	33	12	14	3	8	18	26
24	St. John	7	14	11	3	8	9	17
25	St. John	10	15	14	4	10	11	21
26	Miss							
27	St. John	35	21	12	1	11	7	18
28	St. John	14	20	20	3	17	12	29
29	St. John	16	22	5	0	5	9	14
30	St. John	33	16	5	0	5	10	15
31	St. John	31	11	(dead)				
32	Miss							
33	St. John	1	15	5	0	5	6	11
34	Miss							

DATA FOR TREES IN ROW 3

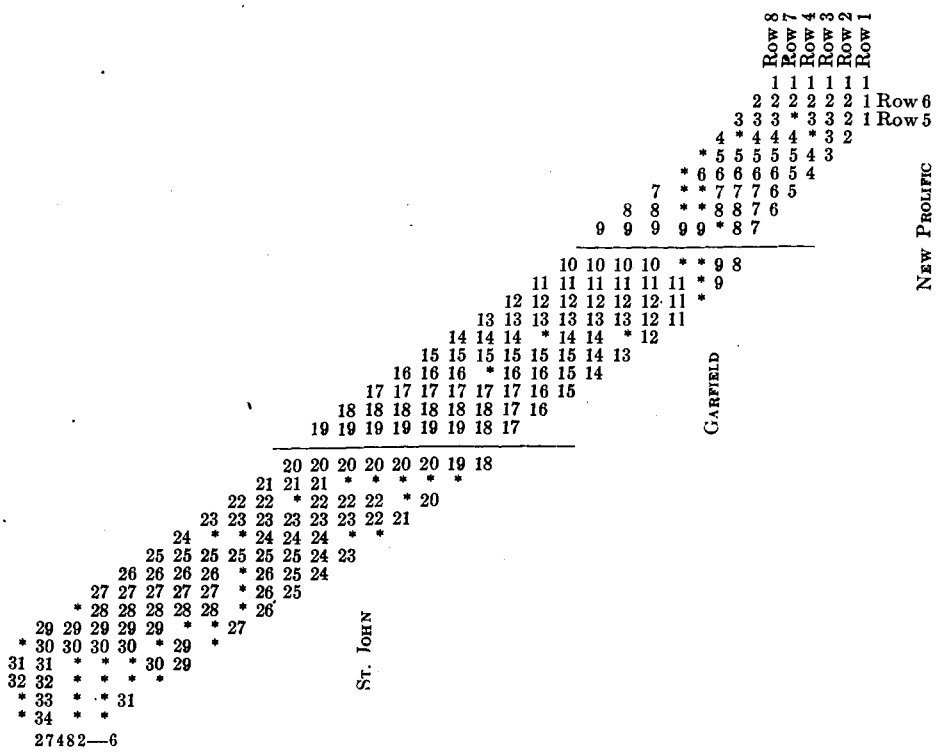
No.	Variety	Cankers treated, wood of all ages		1920 observations on wood 3 years and older				
		1918	1919	Scars found	Scars healing	Scars spreading	New cankers	Total active cankers
1	New Prolific	6	3	5	2	3	0	3
2	New Prolific	37	6	13	6	7	6	13
3	Miss							
4	New Prolific	16	4	7	2	5	3	8
5	New Prolific	34	5	12	5	7	4	11
6	New Prolific	59	4	10	2	8	12	20
7	New Prolific	37	9	10	3	7	5	12
8	Miss							
9	New Prolific	14	5	6	3	3	3	6
10	Garfield	53	10	14	8	6	3	9
11	Garfield	54	17	16	6	10	11	21
12	Garfield	65	15	17	3	14	7	21
13	Garfield	57	14	12	10	2	5	7
14	Miss							
15	Garfield	55	16	21	10	11	6	17
16	Miss							
17	Garfield	58	22	32	10	22	12	34
18	Garfield	86	17	15	6	9	16	25
19	Garfield	99	29	27	6	21	18	39
20	St. John	28	29	23	6	17	12	29
21	Miss							
22	St. John	55	11	18	6	12	7	19
23	St. John	2	3	3	1	2	3	5
24	St. John	14	10	16	2	14	3	17
25	St. John	12	6	13	3	10	4	14
26	St. John	44	16	13	2	11	14	25
27	St. John	83	17	27	7	20	14	34
28	St. John	78	11	22	4	18	8	26
29	St. John	99	8	6	0	6	3	9
30	St. John	13	6	8	3	5	0	5
31	Miss							
32	St. John	17	4	9	1	8	4	12
33	Miss							
34	Miss							

DATA FOR TREES IN ROW 4

No.	Variety	Cankers treated, wood of all ages		1920 observations on wood 3 years and older				
		1918	1919	Scars found	Scars healing	Scars spreading	New cankers	Total active cankers
1	New Prolific	5	5	6	2	4	2	6
2	New Prolific	25	6	2	0	2	0	2
3	New Prolific	44	5	15	10	5	0	5
4	New Prolific	83	10	24	10	14	8	22
5	New Prolific	43	8	14	6	8	5	13
6	New Prolific	49	16	13	5	8	3	11
7	Miss							
8	Miss							
9	New Prolific	68	10	15	6	9	4	13
10	Garfield	45	6	6	1	5	4	9
11	Garfield	90	22	25	9	16	4	20
12	Garfield	77	35	32	2	30	9	39
13	Garfield	126	20	18	4	14	6	20
14	Garfield	123	25	13	4	9	9	18
15	Garfield	70	9	13	4	9	8	17
16	Garfield	73	14	18	6	12	4	16
17	Garfield	34	36	29	7	22	16	38
18	Garfield	103	32	36	8	28	10	38
19	Garfield	13	8	8	2	6	2	8
20	St. John	46	29	18	8	10	7	17
21	St. John	35	27	22	6	16	8	24
22	Miss							
23	St. John	78	70	28	6	22	12	34
24	Miss							
25	St. John	17	26	21	5	16	4	20
26	St. John	34	12	15	3	12	6	18
27	St. John	9	16	19	4	15	4	19
28	St. John	32	12	21	3	18	5	23
29	St. John	25	14	13	2	11	8	19
30	St. John	29	7	10	3	7	9	16
31	St. John	35	7	7	1	6	3	9
32	St. John	16	17	14	5	9	12	21

DATA FOR TREES IN ROWS 5, 6, 7 AND 8

No.	Row 5		Row 6		Row 7		Row 8	
	Variety	Cankers	Variety	Cankers	Variety	Cankers	Variety	Cankers
1	New Prolific	14	New Prolific	19	New Prolific	13	New Prolific	18
2	New Prolific	7	New Prolific	24	New Prolific	16	New Prolific	8
3	New Prolific	18	New Prolific	20	New Prolific	8	New Prolific	18
4	New Prolific	20	New Prolific	38	Miss	.....	New Prolific	11
5	New Prolific	24	New Prolific	24	New Prolific	20	Miss	.....
6	New Prolific	12	New Prolific	18	New Prolific	4	Miss	.....
7	New Prolific	15	New Prolific	26	Miss	.....	New Prolific	8
8	Garfield	27	New Prolific	21	New Prolific	17	New Prolific	28
9	Garfield	9	Garfield	15	New Prolific	33	New Prolific	19
10	Miss	.....	Miss	.....	Garfield	26	Garfield	37
11	Garfield	14	Garfield	4	Garfield	46	Garfield	28
12	Garfield	8	Garfield	13	Garfield	40	Garfield	22
13	Garfield	21	Miss	.....	Garfield	22	Garfield	20
14	Garfield	53	Garfield	3	Garfield	3	Garfield	4
15	Garfield	88	Garfield	68	Garfield	32	Garfield	26
16	Garfield	34	Garfield	56	Garfield	26	Garfield	55
17	Garfield	18	Garfield	60	Garfield	35	Garfield	50
18	St. John	28	Garfield	78	Garfield	42	Garfield	28
19	Miss	.....	St. John	35	Garfield	15	Garfield	49
20	St. John	12	Miss	.....	St. John	24	St. John	56
21	St. John	52	Miss	.....	St. John	27	St. John	37
22	Miss	.....	St. John	3	St. John	26	St. John	10
23	St. John	32	Miss	.....	St. John	10	St. John	13
24	St. John	4	St. John	69	Miss	.....	St. John	30
25	St. John	31	St. John	43	St. John	45	St. John	54
26	St. John	14	St. John	30	St. John	34	St. John	38
27	St. John	7	Miss	.....	St. John	32	St. John	32
28	Miss	.....	Miss	.....	St. John	12	Miss	.....
29	St. John	22	St. John	15	St. John	41	St. John	14
30	Miss	.....	St. John	18	St. John	18	Miss	.....
31	St. John	4	Miss	.....	St. John	10		
32	Miss	.....						



EXPERIMENTS ON THE CONTROL OF RASPBERRY LEAF-CURL OR YELLOWS

CONDUCTED IN LOUTH TOWNSHIP

The effect of eradicating red raspberry bushes affected by leaf-curl or yellows as a control measure has been under investigation for three years. Three plots of raspberries, all of the variety Cuthbert, on the farms of Mr. Percy Blair and Mr. W. H. Gale have been used for this work. All diseased bushes were eradicated at the following periods: 1918 (no date in records); 1919, at three periods, June 16-18, July 16-17, and August 7-8; 1920, June 30 to July 4. The data were not plotted as to location of the bushes eradicated until 1920. Stakes were used in the two Blair plantations in 1919 to mark the bushes, but about one-fifth of these could not be found this year. It is therefore impossible to give accurate figures on the spread to adjacent bushes and the number of new areas.

The following table gives an approximate idea of the relation of the diseased bushes in 1920 and those of 1919, in plantation 1:—

Number of stakes placed in 1919	239
Number of stakes found in 1920	164
Number of diseased bushes found in 1920 within about 6 feet of stakes	75
Number not within 6 feet of stakes	32
Number of stakes missing	75
Approximate number of diseased bushes next to stakes (at times two or more)	68
Approximate number of stakes with no spread to adjoining bushes in one direction	22
Approximate number of stakes with no spread to adjoining bushes in both directions	36

The efficiency of removing bushes in 1919 in controlling the spread of leaf curl to adjoining bushes was as follows:—

Removal did not prevent spread to 49 adjoining bushes.

Removal prevented spread to 65 adjoining bushes.

Removal did not prevent spread to 58 other bushes.

The following table gives in percentages the amount of leaf curl per row for plantation 1:—

RASPBERRY LEAF CURL: ERADICATION EXPERIMENT

Row	Approx. number bushes 1919	Per cent diseased removed 1919	Per cent suspected removed 1919	Per cent diseased removed 1920
1	154	0·7	1·3	7·2
2	170	0·6	0·6	2·9
3	170	4·1	1·2	0·6
4	156	0·7	0·0	1·9
5	170	2·9	1·8	1·3
6	170	0·6	1·2	1·2
7	156	2·6	1·3	0·7
8	170	1·2	0·0	0·6
9	170	2·9	0·0	2·0
10	160	3·8	1·9	1·9
11	170	10·0	3·5	9·8
12	170	3·5	1·2	2·4
13	170	3·5	0·6	1·8
14	170	5·9	3·5	4·4
15	170	2·9	2·4	3·4
16	170	12·9	4·1	8·1
17	170	4·7	0·0	2·4
18	154	7·1	0·6	4·9
19	170	5·9	2·9	5·0
20	170	8·2	0·6	5·8
21	159	12·6	3·8	7·1
22	170	7·1	1·2	0·6
23	170	1·8	0·6	0·6
24	170	1·8	1·2	2·4
Total	3,999	4·5	1·5	2·8

In the Blair plantation 2, of about 2,000 bushes, there is less leaf-curl and the figures do not show any marked increase from year to year. The following is a summary of the three years' data:—

	1918	1919	1920
Number of bushes removed	30	44	28
Number of places in the rows where disease occurred	11	19	22

In the third plantation belonging to Mr. Gale leaf-curl was not present in any quantity since 1918 and there are no conclusions to be drawn from the work. The plantation consists of about 8,000 or 10,000 bushes, all Cuthbert. In 1918, forty-eight diseased bushes were removed; in 1919 none were found, and in 1920 three were removed. Originally this plantation had a high percentage of leaf-curl and the owner believes that his practice of removing diseased bushes before blossoming time has been the reason for his success where others have failed because they do not eradicate until near the time of the ripening of the berries. This factor of time at which the eradication is done is to be tried in 1921.

CONCLUSIONS

There are no safe conclusions to be drawn from this work so far. The following statements seem to be substantiated, however, by these experiments and general observations:—

1. The malady spreads with ease from a diseased bush to adjoining bushes in the row, even to two or three consecutive bushes, and across the row (usually six feet or less) in the growing season.

2. Newly diseased bushes show slight symptoms in late autumn and are badly affected when they leaf out the next spring.

3. Early eradication before the disseminating agent is active should reduce the amount of leaf-curl the next year if it is infectious.

4. The continuous succession of new suckers through the summer from diseased roots makes complete early eradication impossible.

5. Until the cause and means of spread of this disease are known it will be difficult to plan field experiments on control which will be conclusive.

6. Eradicating diseased bushes is recommended until better methods of control are known, and the removal of the diseased bushes should be accomplished as early in the season as possible. Two other eradications are recommended, one in midsummer especially to remove stray diseased suckers, and a late eradication paying particular attention to the slight symptoms shown by the tips of the suckers. Entire bushes should be carefully removed, attempting to get as much of the root system as possible.

INVESTIGATIONS ON LEAF-CURL OR YELLOWS OF RED RASPBERRIES

The main objects of this project were the determination of the transmissibility and natural mode of transmission of the obscure disease. Toward these ends a large amount of time was spent during the growing season in the following:—

1. General observations on the seasonal development of leaf-curl and its relation to the usual cultural practices.

2. Relation, during the growing season, between leaf-curl and mosaic of raspberry. This mosaic disease is entirely new to science, and, owing to the multiplicity of theoretical considerations that one must weigh in such obscure diseases as leaf-curl and mosaic, our first plans of work were very elementary.

3. A large amount of selected material for histological work was collected and prepared. This was done in hopes that some facts might be learned from such a study that would aid in solving the nature of this disease.

4. Preliminary sets of inoculations of different sorts were made in the field and greenhouse. These included the transfer of sap from diseased plants to healthy and the transfer of possible insect carriers.

5. A large number of individual plants showing the different stages of symptoms of leaf-curl and mosaic were tagged and carefully watched through the season to trace the developments.

A detailed summary of the field work on this disease will not be attempted at this time since another season's work is necessary before accurate conclusions should be drawn on many points. Subject to future corrections, the following is a brief statement of the facts of which we feel reasonably sure:—

1. Leaf-curl or yellows is a disease distinct from the new disease which we believe to be a mosaic.

2. The symptoms of leaf-curl are very distinct and there is but little variation shown in the field.

3. The symptoms of mosaic are likewise distinct but are more variable than those of leaf-curl and are subject to several developmental stages in the field.

4. Coloration of the foliage (except for etiolation) apparently is not related to either of these diseases. Various types of coloration are as likely to occur in plants free from leaf-curl and mosaic as in plants affected by either.

5. Leaf-curl is a systematic disease; once affected the bush is of no commercial value thereafter, only diseased suckers arising from the roots of affected plants.

6. Plants affected by mosaic in various stages of severity have never been seen to develop into leaf-curl. It is not believed that the two diseases are in any way connected. Mosaic does not seem to affect in any way the commercial value of the bush during the growing season. These two statements are more or less contrary to the facts in other mosaic diseases. It might be expected from analogy that dwarfing would accompany severe mosaic and that leaf-curl was a more severe or more advanced stage of mosaic, but such does not seem to apply in the case of the raspberry.

7. Many types of inoculations using the juice of plants affected by leaf-curl were made. None developed symptoms during the remainder of the season although several new leaves were put out after the inoculations were made. Tips of suckers next to diseased bushes developed definite leaf-curl in October, but no artificial inoculations were successful. Of a few insect transfers made from diseased to healthy plants in the greenhouse leaf-curl developed in one case where aphids were used. The "incubation" period was about fifteen days. Some evidence was obtained late in the season that it was the aphid-infested plants that showed the most leaf-curl developing at the tips.

8. Leaf-curled plants have very poor root systems, which may be only a result of leaf-curl and not a causal relation. The absorbing surface is remarkably small and it has often seemed that the amount of dead roots is greater, but the old roots of raspberries are such mutilated and anomalous masses of disused organs that we have never been certain of such observations.

9. From the field work we believe it is very likely that leaf-curl or yellows is infectious and that it is either transmitted above ground by insects or below ground by root contact.

Several lines of work on leaf-curl were attempted in the laboratory during the winter months. A brief summary of the results follows:—

1. Attempts to isolate an organism from the leaf tissues have failed.

2. Plants inoculated by rubbing the leaves of healthy plants until injured with "curled" leaves have failed to develop leaf-curl after one month interval.

3. Inoculations made by inserting split petioles or diseased leaves into the stem of young suckers and sealing the wound have failed to transmit curl after one month.

4. Curl has not been transmitted yet to healthy plants growing in the same pots with curled plants.

5. Mosaic has not been successfully transmitted by bruising healthy leaves with diseased leaves.

6. In attempting to determine the transmissibility by aphids, no aphids could be found in greenhouses during the winter which would accept the raspberries as a food plant, and this had to be abandoned until summer. The over-wintering plants which were aphid infested last year failed to develop any young this winter.

7. Several hundred slides have been made for the histological study of leaf-curl. Material from over forty collections has been sectioned. This represents healthy dark green leaves and light green leaves, typically curled leaves of different ages with and without etiolation, petioles in cross and longitudinal sections from diseased and healthy leaves and sections of the cane, diseased and healthy. There is also some material taken from the same plant at the point where there was a definite transition from healthy to typically curled. Staining methods have been developed, but actual work of staining and studying the material is yet to be done.

8. A study of the effect of varying nutrition upon the raspberry was begun last autumn. However, we failed to obtain suitable germination of the seed and it was abandoned. Many methods of overcoming the hard seed coat were tried. Concentrated sulphuric acid for two hours caused some seed to germinate. The methods gave such erratic results, however, that we could not depend upon getting the number of seedlings wanted. Also it was found that the seedlings made practically no root growth in Shives control solution R5C2 and apparently, even if we had been able to obtain abundant and uniform seedlings, we would have had difficulty in getting them to grow in the water culture solutions.

It is hoped with the experience gained the past year that some definite results on the transmission and control by eradication may be obtained during the coming season.

SEASONAL HISTORY OF BROWN ROT OF STONE FRUITS

CONDUCTED IN NIAGARA, GRANTHAM, LOUTH, CLINTON, GRIMSBY AND SALTFLEET TOWNSHIPS

For three years a study has been made of the relation between the number of mummied fruits overwintering in the ground which develop apothecia and the amount of blossom blight on peach, plum, and cherry. In 1919 considerable data were gathered by my predecessor in Lincoln county on the amount of brown rot developing in the fruit both in the orchard and in the markets. In these studies no attempt had been made to gather the data systematically during the season from selected orchards. Owing to wide variability in the occurrence of brown rot in its various stages according to many different local environmental conditions we have felt that general averages gathered haphazardly were really of little value. Realizing, however, that there were many points of possible correlation in the various manifestations of brown rot in the orchard, a plan of systematic analysis of these factors was attempted this year.

In each of the adjacent pairs of townships (Niagara and Grantham, Louth and Clinton, Grimsby and Saltfleet) representing the stretch of the fruit belt from the Niagara river to Hamilton (about 50 miles) fifteen peach, fifteen plum, and fifteen cherry orchards were chosen for observation throughout the season. This made forty-five orchards of each of the stone fruits or one hundred and thirty-five orchards all told. Within each group of fifteen orchards chosen, five were well cultivated, five fall ploughed only, and five not ploughed for a year. The groups of five similar orchards in each district were distributed to represent all possible topographic features. Each orchard was plotted on graph paper in April and ten trees (representing varieties present and systematically oriented) were selected as observation trees. Careful records were then proposed on the trees in each orchard. The programme as out-

lined above was carried forward to the extent that all the orchards were chosen (except some of the cherry orchards), mapped, the ten trees selected and data taken on the apothecial development under each tree, and the amount of blossom blight on each tree determined. Owing to the nature of the season, there being a long warm and dry spring up until July, practically no apothecia developed and there was a very small and questionable amount of blossom blight. Later in the season when practically no brown rot developed in cherries, plums, or peaches, the collection of data on these trees was abandoned for the season. The following summary of the data gathered will illustrate the negative character of the experiment:—

TOTAL NUMBER OF APOTHECIAL CLUSTERS UNDER TEN TREES

(Average of five orchards)

—	Niag.-Grantham	Louth-Clinton	Grim.-Saltfl.
Peach—			
Well cultivated	0	0	0
Fall ploughed only	0	0	0
Not cultivated	0	1	0
Plum—			
Well cultivated	0	0	0
Fall ploughed only	0	1	0
Not cultivated	0	2·5	0

The following table gives the percentage of blossoms blighted on the marked trees. These figures should be taken as the absolute maximum, because some of the determinations were made late in the season on some varieties, and many brown coloured and apparently blighted blossoms may have been due to other causes than brown rot.

AVERAGE PERCENTAGE BLOSSOM BLIGHT ON THE TREES UNDER OBSERVATION

—	Niag.-Grantham	Louth-Clinton	Grim.-Saltfl.
Peach—			
Well cultivated	0·7	0	0
Fall ploughed only	0·5	0	0
Not cultivated	2·4	0	0
Plum—			
Well cultivated	7·3	0	0
Fall ploughed only	0·4	0	0
Not cultivated	6·8	0·6 (one orchard)	0

STUDIES ON THE NATURE OF SUSCEPTIBILITY

The underlying fundamental facts as to the nature of susceptibility in plants are as yet unknown. An understanding of this factor, its location, physical nature and means of modifying its degree would be a help in devising control measures. It is the next logical field of advance in plant pathological research, for there is no reason why this science should halt after a fair attainment of knowledge as to ætiology and protection measures of control. While possibly no quickly applicable or revolutionary methods of control may arise directly from such fundamental research, it may be confidently expected to make for progress in better control measures, just as any real advance in the science is of value.

It was with these considerations in mind that preliminary studies were begun using potato tubers and bacterial pathogens. During the late winter of 1919-20

about forty pure culture isolations were made from rotting potatoes to secure suitable strains for this work. Considerable time was consumed in purifying these strains, obtaining their gross cultural characters and testing their virulence in potato tubers. All the strains except five were capable of living in potato tubers for at least seven days. An effort was also made to devise a system of making graduated dosages. The studies were continued in the winter of 1920-21. All the forty strains were carried in pure culture throughout the interval. The strains were recultured every two or three weeks. Several new strains were added to the set in the autumn of 1920. When the tubers which were grown for this work from uniform healthy stock were mature in October all the fifty odd strains were tested as to virulence. A majority of them were found no longer capable of living in potato tubers. From these tests strains 15, 16, 17, 18, 19, 21, 22 and 23 were found to be the only ones that produced rapid decay. They were all the same type, both as to cultural characters and as to the character of the decay produced. A similar number of non-rotting strains of the same cultural type were saved as checks and the remainder were discarded. From a second test of these selected strains, culture number 23 was selected as the best.

The following method of inoculation had been used up to this time and was continued for the most of the work:—

1. An all glass (Luer) syringe, with a capacity of 1 cubic centimeter, graduated to 1/100 cc. was used with a number 26, half or one-inch needle.

2. The syringe was sterilized with 95 per cent alcohol by successive washings, then it was washed the same way with two or three changes of sterile distilled water.

3. The suspensions of living and dead bacteria were made in small quantities in sterile distilled water. The content of the suspensions was gauged by eye and was made as nearly uniform as possible in all the work.

4. Graduated dosages were obtained by making from one to five separate injections as close to one another as possible in a straight line. Uniform injections were secured by plunging the needle at full length into the tuber and then after withdrawing it almost to the point enough pressure was exerted to start the appearance of a drop around the needle. With a number 26 needle this amounts to less than 1/100 of a cubic centimeter.

5. All tubers were injected on the flat face midway between the ends and to the right or left of the centre. In this way the lesion developed in one-half of the potato which could be split in two and the sound half used for reinoculation. The cut surface was plunged into melted paraffin and this coating was sufficient to keep the half tuber in a normal condition for ten days at least, which was as long as desired. The injection wounds were closed with melted paraffin, which prevented drying injury.

6. Bacterins (dead bacteria) were prepared by scraping the growth from agar slants made in quart bottles. This material was suspended as a fine emulsion in 95 per cent alcohol and decanted into watch glasses. When dry it was scraped together and pulverized in a mortar. Similar bacterins and sera were prepared by drying lesion tissue and healthy surrounding tissue and grinding these in a mortar.

All the work up until December 1, 1920, and briefly outlined above, was preliminary to the work now started. The first experiment was arranged to determine the effect of the development of a lesion in one-half of a tuber upon the relative susceptibility of the other half.

The following was the plan of the experiment:—

1. Inoculations were made on November 26 into medium-sized, uniform, Irish Cobblers, with a No. 26, one-half inch needle as described above. The culture used (number 23) was the same for the reinoculation of healthy halves as for the original, making it seven days older.

Number of tubers inoculated	Number of injections	Period before second inoculation	Reinoculation healthy half dosage
13	1	7 days	2 each with 1 to 5
13	2	7 days	2 each with 1 to 5
13	3	7 days	2 each with 1 to 5
13	4	7 days	2 each with 1 to 5
13	5	7 days	2 each with 1 to 5
10	checks	7 days	2 each with 1 to 5

2. A set of the same strain of tubers which had been injected on November 5 with a suspension of bacterin MB. (composed of a mixture of several strains of the same nature as number 23) were halved and reinoculated with dosages of 1 to 5 at the same time as the above.

3. A set of the same strain of tubers which received an injection on November 6 of bacterin of strain 10 was similarly treated and included with the above sets. Culture 10 was a yellow chromogen and entirely different from the "*phytophthorus*" type to which culture 23 and those included in bacterin MB. belong.

These three sets were incubated in a constant temperature chamber at about 23°-24° C. On December 3 the tubers were split lengthwise, separating the tubers into halves, one containing the lesion and the other healthy. The cut surface of the healthy halves was immediately paraffined and the reinoculations made with dosages of 1 to 5 of culture number 23 in the same manner and same relative position as the original inoculations were made.

After five days (on December 8) one tuber of each of the cross-inoculations was cut and the lesions compared. The following is a summary of the results:—

1. Checks inoculated November 26 and examined on December 3 when compared with checks uninoculated November 26, inoculated December 3 (with same suspension as reinoculations were made) and examined on December 8, showed identical character and size of lesions. The same sized lesions, one set being seven days old and the other five days, was afterward explained by finding that the lesions of strain 23 reach full size in less than five days.

2. Tubers receiving a dosage of one injection first time and reinoculated with dosages of 1 to 5 injections showed a perfect gradation which in each case was much more extensive than the lesions in the checks. It was estimated that they were twice as extensive.

3. Tubers receiving a dosage of two injections the first time and reinoculated with dosages of 1 to 5 injections also showed more extensive lesions than the checks not receiving the first injections.

4. The tubers receiving the larger dosages of 3, 4, and 5 injections the first time all showed much larger secondary lesions as compared with the checks.

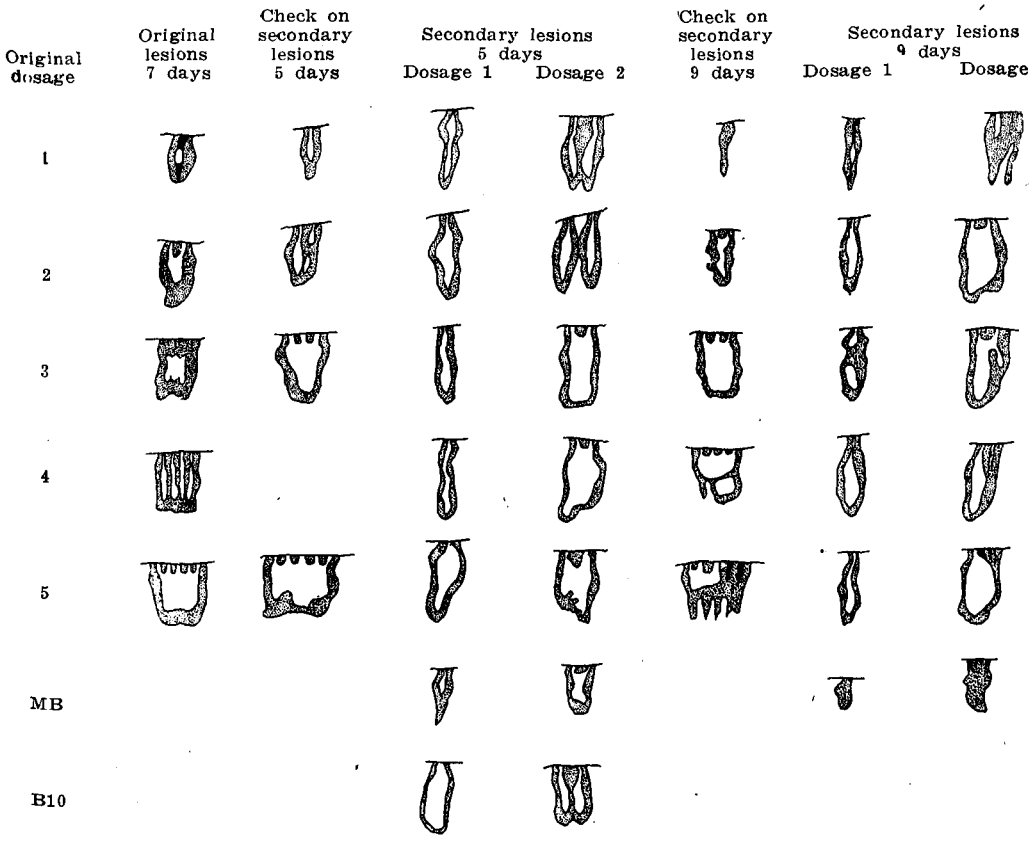
5. The tubers which had received a uniform dosage of bacterin MB. showed secondary lesions of the same character and size as the checks.

6. The tubers which had received a dosage of bacterin 10 were the only set which gave contradictory results within the set. The one receiving a dosage of one injection had a lesion much larger than the check, but the ones receiving dosages of from two to five injections showed lesions smaller than the checks.

A duplicate set of these tubers was examined on December 12 (after nine days) and the size and character of the lesions were identical with the five-day set. The same increase in size over the checks was evident, but no increase was shown over the five-day set. This was later found to be due to the fact that lesions produced by culture 23 reach their maximum size in less than five days at 23° C.

The relative size of the lesions produced by the different dosages is not directly due to the dosage, because several punctures were made. It is therefore doubtful if

the larger lesions (dosages of three to five injections side by side) should be compared, because the spacing of the needle punctures would vary. It was, however, noticeable in the observations made at the time that all the dosages gave perfect gradations in the same proportions when compared with the checks. For the reason of accuracy only the dosages of one and two injections are illustrated in the chart. Drawings were made of each lesion carefully cut to a medium plane, from measurements taken at the time. In each case where there was more than one tuber of a kind, as in the checks, the drawing on the chart is an average condition. Variations were slight within each set.



An experiment was conducted to determine if there was any evidence of the production of "anti-bodies" following injections of suspensions of lesion tissue, healthy tissue contiguous to lesions, and dead bacteria. All of these tests were with the one strain, number 23. Large doses were given by using a veterinarian's hypodermic. The approximate dosage was 0·3 of a cubic centimetre. The openings were paraffined and the tubers incubated at 23° C.

Tissue from along the injection channel and 2 cm. away in these potatoes was preserved in 0·4 per cent trikresol after five days and seven days for agglutination tests. In the case of the tissue taken after five days no correction of the acidity was attempted. This resulted in a rapid coloration of the solution, which reached dark blue or almost black. The later set made after seven days was corrected to about P_H 8·0 by adding to 5 cc. of potato, 9 cc. of n/10 NaOH and 14 cc. of 0.8 per

cent trikresol. This was thought at first to overcome the formation of the deep blue colour, but after standing two or three days the colour formed as deeply as in the first set.

These extracts might be expected to show the following:—

1. In the case of tubers injected with 0·3 cc. of a suspension of lesion tissue (comparable to an anti-serum and bacterin mixed), after five or seven days the tissue around the injection channel may have developed "anti-bodies"; also the tissue in the other half of the potato (2 cm. away) may have developed "anti-bodies." If such have been developed we might expect extracts of this tissue would cause agglutination.

2. In the tubers injected with suspended healthy tissue just beyond lesions we might expect the absorption of 0·3 cc. of antiserum to cause the extracts to show the agglutination reaction.

3. In the tubers injected with a suspension of dead bacteria (bacterin) we might expect a positive agglutination reaction in the surrounding tissues.

Accurate tests of the possible agglutinin content of these extracts are yet to be made. A preliminary test of all the extracts gave negative results, but these tests were not carried for a sufficient length of time to be accurate.

A set of agglutination tests was made direct from the injected tubers as follows:—

1. To a small drop of expressed sap of the injected tuber on a cover glass were added 5 loops of a very dilute suspension of a living culture and these were inverted on Van Tieghem cells.

2. To a small drop of the same suspension of living bacteria was added a very small amount of expressed sap in the same way.

3. Sap from tubers, injected fifteen days previously with 0·3 cc. of a suspension of lesion tissue, healthy tissue surrounding lesions and dead bacteria, was tested along with sap from check tubers incubated for four days at the same temperature.

4. The cells were incubated at 30° C. for twenty-two hours and examined for signs of agglutination. The following table gives the results of the observations:—

Previous treatment	Number of bacteria added to drop	Variety	Motility	Agglutination
dead bacteria	few	G.M.	many motile	slight
dead bacteria	many	G.M.	very few motile	distinct
healthy tissue	few	G.M.	majority motile	slight (?)
healthy tissue	many	G.M.	majority motile	none
lesion tissue	few	G.M.	many motile	slight
lesion tissue	many	G.M.		
not injected	few	G.M.	many motile	distinct
not injected	many	G.M.	many motile	very distinct
not injected	few	I.C.	many motile	distinct
not injected	many	I.C.	majority motile	none
Distilled water check	few	.....	very few motile	none
Distilled water check	many	.....	very few motile	none

While these results have not been checked, it may be noted that they tally with the study of the relative size of lesions in reinoculated tubers. In both cases there was an indication of hypersusceptibility.

A preliminary experiment to test the effect of the development of the lesion produced by strain 23 upon the hydrogen-ion concentration of the sap was made over a period of four days after injection. The following table gives the result in PH:—

Variety and treatment	after 30 hrs.	after 48 hrs.	after 74 hrs.	after 96 hrs.
Irish Cob.—check	6·0	5·8	5·9	6·0
Irish Cob.—injected	5·8	5·9	6·0	5·9
G. Mount.—check	6·0	6·0	6·0	.....
G. Mount.—injected	6·0	6·0	6·0	.....

As seen from the figures above there was practically no change in the acidity and where slight variation occurred in the case of the Irish Cobblers the uninoculated check tubers gave as great a variation as the inoculated ones. This variation was probably due to inexperience in determining the colour changes at the extreme end of the methyl red series. The sap extracts of Irish Cobbler become pink before tests can be completed, and although this was checked through water blanks and solutions without the dye added, it made small errors possible. In the above set of tubers used for the acidity tests the lesions reached maximum size in 72 hours.

In a recent attempt to regulate the dosage so that non-rotting doses of the living bacteria might be injected, the following method was used. (Previous attempts to inject small uniform dosages with the hypodermic had failed because the pressure necessary to inject caused leakage around the piston which could not be measured):—

A hole was made through the tuber with a sterile hollow unpointed veterinarian's needle about 1 mm. in diameter. One end of this channel was closed with paraffin and the channel filled with sterile distilled water. With a hypodermic enough water was then removed to make room for the dosage required. A uniform and very dilute suspension of a four-day culture (cultures of this age are the most virulent) was injected in accurately measured quantities with a number 26 needle, one inch long. The end of the channel was then closed with melted paraffin. The dosages used were 1/100, 2/100, 3/100, 5/100 and 10/100 of a cubic centimeter. The channels held from 15/100 to 20/100 ccm. Examination after six days' incubation at 23° C. showed in both Irish Cobbler and Green Mountain that the lesions produced by an injection of 1/100 ccm. were as extensive as those produced by the larger doses. Acidity tests showed approximately PH 6·0 for small and large doses as well as the incubated checks.

SUMMARY

Because of the preliminary nature of the above-described experiments there are no conclusions to be drawn other than hypothetical suggestions for future work along this line. The following hypotheses are worthy of consideration:—

1. The fact that out of about fifty strains of bacteria isolated from decaying potatoes only a very few after being carried on nutrient agar show rotting potentialities indicates that uninjured potato tissue is highly resistant. Of the few strains (all of the *B. phytophthorus* type) which did cause rotting when introduced with the hypodermic, one strain, number 23, showed greater aggressiveness than the others.

2. The indications gained from reinoculating healthy halves of previously inoculated potatoes seem to point to a condition of hypersusceptibility. The primary lesions advanced to a certain definite and uniform size in a few days. Upon reinoculation the secondary lesions advanced to a uniformly greater size in the same length of time but were then halted in development. Apparently such a reaction precludes the formation of an anti-toxin as an explanation of the halting of the primary lesion since such a factor would then be expected to check the development of the secondary lesions. Since these secondary lesions developed to a larger size in the same length of time in tissue

about two centimeters from the original lesions, it might be theorized that the resisting factor which was originally present in the potato was used in a quantity which drew on the "quantity in store" of this factor and thus made the tissue more susceptible.

3. It seems that the resistant factor which causes the limitation of the lesion to the size it reaches in three days at 23° C. must be present in the potato and not a factor which is developed. The evidence that the strongest agglutination was secured in uninoculated potatoes supports this theory, as well as the time factor. If there is any analogy between plants and animals in this respect we could not expect a resistance factor such as "anti-bodies" to be developed within the period of three days after inoculation. The agglutination tests also suggest that the resistance factor is diminished in the period of lesion formation.

4. The fact that no change in acidity was detected in inoculated potatoes during the development of the lesions suggests that there is no great physiologic disturbance caused, such as accompanies the formation of "anti-bodies" in animals as evidenced by rise in temperature and acidity changes in the blood.

5. Taking all the preliminary evidence cited above it suggests two things as to the nature of the susceptibility of potato tuber tissue to strain 23:—

(*a*) There seems to be no indication that any sort of anti-bodies are developed due to the invasion of this organism or its chemical products.

(*b*) There seems to be resistant factor (of unknown nature) normally present in potato tuber tissue which, although it allows rapid decay for about two days, finally causes the limitation of the size of the lesion at about the third or fourth day. Also that this resistant factor is less potent to stop secondary lesions due to reinoculation.

It appears now that our selection of the potato tuber as a living host and rotting bacteria as a type of pathogen for the study of the nature of susceptibility has led us into difficulties which are complex. This combination of host and parasite seemed to suit conditions for such a study. The host material could be secured in abundance (it should of course be as far as possible free from disease, of uniform strain and as pure a line as possible), and R. J. Wagner in the Centralbl. für Bakt. II. for 1914 and 1916 had apparently demonstrated anti-body formation in potato tubers inoculated with rotting organisms. Also potato tubers furnished a type of living plant tissue which we could work with in the laboratory during the winter (since we have no greenhouse accommodations, living plants could not be grown). It has proved, however, that there seems to be no normal high degree of resistance to the strains of bacteria that we have been able to secure, which handicaps us in working with susceptibility. It seems that the first inquiries into the nature of susceptibility can better be made with plants and pathogens where the normal condition of the host is a high degree of susceptibility. Then by minimum dosages of the living bacteria and the use of bacterins, anti-sera, and antitoxins, one could study their effect on reducing the normal degree of susceptibility. The host plant chosen should be easily grown under experimental conditions and preferably a rapid-growing plant, where various stages in growth can be easily timed. For the above reasons, it is questionable if we should try to proceed with the potato tuber as a subject of study.

THE PLANT DISEASE SURVEY OF CANADA

Acting upon the decision of the conference of members of the staff of the Division of Botany for the institution of a plant disease survey in Canada, considerable time was spent during the year on this project. Most of the office work connected with the survey was done here. An appeal to many specialists in botanical science throughout Canada to co-operate in this work was made by Mr. Fraser and myself. Also all the field agents of the Division of Botany were given instructions for submitting as many disease survey reports as possible. The plan of the survey was to accumulate enough individual field records on the forms provided so that approximate averages

of the percentage prevalence of the commoner diseases of field, garden and orchard crops could be determined for all parts of the country. Summaries for the provinces of Manitoba, Saskatchewan, Alberta and British Columbia were prepared by Messrs. Bisby, Conners, Fraser, Bailey and Eastham. This was a great help in compiling the general summary. For the eastern provinces outside the Niagara fruit district we failed to get a sufficient number of field records to make estimates, except for potato diseases. Mr. Partridge kindly prepared a summary by counties from the field records of the potato seed certification service. The result of this first year's effort convinced us that we cannot depend upon the method of soliciting individual field records and it is planned that, for the coming year, some person in each province will be made responsible for summaries of the conditions in that province. This will result in important improvements such as:—

1. More local observers will be utilized.
2. Persons in closer touch with local conditions will make the summaries and more correctly interpret the field data according to their personal observation.
3. The amount of work involved at this office will be greatly reduced.
4. The persons responsible for the data from each province will be stimulated by the necessity of making a report to be more systematic in the collection of data than if individual field records only were to be sent in.

The report on the plant disease survey was completed some time ago and submitted separately with the request that it be mimeographed and distributed to those interested.

RESULTS OF THE PLANT DISEASE SURVEY IN LINCOLN AND WENTWORTH COUNTIES, ONTARIO

Field records were accumulated throughout the season in the Niagara fruit belt on the percentage prevalence of the commoner diseases. A summary of these data is included in the plant disease survey report. Following is a brief summary:—

Apple,—
Scab: slight in 5 orchards, practically none in 68 orchards, average 0·07 per cent.
Twig blight: moderate in 18 orchards, slight in 73 orchards, average 1·5 per cent.

Cherry,—
Brown rot: slight in a few orchards, none in the majority.
Yellow leaf: slight in 21 orchards, practically none in 130 orchards.

Currant,—
Rust: found in 15 out of 63 plantings,—no damage.
Leaf spots: rare.

Gooseberry,—
Leaf spots: rare.

Grape,—
Mildews, rare.

Peach,—
Leaf curl: 12 to 14 per cent in unsprayed orchards, 0·14 per cent to 1 per cent in sprayed.
Brown rot: slight in 14 orchards, none in 112 orchards.
Yellows and little peach: slight in 22 orchards (0·2 per cent), none in 154 orchards.

Pear,—
Fire blight: Twig blight slight in 34 orchards, none in 97 orchards.
Scab: very rare.

Plum,—

Brown rot: slight in 85 orchards (2·3 per cent), none in 44 orchards.

Raspberry,—

Leaf curl: average loss in cane stand around 10 per cent.

Strawberry,—

Leaf blight: rare, about 2 per cent leaf surface affected late in season.

FRUIT DISTRIBUTION MAPS

At the same time the brown rot studies were being made in the spring, records were accumulated on the location of the various orchards and small fruit plantations in the territory covered. Since almost the entire fruit district between the Niagara river and Hamilton was covered in this work we obtained a fairly accurate fruit distribution map of the district. The areas under fruit were sketched in on sheets representing the concessions and are supposed to show approximately, the location and size of the planting and the kind of fruit. Enlarged maps of the townships were made on tracing linen during the winter by Mr. Tucker and the field data transferred to these maps. Blue-prints of these maps will be of assistance in many ways in the field work.

MISCELLANEOUS

White pine blister rust.—Upon request we carried forward the work on white pine blister rust until Mr. McCallum was appointed. The woodlot survey records and the five sample control areas were carefully gone over by Mr. Smart, the field agent employed for this work. Since all the records of this work were turned over to Mr. McCallum in September, a report on this work will be made by him.

Mosaic and leaf-roll of potato.—Two plots of potatoes were planted by Mr. Peppin at the Vineland Horticultural Station. One plot consisted of nine rows of Irish Cobblers about 50 feet long. The centre row was from leaf-roll stock (Garnet Chili used in this row instead of Irish Cobblers) and the four rows on either side were healthy stock. The other plot was the same size and consisted of Green Mountains, the centre row being from mosaic stock. The purpose of the experiment was to determine the rate of spread from the centre row year by year. Seed saved from each row was to be planted in the same position the next year. Mr. Peppin's instructions as to the care of these plots were carried out. They were sprayed four times and no late blight or early blight occurred in the plots. A slight amount of *Rhizoctonia* and Blackleg occurred and this was rogued. Seed was saved from each hill and placed in separate bags for each row. This seed was stored and came through the winter in good shape.

Extension activities.—There has been very little call for our assistance during the year, either for special diagnosis and advice or for other extension work. Throughout the season the common fruit diseases were of no practical importance. All crops were large. The grower was worrying over labour supply, the basket shortage, and marketing difficulties, and cared little about fruit diseases. During the winter their attention has been entirely taken up with the marketing problem and the formation of the central selling company.

Lightning injury of field-grown tomatoes.—There were at least three fields of tomatoes in Grantham and Niagara townships which suffered from lightning injury during one severe storm. Large areas 30 feet or more in diameter were killed. The plants wilted slowly and alarm was expressed by the growers who thought it was a new disease. The areas did not enlarge after the first few days when the wilting began to develop.

Electro-culture.—An electro-culture table was constructed to fulfil the need of growing a few plants for experimental purpose during the winter. The table is 4 by 5 feet. Suspended from the ceiling is a rectangular frame supporting nine outlets. These are arranged on sliding rods so that either nine or six outlets may be used, and in each case they can be adjusted so that equal lighting is secured. Two hundred watt nitrogen-filled bulbs have been used so far. About fifty dormant raspberry roots were started on the table the middle of February, using the nine outlets continuously. Within a month all the healthy roots had sent up suckers at least a foot high. In two months some suckers are almost three feet high and still growing well. For the last month only six outlets have been used (1,200 watts continuous lighting). The fruiting canes bloomed in about six weeks from the time they were placed on the table. Beans in nutrient solutions grew well until they contracted some trouble which we could not diagnose. Apparently 1,200 watts of continuous light is too much for beans. Potatoes in nutrient solution have done well so far. Good roots and tops with healthy green leaves have developed rapidly. Not counting the original expense of installation, the cost of growing plants by this method for experimental work is not great. As long as greenhouse facilities are lacking it will aid in a small way to fulfil this function. The lights raise the temperature about 10° F., but by manipulating the air-drainage in the room it can be kept fairly constant.

REPORT OF THE SASKATOON LABORATORY OF PLANT PATHOLOGY IN CO-OPERATION WITH THE UNIVERSITY OF SASKATCHEWAN, AND THE DOMINION LABORATORY AT INDIAN HEAD, FOR 1920-21.

W. P. FRASER, *Plant Pathologist, Officer in Charge*

As the work of the Saskatoon and Indian Head Laboratories of Plant Pathology was carried out in close co-operation, and as the officer in charge of the latter, Mr. D. L. Bailey, resigned at the end of September, it was thought best to combine the reports of these laboratories. Greenhouse experiments and laboratory work were carried on chiefly at Saskatoon, but most of the field experiments were at Indian Head.

At Saskatoon, the university provided a modern greenhouse, about 20 feet by 50 feet, with three compartments, and a laboratory in connection about 16 feet by 28 feet in size. In addition, a good office was provided in a separate building. The ground used for the field experiments at Saskatoon was also prepared for seeding by the university.

Miss Margaret Newton, as assistant pathologist, aided in the work of the laboratory, especially in the greenhouse experiments to determine the strains of stem rust on wheat, during the summer and fall, but resigned at the end of the year. Mr. J. C. Forbes was employed as a temporary assistant during the summer.

The Indian Head Laboratory was under the charge of Mr. D. L. Bailey, who supervised the field experiments there during the summer. In winter he was associated in the laboratory work and greenhouse experiments at Saskatoon. The preparation of the ground, and seeding of the larger plots at Indian Head, was done by Superintendent MacKenzie.

PLANT DISEASE SURVEY

No systematic survey was carried out in Western Canada during the year, but many field observations were made, and the most important of these are here recorded.

The spring and early summer were rather moist, but later in the season central and northern Saskatchewan suffered severely from lack of rain, and the crops were

generally light in those districts. There was more rain in Manitoba, and the crops were better. In Alberta, except in the southeast, there was more moisture, and on the whole the crops were very good.

WHEAT

STEM RUST, *Puccinia graminis.*—Stem rust was first collected on wheat on June 30 at Winnipeg by Dr. Bisby. A few days later it was found to be present in several places in southern Manitoba. It was collected first on wheat in Saskatchewan at Weyburn (two pustules) by D. L. Bailey on July 9, and on the 14th. a few pustules at Indian Head. Two pustules were collected on Marquis at Yorkton on July 15 by

Locality of rust collections, 1921

J. C. Forbes. It appeared about the last of July in Saskatoon, and the first of August at Scott. The first collection at Edmonton was on August 12, a few scattered pustules but no secondary infection. Late grain was rather heavily rusted over Saskatchewan, but little damage was done. Early grain showed little rust. In Manitoba there was considerable damage to late seeded wheat. In northern Alberta there was very little rust on the main crop, but on late grain a few pustules could be collected. In southern Alberta there was practically no stem rust. On very late growth a few pustules could be collected in a few places, but none could be found on the main crop. No cereal rusts were found in the Peace River district. The distribution of the rust was much the same as in 1919, but stem rust was more severe in that season and did much damage in northern Saskatchewan to late grain. No stem rust was collected in southern Alberta in 1919, the season being very dry.

LEAF RUST, *Puccinia triticina.*—This rust was found here and there throughout the West, but was not common in Saskatchewan, and rare in Alberta.

STRIPE RUST, *Puccinia glumarum.*—This rust was collected at Stettler, Alta., on *Hordeum jubatum,* by Miss M. Newton. Attempts were made in the greenhouse to infect wheat, but without results. It was also collected in abundance on *Hordeum jubatum* at Edmonton, Alta., in 1919, but also failed to infect wheat.

LOOSE SMUT, *Cstilago Tritici.*—This smut was found commonly on wheat. One large field showed 5 per cent infection. Generally fields were almost free or showed one-half per cent to one per cent of this smut.

BUNT or COVERED SMUT, *Tilletia Tritici,* and *T. lævis.*—These smuts were not common except locally. All of the collections were *Tilletia Tritici,* except in some check plots for smut control at Indian Head, where the smut was *Tilletia lævis.*

SCAB, *Gibberella Saubinetii.*—Scab of wheat was not collected in Saskatchewan or Alberta, and very little was found in Manitoba. In 1919, scab was prevalent in Manitoba, doing a considerable local damage. A few collections were made in Saskatchewan, but no serious injury was done.

ROOT ROTS.—These were common in some districts in Saskatchewan, and seemed to be due to a species of *Helminthosporium.*

GLUME SPOT due to *Septoria.*—No collections were made. It was not rare in 1919.

BASAL GLUME ROT, *Bacterium atrofaciens.*—Collections were made at Scott. It was quite severe in a few small plots. A collection was also made at Morse, Sask.

ERGOT.—Not collected this season, though several collections were made in 1919.

POWDERY MILDEW, *Erysiphe graminis.*—Though troublesome on wheat plants in the greenhouse, was not collected in the field.

RYE

STEM RUST.—Was not common on rye and did no damage.

LEAF RUST caused by *Puccinia Asperifolii.*—This rust was rare on rye, except in the Edmonton district, where it was quite severe though apparently not doing serious injury.

ERGOT.—Ergot was general, but usually not severe, not being more than 1 per cent to 3 per cent.

POWDERY MILDEW, caused by *Erysiphe graminis.*—This was abundant at Edmonton on rye.

BARLEY

STEM RUST, *Puccinia graminis.*—Was common on barley wherever rust was prevalent, but did little or no damage.

LOOSE SMUT, *Ustilago nuda.*—This smut was common on barley, but generally the percentage was small, averaging not more than one per cent to five per cent.

COVERED SMUT, *Ustilago Hordei.*—Not so common as the loose smut, but occurred in many places.

STRIPE DISEASE, due to *Helminthosporium gramineum.*—Not rare; in some places quite severe.

SPOT BLOTCH, *Helminthosporium sativum.*—Quite severe in some places but generally was not serious. It was not nearly as common or severe as in 1919.

NET BLOTCH, *Helminthosporium teres.*—This was present in many fields, but did not seem to cause much injury except in some small experimental lots.

OATS

STEM RUST.—Stem rust was present on oats in a few places, but it was not at all common. No collections were made in Alberta.

LEAF RUST, *Puccinia coronata.*—This rust was rare in Saskatchewan, and no collections were made in Alberta.

SMUTS, *Ustilago Avenae* and *U. laevis.*—These smuts caused some loss, but usually only a small percentage.

Bacterial leaf spots were common in some districts.

FLAX

RUST, *Melampsora Lini.*—Rust was collected in several places and seemed to be generally distributed, though in no place severe. A collection was made in the Peace River district.

WILT, *Fusarium Lini.*—Wilt was severe in some fields in Saskatchewan and caused local losses.

SUNFLOWER

SUNFLOWER RUST, *Puccinia Helianthi.*—This rust was quite common on sunflowers in Manitoba and Saskatchewan, and caused shrivelling of the lower leaves. It was not collected this season at Alberta though previous collections were made.

Selerotinia libertiana (more probably *S. perplexa* Law).—A stem rot caused probably by this fungus was found at Edmonton, Lacombe and Vermilion by Miss Newton. It was also observed at Morden, Man.

PEA

Pea blight, caused by *Ascochyta Pisi,* was collected in a few places but was not common. Collections were also made of *Septoria* blight.

BEAN

Bacterial blight of bean was not so common as in 1919, only a few collections being made.

POTATO

Early blight caused by *Macrosporium Solani* was rather rare, though common in 1919.

RHIZOCTONIA, *Rhizoctonia Solani* was very severe, much more severe than usual. It is difficult to estimate the percentage of loss due to this disease, but it must be very great.

Blackleg was not so common as in the previous season, but in some places caused serious loss.

Wilt caused by *Fusarium* was not generally prevalent.

Scab caused by *Actinomyces scabies* was very common.

Powdery scab was collected at Edmonton in 1919, but no collections were made anywhere in 1920.

Late Blight, caused by *Phytophthora infestans,* was not collected in 1920, nor has the writer ever observed it in Western Canada.

BLACK CURRANT

Powdery mildew, *Sphaerotheca mors-uvae,* was quite severe on black currents at Saskatoon, but appeared too late to do serious injury.

ASTER

Wilt of Aster, probably due to a *Fusarium,* was present at Indian Head.

RHUBARB

A disease of rhubarb, probably bacterial, was quite severe in some gardens at Indian Head and Scott in Saskatchewan.

WESTERN RYE GRASS

Leaf rust due to *Puccinia Clematidis* was prevalent in some districts, but did practically no damage.

Smut, due to *Ustilago Agropyri,* was not commonly observed, though collected at Saskatoon and Indian Head.

AWNLESS BROME GRASS

A leaf spot of Awnless Brome was quite severe in some districts in Saskatchewan This disease has been prevalent in Western Canada for several years.

TIMOTHY

Puccinia graminis (Phlei-pratensis).—This rust was more or less common on Timothy throughout the west, though more abundant at Edmonton. Collections were also made in the Peace River district.

TEST OF SOLUTION FOR RUST CONTROL

Mr. R. Barry, of Young, Sask., asked to have a solution (the composition of which he did not disclose) tested, claiming that the solution would control both rust and smut. Mr. Barry furnished a sufficient quantity of the solution. This consisted of a pleasant smelling liquid, with some substance in suspension. The tests were carried out at Indian Head on wheat. Four plots were used, each containing about 400 square feet.

Variety	Treatment	Date	Result	Smut per cent
1. Early Red Fife.....	5 min. dip in Barry solution. Covered 2 hrs.	May 17	Very badly rusted	
2. Early Red Fife.....	No treatment.....	"	Very badly rusted	
3. Marquis.....	5 min. dip in Barry solution. Not covered	"	Badly rusted	19·3
4. Marquis.....	5 min. dip in Barry solution. Covered 2 hrs.	"	Badly rusted	11·6
5. Marquis.....	No treatment.....	"	Badly rusted	26·0
6. Marquis.....	Ordinary wet treatment. Dipped in formalin solution 1-320 5 mins.—covered 2 hrs.	"	Badly rusted	0·0

From these experiments it was evident that the solution was of no value whatever for the control of rust, and though it reduced the amount of smut somewhat, it could not be recommended for seed treatment for the control of smut.

EXPERIMENT TO DETERMINE THE EFFECT OF STEM RUST ON DIFFERENT VARIETIES OF WHEAT AND EMMER

ALSO TO DETERMINE THE BIOLOGIC FORMS THAT WILL DEVELOP UNDER VARYING CONDITIONS

An experiment was carried out in co-operation with a number of the Dominion Experimental Stations in Western Canada, and the Field Husbandry Departments of the Universities of Manitoba and Alberta.

An outline of the experiment is given below:—

Durum	Common Wheat (Spring)	Emmer
Kubanka, C.I. 1440	Marquis, Ottawa 15	White Spring, C.I. 3686
" " 2094	Power, C.I. 3697	Khapli C.I. 4013
" " 4063	Preston, C.I. 3081	
Kubanka, Ottawa A	Haynes, C.I. 2874	
Arnautka, C.I. 4064	Prelude, Ottawa 135	
" " 6236	Early Red Fife, Ottawa 16	
Mindum, C.I. 5296	Ruby, Ottawa 623	
Acme, C.I. 5284	Red Bobs	
Monad, C.I. 3320	Kubanka x Haynes, C.I. 4788	
D.-5....C.I. 3322	Kubanka x Preston, C.I. 4789	
	Kota, C.I. 5878	

The plan of the experiment was to grow one row of each variety, 16 feet in length.

The seed was supplied in weighed packets ready for sowing. A member of the Division of Botany visited each of the stations to inspect experiments and to take notes on the percentage of rust, and to collect rust for greenhouse studies.

The rows were inspected and the percentage of rust estimated by Miss Margaret Newton, of the Dominion Laboratory of Plant Pathology at Saskatoon.

Two sowings were made at Saskatoon and Indian Head, about two weeks apart. The yield of the middle row of each variety was also noted at these stations.

The results of these experiments at the various stations are appended in tabular form.

Of the durums, Acme and Monad showed a considerable resistance.

D.-5, a red durum, showed marked resistance at all the stations.

Iumillo, a selection from the durum Iumillo, made by Prof. W. P. Thompson of Saskatchewan University, was sown at Saskatoon and Indian Head and remained altogether free from rust.

Of the common wheats, Kota was the only one that showed resistance.

White Spring Emmer was practically free from rust at all the stations, though rusting heavily in Saskatoon in 1919. The strain of rust attacking Emmer was late in appearing in 1920. As the most common and widespread strain of rust in Western Canada infects rather heavily all of the varieties of spring wheat used in the experiments, little else of value as regards the presence of strains could be learned from the experiment by field observations, but collections of rust from the rows at various stations were made and are being studied in the greenhouse.

LIST OF STATIONS AND COLLABORATORS

Dominion Experimental Farm, Morden, Man.—E. M. Straight, Superintendent.

Manitoba Agricultural College, Winnipeg, Man.—T. J. Harrison, Professor of Field Husbandry.

Dominion Experimental Farm, Brandon, Man.—W. C. McKillican, Superintendent.

Dominion Experimental Farm, Indian Head, Sask.—N. D. MacKenzie, Superintendent; D. L. Bailey, Pathologist.

University of Saskatchewan, (Dominion Laboratory), Saskatoon, Sask.—W. P. Fraser, Pathologist; M. Newton, Pathologist.
Dominion Experimental Farm, Rosthern, Sask.—W. A. Munro, Superintendent.
Dominion Experimental Farm, Scott, Sask.—M. J. Tinline, Superintendent.
University of Alberta, Edmonton, Alta.—G. H. Cutler, Professor of Field Husbandry.

THE RESULTS OF THE EXPERIMENT, SASKATOON

Class and variety	C.I. No.	Stem-rust infection, per cent			Yield per acre, bushels		
		First sowing	Second sowing	Average	First sowing	Second sowing	Average
DURUM		May 11	May 25		May 11	May 25	
Kubanka	1440	10	30	20·0	24·6	31·6	28·1
Kubanka	2094	10	.....	.....	30·0	.....	.....
Kubanka	4063	15	30	22·5	36·2	52·0	44·1
Arnautka	4064	10	30	20·0	33·0	46·0	39·5
Arnautka	6263	7	.....	.....	27·8	.....	.....
Mindum	5296	6	10	8·0	39·7	44·4	42·0
Acme	5284	3	7	5·0	22·0	41·6	31·8
Monad	3320	3	7	5·0	24·5	44·2	34·3
D.-5	3322	1	3	2·0	20·4	28·9	24·6
COMMON							
Marquis	0·15	20	25	22·5	26·3	x	.....
Power	3697	20	40	30·0	36·1	25·0	30·5
Preston	3081	25	35	30·0	23·6	25·0	24·3
Haynes	2874	25	40	32·5	25·0	27·7	26·3
Prelude	0·135	25	35	30·0	.....	.....	.....
Ruby	0·623	20	.....	.....	18·5	x	.....
Kub. x Haynes	4788	20	40	30·0	28·3	35·8	32·0
Kub. x Preston	4789	25	35	30·0	27·4	45·0	36·2
Kota	5878	3	1	2·0	20·0	31·3	25·6
EMMER							
White Spring	3686	0	0	0·0	342 gms.	.....	.....
Khapli	4013	1	1	1·0	182 gms.		.....
Additional: DURUM		May 11	May 25				
Kubanka	A.	10	40	25·0	26·5	46·7	36·6
Iumillo	.....	0	0	0·0	33·2	.....	.....
COMMON							
Red Bobs	.....	20	15	17·5	20·8	x	.....
Early Red Fife	0·16	20	.....	.....	27·3	.....	.....

x Destroyed by sparrows.

RESULTS OF EXPERIMENT AT INDIAN HEAD

Class and variety	C.I. No.	Stem-rust infection, per cent			Yield per acre bushels		
		First sowing	Second sowing	Average	First sowing	Second sowing	Average
DURUM		May 15	May 28				
Kubanka	1440	35	40	37·5	42·5	.....	.....
Kubanka	2094	35	.....	.....	54·6	.....	.....
Kubanka	4063	40	40	40·0	47·2	.....	.....
Arnautka	4064	35	35	35·0	43·0	.....	.....
Arnautka	6236	40	.....	.....	54·5	.....	.....
Mindum	5296	35	35	35·0	45·6	.....	.....
Acme	5284	15	25	20·0	49·9	.....	.....
Monad	3320	15	25	20·0	46·0	.....	.....
D.-5	3322	3	3	3·0	53·6	.....	.....
COMMON							
Marquis	0·15	45	50	47·5	46·6	.....	.....
Power	3697	40	65	52·5	43·9	.....	.....
Preston	3081	45	65	55·0	30·0	34·7	32·3
Haynes	2874	35	55	45·0	26·6	25·0	25·8
Prelude	0·135	40	55	47·5	x	.....	.....
Ruby	0·623	45	65	55·0	38·7	.....	.....
Kub. x Haynes	4788	40	65	52·5	53·1	.....	.....
Kub. x Preston	4789	40	65	52·5	47·1	.....	.....
Kota	5878	30	35	32·5	36·1	.....	.....
EMMER							
White Spring	3686	1	1	1·0	588 gms.	.....	.....
Khapli	4013	1	1	1·0	502 gms.	.....	.....
Additional:— DURUM		May 15	May 28				
Kubanka	A	50	45	47·5	53·8	.....	.....
Iumillo	.....	0	0	0·0	52·6	.....	.....
COMMON							
Red Bobs	.....	50	65	57·5	36·9	.....	.....
Early Red Fife	0·16	50	65	57·5	32·6	.....	.....

xDestroyed by sparrows.

RESULTS OF THE EXPERIMENT AT THE VARIOUS EXPERIMENTAL STATIONS AND UNIVERSITIES

Experimental Stations	Date sown, May, 1920	Date examined, 1920	Kubanka, 1440	Kubanka, 2094	Kubanka, 4063	Kubanka, Ottawa A.	Arnautka, 4064	Arnautka, 6236	Mindum, 5296	Acme, 5284	Monad, 3320	D.-5, 3322	Marquis, Ottawa 15	Power, 3697	Preston, 3081	Haynes, 2874	Prelude, Ottawa 135	Ruby, Ottawa 623	Kub. x Haynes, 4788	Kub. x Preston, 4789	Kota, 5878	Red Bobs	Early Red Fife, 0-16	White Spring, Emmer, 3686	Khapli, 4013
Morden	....	Aug. 27	25	25	30	40	35	35	35	7	7	1	50	50	65	50	50	50	40	50	40	75	75	2	1
Winnipeg	....	Aug. 26	40	40	40	50	50	50	50	25	25	3	50	50	75	65	55	65	55	65	40	65	75	2	1
Brandon	19	Aug. 28	40	50	40	50	50	....	50	30	25	3	50	50	65	65	65	65	50	65	50	65	65	3	1
Indian Head	15	Aug. 30	35	35	40	50	35	40	35	15	15	3	45	40	45	35	40	45	40	40	30	50	50	1	1
	20	Aug. 30	40	....	40	45	35	....	35	25	25	3	50	65	65	55	55	65	65	65	35	65	65	1	1
Saskatoon	11	Aug. 14	10	10	15	10	10	7	6	3	3	1	20	20	25	25	25	20	20	25	3	20	20	0	1
	25	Sept. 6	30	....	30	40	30	....	10	7	7	3	25	40	35	40	35	....	40	35	1	25	....	0	1
Scott	20	Aug. 10	2	2	3	2	1	1	0	0	1	0	10	8	20	15	20	15	8	8	1	15	15	1	1
Edmonton	29	Sept. 8	8	10	10	5	10	10	2	1	1	0	15	15	25	25	8	8	8	8	1	15	25	0	1
Rosthern	22	Sept. 2	35	40	45	45	40	35	10	7	7	1	25	40	35	75	35	35	50	40	3	35	40	1	1

In addition, a few varieties of wheat, crosses between Emmer and Common wheat, were tested for rust resistance in the field at Indian Head and Saskatoon. These varieties were supplied by Dr. C. E. Saunders. The numbers tested were 43 B, 44 A, 44 G, 45 B, 45 E, and 46 G. None of these varieties, however, showed any marked resistance to stem rust.

(This experiment was carried out in co-operation with the United States Department of Agriculture).

WESTERN RYE SMUT INVESTIGATION

PROJECT No. 1

The experiments to determine the life-history and method of control of smut on western rye grass were continued at Saskatoon and Indian Head. Two rows, about 30 feet long, were used in each treatment. The results of the experiments are tabulated below:—

	Per cent smut
Saskatoon—	
Commercial seed, no treatment	No smut
Commercial seed, dusted with last season's smut spores	23·3
Commercial seed, dusted with two years old smut spores	3·96
Commercial seed, dusted with smut spores, then treated with formalin (1-40)	No smut
Indian Head—	
Commercial seed, no treatment	Trace of smut
Commercial seed, dusted with last season's smut spores (no treatment)	12·5
Commercial seed, dusted with two years old smut spores	3.75
Commercial seed, dusted with smut spores, then treated with formalin	No smut

These experiments confirm the experiments carried on in 1918-19, and show that the smut is readily controlled by the ordinary formalin treatment. No injury to the seed was evident. These experiments also show that the spores remain viable for at least one year.

The smut was also studied in the Laboratory. Spores were found to germinate readily in sugar solution, sporidia being developed in abundance, indicating that this smut belongs to the seeding infection group.

The smut clearly belongs to the genus *Ustilago* and is close to *Ustilago bromivora* (Tul.) Fisch., which has only been reported on the genus *Bromus*. There do not seem to be any marked morphological differences from that species.

Dr. Clinton has tentatively named the species *Ustilago Agropyri*.

WINTERING OVER OF THE UREDOSPORES OF STEM RUST

PROJECT No. 2

The object of these experiments was to determine whether the uredospores of the stem rust on cereals survive the winter on cereals or grasses.

Many collections of stem rust were made on grasses known to be susceptible, as *Hordeum jubatum, Agropyron tenerum,* and on wheat straw that had been exposed to the weather during the winter. These collections were made at Saskatoon, Indian Head, and other places.

A collection of stem rust on *Agropyron tenerum* on March 8 gave two per cent to six per cent germination. Later collections showed no germination. Collections on wheat and *Hordeum jubatum* and other grasses did not germinate.

The results confirm experiments of previous years and indicate the uredospores may live over on grasses. There is no field evidence, however, to show that spring infection comes from this source, as will be seen from the experiments described under "First Appearance of Stem Rust."

SEED TREATMENT OF CEREALS BY THE DRY METHOD

PROJECT No. 5

To determine whether the dry method for smut control is safe and effective in comparison with the ordinary wet method.

Place of experiments—Indian Head.

Date of seeding—May 17, 1920.

Area of plots—400 square feet.

Solution—One part 40 per cent formalin (tested), one part water.

Wheat—

Plot A.—Sprayed with atomizer at rate of 3ccm. per 2 quarts of grain—covered 5 hours.

" B.—As in "A," but four times amount of solution used.

" C.—Ordinary wet treatment with formalin (dipped in 1-320 formalin solution—covered 2 hours).

" D.—Check. No treatment.

RESULTS

Plot A.—No smut; germination reduced 50 per cent.

" B.—No smut; seed killed—only 20 plants appeared.

" C.—No smut; no seed injury evident.

" D.—Check. Per cent smut, 26.

Oats—

Plot A.—Sprayed with solution 3 ccm. per 2 quarts—covered 5 hours.

" B.—Sprayed with solution 9 ccm. per 2 quarts—covered 5 hours.

" C.—Ordinary wet treatment (dipped in formalin solution 1-320 5 mins.—covered 2 hours).

" D.—Check. No treatment.

RESULTS

Plot A.—No smut; no injury evident.

" B.—No smut; no seed injury evident.

" C.—Per cent smut, 1¼; no evident injury.

" D.—Check. No treatment. Smut per cent, 28.5.

Owing to a mistake, the amounts of solution used in Plots A were twice as much as recommended—i.e., 1 quart to 50 bushels of grain. Nevertheless, the experiment indicates that the dry method of seed treatment is likely to cause serious injury in the case of wheat.

While one and a quarter per cent of smut was present in the plot of oats treated by the ordinary wet method, yet it should not be taken to indicate that the method is not effective. In all other experiments with this method it gave perfect smut control.

FIRST APPEARANCE OF STEM RUST

PROJECT No. 6

Experiments were carried on to determine, if possible, date of the first appearance of the rust, how the rust passes the winter, and the origin of infection on wheat and cereals.

Field survey was made in many localities of susceptible grasses, cereals and grasses, during spring and early summer. Rust first appeared on barberries, and was

collected next on grasses in the vicinity of barberries. The next collections were on wheat, and the rust seemed to spread from wheat to grasses. There was no evidence whatever that the rust wintered on grasses and spread to wheat.

The first appearance of stem rust, and the locations, were as follows, in each case on wheat:—

June 30.—Winnipeg, two pustules only noted, reported by Dr. Bisby.
July 8.—Reported at Brandon by Conners.
" 9.—Two pustules observed at Weyburn, Sask., by Bailey.
" 10.—Two pustules on one leaf observed at Virden, Man., by Conners.
" 14.—Two pustules observed at Indian Head by Bailey.
" 15.—Two pustules observed at Yorkton, Sask., by Forbes.
" 31.—Reported at Prince Albert.
Aug. 2.—Reported at Saskatoon.
(Secondary infection in one place, so it probably appeared about ten days earlier.)
" 3.—Reported at Scott—a few pustules.
" 12.—Reported at Edmonton.

STRIPE DISEASE OF BARLEY

PROJECT No. 9

Experiments were carried on to determine the best means of control for the Stripe Disease of Barley, *Helminthosporium gramineum*. Badly diseased seed (obtained through the kindness of Mr. Milne, Acting Superintendent at Lacombe) was used in these experiments. Three varieties of barley were used. Size of plots for each variety about 200 square feet. Date of seeding, May 17:—

Variety	No. treatment Check	Hot water treatment at 52° c. Presoaking 4 hours	Formalin 1-320 5 minutes' dip	Formalin 1-320 Soak 2 hrs.
Manchurian.....	62·0	(hot water: 10 mins.) % of disease 17·6.	26·3	5·3
Odessa.....	57·0	(hot water: 15 mins.) % of disease 11.3.	26·0	4·6
Stella.....	56·3	(hot water: 12 mins.) % of disease 14·0.	27·0	6·6

It will be seen from the results that the soaking in formalin for two hours gives the most satisfactory control of the disease. No injury to germination was apparent, though no tests were made, and yield tests were not taken owing to a difficulty in harvesting.

STRAINS OF STEM RUST ON WHEAT

As the work on the strains of stem rust on wheat has not been carried far, it was thought advisable to give only a brief outline of these experiments.

As it has been shown by work done by Dr. Stakman that a number of well defined strains of the stem rust on wheat, *Puccinia graminis*, are present in the United States; as soon as greenhouse space was available experiments were begun to determine the different strains that might be present in Western Canada.

As the breeding of wheat for rust resistance seems the most hopeful means of combatting the rust, it was thought to be of much importance to get all the data

possible on the strains of rust occurring on wheat. Experiments to determine distribution, time of appearance and nature of the strains of rust present, were undertaken. The work was begun in January, 1920.

Through the kindness of Dr. Stakman of Minnesota Agricultural College, we were able to use the differential hosts which he found most satisfactory in his work. That is, a number of varieties of spring wheat and Emmer were found to re-act in different ways when inoculated with different collections of rust. These reactions were definite and consistent. Thus, by using a number of differential hosts we were able to separate a number of strains of rust in Canada.

Collections of stem rust were made in different places during the season of 1919. As little greenhouse space was available until January, it was not possible to keep many collections living until then. Collections, however, were made at the following places:—

In Manitoba.—At Winnipeg and Brandon.

In Saskatchewan.—At Carnoustie, Indian Head, Saltcoats, Leslie, Quill Lake, Howell, Saskatoon, Zealandia, Redberry Lake, Carlton, Shell Brook, Prince Albert, Melfort, and Riverstone.

In Alberta.—At Vermilion and Edmonton.

Four distinct strains were isolated, which, as they were similar to those isolated by Dr. Stakman, were designated by Roman numerals used by him.

No. XVII from collections at Saskatoon, Zealandia, Riverstone, Howell, Redberry Lake, Saltcoats and Carlton.
XVIII " " " Riverstone, Melfort, Zealandia and Leslie.
XXI " " " Winnipeg, Brandon and Edmonton.
IX " " " Saskatoon, Quill Lake and Melfort.

The location of the places where these collections were made can be seen from the accompanying map.

In the summer of 1920 collections were made from the three Prairie Provinces, an effort being made to obtain collections distributed over the whole wheat-growing area. In all 53 collections were made from the following places:—

In Manitoba from—			
Winnipeg	3 collections	Treesbank	1 collection
Morden	1 "	Brandon	2 "
Boissevain	1 "	Rapid City	1 "
Napinka	1 "	Dauphin	1 "
In Saskatchewan from—			
Carlyle	2 collections	Watrous	1 collection
Weyburn	1 "	Rosetown	1 "
Swift Current	1 "	Saskatoon	2 "
Moose Jaw	2 "	Rosthern	6 "
Regina	1 "	Scott	1 "
Indian Head	5 "	Melfort	1 "
Yorkton	1 "	Prince Albert	1 "
Govan	1 "	Shell Brook	1 "
Elbow	1 "	Mervin	2 "
In Alberta from—			
Macleod	1 collection	Edmonton	3 collections
Carstairs	1 "	Stettler	1 "
Lacombe	2 "	Camrose	1 "
Vermilion	1 "	Vegreville	2 "

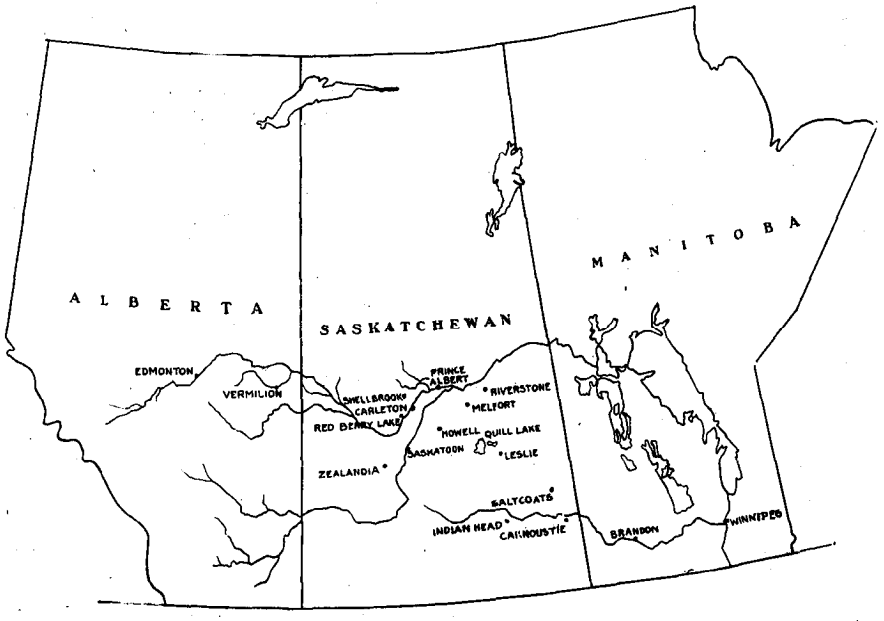
The work during the early part of 1920 was carried on chiefly by Mr. D. L. Bailey, and during the fall and winter of 1920 was carried on chiefly by Miss Margaret Newton.

It was held up during the early part of 1921 by the resignation of Miss Newton and the illness of the officer in charge.

By the end of the year the following strains were identified:—

Strain XVII at Indian Head, Winnipeg, Saskatoon, Napinka, Govan, Stettler and Dauphin.
XVIII " Weyburn and Yorkton.
IX " Edmonton.
XII " Indian Head.
XI " Rosthern.

The work shows clearly that strain XVII is much more common and much more widely distributed in 1919 and 1920 than the other strains. It was also present in greater abundance. It also appeared earlier in the season.



In 1919 strain IX was much more abundant at Saskatoon than in 1920, White Spring Emmer in the field being heavily rusted. In 1920 strain IX was late in appearing—it did not appear until nearly time of harvesting. This was indicated by the fact that White Spring Emmer, which is susceptible to strain IX, did not rust until very late in the season.

It is intended to determine as far as possible the collections made in 1920, and to carry on the work until further data are obtained on number, date of appearance, and relative prevalence in strains occurring on wheat in Western Canada.

BARBERRY AND BUCKTHORN SURVEY

Field survey was carried on during the summer by Mr. J. L. M. Macara, Plant Disease Investigator. Field work began on June 1 and ended on September 29. The survey was confined to the cities and towns.

The following places in Saskatchewan were surveyed and reported free from barberries and buckthorn: Arcola, Battleford, Carlyle, Craik, Davidson, Govan, Moosomin, Melfort, Nokomis, Qu'Appelle, Watrous, Whitewood, Wolseley.

The following places were surveyed, and barberries found: Rosthern, Prince Albert, North Battleford, Regina, Moose Jaw, Saskatoon.

In these places altogether fifty common barberries were located.

At the same time, field survey for buckthorn was made, and in some of the cities, especially Regina, a large number of hedges have been planted. Hedges or shrubs were reported from the following cities or towns: Rosthern, Regina, Moose Jaw, Sutherland, Saskatoon.

While the report on barberries and buckthorns is doubtless correct, as specimens were in nearly all cases collected and forwarded to the Laboratory, yet it is probable that some were overlooked. However, the survey has established that not many barberries or buckthorn have been planted in Western Canada except in some of the larger cities.

BARBERRY SURVEY IN MANITOBA, 1920

During the season 1920, Mr. J. L. Macara made a survey of the cities and the more important towns in the province of Manitoba for barberry. Concurrently with this survey observations were made on the prevalence and distribution of Japanese barberry and buckthorn.

No barberries were found in the following towns: Brandon, Boissevain, Carberry, Deloraine, Emerson, Gretna, Hartney, Minnedosa, Morden, Morris, Neepawa, Oak Lake, Plum Coulee, Portage la Prairie, Rapid City, Reston, Souris, Virden, Winkler.

Dr. Bisby, Plant Pathologist of the Manitoba Agricultural College, reported a few barberries at Melita. To the present this is the only occurrence reported outside of Winnipeg.

As an ornamental shrub, the common barberry has been used in Winnipeg. Twenty locations were reported on private property. The bushes were frequently heavily rusted. The public parks were either free from barberries, or have been cleared of them. The latter places will be inspected again to see that no fresh shoots have sprung up from old roots remaining in the soil.

Only one report of Japanese barberry was made. Doubtless a few others, especially in the parks, are to be found, but it indicates its relative scarcity.

The buckthorn, like the barberry, is mostly confined to Winnipeg. Here it is abundant. Many of the private grounds have hedges of this. In the parks the bushes are usually grown in clumps. The buckthorn was frequently rusted, especially in the parks.

ECONOMIC AND SYSTEMATIC BOTANY

JOHN ADAMS, M.A., *Botanist.*

During the past year many inquiries of the usual kind were received dealing with weeds and poisonous plants, medicinal plants, and wild rice. There were also various miscellaneous inquiries concerning broom corn, chicory, kapok, prickly pear, maté, arbutus, tarragon, willows used for baskets, use of milkweed cotton for textile purposes, plants used as food by muskrats and wild ducks, the culture of trees for rearing silkworms, etc.

The number of specimens sent in for identification and report on their properties amounted to 550. Among these was a white-fruited Juneberry received from Picture Butte, Alberta.

The Annual Exchange List of Seeds contained 511 species and was sent to various Botanical Gardens in the following countries: United States, Brazil, Argentine Republic, Uruguay, England, Scotland, Ireland, France, Switzerland, Italy, Czecho-Slovakia, Poland, Roumania, Germany, Belgium, Holland, Denmark, Sweden, Norway, Ceylon, Straits Settlements, Java, Japan, and Australia.

During the year 642 packets of seeds were received from various foreign Botanical Gardens as well as rooted plants of *Pinus bungeana* from Washington, D.C., and of *Taxus baccata* from Glasnevin Botanic Garden, Ireland.

Altogether 677 packets of seeds were sent out and 10 species of rooted plants or cuttings.

Experimental plots were again devoted to the culture of broom corn, sunflower, soy bean (four varieties), castor oil, and hemp. All of these ripened seeds satisfactorily but the growth of hemp was somewhat hindered by the attack of a fungus.

Some experiments were made to test the action of "Atlas A" Weed Killer on weeds growing on paths and on lawns. The spraying solution was diluted to a strength of 1 in 20 of water. The following weeds growing on roads in the Arboretum were killed by one application: Annual Meadow Grass (*Poa annua*), Knotweed (*Polygonum aviculare*), Purslane (*Portulaca oleracea*), Tumbling Pigweed (*Amaranthus graecizans*), Black Medick (*Medicago lupulina*). The stem and leaves of Field Bindweed (*Convolvulus arvensis*) were killed but the underground parts survived. Numerous seedlings of Silver Maple (*Acer saccharinum*) were also killed.

With regard to weeds growing among the grass on the lawn the leaves of Broad-leaved Plantain (*Plantago major*) and Mouse-ear Hawkweed (*Hieracium Pilosella*) were killed, while Dandelion (*Taraxacum officinale*), Mouse-ear Chickweed (*Cerastium vulgatum*), Thyme-leaved Speedwell (*Veronica serpyllifolia*) and Lady's Sorrel (*Oxalis corniculata*) were severely damaged by a single application. At the same time White Clover (*Trifolium repens*) was equally injured.

Tests were also made on Canada Thistle (*Cirsium arvense*) and Poison Ivy (*Rhus Toxicodendron*) with the result that the leaves were all killed.

A press article on "Oil-bearing Seeds" was published during the year and a physiological paper entitled "Relation of Flax to Varying Amounts of Light" appeared in the "Botanical Gazette" for August, 1920.