DOMINION OF CANADA
DEPARTMENT OF AGRICULTURE
DOMINION EXPERIMENTAL FARMS

DIVISION OF BOTANY

REPORT OF THE DOMINION BOTANIST

H. T. GÜSSOW

FOR THE YEAR 1922

Core rot in apple orchard—Affected fruits are discarded.
Photo: H. R. McLarty.

Printed by authority of the Hon. W. R. Motherwell, Minister of Agriculture, Ottawa, 1923

OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1923

DIVISION OF BOTANY

Report of the Dominion Botanist H. T. Güssow, for the Year, 1923

The present report furnishes an account of the work done by the members of the staff of the Central Laboratory, Ottawa, including such phases of work as relate to plant disease investigations carried on under the Destructive Insect and Pest Act appropriation, as well as the reports from Officers in charge of the branch laboratories.

A. CENTRAL LABORATORY

ECONOMIC AND GENERAL BOTANY

The present report covers the period from 1st April to 31st December, 1922. There were as usual enquiries concerning literature dealing with the flora of Canada, medicinal plants and markets for the same, eradication of weeds, poisonous plants, wild rice, and various other miscellaneous subjects. The total number of plants sent in for identification amounted to 714.

One of the weeds sent in for report was Buffalo Bur (*Solanum rostratum* Dunal). This was received towards the end of August from Salmon Arm, B.C., and appears to be the first record of its occurrence in that province. Its previous distribution in Canada will be found in "Seasonable Hints" for March, 1922.

Some serious cases of poisoning occurred during the year. The most distressing was that which happened on 4th May, 1922, at L'Orignal, Ont., when four children, the father, mother, and grandfather died before even ng the same day after having eaten for dinner the mashed roots of Water Hemlock (*Cicuta maculata* L.) in mistake for those of Garden Parsnip.

Cases of poisoning among live stock were also fairly frequent. At Shedden, Ont., nine cattle which had been pasturing on a field of sweet clover from 15th May to 8th June died between the 8th and 10th June. No apparent cause of death could be d.scovered and the presumption is that their deaths were caused by the sweet clover. In this connection, Prof. Ewart of Melbourne, Australia, writes "All the species of *Melilotus* contain Cumarin, a volatile, odoriferous principle, which, in excess, produces a disinclinat.on to locomotion, paralysis, and ultimately fatal symptoms. No harm is to be apprehended if the amount does not exceed 10 per cent of the herbage."

Several horses died at Arnprior, Ont., from apparent poisoning. They appear to have eaten considerable quantities of Water-pepper (*Polygonum*), and in view of the above occurrence this plant must be regarded as suspicious.

A farmer living at Hartington, Ont., forwarded a sample of Field Horsetail (*Equisetum arvense* L.) for report. He stated that a mare had died and he thought this plant was present in the hay she ate, as the symptoms pointed to poisoning.

Another farmer living at Petite Mascouche, Que., lost 5 cows and 2 horses through being poisoned by Water Hemlock.

Seeds were exchanged with the following Botanical Gardens: Trinity College, Dublin, Ireland; Edinburgh, Scotland; Kew, England; Goteborg, Sweden; Lund, Sweden; Upsala, Sweden; Berlin-Dahlem, Germany; Proskau, Germany; La Mortola, Italy; Palermo, Italy; Tunis, North Africa; Sydney, New South Wales; Montevideo, Uruguay; Buenos Ayres, Argentine Republic.

62007—1½

A quantity of seeds of Chile Beech (*Nothofagus obliqua* Blume) was received from Mr. H. R. Christie, Department of Forestry, University of British Columbia, Vancouver.

A number of seeds of Mexican Cypress (*Taxodium mucronatum* Tenore) the national tree of Mexico, were received from Professor Juan Balme, Mexico City.

Twelve young Osigian mulberry trees were received from the Osigian Silk Corporation of Canada, Hamilton, for the purpose of testing their hardiness in the climate of Ottawa. The roots were very dry when they arrived, consequently only about half of them made a good growth during the summer, producing shoots from one to three feet in length.

Nine species of Dogwood (*Cornus*) were sent to Paris, France, and a package of seeds of Basswood (*Tilia americana* L.) to Brussels, Belgium, to persons requesting the same for purposes of research.

Four sacks of cones of Norway Maple, Blue Spruce and European Larch were forwarded to the Berthierville Nursery, Quebec, in response to a request from the manager of the Provincial Forestry Institution.

In addition, a number of samples of wild rice seed, roots, and cuttings of various plants were sent to different persons in Canada.

Altogether, during the nine months, 396 packets of seeds were received and 351 packets of seeds were sent out.

The trials of soy bean and broom corn were continued. Three varieties of soy bean again produced a good crop of well-ripened seeds. As these varieties have now been tested for seven years at Ottawa with good results, there is no doubt that certain varieties of soy bean are well suited for cultivation in Canada.

The broom corn was the black-seeded variety experimented with in previous years. The average length of "brush" in fifteen of the best plants was 20 inches, a result not equal to that of previous years.

A small plot of Sesame (*Sesamum indicum L.*) was sown in the open. While the season was too short for the majority of the plants to ripen their seeds still a few were obtained for further experiment.

The planting of the plots devoted to the herbaceous species of the Canadian flora according to their families was continued. In addition, certain plots were devoted to special groups with similar climatic conditions, such as alpine plants, prairie plants, etc. Altogether, 120 plots have been laid out.

The experiments of a physiological nature on the relation of plants to various conditions of light were continued.

On the nights of October 19th, 20th, 21st the thermometer fell to 16°, 17°, 18°F respectfully. As many of the shrubs and trees in the Arboretum had not shed their leaves on these dates a favourable opportunity presented itself for making observations on the hardiness of certain species. An investigation made by the foreman on October 26th showed that the following species had the leaves still green or partially green:—

Amelanchier oblongifolia, Betula alba fastigiata, Betula dentata viscosa pyramidalis, Betula tristis, Carpinus Betulus, Colutea sp., Cytisus sp., Diervilla lutea, Euonymus europaeus, Ligustrum vulgare, Lonicera Morrowi, Lonicera segreziensis, Lonicera xylosteoides, Prunus Cerasus Rhexii, Prunus serotina asplenifolia, Prunus utahensis, Pyrus Aucuparia, Pyrus baccata, Pyrus prunifolia, Quercus Pseudo-aegilops, Quercus coccinea (one tree) *Rhamnus sp., Spiraea Aitchisoni, Spiraea arguta, Spiraea carpinifolia, Syringa vulgaris:* Fürst Liechtenstein, Madame Morel, Madame Casimir Perier; *Viburnum Lantana, Viburnum nepalense.*

DOMINION WEED SURVEY

With a view to extending the service which the Division has been able to offer to farmers in the matter of weed control, arrangements were effected late in the year whereby a member of the staff will devote a large portion of his time to inaugurating a more aggressive policy in regard to these problems. In furtherance of this object, farmers will be invited by questionnaire, through the press, or otherwise, to report to us what weeds are giving them most concern, and under what conditions they are proving troublesome. Besides giving us the point of contact with the farmer's problems which we need, these reports are expected to help us to make our recommendations more definite and applicable to individual cases than they can be from the meagre information usually conveyed to us in a letter.

For the benefit of the present reader who may wish to avail himself of this service, we reproduce herewith questions which cover the principal information dsired.

1. Which do you consider to be your worst weeds?
2. For what reasons do you count each of these among your worst?
3. In what crops or places is each weed troublesome?
4. What is the character of the soil?
5. Have you underdrainage or is land naturally well drained?
6. What rotation of crops, if any, do you follow?
7. What methods of control have you already tried?

Any weed not familiar by name, should be sent to us for identification. Parcels up to 12 ounces, and letters, addressed The Dominion Botanist, Central Experimental Farm, Ottawa, are postage free.

From the reports thus received and from every available source, our present knowledge of weed prevalence throughout Canada, and of the difficulties in each region standing in the way of control, will gradually be made more complete. Obscure points needing investigation will receive attention as they come up. Possible methods of bringing about community effort against easily-spread weeds, such as sow thistle and Russian thistle, will have to be tried, and the encouragement of better enforcement of provincial weed legislation may well be required in parts of Canada. In some localities the necessity of action against weeds is being well recognized, but in others indifference, or perhaps a feeling, that weeds are inevitable and to be accepted as a matter of course, prevents the taking of steps which would greatly lessen the evil.

It is not generally realized that the loss in Canada, due to weeds, in the way of reduced yields and increased cost of production, amounts to many millions of dollars annually. With a few persistent weeds, reduction of these losses may involve idleness of the land for a season, or expensive treatment, but it should always be recognized that most damage can be prevented by methods quite in line with the best farm practice, which also makes for satisfactory crops meanwhile. In short, clean farms are largely a matter of good farming, as one may see on any summer trip through the country.

FOREST PATHOLOGY

WHITE PINE BLISTER RUST

In Eastern Canada.—During the present season our knowledge of the distribution of rust was considerably extended. Previously this disease had been known to be present only in Ontario and Quebec, but it has now been recorded for Prince Edward Island, Nova Scotia, and New Brunswick. That is to say, blister rust is present in every province in which eastern white pine

occurs with the exception of Manitoba, where the amount of pine is negligible. In Prince Edward Island, which is a province almost entirely devoted to agriculture, rust was found on black currants at Charlottetown. As the amount of white pine occurring in the province is of slight importance from a commercial point of view, the chief damage which might result there from the presence of rust would be to trees planted for ornamental purposes. In Nova Scotia the disease was observed in several widely-separated localities, in each case upon black currants. These points were as follows—Kentville, Weymouth, Truro, River John, Nappan, Rockingham Station, and Pictou. The greater part of the remaining white pine in Nova Scotia occurs in Queen's and Shelburne counties, where rust has not as yet been found. In New Brunswick, rust was found at Little Shemogue in Westmorland county, also on black currants. Nova Scotia and New Brunswick contain approximately the same amount of white pine i.e. about half a billion feet. Apparently rust has not been present very long in the maritime provinces, though how it was introduced there is not yet clear. No infected pines have been found to date.

In Quebec, rust is more or less prevalent throughout that portion of the province lying south of the St. Lawrence and west of Quebec. It also occurs on the north shore betwen Quebec and Montreal and on farther west along the north shore of the Ottawa, probably as far as the district opposite the city of Ottawa. In Ontario, the disease is generally distributed throughout the southern part of the province north to a line joining the Muskoka district with Renfrew county. In the latter region especially there are valuable stands of young white pine. Rust has been present here for at least four years but as yet the pine stage of the disease has not been found. In southern Ontario the land is devoted mainly to agriculture and it may be said that there are now practically no commercial stands of white pine, though the amount contained in farmers' woodlots is probably considerable.

The feature which is of greatest moment as far as eastern Canada is concerned is the comparative abundance of the currant stage of the rust and the scarcity of the pine stage. In the Niagara peninsula, where the disease has been present for from thirteen to fifteen years and where there are large numbers of cultivated currants and gooseberries of all kinds, one would expect that conditions for dissemination and development would be very favourable. As a matter of fact, however, the results of a study continued over a period of four years show that an average of less than 2 per cent of the pines found in farmers' woodlots are affected. In this connection, though, it should be borne in mind that the district is an agricultural one and the amount of white pine which occurs there is small so that these figures are probably not indicative of what conditions might be in a district containing a large quantity of pine. As far as damage to pine on a large scale is concerned, such as occurs in the northeastern States, it may be safely said that this has not yet occurred anywhere in Eastern Canada.

Why it is that the percentage of infected pines is not greater in view of conditions obtaining in New York and in the New England States is not apparent, but the fact remains that rust has not yet established itself to any extent in areas containing merchantable quantities of white pine. It may be that it has not been present long enough in such districts to indicate what damage may result from its continued occurrence there or it may be that prevailing conditions—especially as regards temperature and moisture—are not as favourable to its development as are conditions elsewhere. In any case the logical course seems to be to continue to maintain a staff of men in the field each year who will keep a close check upon the progress of the disease and, if at any time it should be found to be developing upon a large scale, control measures could then be applied. Since this rust is not known to spread from

pine to pine, the eradication of the alternate host at any time would prevent the further spread of the fungus and confine the damage to those trees already infected.

During the month of May we were assisted in our field work by the Dominion Forestry Branch and by the Ontario Forestry Branch. Each of these services placed one man at our disposal to be used in the inspection of pines.

In British Columbia.—The purpose of our work in British Columbia this year was to determine the extent, degree, and, if possible, origin of the infection which had been found there during the previous autumn. For this work three full-time men were appointed by the Dominion, one full-time and one part-time man by the Forest Branch of the Provincial Government and, for observation purposes, members of the United States blister rust field staff were occasionally attached to our parties. Scouting was begun early in April, at which time, of course, only pines could be examined for evidence of disease. As the most likely manner in which infected trees might be located, inspection was carried out as follows:—

(1) Inspection of localities where infected pines had been found the previous autumn.

(2) Inspection of pines which had been imported into British Columbia between 1910 and 1914.

(3) Inspection of pines to be found in the nurseries throughout the Province.

(4) Inspection of pines near *Ribes* which had been diseased the previous year.

A small group of eastern white pines in Stanley Park, Vancouver, were known to have been infected with rust the preceding autumn and they were destroyed early this year. Inspection of Mr. Frank Burnett's grounds at Point Grey where there was a suspected case of infection on a specimen of Swiss stone pine (*Pinus Cembra*) showed that rust was not present there.

Between the years 1910, the earliest for which records were available, and 1914, when importation was prohibited by federal quarantine, there were about 1,350 five-leaved pines brought into British Columbia. While it was not possible to locate all of these owing to the length of time which had elapsed, the final disposition of the greater part of them was learned. Only one plantation of imported trees was found which contained diseased pines. This belonged to Mr. Thomas Newman who in 1910 imported 1,000 young white pines (*P. Strobus*) from France. At the time of inspection only 180 of these were still living. The others had succumbed either to the rust or lack of attention. Of the remaining trees one-third were infected. The oldest canker was found on the growth of 1910. It is very probable that rust was brought in on this shipment though there may have been other introductions.

In the various nurseries of the province very little white pine stock was found and it was all free from rust.

The inspection of pines located near *Ribes* which were known to have been diseased the previous year was the line of investigation most productive of results. On April 29, pine infection was first found. This was in the arboretum of the provincial university at Point Grey where a young western white pine (*P. monticola*) and a small white barked pine (*P. albicaulis*) were found to be infected. Shortly afterward many infected native white pines were located in North Vancouver and, in fact, in all localities where *Ribes* had been diseased previously. In this way and later by scouting for the rust on *Ribes* the distribution of the disease upon the coast was fairly well defined. With Vancouver as a centre it was found to occur as follows—northwest along the coast for about 140 miles to Loughborough Inlet and to Bute Inlet, north along the

route of the Pacific Great Eastern Railway for about 100 miles, east up the Fraser Valley to Hope about 90 miles, and south to within a mile of the international boundary. Rust was also found at several points on Vancouver Island, notably at Qualicum Beach. Along these several lines the disease was practically continuous in its mode of occurrence and throughout both hosts were found affected, usually in close association.

From observations made during the season, it would appear that the western white pine is even more susceptible to rust than is the eastern species. At Daisy Lake on the Pacific Great Eastern Railway rust is very prevalent and many trees have died as the result of infection. The majority of infections date only from 1916 and in many cases death has resulted from numerous twig infections which have caused complete defoliation and subsequent death of the tree before the production of æcidia.

Late in May, some preliminary inspection of pines was done in the interior around Revelstoke, without finding any rust however, and this, together with the fact that nothing had been found farther south in the Kootenay country the previous autumn, led us to believe that the interior of the province was free from disease. On July 28, though, infection was found at two points—at Revelstoke and at Beaton near the upper end of the Arrow Lakes. Intensive scouting was immediately begun in this district and as a result a good deal of rust was located. A hopeful feature of the situation is that the disease has apparently not been present in this region for more than six years and that altogether only 14 cases of pine infection were found. One of these was at Revelstoke, six at Beaton and seven at Canoe. These trees were all destroyed. Inspection of cultivated black currants showed rust to be present at Notch Hill, 80 miles west of Revelstoke along the Canadian Pacific Railway, and at several intervening points viz. Taft, Craigellachie, Malakwa, Solsqua, Sicamous, Canoe, Salmon Arm, and Tappen.

Between Sicamous and Vernon, rust was found at Mara, Grindrod and Enderby. Southeast from Enderby, infection was found to within four miles of Mabel Lake and also southwest of Mabel Lake near Lumby. At Arrowhead, ten miles from Beaton, and at Sidmouth between Arrowhead and Revelstoke. the disease was also located. Although considerable inspection of wild *Ribes* was done in this district, only one plant was found infected. This was *Ribes lacustre*, observed by Dr. L. H. Pennington at Beaton. This indicates that the disease is as yet largely confined to cultivated black currants.

As pointed out in the report for last year, white pine is a tree of minor importance in British Columbia. The total stand is estimated at 2.7 billion feet or about four-fifths of 1 per cent of the total amount of timber in the province. In view of conditions in regard to rust upon the coast as revealed by the work of this year, and having in mind the relative unimportance of white pine, it would not be a suond economic policy to expend money in controlling the disease there by the eradication of *Ribes*, both wild and cultivated. Moreover, in certain sections it would likely be found that the value of cultivated currants and gooseberries exceeded that of white pine in the same area. The greater part of the white pine occurs in the Kootenay county and, if this could be protected at small cost, it would probably be worth while to do so. Since rust has apparently been present but a short time in this part of the province infection may still be localized. If the work to be done during the coming year shows this to be the case, the question of the eradication of the cultivated black currant, which would undoubtedly check the progress of the rust greatly, will be carefully considered.

For the purpose of studying relative susceptibility to rust, an experimental plot is being established at Daisy lake. Here all species of *Ribes* and of five-

leaved pines occurring in the province will be grown and the effects of the fungus upon the various hosts noted. The location is a very favourable one for this purpose as some of the heaviest infections found are located here.

In carrying out our programme of scouting this year, valuable assistance was given to members of our field staff by several agencies, and it is desired to acknowledge this aid here. The officials of the Air Board stationed at the Jericho Beach Air Station at Vancouver saved our staff much time by extending to them the use of their flying boats. As a means of rapid transportation and of reaching points difficult of access by ordinary means of travel, this assistance was invaluable. Without this co-operation there can be no doubt that our small staff of men could not have determined the distribution of rust upon the coast nearly as accurately as they did. In addition to appointing two men to work under the direction of our officer-in-charge, the Forest Branch of the provincial government helped us greatly in other ways. Their forest rangers were informed of the nature of the work and in several cases they reported infection. Our men were also accorded the use of motor patrol boats, both on the coast and in inland waters, and of railway speeder patrols. Further, the Forest Branch placed a motor car at the disposal of our officer-in-charge. The Dominion Forestry Branch instructed its rangers located in the Railway Belt to keep a watch for rust and to help our men in every way possible. Mr. J. W. Eastham, Provincial Plant Pathologist, assisted materially with the work of scouting and also did some publicity work in regard to this disease. Horticultural inspectors were instructed to co-operate with our staff in any way possible. The management of the Pacific Great Eastern Railway placed transportation facilities at the disposal of our men and certain of the daily newspapers did excellent work in recording the activities and aims of our field staff. Many people whose interest had been aroused through reading such blister rust news items, made further inquiries and several sent in specimens of the disease.

ROOT ASPHYXIATION

(Fig. 1)

In order that the roots of trees, and of other plants as well, may function properly it is essential that there be an abundant supply of oxygen present in the surrounding soil. Oxygen is necessary for growth and for the formation of reserve food material in the roots. Further, nitrogen fixation cannot take place in soils which are deficient in this gas. Whenever this condition occurs to a marked degree, then the roots cease to function normally and as a consequence disease and often death follow. Poor aeration of the soil may be due to flooding with water, the presence of hard pan at a short distance below the surface of the ground, the presence of paving material about the base of the tree, or to raising the ground level beneath the tree by the addition of earth.

The death of trees due to the latter two causes is not infrequent in our cities. The accompanying figure illustrates how this may occur. In opening up a new street in that part of Ottawa near the Experimental Farm it was necessary to cross a small swamp and, in order to do so, a good deal of filling in had to be done. In the course of this work, earth was built up to a height of several feet around several larch trees which happened to be situated on the line of the new street. This was done during the summer of 1921, and a year later these trees were dead—clearly as a result of root asphyxiation. A similar case has been observed upon the Driveway. Not far from Bank Street, earth has been built up about the base of a large white pine and there is now a beautiful grassy knoll

about forty square feet in extent and from two to three feet in depth beneath the tree. This result, however, has been gained at the expense of the life of the tree, the roots of which were effectually suffocated in this way.

FIG. 1.—Death of trees due to root asphyxiation.
Photo H. T. Güssow.

IRIS RHIZOME ROT

During the summer of 1922, some investigations into the nature of the iris rhizome rot were undertaken by Mr. F. L. Drayton, Plant Pathologist at the Central Laboratory. Owing to the interest taken by iris growers, his results are herewith recorded.

SYMPTOMS OF THE DISEASE

In the spring, the leaves begin to turn yellow at the tips; water-soaked, translucent areas appear at their base; followed by a rapid breakdown of tissues; the affected leaves finally falling over. On examining the rhizome of a diseased plant, there will be found decay, turning the substance into a slimy mass with an offensive odour. The disease may also appear in the fall after heavy rains. These infections may be slight, the lesions may dry up and be difficult to detect in dry rhizomes offered for sale, but the organisms present will become active the following spring and gradually destroy the plant.

CONDITIONS FAVOURABLE TO THE DISEASE

An excess of water in the tissues apparently renders the plant more susceptible, the disease being worst after spells of rain and cloudy weather, abating in hot, dry weather; lack of sunshine being markedly favourable to the disease. Erwin F. Smith reports this disease serious in one garden in shaded parts and absent in clumps of the same variety exposed fully to the sun.

The presence of decaying vegetable matter in the soil, brought about by the use of barnyard manure as a fertilizer or mulch, seems to supply the best medium for the causal organisms and favours the spread of the disease.

CAUSAL ORGANISM

The organism associated with diseased material was isolated and artificial inoculations with this, both in the rhizome and the lower portions of the stem, produced the typical decay. This organism proved to be identical with that described by L. R. Jones as the cause of a soft rot of carrots and other vegetables, named *Bacillus carotovorus,* and later proved to be the cause of the iris rhizome rot. Briefly, it is rod-shaped, 8μ by 2μ, non-capsulate, non-sporiferous and actively motile. The bacilli are very sensitive to dry air and sunlight, an exposure of ten minutes to direct sunlight or two hours to diffuse sunlight being sufficient to kill them. They are quite resistant to frost.

CONTROL MEASURES

The following recommendations for the control of this disease are suggested:—

1. Avoid injury to the plants by cultivating or other tools.
2. Carefully avoid the transference of soil from infected to uninfected beds.
3. Land in which soft-rotted carrots, turnips, radishes, or celery have been grown should be avoided for iris culture.
4. Diseased material of the above vegetables or iris should not be placed on a compost heap, but burned.
5. In the early stages of decay, a plant may be saved by cutting away diseased tissues to a point well within the healthy area, and then disinfecting the rhizome in a solution of potassium permanganate, one teaspoonful to a quart of water, and replanting in clean soil.
6. Use land which receives maximum sunlight and is well drained. Where irrigation is practised, the supply of water should be limited.
7. Barnyard manure as a fertilizer or mulch should be avoided. Acid phosphate, bone meal, or gypsum should be used for fertilization, with occasional light dressings of water-slacked lime or ground limestone in the fall.
8. Newly-purchased plants should be carefully examined for signs of rot. As a further precaution, new plants might be isolated by growing them for a season in six- or eight-inch pots to verify their freedom from the disease.

NITRO-CULTURES FOR LEGUMINOUS CROPS

Distribution of nitro-cultures was commenced by this division in 1915; since then, the number of requests for the cultures has steadily increased until in 1922 the total number sent out was 3,750. The following table shows their distribution:—

Prince Edward Island	84
Nova Scotia	401
New Brunswick	168
Quebec	400
Ontario	1,183
Manitoba	56
Saskatchewan	404
Alberta	463
British Columbia	586
Barbados, West Indies	2
New York State	2
Newfoundland	1
	3,750

Directions for use, as well as report forms, are sent out together with the cultures.

PHYTOPATHOLOGICAL NOTES

Club Root, caused by *Plasmodiophora Brassicae Wor.*

Interesting specimens of this disease on cauliflower plants were sent in from Outremont, Que. The proliferations of the stems just below the level of the ground were surprisingly extensive.

Flax Rust, caused by *Melampsora Lini* Bolley.

While not extensive in its occurrence, this disease, when present, greatly deteriorates the quality of the fibre. Transverse and longitudinal sections of diseased stems reveal the invasion of the fungus, resulting in a loosening of the epidermis from the wood. The bast fibres are most strongly attacked, becoming smaller and crowded together, the cavity in the fibres being often invisible on account of the collapsing of the walls. The cortex also shows fungus invasion with the production of giant cells. The fibres thus attacked become quite worthless. Brown spots which sometimes appear on the fibre have been shown to be caused by the rust mycelial growth, which protects the fibre from pectin and cellulose solution by the organisms in the retting process.

Eel worm on Carrot, Heterodera radicicola (fig. 2.)

Specimens of carrots badly infected with eel worms were sent in by the Division of Horticulture for examination. The history of the field from which they were taken shows that they followed a crop of tomatoes which had been also badly affected.

Root Rot of Sunflowers, caused by *Selerotinia* sp. probably *libertiana* (fig. 3.)

This disease occasions severe losses, especially in sunflowers grown for seed. In the cereal experiments, 45 per cent of the plants in a two-acre plot were affected and killed. This is, like other soil diseases, a difficult one to control, precautionary measures of rotation and destruction of diseased material being the only means of protecting the plants.

Potato Common Scab, caused by *Actinomyces scabies* (Thaxter) Güssow

Nine plots were laid out in a field known to be heavily infected with the scab organism, each plot being 100 square feet in area, with the object of testing the efficacy of sulphur and inoculated sulphur for the control of the scab. Three plots each, of a check, sulphur, and inoculated sulphur, were used and planted with Irish Cobbler seed. No improvement in the treated plots was obtained, approximately 60 per cent of scab being obtained from each plot. On digging the potatoes, a great deal of the sulphur was found in the soil quite unaltered after its season in the ground. This would seem to indicate that, at least in certain types of soil, the oxidation of the sulphur takes place very slowly, and that probably the applications should be made the previous season or at least the previous fall, so as to get any appreciable increase in the soil acidity, which is the factor looked for in the control of the scab.

DOMINION PLANT DISEASE SURVEY

The objects of a plant disease survey may be summarized as follows:—

(1) To determine the prevalence of plant diseases already known to science, and their relative importance within any area.

(2) To ascertain whether any areas are free from these diseases, in order that steps may be taken to prevent their introduction; to assist in the formulation of measures for their extermination from any area in which they may have become recently established, and to issue information to the farming public relating to their effective control when not widely prevalent in a locality.

FIG. 2.—Root nodules on carrot caused by eelworm.
Photo F. L. Drayton.

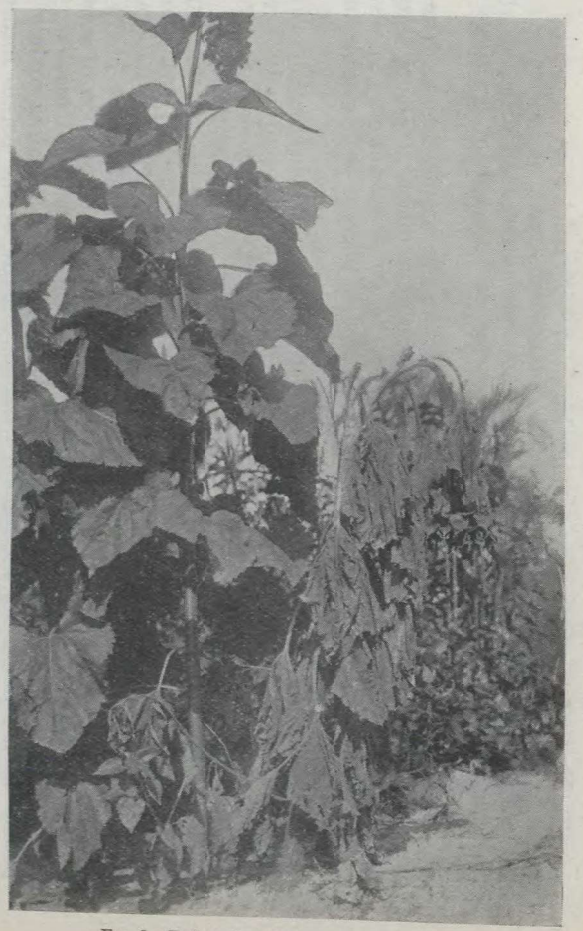


FIG. 3.—Dying of sunflowers due to root rot.
Photo F. L. Drayton.

(3) To provide means for keeping in touch with conditions generally, and particularly in regard to any disease not hitherto observed, or new to science, thus making it possible to have prompt attention directed to diseases which should essentially be kept out from certain areas, or be made subject to special researches.

It will be noted, the above merely constitutes the application to domestic conditions of legislative measures regulating the importation of plants through which diseases may be introduced from abroad, the aim being not only to prevent the introduction of diseases from abroad, but also to prevent their establishment and spread throughout the country.

With the objects as outlined in view, an annual plant disease survey was commenced in 1920 by the Division of Botany. In that year and in 1921, compilation of the field reports received from collaborators was undertaken by Dr. W. H. Rankin of the Dominion Field Laboratory of Plant Pathology, St. Catharines, Ont.; the compiled reports, which have proved to be valuable sources of information, being sent out in multigraphed form. Last year, owing to the resignation of Dr. Rankin, the work was transferred to the Central Laboratory of the Division of Botany at Ottawa and placed in the hands of Mr. F. L. Drayton, Plant Pathologist, who recently completed the compilation of a report for 1922, and who has also prepared the appended summary of results. This report contains 183 pages, including a section of 120 pages dealing mainly with potato disease percentages compiled from the reports of the potato inspection service by Mr. G. Partridge, Chief Plant Disease Inspector.

Owing to the present limited number of collaborators, it is not claimed that evidence contained in the report as to the amount of disease prevailing in any one place is necessarily conclusive. The same may be said with regard to diseases not observed or reported. It has, however, been the endeavour to render evidence as substantive as possible, and to this end, in addition to the whole staff of the Division of Botany acting as collaborators, the co-operation of workers outside the divisional staff has been solicited and generously forthcoming, valuable field reports having been received from British Columbia by Mr. J. W. Eastham, Provincial Plant Pathologist; from Alberta by Mr. G. E. Delong, Assistant to the Superintendent, Dominion Experimental Station, Lacombe; from Manitoba by Professor V. W. Jackson, Department of Botany, Manitoba Agricultural College; from Ontario by Dr. J. H. Faull, Professor of Botany, University of Toronto, Professor J. E. Howitt, and Dr. R. E. Stone, Department of Botany, Ontario Agricultural College, and Dr. W. T. MacClement, Professor of Botany, Queen's University; from Quebec by Dr. B. T. Dickson, Professor of Botany, Macdonald College, and Mr. J. G. Coulson, Macdonald College; and from Nova Scotia by Mr. A. Kelsall of the Dominion Entomological Branch, Annapolis Royal.

In the appended summary of results showing the distribution of diseases, their occurrence is indicated by the use in brackets of the first letters respectively of the various provinces wherein they were found to be present.

SUMMARY OF RESULTS

Cereal Diseases

Barley.....	*Helminthosporium gramineum* (Rab.) Erik.	(A., S., O., Q., M., P.E.I.)
	Helminthosporium teres, Sacc.	(A., S., M.)
	Puccinia graminis Pers.	(A., S., M., O., Q., P.E.I.)
	Rhynchosporium Secalis (Heins.) Davis	(A.)
	Ustilago Hordei (Pers.) K. & S.	(A., S., M., O., Q., P.E.I.)
	Ustilago nuda (Jens.) K. & S.	(A., S., M., O., Q., P.E.I.)

SUMMARY OF RESULTS—*Continued*

CEREAL DISEASES—*Concluded*

Oats	*Bacterium coronafaciens* Elliott (S.)
	Gibberella Saubinettii (Mont.) Sacc. (N.B.)
	Puccinia coronata Cda. (A., S., M., O., Q., N.B., P.E.I.)
	Puccinia graminis Pers. (A., S., M., O., Q., N.B., P.E.I.)
	Ustilago Avenae (Pers.) Jens.. } (A., S., M., O., Q., N.B., N.S., P.E.I.)
	Ustilago levis (K. & S.) Magn. }
Rye	*Claviceps purpurea* (Fr.) Tul. (A., S., M.)
	Puccinia dispersa E. & H. (A., S., M., O.)
	Puccinia graminis Pers. (M.)
Wheat	*Bacterium atrofaciens* McCulloch (A. S., M.)
	Claviceps purpurea (Fr.) Tul. (S., M., N.B.)
	Erysiphe graminis D.C. (S., P.E.I.)
	Gibberella Saubinettii (Mont.) Sacc. (S., M., N.B., P.E.I.)
	Helminthosporium sativum (P.) K. & B. (S.)
	Krinkle Joint (A., S.)
	Puccinia graminis Pers. (A., S., M., O., Q., N.B., N.S., P.E.I.)
	Puccinia triticina Eriks. (A., S., M., O., N.S., P.E.I.)
	Septoria nodorum Berk. (A., S., N.B.)
	Tilletia laevis Kuhn } (A., S., M., O., Q., P.E.I.)
	Tilletia Tritici (Bjerk.) Wint. }
	Ustilago Tritici (Pers.) Rostr. (A., S., M., O., Q., N.B., P.E.I.)

FORAGE AND FIBRE CROP DISEASES

Alfalfa	*Peronospora Trifoliorum* de Bary (M.)
	Pseudopeziza Medicaginis (Lib.) Sacc. (B.C., A., M., O., P.E.I.)
	Sclerotinia Trifoliorum Eriks. (B.C.)
Clovers	*Erysiphe Polygoni* D.C. (M., O., Q., N.B., N.S., P.E.I.)
	Mosaic (Q., N.B.)
	Phyllachora Trifolii (Pers.) Fcl. (M., Q.)
	Pseudopeziza Trifolii (Pers.) Fcl. (N.B.)
	Uromyces Trifolii (Pers.) Fcl. (A., S., M., P.E.I.)
Corn	*Puccinia Sorghi* Schw. (M., O.)
	Ustilago Zeae Schw. (M., O.)
Flax	*Fusarium Lini* Bolley (S., M.)
	Melampsora Lini D.C. (A., S., M., O., P.E.I.)
Grasses	*Claviceps purpurea* (Fr.) Tul. (S.)
	Puccinia Clematidis (D.C.) Lag. (M.)
	Puccinia glumarum (Shüm.) Er. & Hu. (A.)
	Puccinia graminis Pers. (S., A., M.)
	Ustilago Agropyri Clinton (A.)
Millet	*Sorosporium Syntherismae* (Peck) Farl. (S.)
Sunflower	*Erysiphe Cichoracearum* D.C. (M.)
	Puccinia Helianthi Schw. (S., M., O., Q.)
	Sclerotinia sp. (B.C., M., Q., O.)

FRUIT DISEASES

Apple	*Armillaria mellea* (Vahl.) Quel. (B.C.)
	Bacillus amylovorus (Burr.) Trev.. (B.C., O., P.E.I., N.S.. M.)
	Bitter pit (B.C., O.)
	Core rot (B.C.)
	Cylindrosporium Pomi Brooks (N.B.)
	Drought spot (B.C.)
	Gloeodes pomigena (Schw.) Colby (O., N.S.)
	Glomerella rufomaculans Spaul. & von Sch. (Q., N.B.)
	Nectria galligena Bres. (B.C., N.S.)
	Nectria sp. (N.B.)
	Neofabraea malicorticis (Cord.) Jack. (B.C.)
	Phyllosticta sp. (Q.)
	Physalospora Cydoniae Arn. (M., O., Q., N.B., N.S.)
	Podosphaera leucotricha (E. & E.) Salm. (B.C.)
	Sclerotinia cinerea (Bon.) Wor. (Q.)
	Stereum purpureum Pers. (N.B., M., O.)
	Venturia inaequalis (Cke.) Wint. (B.C., M., O., Q., N.S., N.B., P.E.I.)
	Winter injury (B.C.)

SUMMARY OF RESULTS—*Continued*

FRUIT DISEASES—*Concluded*

Apricot	Winter injury (B.C.)
Cherry	*Coccomyces sp.* (O., P.E.I., N.S.)
	Coryneum Beijerinckii Oud. (S.)
	Podosphaera Oxyacanthae (D.C.) de Bary (S., M.)
	Sclerotinia cinerea (Bon.) Wor. (B.C., S., M., O., P.E.I., N.S.)
	Taphrina Cerasi (Fcl.) Sad. (B.C.)
Currant	*Cronartium ribicola* F. de Wald (B.C., O., P.E.I., N.B.)
	Mycosphaerella Grossulariae Lag. } (B.C. S., O., P.E.I., M., N.S., A.)
	Pseudopeziza Ribis Kleb. }
	Puccinia Pringsheimiana Kleb. (S., P.E.I., A., N.S., O.)
	Sphaerotheca mors-uvae (Schw.) B. & C. (S.)
Gooseberry	*Mycosphaerella Grossulariae* Lag. } (B.C., P.E.I., N.S.)
	Pseudopeziza Ribis Kleb. }
	Puccinia Pringsheimiana Kleb. (M., Q.)
	Sphaerotheca mors-uvae (Schw.) B. & C. (B.C., N.S., P.E.I., O.)
Grape	*Cryptosporella viticola* (Red.) Shear. (O.)
	Guignardia Bidwellii (Ell.) V. & R. (O.)
	Plasmopara viticola (B. & C.) Berl. & de Toni (O., Q.)
	Uncinula necator Schw. (O.)
Peach	*Cladosporium carpophilum* Thüm. (O., B.C.)
	Sclerotinia cinerea (Bon.) Wor. (O.)
	Sphaerotheca pannosa (Wal.) Lev. (O., B.C.)
	Taphrina deformans (Fcl.) Tul. (B.C., O., N.S.)
	Yellows (O.)
Pear	*Bacillus amylovorus* (Burr.) de T. (B.C., O., N.S.)
	Bacillus tumefaciens E.F.S. (O.)
	Core rot (B.C.)
	Venturia pyrina Aderh. (O., B.C., P.E.I., N.S.)
Plum	*Coccomyces prunophorae* Higg. (O.)
	Dibotryon morbosum (Schw.) T. & S. (P.E.I., B.C., N.S., M.)
	Sclerotinia cinerea (Bon.) Wor. (B.C., M., O., Q., P.E.I., N.S.)
	Taphrina Pruni (Fcl.) Tul. (S., M., O., Q., N.S.)
Quince	*Fabraea maculata* (Lev.) Atk. (O.)
	Gymnosporangium sp. (O.)
Raspberry	*Acrostalagmus caulophagus* Law. (O.)
	Bacillus tumefaciens E.F.S. (O., B.C.)
	Gloeosporium venetum Speg. (O.)
	Leaf curl (O., P.E.I., N.S.)
	Mosaic (B.C., O., Q., P.E.I., N.S., M.)
	Mycosphaerella rubina (Pk.) Jacz. (O.)
	Winter injury (O.)
Strawberry	*Mollisia earliana* E. & E. (O.)
	Mycosphaerella Fragariae (Schw.) Lin. (S., O., Q., P.E.I., N.S., M., B.C.)
	Sphaerotheca Humuli (D.C.) Burr. (S., O., P.E.I.)

VEGETABLE AND FIELD CROP DISEASES

Asparagus	*Puccinia Asparagi* D.C. (N.B.)
	Rusty tips (N.B.)
Bean	*Colletotrichum Lindemuthianum* (S. & M.) B. & C. (B.C., M., Q., O., N.B., P.E.I., A., S.)
	Mosaic (Q., O., N.B., M.)
	Pseudomonas Phaseoli E.F.S. (S., M., Q., N.B., P.E.I., A.)
	Sclerotinia libertiana Fckl. (Q., N.B.)
	Uromyces appendiculatus (Pers.) Link. (N.B.)
Beet	*Actinomyces scabies* (Thax.) Güss. (N.B., O.)
	Cercospora beticola Sacc. (N.B.)
	Rhizoctonia (N.B.)
Cabbage	*Pseudomonas campestris* (Pamm.) E.F.S. (O., Q.)
Carrot	*Rhizoctonia* (N.B.)
	Sclerotinia libertiana Fckl. (N.B.)
Celery	*Bacillus carotovorus* Jones (N.B.)
	Cercospora Apii Fr. (O., N.B.)
	Septoria Petroselini Desm. (B.C., Q., O.)
Cucumber	*Bacillus tracheiphilus* E.F.S. (N.B., Q.)
	Colletotrichum lagenarium (Pers.) E. & H. (N.B.)
	Mosaic (N.B., O.)

SUMMARY OF RESULTS—*Continued*

VEGETABLE AND FIELD CROP DISEASES—*Concluded*

Lettuce	*Sclerotinia libertiana* Fckl. (N.B.)
Onions	*Botrytis Allii* Munn. (S.)
	Fusarium malli Taub. (Q.)
	Peronospora Schleideni Ung. (Q., O., B.C.)
	Urocystis Cepulae Frost (Q., M.)
Pea	*Erysiphe Polygom* D.C. (B.C., P.E.I.)
	Mosaic (Q.)
	Root rot (O.)
Pepper	Blossom end rot (B.C.)
Potato	*Phytophthora infestans* (Mont.) de Bary (B.C., Q., N.B., P.E.I., O., N.S.)
	Actinomyces scabies (Thax.) Güss. (A., M., O., Q., N.B., N.S., P.E.I.)
	Alternaria Solani (E. & M.) J. & G. (S., M., Q., N.B., O., N.S., P.E.I.)
	Corticium vagum Solani B. & C. (S., M., B.C., O., Q., N.B., N.S., P.E.I.)
	Tip Burn (M., Q., O., N.B., S.)
	Leaf Roll (M., Q., N.B., B.C., A., S., O., N.S., P.E.I.)
	Mosaic (M., Q., N.B., B.C., A., S., O., N.S., P.E.I.)
	Curly Dwarf (M.)
	Spindling Sprout (M.)
	Bacillus solanisaprus Har. (M., N.B., B.C., A., S., O., Q., N.S., P.E.I.)
	Fusarium oxysporum Schl. and *Verticillium albo-atrum* McA. (M., N.B., B.C., A., O., Q., P.E.I., N.S.)
	Net Necrosis (M.)
	Hollow heart (M.)
	Vermicularia sp. (Q.)
	Spindling Tuber (N.B.)
Rhubarb	Crown Rot (S.)
Tomato	*Alternaria Solani* (E. & M.) J. & G. (Q., N.B., O.)
	Blossom end rot (O., Q., B.C., M., S.)
	Cladosporium fulvum Cke. (N.B.)
	Colletotrichum phomoides (Sacc.) Chest. (N.B.)
	Mosaic (Q., N.B., P.E.I., O., M.)
	Phytophthora infestans (Mont.) de Bary (N.B.)
	Sclerotinia libertiana Fckl. (N.B.)
	Septoria Lycopersici Speg. (O., N.B., B.C., M.)
	Western Yellow Blight (B.C.)
Turnip	*Bacillus carotovorus* Jones (N.B.)
	Cystopus candidus (Pers.) Lev. (N.B.)
	Peronospora parasitica (Pers.) de Bary (N.B.)
	Plasmodiophora Brassicae Wor. (N.B., N.S., P.E.I.)
	Peronospora parasitica (Pers.) de Bary (N.B.)
	Storage rots (N.B.)

DISEASES OF ORNAMENTAL PLANTS

Aster	*Fusarium conglutinans* Wall. (O., M.)
	Sclerotinia libertiana Fckl. (N.B.)
	Yellows (O., N.B.)
Barberry	*Puccinia graminis* Pers. (M.)
Hollyhock	*Puccinia Malvacearum* Mont. (N.B.)
Honeysuckle	*Microsphaera Alni* (Wall.) Salm. (M.)
Iris	*Bacillus carotovorus* Jones (O., Q.)
Paeony	*Alternaria sp.* (Q.)
	Cladosporium sp. (Q.)
	Fusarium sp. (Q.)
	Septoria Paeoniae West *var. berolinensis* Allesch. (Q.)
Roses	*Phragmidium sp.* (M., O.)
Sweet Pea	*Bacillus Lathyri* M. & T. (Q.)
	Mosaic (Q.)

FOREST AND SHADE TREE DISEASES

Arbor Vitae	Red Branch (O., Q.)
Balsam	Butt and Heart Rots (O., Q.)
	Red Branch (O., Q.)
	Rusts (O., Q.)

SUMMARY OF RESULTS—*Concluded*

FOREST AND SHADE TREE DISEASES—*Concluded*

Butternut	*Gnomonia veneta* Kleb. (Q.)
Elm	*Dothidella Ulmi* Duv. (Q.)
Horse Chestnut	*Phyllosticta sphaeropsidea* E. & E. (Q.)
Maple	Wilt disease (O.)
Pines	Red Branch (O., Q.)
Poplar	*Melampsora Medusae* Thum. (M.)
	Uncinula Salicis (D.C.) Wint. (M.)
Spruce	Red Branch (O., Q.)
White Pine	*Peridermium Strobi* Kleb. (B.C., N.S., O.)
Willow	*Dothichiza populea* S. & B. (N.B.)

MYCOLOGICAL EXHIBIT

A strong feature of the Toronto Exhibition was the exhibit of the Central Experimental Farm in the Horticultural Building. A large collection of mushrooms was exhibited by the Division of Botany in co-operation with the members of the Mycological Society of Ontario, who supplied us daily with fresh specimens and without whose assistance we should surely have failed in our efforts. This exhibit proved a strong attraction from the beginning. From early morning till closing time throughout the whole fair, the exhibit was thronged with an eager crowd anxious to see the several varieties, but more particularly to learn how to distinguish between the poisonous and edible sorts. With a start of 64 varieties, the list increased till at the close it reached 94. Of these, only four or five were poisonous, the remainder edible. Four varieties new to this district were on exhibition.

Immediately following the Toronto exhibition, the Central Canada Fair at Ottawa, was held, where a similar exhibit attracted great interest. There cannot be any doubt that exhibiting poisonous as well as edible mushrooms to a large number of persons and explaining the distinctive features by which fungi may be recognized, will assist in educating the public to avoid fatal mistakes when using mushrooms collected by their own hands for food.

A most interesting, as well as exceedingly rare, specimen of fungus was sent us by Mr. J. Schmidt of Rossland, B.C., to whose painstaking efforts in collecting additional specimens we are indebted. The fungus was unknown to us, although the genus was recognized as *Pholiota*. On consulting mycological specialists in the United States, we finally were able to identify this interesting specimen. Because of the rare occurrence the fungus is herewith described in detail.

Pholiota aurea PERS. (Fig 4).—Pileus 5-10 c.m. broad, ochre to foxy golden yellow, surface granular; dusty, owing to the even-coloured, very dense and very minute flaky scales; dry; nearly hemispherical or bell-shaped, finally umbonate with a prominent umbo, often from the very beginning acute. The edge at first incurved, later flattened out and smooth, carries at times the ragged remains of the veil: firm and rather tough, fleshy towards the edge, gradually thinning. Stem 10-18 cm. long, 10-25 mm. ($\frac{3}{4}$-$1\frac{1}{4}$ in.) at middle, spongy stuffed, below as well as towards the exterior of the upright wide membranous annulus, covered with densely crowded granular floury or flaky foxy-yellow scales, which through low temperature are coloured brownish-red. These flakes occur on lighter coloured ground and are more or less persistent; above and towards the centre of the ring whitish to pale ochre, towards the tip covered with a faint white bloom, from the more or less bladderlike base (25-35 mm.) Gills almost free, or very slightly attached, narrow, thin, barely crowded, ochre creamish yellow, finally darker with entire even coloured edge. Flesh creamy pale yellow,

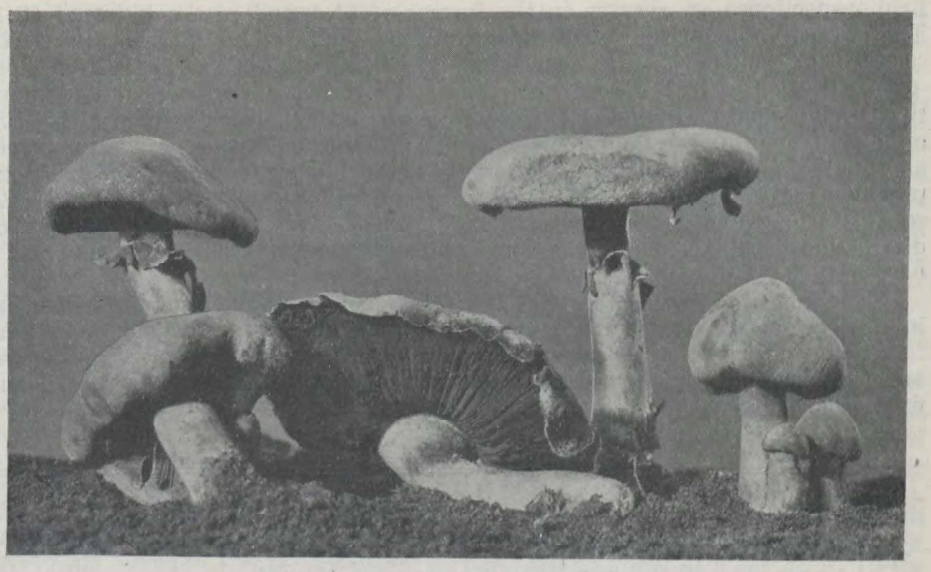


FIG. 4.—Pholiota aurea, a rare Canadian fungus.
Photo H. T. Güssow.

when exposed to the air slightly yellowing, mild, with weak odor; on the ground of deciduous and coniferous woods, never on stumps, more or less crowded, rare. Spores ferruginous, elongate, elliptical 10-15 by 4-6 μ, smooth. Basidia 28-32 by 7-9 μ, 4-spored. Cystidia absent.

POTATO INSPECTION AND CERTIFICATION

In reporting upon this work for 1921, reference was made to the steadily increasing number of potato growers who were evincing interest in the question of certified seed, and to the consequent improvement, in many districts, in the methods applied in potato growing, and the results obtained. During the past year a further increase was much in evidence, particularly in the Maritime Provinces.

In Prince Edward Island 2,367 acres were inspected, as compared with 963 acres in 1921—an increase of almost 250 per cent. Similarly, in New Brunswick 3,134 acres were inspected, as compared with 951 acres in 1921—an increase of 330 per cent. In the latter province, however, this increase was partly accounted for by the fact that in conjunction with the inspection for certified seed an inspection was made of all the fields entered in the Provincial Standing Field Crop Competition. Although such fields were primarily inspected in the interests of this competition, one of the conditions of entry provided that any grower whose field was found by the inspector to attain the standard for certified seed, should be entitled to submit his crop for certification. Unfortunately, the fields inspected for certified seed, and those inspected in the interests of the competition, were not separately listed in the field inspection reports, this making it impossible to compile the two records separately. This has had the effect of making the percentage of fields in New Brunswick passing the certification standard appear relatively low.

The total number of fields and acres inspected throughout the country, from Prince Edward Island to Alberta, inclusive, was 3,283 and 11,250, respectively. Of this number, 2,139 fields, containing 6,991 acres, passed the two

field inspections; an average in the former of 65·1 and in the latter of 62·1. The average amount of disease present in the fields which were accepted for certification, subject to tuber inspection, was: Blackleg, ·47 per cent; Leaf Roll, ·65 per cent; Mosaic, 1·06 per cent; Wilts, ·14 per cent. It will thus be apparent that, with a combined average of only 2·2 per cent of the four important diseases named, and presuming the diagnosis of conditions found to be as nearly correct as possible, the crops of the 6,991 acres in which these satisfactory conditions prevailed, should do much still further to enhance the status of the Canadian seed potato, provided well-organized facilities are available to have them introduced into localities where the introduction of better seed is found to be a necessity.

The following figures, compiled from the reports received from the inspectors in the various provinces, are quoted in order to show in detail the work performed, the distribution throughout the country of the four diseases named above, and the difference between the amount of disease present in fields passed and fields rejected:—

FIELD INSPECTION OF POTATOES, 1922

	Number fields inspected	Number acres inspected	Number fields passed	Number acres passed	Per cent fields passed	Per cent acres passed
Prince Edward Island	621	2,367	553	2,155	89·0	90·6
Nova Scotia (Garnet Chili)	125	235⅜	81	156¼	64·8	66·4
Nova Scotia (other varieties)	87	135¼	61	87⅞	70·1	64·8
New Brunswick	785	3,134¾	316	1,258¾	40·3	40·0
Quebec	682	2,360¾	526	1,956¾	77·1	82·6
Ontario (Southern)	136	327⅜	68	152½	50·0	46·5
Ontario (Northern)	148	231⅜	85	130⅛	57·4	56·3
Manitoba	191	976	113	533	59·2	54·6
Saskatchewan	282	844	207	385	73·4	45·6
Alberta	226	628½	129	176¾	57·1	28·1

PERCENTAGE OF DISEASES FOUND

		P.E.I.	N.S.	N.B.	Que.	Ont. S.	Ont. N.	Man.	Sask.	Alta.
Average per cent disease in total fields inspected	Blackleg	2·3	1·4	1·0	0·29	0·3	0·8	1·2	1·4	2·0
	Leaf Roll	0·39	1·9	0·36	0·26	2·2	0·9	2·3	0·6	0·3
	Mosaic	6·0	2·1	10·1	1·6	4·1	2·8	0·6	1·4	1·9
	Wilts	0·21	0·004	0·03	0·07	0·0	0·1	·0·17	0·05	1·4
Average per cent disease in fields passed	Blackleg	1·8	0·09	0·39	0·19	0·3	0·3	0·5	0·65	0·5
	Leaf Roll	0·36	0·48	0·31	0·24	1·0	0·7	1·2	0·37	0·2
	Mosaic	2·0	0·8	1·4	0·58	1·1	1·2	0·4	0·74	0·7
	Wilts	0·21	0·005	0·02	0·075	0·0	0·1	0·15	0·04	1·0
Average per cent disease in fields rejected	Blackleg	4·7	3·0	1·3	0·35	0·1	1·1	2·2	3·7	4·1
	Leaf Roll	0·54	3·4	0·42	0·52	3·1	1·0	3·5	1·2	0·4
	Mosaic	29·4	3·6	14·4	4·1	5·3	4·0	0·9	3·3	3·5
	Wilts	0·33	0·0	0·03	0·03	0·0	0·1	0·2	0·06	1·8

A study of these figures reveals the fact that Mosaic continues to be very prevalent and, particularly from Prince Edward Island to Ontario, more responsible than any other disease for the rejection of fields submitted for inspection. This will be still more evident when it is stated that of the 1,144 fields rejected, 484 were rejected owing to Mosaic, leaving 660 rejections attributable to all other causes. Deducting from this latter figure 375 rejections which were made owing to the presence of a too large percentage of foreign varieties, it will be seen that, even though the remaining rejections were attributable to one other disease alone, Mosaic would still be by far the greatest offender. The records, however, show that the remaining 285 rejections are divided between Blackleg, Leaf Roll and Wilts in the proportions of about 30 per cent, 40 per cent and 10 per cent respectively, the other 20 per cent being divided amongst other causes for rejection, such as Rhizoctonia, Late Blight, Early Blight, lack of vigour in seed, etc.

Up to the present, the formulation of standards for field and tuber inspection has been done annually, with such changes made in previous standards as experience seemed to warrant. By unanimous agreement among the members of a committee composed of Professor A. H. MacLennan, Mr. L. H. Newman, the Dominion Botanist, and the Chief Plant Disease Inspector, it is now proposed, commencing with next season, to adopt permanent standards, applicable to all inspections for certified seed. These, while not greatly varying from those previously adopted, make provision for the combination of Leaf Roll, Curly Dwarf, Crinkle, Spindling Sprout, and Streak, under the head of Leaf Roll, with a combined total tolerance of 6 per cent; the proposed field inspection standard being as follows:

FIELD INSPECTION STANDARD

	Per cent
Black leg	3
Leaf Roll (Curly Dwarf, etc.)	2
Mosaic	2
Wilts	3

Providing that in no case shall a total of more than 6 per cent be allowed.

The following is the standard proposed for tuber inspection:—

TUBER INSPECTION STANDARD

	Per cent
Bacterial Rot or Wilt	2
Late Blight and Dry Rot	3
Common Scab and Rhizoctonia—severe	5
Powdery Scab	1

Providing that in no case shall a total of more than 10 per cent be allowed.

Not more than 2 per cent of the tubers shall be off type or damaged by sunburn, cuts, cracks, bruises, insects, etc.

Not more than 5 per cent by weight of the tubers shall be below three ounces or above twelve ounces.

Late Blight, Early Blight, Tip Burn, and insect injury, are recorded in the field inspection report under the headings " Slight ", " Moderate ", and " Severe ". Since, generally speaking, these troubles may be, indeed should be kept from becoming severe by the frequent use of fungicides and insecticides, and since, in the case of the three latter troubles, a severe attack obviously affects the vitality of the crop—a severe attack of Late Blight being still more disastrous—any field severely affected by these troubles and so categorized in the field inspection report, is rejected.

A rather troublesome question which arises in connection with the maintenance of uniform standards is " What importance should be attached to

Rhizoctonia?" This trouble appears to be everywhere; in some parts to a negligible extent only, in other parts it is so severe in some years—as in Manitoba and parts of Saskatchewan and Alberta during the past year—that its effect upon the crop cannot be disregarded. Adjustment can, of course, be made in the application of the tuber inspection standard, in which 10 per cent is allowed, but the crops from some fields in the provinces referred to have been affected from 80 per cent to 100 per cent, which was a foregone conclusion, considering the conditions observed in these fields.

This trouble does not appear to be subject to control by seed treatment. It would therefore seem to be of importance that investigation of Rhizoctonia should be made from other standpoints, such as soil temperature, date of planting, date of digging, etc. In 1921 some evidence was obtained by Mr. Herbert Groh, supervisor of inspection for Manitoba, which indicated that a low percentage of Rhizoctonia was associated with immaturity of crop. This evidence was later supported by data secured through the courtesy of Dr. Bisby, at the Manitoba Agricultural College, from a series of tuber treatment experiments. Potatoes dug at successive dates, showed consistent increase of black scurf with each digging until the sixth, the seventh remaining practically the same at a figure so high as to leave little room for further increase.

During the fall and early winter, the usual inspection was made, as far as possible, of the crops from the fields which passed the two field inspections, as a result of which it was ascertained that approximately 440,000 bushels of certified seed were available. The tuber inspection will be renewed in the early spring, when it is estimated that 50,000 bushels will be added to the above amount.

A considerable quantity of certified seed was again sold in the United States and Bermuda. From Prince Edward Island alone, 70 carloads of Irish Cobblers went to Virginia, and from Nova Scotia about 7,000 barrels of certified seed of the Garnet Chili variety were shipped to Bermuda, while from New Brunswick, a number of carloads of Irish Cobblers and Green Mountains were contracted for by buyers in the United States. Certified seed of Canadian origin has established a favourable reputation in the United States, and it may be timely here to suggest to growers of certified seed, particularly those who are working with improved strains, that they never fail to retain sufficient seed each year for the following season's planting, in order that the favourable reputation referred to may be maintained. In other words, it is not a wise policy for a grower to allow his stock of good seed to become depleted, however favourable the market may be, for by so doing he runs the risk of having to use, for the following season, seed of a reputation less desirable than that which he has disposed of.

A staff of thirty-eight men was engaged in the work for varying periods during the year. Of this number, the services of nine men were lent by the following Provincial Departments of Agriculture: Prince Edward Island, 1; New Brunswick, 2; Quebec, 3; Ontario, 3. The co-operation of officials of the Departments of Agriculture in all the provinces again formed an outstanding and greatly appreciated feature of the year's activities.

Some difficulty and confusion has been experienced in the past owing to the lack of knowledge on the part of the growers desirous of purchasing "certified seed potatoes" of the appearance of the official certification tag issued in accordance with the regulations governing the inspection. In order that this difficulty and confusion may be as largely as possible obviated, an illustration

of the tag which is issued by the Department for the certification of seed potatoes, qualified to receive same, will be found below:

CERTIFIED SEED POTATOES

GRADE:

EXTRA No 1

VARIETY:

Certificate No......

Grower's No......

This tag is the only guarantee of the bona fide contents as government "certified" seed of any bag, barrel, or other container of potatoes to which it may be attached. It is therefore suggested to all interested buyers and growers that they acquaint themselves thoroughly with its wording and appearance.

B. BRANCH LABORATORIES

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

(J. B. MacCurry, *Plant Pathologist, Officer in Charge*)

The work of this laboratory during the past year consisted chiefly of experiments on the nature and control of the more important potato diseases. In addition, considerable time was devoted to extension work throughout the province and, during the autumn, exhibits of plant diseases were displayed at the fairs held at Charlottetown, Summerside, Georgetown, and Souris. A series of lectures on "Diseases of Field Crops" was given at the People's School, St. Francis Xavier College, Antigonish, N.S.

The plant disease survey which was conducted for the first time in Nova Scotia and Prince Edward Island in 1921, was continued in the latter province in 1922.

LATE BLIGHT AND ROT OF POTATOES

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

During the past eight years, experiments have been conducted at this laboratory with a view to ascertaining the most effective and most economical methods of controlling late blight and rot of potatoes. This very destructive disease occurs every year to a greater or lesser extent in the Maritime Provinces, although it was almost entirely absent from Prince Edward Island in 1921.

EXTENT OF LOSSES FROM BLIGHT FOR A PERIOD OF EIGHT YEARS IN PRINCE EDWARD ISLAND

	Per cent
1915. (remarkable blight free year)	1·2
1916	29·5
1917	15·6
1918	27·6
1919	44·5
1920	49·2
1921 (no blight occurred)	0·0
1922	16·5
Average for eight years	23·0

NOTE—Figures for 1922 show rot to December only.

EXPERIMENT TO TEST THE INFLUENCE OF NUMBER OF SPRAYS UPON AMOUNT OF ROT AND UPON YIELD, 1922

(Variety—Green Mountain)

(Average of Two Duplicate Plots)

Plot	Number of Sprays applied	Per cent rot—			Yield per acre in bush.
		In field	In cellar	Total	
1	1 2 3 4 5 6	2·5	0·0	2·5	341·4
2	1 2 3 4 5	2·7	1·9	4·6	393·0
3	1 2 3 4	4·5	10·6	15·1	396·0
4	Check	20·1	3·0	23·1	300·5
5	1 2 3	21·4	1·7	23·1	381·0
6	2 3 4 5 6	6·4	0·6	7·0	373·8
7	2 3 4 5	8·3	0·6	8·9	376·3
8	Check	11·6	0·6	12·2	343·7
9	2 3 4	6·3	0·3	6·6	377·4
10	3 4 5 6	10·0	1·7	11·7	341·0
11	3 4 5	7·4	1·3	8·7	326·3
12	Check	11·7	2·6	14·3	321·2

The season of 1922 impressed very clearly upon the potato growers the value of applying each spray at the required time, and the loss entailed through neglect to spray thoroughly. In many cases where certain of the sprays were omitted, the amount of rot which developed was considerable. The importance of spraying Irish Cobblers at least four times and Green Mountains six times was very evident. The best time to commence spraying in Prince Edward Island is the last week in July. If the foliage is heavy and remains green late in the season, an additional application should be given. The results obtained this year from spraying Green Mountains with Bordeaux mixture (4:4:40 strength), every two weeks, again show that losses from late blight can be reduced to a small percentage.

STRENGTH OF SPRAYS

During the past year the most promising results were obtained by increasing the strength of sprays from 4:4:40 (i.e. lime 4 lbs., sulphate of copper 4 lbs.,

and water 40 gals.). Not only was the amount of rot reduced but the yield was increased. Casein added to Bordeaux mixture, as a sticker, gave the next best results. Where the 8:8:40 strength of Bordeaux was used, a higher yield was obtained than with 2:2:40, 4:4:40, or 6:6:40, while 4:4:40 gave a smaller percentage of rot. For effective control of blight the spray should be applied at the rate of about 80 gallons per acre, under good pressure.

EXPERIMENT TO TEST THE VALUE OF VARIOUS STRENGTHS OF BORDEAUX MIXTURE, 1922
(Average of duplicate plots)

Plot	Spray	Per cent rot—			Total yield per acre bush
		in field	in cellar	total	
1	2 : 2 : 40	8·3	0·0	8·3	324·8
2	6 : 6 : 40	10·8	0·8	11·6	383·5
3	Arsenate of lime	10·0	4·1	14·1	355·2
4	Check	8·0	1·9	9·9	294·7
5	4 : 4 : 40	2·6	0·6	3·2	332·4
6	8 : 8 : 40	7·4	0·3	7·7	400·9
7	Check	10·4	2·1	12·5	318·4
8	Modified*	0·3	0·6	0·9	480·0
9	4 : 4 : 40 and Casein	1·7	1·3	3·0	347·3

*1st—4 : 4 : 40; 2nd—6 : 6 : 40; 3rd—8 : 8 : 40; 4th—10 : 10 : 40; 5th—12 : 12 : 40.

EXPERIMENTS WITH VARIETIES OF POTATOES RESISTANT TO LATE BLIGHT

In 1920 a number of blight-resistant varieties of potatoes were received from Mr. Paul A. Murphy, Royal College of Science, Dublin, Ireland. These varieties were tested for disease resistance the same year under normal cultural methods with the exception that no fungicidal sprays were applied. In that year late blight was very severe, and in all the varieties the resistance to the disease was well marked, although the yield was low and the tubers, on the whole, were small. The presence and subsequent increase of leaf roll and mosaic disease necessitated the discarding of several of the varieties.

PERCENTAGE ROT IN IRISH VARIETIES 1920 AND 1922

	1920*	1922
Arran Chief (Glasnevin)	0·0	2·9
Irish Chieftain (Glasnevin)	0·0	* *
Lochar	0·0	0·0
Leinster Wonder	2·0	0·0
Arran Comrade	1·4	0·9
Northern Invincible	0·0	0·0
Shamrock	0·0	0·0
Clifden Seedling	0·0	0·3
Arran Chief (Clifden)	0·0	* *
Summit	0·0	2·6
Irish Chieftain (Clifden)	0·0	* *
Up-to-Date	1·3	13·1
Green Mountain (Check)	60·08	16·5

*No blight developed on any of the varieties in 1921.
* * Discontinued owing to leaf roll and mosaic disease appearing.

During the past year there was a noticeable increase in susceptibility to late blight in certain varieties, particularly Up-to-Date. There was also a considerable increase in the amount of mosaic and leaf roll. A higher proportion of the tubers were small and poorly shaped. It is also interesting to note in this connection that the yields of the Irish varieties, which have been tested for the past three years at Charlottetown, were far below those of the standard varieties grown in Canada.

LEAF ROLL AND MOSAIC COUNTS IB 1922 OF VARIETIES FROM IRELAND

Variety	Mosaic	Leaf Roll
	per cent	per cent
Leinster Wonder	84	0
Clifden Seedling	100	0
Arran Comrade	36	6
Arran Chief (Clifden)	44	0
Summit	12	0
Lochar	0	0
Northern Invincible	60	0
Shamrock	25	0
Up-to-date	0	95

IMMATURE SEED EXPERIMENTS, 1920-1922

In order to compare the value of mature *versus* immature seed, an experiment was commenced in 1920 in which five lots of Green Mountain were planted on different dates and all harvested on the same date. Good, sound seed was selected and all the plots were subjected to the same cultural and spraying methods throughout the season.

The following are the results obtained from the respective plots:—

EXPERIMENT TO TEST THE VALUE OF IMMATURE SEED

Variety—Green Mountain

Planted 1920	Harvested 1920	Planted 1921	Harvested 1921	Yield per acre in bushels		
				Marketable	Small	Total
June 2	Sept. 22	June 4	Oct. 4	176	62	238
June 15	Sept. 22	June 4	Oct. 4	123	79	202
July 1	Sept. 22	June 4	Oct. 4	211	70	281
July 7	Sept. 22	June 4	Oct. 4	150	88	238
July 15	Sept. 22	June 4	Oct. 4	202	44	246

While the results obtained in the above experiment were inconclusive, there was, nevertheless, a certain amount of evidence in favour of the use of immature seed.

In a previous experiment, two lots of Green Mountain were harvested on different dates in 1919 and planted on the same date in 1920.

EXPERIMENT TO TEST THE VALUE OF IMMATURE SEED, 1920

Variety—Green Mountain

Planted 1919	Harvested 1919	Planted 1920	Harvested 1920	Yield	
				per plot in lb.	per acre in bush.
June 16	Sept. 14	June 2	Sept. 23	103	291½
June 16	Oct. 4	June 2	Sept. 23	87	246

The above experiment indicated an advantage in favour of immature seed of 45½ bushels per acre. In the present instance, however, mosaic was very prevalent, being present in both mature and immature seed to the extent of 50

and 32 per cent respectively. By making due allowance for the reduction in yield of the mature seed due to the higher percentage of mosaic plants, there is still a difference of 22½ bushels per acre to the credit of the immature seed.

The amount of mosaic present rendered the stock unfit for further experimental work on this subject, and another series of experiments was commenced with fresh healthy stock. In 1920, three lots of Green Mountain were harvested at different stages of maturity, twenty days early, ten days early, and at maturity, respectively. The following year (1921) they were planted in rows side by side, all on the same date. The several plots yielded as follows:—

EXPERIMENT TO TEST VALUE OF IMMATURE SEED 1921

Variety—Green Mountain

Plot	Planted 1920	Harvested 1920	Planted 1921	Harvested 1921	Yield per acre in bush.		
					Marketable	Small	Total
1	June 2	Sept. 11	June 3	Sept. 26	236	39	275
2	June 2	Sept. 22	June 3	Sept. 26	211	46	257
3	June 2	Oct. 4	June 3	Sept. 26	224	50	274

A similar experiment in which Irish Cobblers were used gave the following results:—

EXPERIMENT TO TEST THE VALUE OF IMMATURE SEED 1921

Variety—Irish Cobbler

Plot	Planted 1920	Harvested 1920	Planted 1921	Harvested 1921	Yield per acre in bush.		
					Marketable	Small	Total
1	June 2	Aug. 24	June 3	Sept. 13	162	35	197
2	June 2	Sept. 4	June 3	Sept. 13	155	46	201
3	June 2	Sept. 15	June 3	Sept. 13	135	46	181

In 1921 similar lots of both Green Mountains and Irish Cobblers were harvested on different dates and planted on June 1 in 1922. The various plots yielded as follows:—

EXPERIMENT TO TEST THE VALUE OF IMMATURE SEED 1922

Variety—Green Mountain

Plot	Planted 1921	Harvested 1921	Planted 1922	Harvested 1922	Yield per acre in bush.		
					Marketable	Small	Total
1	May 30	Sept. 10	June 1	Sept. 26	412·2	73·7	485·9
2	May 30	Sept. 21	June 1	Sept. 26	293·7	57·9	351·6
3	May 30	Oct. 3	June 1	Sept. 26	234·2	71·3	305·5

EXPERIMENT TO TEST THE VALUE OF IMMATURE SEED 1922

Variety—Irish Cobbler

Plot	Planted 1921	Harvested 1921	Planted 1922	Harvested 1922	Yield per acre in bush.		
					Marketable	Small	Total
1	June 3	Aug. 23	June 1	Sept. 14	305·4	92·2	397·6
2	June 3	Sept. 3	June 1	Sept. 14	250·1	100·1	350·2
3	June 3	Sept. 13	June 1	Sept. 14	199·5	69·8	269·3

From the above figures of the past year's experiments, it will be observed that the immature seed produced a much higher yield than the stock which had been allowed to mature normally. In the case of the Green Mountain, the stock which had been harvested twenty days early in 1921 yielded 180·4 bushels per acre more than the mature seed, while the plot planted with seed which had been harvested ten days early produced 46·1 bushels per acre more than the plot in which mature seed had been used.

In the experiment with Irish Cobbler the less mature seed exhibited an increase in yield of 128·3 bushels per acre, and that which had been harvested ten days 47·4. A very striking increase of 80·9 bushels per acre is noticed in plot 2 over plot 3.

In view of the interest taken in the production of disease-free (certified) potatoes, it is of importance to study every factor likely to aid the production of heavy yields. The question of the use of immature seed *versus* fully matured seed, therefore, has a direct bearing on the point of productivity. The experiments will be continued, with, as far as possible, the elimination of any latitude for experimental error.

COMMON SCAB OF POTATOES

(*Actinomyces scabies* (Thax.) Güssow)

Potato Scab causes a large annual loss of otherwise marketable potatoes, both as regards seed and table potatoes, in Prince Edward Island. Since the organism which is responsible for the disease lives in the soil, the trouble is difficult to control. Experiments on different soil treatments have been carried on for the past two years with a view to devising suitable control measures which might be practically applied. The materials used were ammonium sulphate, flowers of sulphur, commercial fertilizer (ammonium sulphate, acid phosphate, and muriate of potash), alder swamp mud, (which some practical farmers claimed checked potato scab), and a commercial sulphur inoculated with sulphur-oxidizing bacteria.

The different materials were broadcast on the soil and thoroughly incorporated with the soil before the sets were planted.

The experiment was conducted in duplicate. In one set the "seed" used had been treated before cutting by being soaked in formalin solution 1:240 for two hours. Three check plots were kept in each set. Each plot had four rows, but in obtaining the records only the two inside rows of each plot were used.

This experiment was carried on on the farm of Mr. J. J. Trainor, Bedford, P.E.I. The land used in this work had received a heavy application of mussel mud in 1917, and had since produced severely scabbed potatoes. So active was the scab organism in the soil that all the tubers with the exception of those in the "clean" column in the accompanying tables were practically covered with the disease, and were thereby rendered unfit for use. The results are inconclusive and the amount of disease free tubers in any one plot can scarcely be considered an indication of its being due to the treatment which plot received. Further observation will be made to ascertain whether any treatment of badly infected land will reduce scab by any practical means.

EFFECT OF CERTAIN SOIL TREATMENTS AND FERTILIZERS ON THE AMOUNT OF COMMON SCAB
Variety—Green Mountain

Treatment	Amount per acre	Combined yield per acre bush.			
		Marketable	Small	Clean	Total
Alder swamp mud	1,000 bush.	173	62	0	235
	2,000 bush.	168	58	0	226
	3,000 bush.	178	65	1	244
Ammonium sulphate	100 lb.	175	65	0	240
	200 lb.	160	55	0	215
	400 lb.	188	47	0	235
Ammonium sulphate	100 lb.				
Acid phosphate	100 lb.	190	65	0	255
Muriate of potash	50 lb.				
Ammonium sulphate	200 lb.				
Acid phosphate	200 lb.	183	60	1	244
Muriate of potash	100 lb.				
Ammonium sulphate	300 lb.				
Acid phosphate	300 lb.	220	70	0	290
Muriate of potash	150 lb.				
Inoculated sulphur	200 lb.	135	45	4	184
	400 lb.	168	52	0	220
	600 lb.	158	47	0	205
Flowers of sulphur	200 lb.	150	48	5	203
	400 lb.	150	58	6	214
	600 lb.	127	40	5	172
Check (untreated) 1		150	50	0	200
2		148	70	0	218
3		150	68	0	218
Check—Average of all plots		149·3	62·7	0	212

LEAF ROLL

(Fig. 5)

During the past several years, numerous experiments have been carried on with a view to ascertaining:—

1. The nature of the disease.
2. Whether spread by insects.
3. Whether infection is carried over in the soil.
4. Whether infection of healthy plants is brought about by root contact.
5. The value of "rogueing" as a means of controlling the disease.

EXPERIMENTS TO TRANSMIT THE DISEASE BY INSECTS

In a progressive experiment conducted over a period of four years, an attempt was made to convey the trouble from diseased plants to healthy ones through the agency of insects. In this experiment the insects used were aphids removed from potato plants and Colorado beetles (both adults and larvae). Healthy sets of the Irish Cobbler variety were planted in large flower pots, sunk into the ground, and as soon as the sprouts appeared above the soil fine-mesh cheesecloth bags were placed over the different pots. At a suitable time, insects from diseased plants were placed on the healthy plants in the cages, several caged plants being retained as checks. In all cases, the plants remained uniformly healthy and vigorous plants, nor did the progeny of any of the plants exhibit symptoms of leaf roll when planted the following year.

Experiments to Determine Whether Infection Takes Place by Root Contact

Healthy tubers of the Irish Cobbler variety were cut into three sets each. One set of each tuber was planted in a wooden box sunk into the ground; one was planted normally, (uncased) and the third planted in an isolated location away from all other potatoes, and kept as a check. In the case of the first two

Fig. 5.—Alternate rows of leaf roll and healthy potatoes. Note the dwarfed and upright appearance of leaf roll plants. Photo S. G. Peppin.

lots each plant was surrounded with leaf roll plants so that opportunity for infection might be afforded. None of the plants in this experiment was protected from aerial infection by being caged with cheesecloth bags. The results quoted in the tables below are not final, as far as infection through root contact only is concerned.

Experiment 1.—Variety—Irish Cobbler

Treatment	Number Plants	Number Healthy	Number Leaf Roll	Per cent Leaf Roll
Cased	10	7	3	30·0
Uncased	9	2	7	77·7
Check (isolated)	10	10	0	0·0

Experiment II.—Variety—Irish Cobbler

Treatment	Number Plants	Number Healthy	Number Leaf Roll	Per cent Leaf Roll
Cased	20	16	4	20·0
Uncased	20	14	6	30·0
Check (isolated)	20	20	0	0·0

Experiments to Determine Whether Infection is Carried over in the Soil

In an experiment to determine whether infection was carried over in the soil, fifty-two healthy sets of the Garnet Chili variety were planted in four short rows which produced a crop during the previous year severely affected with leaf roll. One tuber was saved from each hill and the following year sets were planted in the same rows in the same relative position. In no case did any leaf roll develop.

Experiment to Determine the Possibility of Eliminating Leaf Roll by the Removal of Diseased Hills

This experiment was commenced in 1919 to obtain information as to the value of early and late "rogueing". The method of procedure was as follows: three series of plots were planted, each series having five plots of one hundred hills each. Disease-free seed of the Garnet Chili variety was used throughout. Into the five plots of each series various percentages of diseased plants were introduced, viz.: 2, 5, 10, 25, and 50 per cent respectively. One series was "rogued" of all leaf roll plants as soon as the symptoms of the disease became apparent; one plot was "rogued" of all diseased plants several weeks later, and the tubers discarded; and one plot left unrogued as a check.

Early and Late Rogueing Experiment for the Control of Leaf Roll in the Field

Original Disease Introduced			2 per cent	5 per cent	10 per cent	25 per cent	50 per cent
Planted	Rogued	Harvested					
1919–June 3.....	July 17	Oct. 9	2	5	10	25	50
June 3.....	Sept. 15	Oct. 10	2	5	10	25	50
June 3.....	Unrogued	Oct. 11	2	5	10	25	50
1920–June 2.....	July 22	Sept. 15	0	2	0	2	27
June 2.....	Aug. 18	Sept. 16	1	6	19	31	54
June 2.....	Unrogued	Sept. 17	5	7	13	56	68
1921–May 31.....	July 15	Sept. 26	0	3	0	11	48
May 31.....	Aug. 16	Sept. 27	4	25	44	75	78
May 31.....	Unrogued	Sept. 28	18·2	13	52	88	96

Average weight of leaf roll hills..... 2·2 oz.
Average weight of healthy hills.....10·9 oz.

From the above results it will be observed 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, and 10 per cent plots. Less satisfactory results, as might be expected were obtained in the 25 per cent and 50 per cent plots. Where the rogueing was done late in the season more leaf roll developed in the remaining plants than was originally introduced in every case, except the 2 per cent plot in 1920 in which only one diseased plant was found. During the following season, however, the leaf roll plants in this plot increased to 4 per cent, emphasizing the necessity of early rogueing.

In our extension work in this province we have consistently recommended the early eradication of diseased plants as a means of at least lessening the normal spread of the disease to healthy plants. If the work is done thoroughly it may result in the entire elimination of the disease from the crop. In order, however, for this practice to be effective as a control measure, the fields should be gone through from six to eight weeks after planting, and at frequent intervals thereafter. All affected plants should be carefully removed as soon as detected. Any tubers which may have formed should also be removed.

Mosaic—Experiment to Determine the Possibility of Eliminating Mosaic by the Removal of Diseased Hills

This experiment, which is similar to the one described under leaf roll was also commenced in 1919. The only way in which the two experiments differed was in the variety of potatoes used, which in this case was Green Mountain. As in the leaf roll experiment, the original number of plants in the rogued plots was maintained by additional sets being cut from several tubers.

Early and Late Rogueing Experiment for the Control of Mosaic in the Field

Original Disease Introduced			2 per cent	5 per cent	10 per cent	25 per cent	50 per cent.
Planted	Rogued	Harvested					
1919–June 3.....	July 17	Oct. 9	2	5	10	25	50
June 3.....	Sept. 15	Oct. 10	2	5	10	25	50
June 3.....	Unrogued	Oct. 11	2	5	10	25	50
1920–June 2.....	July 22	Oct. 6	6	9	27	8	4
June 2.....	Sept. 13	Oct. 7	6	23	30	48	47
June 2.....	Unrogued	Oct. 8	17	34	57	69	60
1921–May 31.....	July 15	Sept. 26	11·2	14·1	45·0	14	32
May 31.....	Aug. 1	Sept. 27	39·0	53·0	55·0	89	73
May 31.....	Unrogued	Sept. 28	84·0	55·5	82·1	96	90

Average weight of mosaic hills.....17 oz.
Average weight of healthy hills.....24·4 oz.

The results tabulated above indicate that "rogueing" is less satisfactory for preventing the spread of mosaic than it is for controlling leaf roll. During the second year, in the series where early rogueing was practised, the disease increased to 6 per cent in the 2 per cent plot, to 9 per cent in the 5 per cent plot, and to 27 per cent in the 10 per cent plot, the disease in each case representing a higher percentage than had been originally introduced. In spite of the fact that all diseased plants were removed on July 22 in 1920, these three plots, when grown in 1921, developed the disease to the extent of 11·2 per cent, 14·1 per cent, and 45 per cent respectively. The disease was remarkably reduced in the 25 per cent and 50 per cent plots, which had been rogued early. The results, however, for 1920 and 1921, show the uselessness of late rogueing. Owing to the high percentages of disease which had developed in the late rogued and unrogued plots, the experiment was repeated in 1922 with a fresh lot of disease-free seed of the same variety.

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

(J. F. Hockey, *Acting Plant Pathologist in Charge*)

During the past year the activities of this laboratory were chiefly of an extension and demonstration nature. This was due, in part, to the necessity of demonstrating control measures for raspberry diseases, and also to the resignation of the former Officer in charge, Dr. W. H. Rankin, and his departure early in the season. In April, Circular No. 1, N.S. "Mosaic and Leaf Curl of the Cultivated Red Raspberry" was distributed to about 3,000 persons, through the mailing list at the Horticultural Experiment Station, Vineland. At the same time a short mimeographed paragraph was included, inviting growers desirous of

selling disease-free raspberry stock for planting to apply to this office for the services of our inspector. Fair use was made of these services by the growers.

The year has been favourable to the development of fungous diseases. Their increased prevalence would have resulted in a serious financial loss to the growers had it not been that many of the fruits were exceptionally abundant.

During the year, addresses have been given at various meetings of fruit growers and farmers generally on topics of local interest in the control of diseases.

CONTROL OF RASPBERRY LEAF CURL

In May and June, 1921, several commercial plantations were placed at our disposal for the purpose of testing the effect, on leaf curl, of the removal of diseased plants. The following brief table gives a summary of the condition of the plots as found in the spring of 1922 in the final check.

——	Length of Rows	Leaf Curl, 1921	Leaf Curl, 1922
Eradicated	1,470 feet	182 feet —12·3%	61 feet— 4·1 %
Check	910 feet	44 feet— 4·8%	66 feet—7·2%

In the rows from which diseased plants were removed several factors were observed causing a higher percentage of leaf curl in 1922 than was expected. Imperfect eradication of the diseased plants is a common cause of failure. This is due to the fact that the roots of a raspberry plant spread for a considerable distance and new suckers may appear three to eight feet from the parent plant. When a diseased plant is removed, an effort should be made to extract as many of these roots as possible. The complete removal of the entire root system of plants over two years of age is by no means easy.

In the above table there is a reduction in one year of 8·2 per cent in the amount of leaf curl present. Of the 61 feet found in 1922, 33 feet, or 2·2 per cent, are represented by new areas in the plots. The appearance of these areas may be partly accounted for by the presence of leaf curl in adjacent rows in the plantation which we were not permitted to rogue. These constitute a very close source of infection, and place the experimental rows at a disadvantage. Were an entire plantation rogued, we are satisfied that almost perfect control would be obtained. Our observations lead us to the conclusion that the disease will not, under normal conditions, appear in a patch isolated by at least 50 feet from other plantings of *Rubus* species.

From the results on these plots and observations on many plantations during the past year, the following additional recommendations for control of raspbery leaf curl are given.

1. Rogueing, *i.e.*, the removal of diseased plants, must be done early in the spring as soon as the disease can be identified. This year the aphids were to be found before leaf curl plants were readily identified.

2. One and two-year-old plantations should be most carefully rogued, as complete eradication of the diseased plants from such patches is a more economical operation than in the older patches, and will eliminate future sources of infection.

3. The entire root system of the plants must be removed. This is only possible in young plantations; but, where this has been done, almost perfect control of the disease is obtained.

4. The necessity of removing all rogued plants from the plantation on digging them, and, preferably, their immediate destruction, cannot be too greatly emphasized.

This spring three new control plots were started. According to the lessons learned from previous experiments, a more accurate method of arranging the plots was used, and it is hoped that we will obtain some further information on the control of leaf curl in the near future. The necessity of still further control plots is not evident, since an active interest is being taken by the growers in eradicating leaf curl as soon as it appears in a plantation.

HISTOLOGY OF LEAF CURL

No satisfactory conclusion could be reached from histological studies. There is an obvious accumulation of starch in the leaves, and necrosis occurs in certain elements of the phloem. The histological similarity between leaf curl of raspberry and leaf roll of potato leads to the conclusion that a complete investigation of one of the diseases would facilitate the investigation of the other.

The Mosaic Disease of Raspberry

During the season of 1921, three experimental control plots for the study of mosaic disease of raspberries were laid out. These patches were accurately charted, and the exact location of every mosaic plant marked on special paper. All plants and suckers showing any symptoms of mosaic were removed, and a special effort was made to remove the entire root system in each case. The bushes which were removed were carried a safe distance from the plantation every few minutes. The theory for rogueing mosaic plants from a bearing plantation, after the picking of the fruit, was given on page 60 of the Interim Report of the Dominion Botanist for the year ending March 31, 1922.

The results from these plots have been uniformly satisfactory. There was an interval of one year between rogueing and making the final check. Since all experimental rogueing was done in fruiting plantations, no actual data are available on the control of mosaic in new and one-year-old plantations. Several of these have been rogued this season at the request of the growers, but no attempt has been made to keep an accurate check on them. The results from the three plots are given below:—

Plot I—O.E.W., Louth Township

Row	Mosaic 1921		Mosaic 1922			
			New		Spread	
	Areas	Feet	Areas	Feet	Areas	Feet
1	6	21·5	0	0	0	0
2	6	18·5	0	0	2	1
3	5	10·	0	0	0	0
4	6	13·	0	0	2	1
5	5	6·	1	2	0	0
6	4	10·5	0	0	1	2·5
7	3	4·	0	0	0	0
8	8	19·	0	0	0	0
9	0	0	0	0	0	0
10	5	6·	0	0	0	0
11	2	8·	1	1	0	0
	50	116·5	2	3	5	4·5

Total length of rows.....2,475 feet
Mosaic in 1921.....116·5 feet or 4·71 per cent
Mosaic in 1922.....7·5 feet or 0·30 per cent

Rows 1, 3, 5, 7, 9 and 11 were two years old when rogued. The remaining rows were eight years old. This point is worthy of note, as it will be seen that there was no spread of mosaic from areas in the two-year-old rows which had been rogued. In two of these rows were found two areas totalling three feet in length which were new infections. This plot furnishes proof that it is only in a young plantation (*i.e.* up to 2 years old), that rogueing can be done successfully on a practical basis. Fairly good control was obtained in the older rows, but the rogueing is more difficult; and it is not considered advisable to rogue a patch of that age. In the entire plot, 50 areas containing mosaic plants were rogued. This means that there were 100 plants adjacent to these areas to which the disease might have spread. By spread are meant infections which might have already taken place without any visible symptoms at the time of rogueing. Of the 100 chances for spread only 5 actually developed mosaic, and these were in the rows of eight-year-old plants.

PLOT II—O.E.W., LOUTH TOWNSHIP

Total length of rows.....4,655 feet
Total mosaic eradicated in 1921.....548·5 feet or 11·78 per cent
Total mosaic eradicated in 1922.....58·5 feet or 1·25 per cent

Of the 58·5 feet found in 1922, 13 feet or ·25 per cent were new areas and 45·5 feet or 1 per cent were spread, most of which can be accounted for by incomplete eradication due to the age, 6 years, of the plantation. The control shows a substantial reduction in the amount of mosaic in one year. Many of the gaps caused by rogueing diseased plants were replanted in the spring by the owner; no mosaic symptoms have appeared on any of these plants.

PLOT 3—G. R., GRIMSBY, E.

Row	Mosaic 1921		Mosaic 1922			
			New		Spread	
	Areas	Feet	Areas	Feet	Areas	Feet
1	10	22·5	1	1	2	1
2	10	57·	0	0	3	2
3	9	24·5	0	0	4	2
4	6	9·	0	0	1	1
5	8	42·	2	2	1	0·5
6	12	30·	1	1	4	3
	55	185·	4	4	15	9·5

Total length of rows.....575 feet
Total mosaic 1921.....185 feet or 32·17 per cent
Total mosaic 1922.....13·5 feet or 2·35 per cent

This plantation was three years old at the time of rogueing and, in spite of the high percentage of mosaic originally present, a substantial disease control is shown. This fall the owner replanted the gaps made by rogueing, after having removed the diseased plants found in the patch this year.

It was the intention of this office to lay out several demonstration plots on the control of mosaic in commercial plantings throughout the Niagara district in 1922. Plans were made and some patches secured, but, by the time the rogueing should have been done, our time was completely taken up with the certified disease-free plantations and the general inspection work conducted at the request of the growers. This work has proved to be of greater value to them than demonstration plots, hence it is not considered advisable at the present time to plan further experiments in rogueing on a commercial scale, when we are able to obtain results directly from the grower and supervise his operations in many cases.

62007—5½

RECOMMENDATIONS FOR THE CONTROL OF MOSAIC

Controlling raspberry mosaic is an operation which should commence the same year the patch is planted. The planting of disease-free stock is, of course, the first and foremost requirement. As soon as it is possible readily to identify the symptoms of the disease, the young plantation should be carefully inspected by the grower and any infected plants dug out. The root system at this time is poorly developed and thorough removal is a comparatively simple operation. The spaces thus left in a plantation may be replanted at any time without fear of infection from the soil. The patch should be carefully inspected two or three times during the season and all diseased plants removed.

The following season it is advisable to continue careful inspections, and rogueing if necessary. The gaps caused by removal may be replanted, and the entire plantation kept complete. If the rogueing is thorough the first season and the gaps are replanted with healthy stock, little or no time will be lost in bringing the entire plantation into full bearing in the usual time.

Another reason for careful eradication of mosaic in young plantations is that, when a patch is in its second growing year, it yields the largest number of suckers suitable for nursery stock. This fact, if borne in mind by the growers, will lead to a gradual eradication of mosaic from the district. This was well illustrated by the case of a grower who obtained nursery stock from one of the plantations which had been rogued for experimental control. Adjoining the small plantation set out with this stock he planted a few rows with plants from his own patch which contained 50 per cent mosaic. At his request the patch was inspected and rogued this summer. There was less than 1 per cent mosaic in the rows containing the stock from the rogued plantation, while the other rows were so heavily infested, that a plough was used to eradicate the entire part which had been planted from his own stock.

From our observations to date it does not appear to be advisable to rogue a bearing plantation over three years of age; and in no case would it be advisable to rogue a bearing patch having more than five to ten per cent mosaic. The normal life of a raspberry patch in this district is six to nine years. By that is meant that its most profitable years to the grower are over at that time, and the patch is then removed. Thus it can be seen that the removal of more than 10 per cent of the plants from a patch over three years of age materially reduces the yield; and, if the spaces are replanted, it is two or three years before these new plants are in full bearing. By that time the grower is preparing to remove the plantation, and he has gained little by his extra work. In place of attempting to clean out a fruiting plantation it is advisable to plant out a new area immediately, isolated by 50 to 100 feet from any nearby wild or cultivated species, and to follow the control measures as outlined for a young plantation.

It is hoped that the experiments, which are now under way to test spraying and dusting for control of the insects responsible for the spread of mosaic and leaf curl, will yield results in time to be of value to the new plantings, before they reach the full bearing stage.

The same recommendations given for the control of leaf curl apply with equal force to the control of mosaic, except that the latter cannot be identified as early in the spring as the former, and consequently the rogueing must be done at a later date. It is essential, however, that all plants which are dug out be carried to some distance from the patch before the leaves begin to wilt, as the aphids connected with the dissemination of mosaic crawl away from plants in wilting condition and seek healthy plants of the same species, thus spreading infection.

EXTENT TO WHICH CANES ARE DWARFED

In the annual report for last year, mention was made of an experiment to determine the annual rate of dwarfing of mosaic plants. The results of the first year's data were given in full, showing that the average height of mosaic canes diseased for one year was 4 feet 6·1 inch compared with 5 feet 6·5 inch for the adjacent healthy canes. The comparison in diameter of the same twenty-five clumps each of diseased and healthy yielded an average diameter of 0·34 inches compared with 0·43 inches for the healthy. These plants were all marked for comparative measurements to be made in 1922; but the entire patch was so severely winter-killed that it was ploughed up by the grower early in the spring.

RATE OF SPREAD OF MOSAIC

A young plantation of about one acre was closely inspected last season and all mosaic plants banded and charted. The amount of mosaic at that time, September, 1921, was 0·9 per cent. This year the plantation made its first real growth and was inspected several times to determine the spread that had taken place during the season. The final inspection was made early in October, when it was found that no additional plants were infected.

It is difficult to account for this when we consider that other patches of the same age showed marked spread of infection. There are one or two points, which may have a bearing on this subject, that are worthy of mention. This young patch was adjacent to an old planting having a high percentage of mosaic last year. This spring, however, the old patch was taken out on account of winter-killing, thus removing the main source of infection. Also, the young patch was interplanted with a root crop last season. Such intercropping appears to influence the presence of other insects, which are more general feeders than *Aphis rubiphila*, Patch, largely the distributing agent of the disease; but there is a strong suspicion, resulting from observations on young plantations, that other insects, especially leaf-hoppers, may be active disseminating agents of raspberry mosaic.

Contrary to our previous reports, there appear to have been three distinct periods of infection this season. The first took place early in the season, and caused the development of symptoms prior to picking time, July and early August. There was also another period of infection which resulted in the appearance of mosaic symptoms on previously healthy plants early in September. The third period of infection gave rise to symptoms during October. This was doubted at first, but definite mottling appeared on all tip leaves before the growth ceased in the fall. The cool, damp weather conditions at intervals during the summer are believed to account for these periods, as the disease-conveying aphids became more active during cool weather, and were easily found at any time during the entire season.

LIFE-HISTORY OF APHIS RUBIPHILA, PATCH

Our observations having shown the close relation of the disease to *Aphis rubiphila*, Patch, Mr. Ross of the Entomological Branch is now endeavouring to make a complete study of the life-history of this insect; and a co-operative study of its relationship to mosaic disease is under way. Efforts will be made to determine the presence of other disseminating agents. An extensive programme on this subject is planned, and it is hoped that some valuable information will be gained.

Experimental field plots have also been planted this fall in order to continue field investigation on mosaic. Some of the points receiving attention are:—

1. Comparison in yield from year to year to determine the actual yearly decrease in yield from mosaic plants.

2. From this to determine the actual loss to the grower having mosaic present in his patch.

3. Spraying and dusting experiments to control the disseminating agent or agents.

4. To determine the period of life and usefulness of a diseased plant from the time of its inoculation under field conditions.

Raspberry Inspection Service

A strong effort was made during the summer to draw the attention of all raspberry growers to the prevalence of leaf curl and mosaic in the commercial plantings. It was decided to place at the disposal of all growers accurate information regarding the disease, and to offer them our services for the inspection of plantations. Wide publicity was given from Vineland, where there is available a new mailing list including 3,500, or more, active growers, or parties directly interested in horticulture. In July a circular letter was dispatched, signed by the director, Vineland Station, urging raspberry growers to seek information and inspection, if desired, from this office, in order that control of mosaic might be attempted as early as possible. This letter was given wide publicity in daily papers and farm periodicals.

Requests for information were received from many scattered districts in Ontario and Quebec, and a few from outlying provinces, and States in the Union. The majority of requests, however, were for inspection, and came from growers in the Niagara and north shore of lake Ontario districts. The assistance of two temporary inspectors was necessary in order to cover the inspection in the immediate districts within the desired time.

The major part of this work was done during August and September. The number of inspections during this period totalled 217, and the acreage inspected totalled 202. No effort was made to determine the exact percentage of mosaic present in these plantations when it was obviously over 10 or 15 per cent. The main purpose of this service was to point out the progressive symptoms of mosaic as they appeared in the plantation, and to assist the growers in determining the advisability of rogueing their patches. Considerable difficulty was experienced in acquainting the growers with the early stages of mosaic, but few, if any, failed to become well acquainted with the advanced stages of the disease.

The recommendations were based on: the age of the plantation; approximate percentage of mosaic present; advisability of securing nursery stock from the plantation. Growers having young fruiting plantations with less than 10 per cent mosaic present were advised to rogue the patches, or at least parts of the patches, so that they could better obtain clean nursery stock for planting. If, however, the grower had young plantations not yet in bearing and fairly well isolated from the older patches, it was deemed advisable to rogue these, and allow the fruiting plantations to run their natural course. A distinct advantage is gained in cleaning out the young patches, as they are easier to replant, and also yield a high percentage of suitable nursery stock in their second and third growing years. Hence particular attention was paid to these and growers were urged to rogue their young plantations and keep them free from mosaic, in order that the patch might be uniformly healthy when it came into full bearing. When requested, the inspectors demonstrated or assisted in the rogueing.

Occasional inspections were made in districts where the requests were not sufficiently concentrated to warrant stationing one of the inspectors. Requests for inspection were received as late as October. For the entire season a

minimum estimate of inspections would total 250 and the acreage inspected in the neighbourhood of 300 acres.

This inspection service was conducted independently of the certification of disease-free stock which is detailed in another part of this report.

This service has been greatly appreciated by the growers, and appears to be a more satisfactory method of demonstrating the control of raspberry mosaic than the previously considered plan of demonstration plots scattered throughout the district. The necessity of this type of service is further emphasized by the manner in which growers usually obtain their nursery stock. It has been their custom to secure plants either from their own or their neighbour's patch with little or no charge. Hence diseased plants have been transplanted in increasing quantities in the young plantations, without the knowledge of the grower. An effort has been made to discourage the growers from this practice, unless they are satisfied that the plantation, from which they secure their plants, is comparatively free from mosaic.

CERTIFIED DISEASE-FREE RASPBERRY STOCK

The urgent need for the adoption of systematic control measures against mosaic and leaf curl of the red raspberry led to the authorization of a system of inspection and certification of plantings which could be recommended as a source of nursery stock. Regulations were agreed upon, and the growers were informed by means of a circular letter enclosed in the envelopes used for mailing copies of Circular No. 1, N.S., in April, that applications for the use of this service must be sent to this office by May 1.

In reply to these notices eleven applications reached the laboratory calling for the inspection of twenty-two acres of raspberries, mostly Cuthberts. The first inspection of these patches was made in the latter part of May and early in June. At this time the leaf curl was rogued, and the general health of the plantation determined. Two or three of the plantations were disqualified on account of their general inferior condition, or on account of their proximity to other raspberry plants, cultivated or wild.

A second inspection was made early in August. This was the more important one, as it called for the determination of the amount of mosaic and cane diseases present. The patches which were accepted after this inspection were rogued under supervision, and all mosaic plants as well as adjacent healthy ones were very carefully removed. Cane diseases were not found of sufficient importance in the patches to warrant the eradication of many affected plants. Spur blight was the commonest of these on Cuthberts and Herberts, but the loss caused by this disease in the Niagara district is practically negligible.

As a result of these two inspections, eight growers having an aggregate of eleven acres, were given certificates stating that their patch "had been duly inspected and rogued, and was hereby declared sufficiently free from disease for the purpose of disposal as nursery stock for planting." In order to protect the purchaser the cetificate was issued subject to the following conditions:—

1. Plants showing symptoms of crown gall shall not be offered for sale, but must be destroyed by burning.
2. Plants showing symptoms of spur blight, cane blight, or other cane diseases, shall not be included.
3. The grower shall keep a list giving the names of growers to whom he sold plants, and the approximate number of plants sold.

The last condition was inserted in order that we might have some means of checking up the new plantings next year, and determining the value of this service. There are some features which are open to question, and it is hoped to

evolve an improvement from the experience already gained as the result of one season's work.

During the summer it was seen that there would be an inadequate supply of certified stock to meet the demand, so an effort was made to locate plantations free from mosaic and leaf curl, or having a sufficiently low percentage of diseased plants which could be easily removed. Most of these plantations were fit for certification, but only one inspection was made, and it was not deemed advisable to deviate from the regulations. A further list of seven growers offered fourteen acres from which additional stock could be secured. In this list five of the growers had patches in which no mosaic was found. These will doubtless be certified next season.

In September, a circular letter was distributed, through the Vineland Station mailing list, giving the names of growers having certified stock for sale. This was supplemented by a list of growers having recommended stock for sale. The complete list is by no means a formidable one, but it is hoped that it will form a nucleus for the more ambitious growers, and lead the way to a subsequent greater demand for this class of stock.

It is becoming increasingly apparent that clean stock is one of the most important factors in the control of raspberry mosaic. The general inspection service inaugurated this year has yielded strong evidence of the need for more care on the part of the growers in securing their planting stock. Many are setting out new plantations this fall and next spring with certified or recommended stock, in the hope that the additional cost of such stock will be offset by the better health of the plants thus secured. There is no guarantee that certified stock will be 100 per cent mosaic-free, but we believe that, if any mosaic is present in the young planting next year, it will be scarce and consequently readily controlled. It is physically impossible to eradicate this disease in one year. But the gradual process of creating a demand for clean stock, and the interest of the growers in keeping their plantations clean will lead, we feel sure, to a speedy control of this disease.

It should be possible next season to obtain information concerning many other Cuthbert plantations in Ontario, which are now free from mosaic, and would yield a good supply of nursery stock. These are the ideal ones for certification, but in this district they are few in number. Some of those found early in the season could have been certified, but the growers did not wish to grow planting stock, as it interfered with their methods of cultivation.

The Cuthbert is by far the most popular variety in the Niagara district, and it is essential that the nursery stock of this variety be improved in quality, or there will be a decrease in the number of growers now propagating this berry on a commercial scale.

Blue Stem of the Black Raspberry

This disease has not been previously reported from the Niagara district. Probably few are acquainted with it, because of the comparatively little attention paid to black raspberries in this section. The blue stem condition as described by W. H. Lawrence (Wash. Agr. Expt. Sta. Bul. 108, 1912) was found this season in various patches through the district, and in isolated seedling plots at the Horticultural Experiment Station, Vineland.

In most cases the entire plant was defoliated or nearly so; in the latter case the remaining leaves were yellowish and drooping. Occasionally a plant was found with one or two canes apparently dead, whereas the remaining canes showed the blue colouration developing along the base of the stems with the tips of the canes still normal. The colour of the diseased stems is a bluish-purple to black.

On a microscopic examination of the diseased canes in the field and laboratory, no superficial fungous growth could be observed. An examination of free hand sections of the stems revealed the presence of fungous mycelium in the wood elements. Some of the tissues were completely plugged with mycelium. No evidence of internal fruiting bodies has been found in these examinations.

Specimens of diseased canes were kept under moist conditions in order to observe any fungous growth which might take place, and to note especially the character of the growth on cut surfaces of the canes.

Small pieces of the internal tissue were used in making initial cultures on nutrient agar. These cultures yielded a very predominant fungous growth closely resembling that isolated by Lawrence in Washington, and described in 1912 as *Acrostalagmus caulophagus*, Lawrence. Typical verticillate conidiophores were produced in abundance, bearing at their tips heads of conidia enclosed in droplets of moisture.

The specimens placed in moist chambers yielded the same fungus on the cut surfaces, fruiting abundantly. On the bark too were found minute scattered tufts, 0·25—0·5 mm. in diameter and height, which, on close examination, were found to be the conidiophores of this fungus. The heads of conidia varied in diameter from 10-30 μ, with the average from 10-15 μ. These contained many hyaline spores, oblong to oval in shape, and from 3-8 μ x 2-4 μ in size.

There is still doubt as to the specific name of this fungus. Carpenter (Jour. Agr. Res. 12, 9:529-546, 1918) is strongly of the opinion that the fungus described by Lawrence as *A. caulophagus* does not differ from *Verticillium albo-atrum*, R. and B. sufficiently to warrant the adoption of another name.

In the U. S. Dept. of Agr. Plant Disease Bulletin for November 1, 1922, Dr. C. L. Shear reports the presence of this disease in Michigan, having isolated the fungus from material collected in that state. The presence of blue stem in Ohio and New York States is also reported by R. B. Wilcox and W. H. Rankin respectively. In the same Bulletin an infectious blue stem, distinct from that described by Lawrence, is reported prevalent at Geneva, N.Y. This condition has not been observed in the Niagra district this year, as all material collected has yielded the same fungus in culture.

Pea Root Rot

In June, 1922, a request came to this office for a field investigation of what appeared to be a serious disease of peas in Prince Edward County, Ontario. Peas are grown there for both canning and seed purposes. This year, some 3,000 acres were planted in the Wellington district of that county. Of this acreage approximately 500 acres were 50 per cent of a loss through the disease, and 150 acres or more were a total loss. This represents a loss of nearly 14 per cent in that particular district.

In 1920 the growers' net return from their pea crops ran from \$60-\$100 per acre. This year, however, prices are considerably lower. The net returns for 1922—after deducting bushel for bushel for the seed used—were from \$20-\$30 per acre for growers who raised peas for seed purposes. The returns to growers who sold their crops to the canning factory would exceed this. Assuming the average net returns for both canning and seed purposes to be \$30 per acre, the loss suffered by the growers in the Wellington district for this year may be conservatively placed at \$12,000.

History of the Disease

This disease has been known in the district for about fifteen years, but its severity had not been recorded until the past three years. The only recommendation for possible control, that has been made to the growers up to the present,

is a longer rotation of crops. This has not eliminated the loss in any case. However, one grower laid claim to having suffered a loss for three years in succession due to the root rot. This year he sowed wood ashes on the field, reseeded it with peas and suffered no apparent loss from the disease. This statement is given at its face value, as no independent information is available of the actual condition of the field for the past four years.

The record of crops previously grown on two fields, which were heavily infested with root rot, was obtained from the respective growers.

Field I

1914—Admiral peas and rape ploughed down.
1915—Tomatoes.
1916—Beans.
1917—Fall wheat.
1918—Red clover hay.
1919—Tomatoes.
1920—Peas and potatoes; small area in centre of field diseased.
1921—Oats.
1922—Peas, Roger's winner, badly diseased, total loss.

Field II

1915—Buckwheat.
1916—Oats.
1917—Corn.
1919—Peas, Alaska, no disease.
1920—Oats, seeded down to clover.
1921—Clover, pastured.
1922—Peas, Alaska, badly diseased.

In Field No. I the diseased patch in 1920 was very small. The spread to the entire field is partly accounted for by the methods of cultivation. The field was cross harrowed several times with drag harrows before being seeded. Adjoining this field and cultivated at the same time, as there was no fence to separate the two, was a field of the same size which had been planted to beans. Although the diseased peas and the beans were separated by only a foot or so of cultivated ground, there appeared to be no symptoms of the disease on the beans. Red clover and alfalfa plants in the pea field were dug up, and on the majority of specimens lesions similar to those on the roots of the peas were found. The plants appeared to be vigorous, and apparently had out-grown the effects of the disease.

From observations made in various fields in Wellington district there are none which offer conclusive evidence as to the effect of time of planting, drainage, or type of soil, on the severity of the disease. Low, wet spots in diseased fields were found in which many of the plants were still green. On being dug these plants invariably showed typical lesions. Such plants would no doubt die before they matured their crop, as the lesions were quite deep and, in many cases, completely girdled the stems. In fields of rolling nature where the crop was diseased, there was evidence that the plants on high ground suffered first.

SOIL CONDITION

The soils in this district vary from sand to clay loam and gravelly loam. The entire district has a limestone sub-soil. No marked difference was observed between the soil samples from diseased and healthy fields.

An attempt was made to obtain pure cultures of organisms from diseased material collected in the field. A species of *Fusarium* seemed to be the most

prevalent. This was originally obtained from moist chamber specimens which had developed very profuse mycelial growth. The same fungus was isolated from some seed which was obtained from the Canners Seeds Ltd., Wellington, Ontario, and germinated in the laboratory. The seeds rotted while germinating and failed to develop plants. An almost pure culture of *Fusarium* was obtained from this source and used as an inoculum on some seedlings. The effect was a complete wilting and death of the inoculated plants. The lesions, however, were not identical with those found under field conditions. Other organisms, including a *Phoma* and a *Rhizoctonia* were isolated; but no satisfactory conclusions were obtained from any of the culture work. It is evident that extensive culture of organisms and inoculations are necessary to determine successfully the causal organism or organisms.

Owing to the pressure of other work in the Niagara district, it was impossible to give this problem the attention it deserved. Therefore this report is intended as a summary of the conditions found in the field investigation of the disease in Prince Edward County. We would, however, advise growers to secure perfectly sound seed and adopt a longer rotation of crops.

REPORT OF THE DOMINION FIELD LABORATORY OF PLANT PATHOLOGY AT SASKATOON, IN CO-OPERATION WITH THE UNIVERSITY OF SASKATCHEWAN, AND THE DOMINION FIELD LABORATORY AT INDIAN HEAD FOR 1922

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

The laboratory and greenhouse experiments of the Dominion Laboratories at Saskatoon and Indian Head were carried on at Saskatoon, in a laboratory and greenhouse provided by the University of Saskatchewan. Most of the field experiments were carried out at Indian Head through the co-operation of the Superintendent of the Dominion Experimental Farm, Mr. N. D. McKenzie. There was no one in charge at Indian Head, so the supervision of seeding and inspection of the plots was carried on largely by the assistants in the Laboratory at Saskatoon. Mr. P. M. Simmonds, permanent assistant, aided in carrying on all the work of these laboratories. Messrs. J. H. Craigie and C. E. Maguire were temporary assistants during the summer, and during the periods when not engaged in Potato Inspection work, Mr. H. S. MacLeod assisted in the laboratory work.

The following is an outline of the experiments carried out during the season, and the results obtained.

FIELD EXPERIMENTS TO DETERMINE THE EFFECT OF STEM RUST ON DIFFERENT VARIETIES OF WHEAT AND EMMER, AND THE BIOLOGIC FORMS THAT WILL DEVELOP AT THE DIFFERENT STATIONS

This experiment was begun in 1920. It was carried out this year in co-operation with the Dominion Experimental Farms at Brandon, Indian Head, Rosthern, Scott, Lacombe, the Field Husbandry Department of the Manitoba Agricultural College, Winnipeg, and the Provincial School of Agriculture at Vermilion.

The varieties selected for seeding were those known to have some rust resistance, or early maturing varieties, and the principal varieties of commercial importance in the United States and Canada, and such varieties as are important

differential hosts in determining the different biologic forms of stem rust. A list of the varieties used is given in the table of the results of these experiments which follows.

Each variety was sown in two adjoining rows 16 feet long, except Iumillo, Kubanka (Ottawa A) and Kanred. Of these only one row was seeded. As rust is not usually present to any extent at Scott, Vermilion and Lacombe, all the rows were not seeded at these stations. The percentages of rust as estimated at the various stations are given below in tabular form.

PERCENTAGES OF STEM RUST ON DIFFERENT VARIETIES OF WHEAT AND EMMER, SEEDED AT THE DIFFERENT STATIONS NAMED

Experimental Stations	Date sown, May, 1922	Date examined, 1922	Kubanka, C.I. 1440	Kubanka, C.I. 2094	Kubanka, C.I. 4063	Arnautka, C.I. 1493	Arnautka, C.I. 4064	Arnautka, C.I. 6236	Mindum, C.I. 5296	Acme, C.I. 5284	Monad, C.I. 3320	D-5, C.I. 3322	Kahla, C.I. 5529	Feliss, C.I. 1584	Iumillo	Kubanka, Ottawa A.	Haynes, C.I. 2874	Marquis, Ottawa 15	Power, C.I. 3697	Ruby, Ottawa 623	Kitchener, C.I. 4800	Red Bobs, C.I. 6255	Preston, C.I. 3081	Kota, C.I. 5878	Prelude, Ottawa 135	Early Red Fife, O. 16	Kanred, C.I. 5146	Little Club, C.I. 4066	White Spring Emmer, C.I. 3686	Khapli, C.I. 4013
Winnipeg	23	Aug. 16	40	50	60	65	65	50	40	12	5	0	40	30	0	75	80	70	80	40	75	50	80	12	50	80	0	80	0	0
Brandon	20	Aug. 18	30	20	40	30	40	45	35	10	5	2	50	25	0	50	50	75	70	60	75	65	70	25	40	75	0	85	0	0
Indian Head	19	Aug. 30	30	20	50	45	55	65	35	5	1	1	80	25	1	65	65	75	80	75	85	75	80	15	40	90	0	85	0	0
Saskatoon	18	Aug. 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	tr	0	0
Rosthern	27	Sept. 7	5	5	5	10	15	20	15	tr	tr	tr	15	5	0	30	35	35	55	15	45	20	25	10	15	50	0	60	0	0
Scott	22	Aug. 24	-	-	0	-	-	-	-	0	0	0	-	-	0	-	-	tr	-	tr	tr	tr	-	tr	-	-	-	2	0	-
Vermilion	25	Sept. 2	-	0	-	-	-	-	-	0	tr	-	-	-	0	-	-	tr	-	tr	tr	tr	-	tr	-	-	-	5	0	-
Lacombe	-	Aug. 25 and Sept. 25	-	-	0	-	-	-	-	0	0	0	-	-	0	-	-	0	-	0	0	0	0	0	0	-	-	0	0	-

"tr" = trace.

The rows were examined, and the percentage of rust estimated about the time of ripening. The estimates were made by the Officer in charge of the Laboratory at Saskatoon at all the stations, except Vermilion, where the work was done by Mr. P. M. Simmonds.

It will be seen from the table of results that stem rust was prevalent at Winnipeg, Brandon and Indian Head. At Rosthern there was a considerable development of rust. This was due to very late seeding, and in consequence late maturing of the rows. Hot dry weather in July, and the rapid ripening of the rows prevented development of the rust on the rows at Saskatoon.

It will also be seen from the table that of the Durums; Iumillo, D-5, Monad and Acme showed marked resistance. Of the common wheats Kota alone was resistant. The straw of this variety is weak, and the yield, as far as it has been determined in Western Canada, is not satisfactory; but it would seem at least a favourable wheat for breeding for rust resistance. It does not lodge as badly as the rust resistant Durums.

A list of the Collaborators and Stations where the experiments were carried out is as follows:—

Manitoba Agricultural College, Winnipeg, Man.—W. G. T. Wiener, Cerealist, Department Field Husbandry.

Dominion Experimental Farm, Brandon, Man.—S. J. Sigfusson, Assistant Superintendent.

Dominion Experimental Farm, Indian Head, Sask.—N. D. MacKenzie, Superintendent.
University of Saskatchewan, Dominion Laboratory of Plant Pathology, Saskatoon, Sask.—W. P. Fraser, Officer in charge.
Dominion Experimental Farm, Rosthern, Sask.—F. V. Hutton, Assistant Superintendent.
Dominion Experimental Farm, Scott, Sask.—E. Vannice, Assistant Superintendent.
Provincial School of Agriculture, Vermilion, Alta.—S. H. Gandier, Principal.
Dominion Experimental Farm, Lacombe, Alta.—G. E. DeLong, Assistant Superintendent.

STRAINS OF STEM RUST ON WHEAT

Work on the strains of stem rust was continued in the greenhouse during 1922. Determination of the strains collected in 1921 was completed. From the collections made in that season the following strains were determined.

XVII from Brandon (2 collections), Morden (2 collections), Minto, Rapid City, Winnipeg, Treesbank in Manitoba, and from Melfort, Rosthern (4 collections), Indian Head, Stoughton, Carlyle, Grenfell, Yorkton, Melville, Balcarres (2 collections), Saskatoon (2 collections), Alameda, Tisdale, and Scott in Saskatchewan, and Vermilion in Alberta.

III from Brandon in Manitoba, and Rosthern and Tisdale in Saskatchewan.

XVIII from Winnipeg, Rapid City in Manitoba, and Saskatoon in Saskatchewan.

IX from Brandon in Manitoba, and Carlyle in Saskatchewan.

XI from Moose Jaw and Rosthern in Saskatchewan.

XXI from Rapid City, Treesbank in Manitoba, and Saskatoon in Saskatchewan.

From collections made in 1922 the following strains were determined:—

XXI from Napinka, Killarney, Morden and Brandon in Manitoba, and Melville, Scott, Weyburn (2 collections), Alameda, Regina, McTaggart, Yorkton, Prince Albert (2 collections), Rosthern, Yellow Grass, and Fillmore in Saskatchewan, and from Vermilion and Edmonton in Alberta.

XVII from Winnipeg, Deloraine, Morden in Manitoba, and Rosthern, Canora, Wadena, Saskatoon, Wolseley, Swift Current, Prince Albert, Lanigan and Watrous in Saskatchewan.

III from Morden in Manitoba, and Indian Head and Alameda in Saskatchewan.

XI from Winnipeg in Manitoba, and Saskatoon and Davidson in Saskatchewan.

XVIII from Outlook in Saskatchewan.

IX from Clavet, Saskatchewan.

A number of collections made in 1922 remain to be determined. It will be seen from these results and those already published in the Division of Botany Reports for 1921 and 1922 that strain XVII was by far the most prevalent strain in the seasons of 1919, 1920 and 1921. In 1922 strain XXI was equally, if not more prevalent. These two strains are closely related, attacking all the common wheats and Durums, but differ in their action on Einkorn. The variety of Einkorn used being quite susceptible to strain XVII, but very resistant to strain XXI.

A number of other strains were found to occur in these years, namely XVIII, IX, III, XI, and XII, but these were not general, though present every year since 1919, except XII which was only collected once. Strain XI was not collected in 1919.

In determining strains, use was made of the keys and the differential hosts of wheat as listed by Stakman and Levine (Tech. Bul. No. 8. Minn. Agric. College). The keys were generously supplied in advance of publication by Dr. Stakman.

WINTERING OVER OF THE UREDINIOSPORES OF STEM RUST

Germination tests were made to determine the extent of over wintering of the urediniospores of stem rust (*P. graminis L.*) particularly those of the wheat form, *P. graminis Tritici.* Many tests were made, the following result representing the success obtained.

GERMINATION TESTS

March 13—Saskatoon, Sask. Urediniospores collected from beneath the glumes of wheat spikelets gave a germination of 4 per cent.

April 7—Saskatoon, Sask. Urediniospores collected from beneath the glumes of wheat spikelets gave a germination of 1 per cent; from beneath the leaf sheath of wheat a germination of 2 per cent.

April 7—Rosthern, Sask. Urediniospores of *P. graminis Avenae* collected from beneath the leaf sheath of oats gave a germination of 1 per cent.

April 24—Rosthern, Sask. Urediniospores of *P. graminis Avenae,* collected from beneath the leaf sheath of oats gave a germination of 1 per cent.

April 24—Rosthern, Sask. Urediniospores of *P. graminis Tritici,* collected from beneath the leaf sheath of wheat gave a germination of 1 per cent; from beneath the leaf sheath of wild barley (*Hordeum jubatum* L.) a germination of 6 per cent. The material taken from *H. jubatum* was successfully transferred to wheat in the greenhouse, giving an infection of two pustules which were again transferred and carried for strain determination.

May 2—Rosthern, Sask. Urediniospores collected from beneath the leaf sheath of *H. jubatum* gave a germination of 10 per cent. This material when transferred to wheat gave an infection of two pustules, and was carried as in the previous case.

From these experiments it is evident that the urediniospores of stem rust can survive the winter in a viable condition. Whether these are a source of infection in the field during the spring has not been established. It seems probable if they were an important source of infection, that rust would appear first on the grasses in spring and spread to wheat.

As the season advanced all grasses which are suceptible to *P. graminis* were closely observed to note if possible the early occurrence of stem rust upon them, especially those that had been heavily infected the previous year. This observational work was quite thoroughly done and a considerable territory, representing districts in the three prairie provinces, was covered, but in no case was stem rust reported on any grass before it was found on wheat. Our observations failed to reveal any field evidence of infection from overwintered urediniospores. The only early infection observed was that of susceptible grasses in the vicinity of a few barberry shrubs which evidently came from aecia on the barberry.

These observations have been carried on for a number of years and no evidence has yet been found to indicate that infection comes from urediniospores or mycelium overwintering on grasses. It may be stated that in most of our tests the urediniospores on wheat straw soon lost their vitality after the snow disappeared, the spores on grasses retaining their vitality much longer.

Stem Rust of Oats *(Puccinia graminis Avenæ)*

Leaf rust was present as usual on wheat, but did not appear as early, nor was it as severe as in 1921. The first collection was made at Winnipeg on wheat.

In some places there was a marked development of this rust, but generally it was not severe enough to do much injury. A number of the Ranunculaceae, especially Anemone and Thalictrum were heavily infected with aecia during the spring. These have been shown to belong to the leaf rust of wheat or a closely related rust, so inoculations were made in the greenhouse to find out the relationship of these aecia. In no case was infection secured on wheat, but heavy infection resulted on various grasses of the tribe Hordeae. The results of these experiments will be given in a later report.

Stem Rust of Oats *(Puccinia graminis Avenæ)*

Stem rust of oats was very severe in Southern Manitoba and Southern Saskatchewan, the leaves of the late oats being literally covered with the red stage of this rust. The rust appeared rather early, the first collection being

made at Brandon on July 15. It was at this time so far developed on one plot that the first infection must have taken place at least ten to fifteen days before this date. This rust was so severe on oats in the South that it must have reduced the yield very much. Usually there is a fair crop even when much rust is present. The reduction of yield does not attract much attention. It is desirable that more attention be given to a study of this rust and resistant varieties of oats.

Crown Rust of Oats *(Puccinia coronata* Cda.) and Buckthorn Survey

Along with the barberry survey the inspectors were instructed to report any buckthorn that might be observed. Buckthorn hedges were common in the cities of Regina, Saskatoon, Moose Jaw, and a few of the larger towns, as Indian Head, but very few were present in the smaller towns. Usually in the spring a considerable number of aecia develop on the buckthorn, especially in Southern Saskatchewan. In 1922 owing to favourable conditions for infection, the buckthorns were very heavily infected with aecia. The leaves and young twigs were literally covered with aecia, so the buckthorns appeared yellow at a distance. Aecia were not very common in Northern Saskatchewan, though a considerable number were present on the buckthorn about Saskatoon. To make sure that these shrubs were infected by the Crown Rust of Oats and not by forms connected with grasses, a number of pots of oats were inoculated in the greenhouse with collections of aecia made at Outlook, Regina, and Saskatoon. Very heavy infection followed, showing clearly that the oat form was present on the buckthorn. A very heavy infection of Crown Rust developed in Southern Saskatchewan, practically all of the leaves showing severe infection. This must have reduced the yield to a considerable extent. As far as observations went the rust on oats was heavier in the vicinity of buckthorns. In Northern Saskatchewan, including Saskatoon and northwards very little Crown Rust was present.

There was a very heavy infection of the buffalo berries, *Lepargyrea argentea* (Nutt.) Greene, and *L. canadensis* (L) Greene, and the wolf berry (*Elaeagnus commutata* Bernh.) which are so abundant on the prairies. As the aecia are not definitely connected, but are believed to belong to a coronate rust, aecia from these shrubs were collected and several inoculations made on oats without infection. Successful inoculation resulted on several grasses, but a full report on this work will be left for another time.

From the observations made this season it would seem that the buckthorn, (*Rhamnus cathartica* L.) is a serious menace to the oat crop. It seems probable that it is at least an important source of infection of the Crown Rust, and it should be classed along with the common barberry and its planting and importation forbidden. The buckthorns that have already been planted should be eradicated. It is probable that in most cases the shrubs would be destroyed, when once their nature is pointed out to the owner.

The Crown Rust of Oats was very severe also in Southern Manitoba, but not much survey work was done in that province this season.

COMMON BARBERRY SURVEY

Some time was given to a survey for the presence of common barberries in Saskatchewan. A number of the smaller towns accessible by railway were surveyed; some of these had been previously inspected. The following is a list of those surveyed this season, and found free from buckthorns and common barberries. Alameda, Battleford, Bulyea, Canora, Carnduff, Humboldt, Lashburn, Lloydminster, Melfort, Melville, Nokomis, Rosthern, Stoughton, Watrous, Weyburn, Yorkton, Young and Zelma. No new barberries were located, except three in the city of Regina.

A group of twelve, near Saskatoon, was destroyed, also a hedge on a farm near Outlook. These were located the previous season. Three barberries at Prince Albert and ten in Saskatoon were kept under observation during the season, but no aecia developed. Those in Saskatoon have been examined for several years and no aecia found.

In Saskatchewan the following barberries remain, as far as known. North Battleford 2, Prince Albert 3, Saskatoon 13, Indian Head 1, Regina 3, Imperial 1. Barberries have been destroyed as follows, since the survey was begun. Regina Public Parks, 100, Moose Jaw hedge, Indian Head, 100, Outlook, hedge, Saskatoon (Glencairn Farm), 12. In Regina public parks, and a few other places, the eradication was carried out under the direction of the Weed Commissioner of the Province of Saskatchewan.

The barberries at Glencairn farm, near Saskatoon, developed aecia and were shedding spores on May 30. The susceptible grasses in the vicinity became infected, the first collection being on Western Rye grass (*Agropyron tenerum* Vasey) on June 24, the rust being in the red and black stage. Later the rust spread about 50 yards, and was collected on *A. tenerum* Vasey, *Hordeum jubatum* L., and *Elymus Macounii* Vasey. The season was dry and no further spread could be traced to that source. No wheat fields were near.

As it was desirable to know if the aecia present on barberry belonged to the wheat form of the stem rust, inoculations were tried in the greenhouse on wheat. Collections of aecia on Common Barberry were made at Glencairn Farm, near Saskatoon, and at Outlook. Inoculations were made on wheat and barley, and heavy infection followed, which showed that it was the wheat form that was present on the barberries.

A small shipment of barberries from an Eastern firm was sent to Imperial, but they were not planted when the consignee was informed that importation and planting were illegal.

MANITOBA

As there was no pathologist stationed at Winnipeg little survey was done this season, but the following towns were inspected: Deloraine, Elgin, Melita, Napinka, Oak Lake, Reston, Virden. One shrub was reported from Morden.

Most of the towns accessible to the railways were surveyed in 1919, 1920 and 1921, and no barberries found. In the city of Brandon three barberries were located and destroyed. A number were located in the public parks, cemeteries, and private grounds of the city of Winnipeg. These have all been eradicated, chiefly through the efforts of Professor Jackson, of the Agricultural College, and Dr. Buller, of the University of Manitoba. Barberries still remain on the private grounds, in all one hundred and thirty-five (135) bushes in nine different locations.

On August 10, Mr. Lambert, Agent, United States Cereal Disease Investigations, reported that a hedge of heavily infected barberries seventy feet long had been located at Snowflake, Man., on June 26, and that stem rust at that date was found near on quack grass, wild barley, rye, and barley, which had evidently spread from the barberries. No rust was found on the nearby wheat. As the danger of infection was past when reported by Mr. Lambert and the inspectors engaged on other work, a visit to this place was deferred to the spring. It is probable that a few barberries remain that have not been located, but the survey indicates that practically all the towns are free from barberries.

There remain in Manitoba, as far as our records go, the following barberries: Winnipeg, 135; Snowflake, hedge 70 feet long; Farm near Brandon, 3.

ALBERTA

No systematic survey has been made in Alberta, but none have been observed in the various places visited. Rust is practically absent in the larger part of that province in most seasons.

Experiments with Copper Carbonate Dust and Other Substances for Smut Control

It has been shown by many experiments in Australia, California and Washington, that dusting with copper carbonate is effective in controlling bunt or stinking smut of wheat. It was also found that generally the yield was increased by this treatment. Experiments in 1921 in Minnesota gave perfect control of both bunt of wheat and smut of oats by using two ounces of copper carbonate dust per bushel. As the dusting method offers some advantages over the wet treatment by formaldehyde, it was thought advisable to test this method in the prairie provinces of Canada. These experiments were carried out in co-operation with the Dominion Experimental Farms at Indian Head, Scott, Rosthern, Lacombe, and the Dominion Laboratory of Plant Pathology at Saskatoon. All the seed was treated at the Dominion Laboratory of Plant Pathology at Saskatoon, and forwarded to the various experiment stations. Seeding and other operations including harvesting and threshing were done by the Experiment Stations. The estimate of smut percentage in the plots was made by a member of the Dominion Laboratory of Plant Pathology.

It was also thought advisable to test copper sulphate and lime dust as well as copper carbonate dust in comparison with the ordinary formalin treatment. The dusts used were prepared and generously supplied by Mr. Arthur Kelsall, of the Dominion Entomological Laboratory at Annapolis Royal, N.S. An outline of these experiments is given, and the results of the experiments in tabular form. (Tables No. 1 and No. 2.)

OUTLINE OF EXPERIMENTS

Seed.—Marquis wheat; badly smutted, obtained from the grain inspector at Fort William, Ont., and Winnipeg, Man. The seed used at Indian Head Experimental Farm was Marquis wheat, heavily smutted artificially.

Treatment and Method.—No. 1. Formaldehyde solution, 1 to 320; seed dipped five minutes and then covered one hour. Formaldehyde was tested by Professor Thorvaldson of the Department of Chemistry, University of Saskatchewan, and the solution was made up to proper strength.

No. 2. Copper carbonate dust. The commercial form of copper carbonate in which the copper is all present in that form, the material contains calcium and other impurities. This was used at the rate of two ounces per bushel and shaken thoroughly by hand in a container with the seed.

No. 3. Dehydrated copper sulphate dust and hydrated lime, 15 per cent metallic copper. (·43 pounds dehydrated copper sulphate, ·57 pounds hydrated lime). Also used at the rate of two ounces per bushel, shaken thoroughly by hand in a container with the seed.

No. 4. Check. No treatment.

Germination of seed.—One hundred seeds were tested in each treatment for each station, in sand and soil in the greenhouse and in plates with blotting paper.

Size of the plots.—All the plots were one-fortieth of an acre, seeded in duplicate, except at Rosthern and Indian Head Dominion Laboratory, where only one plot was used for each treatment.

Moisture.—The moisture content of the soil at planting time at all these stations was abundant.

Estimate of smut.—The amount of smut present was estimated by selecting 100 heads from five different places in each plot, chosen at random, and the

percentage based on the amount of smutted heads present in the 500 thus selected. In the formaldehyde treatment the whole plots were examined carefully and no trace of smut found.

Smut present.—In the wheat experiments the smut present was mostly *Tilletia Tritici* (Bjerk.) Wint. and a small amount of *T. laevis* Kühn. In the oat experiments it was *Ustilago levis* (K. & S.) Magn.

Yield.—The yield is given in bushels and the decimal of a bushel per acre.

The names of the collaborators in this work were as follows:—

Indian Head.—N. D. MacKenzie, Superintendent, Dominion Experimental Farm.

Rosthern.—F. V. Hutton, Assistant Superintendent, Dominion Experimental Farm.

Scott.—E. Vannice, Assistant Superintendent, Dominion Experimental Farm.

Lacombe.—G. E. DeLong, Assistant Superintendent, Dominion Experimental Farm.

Indian Head Dominion Laboratory.—The experiments at Indian Head Dominion Laboratory were supervised by the staff of the Dominion Laboratory at Saskatoon.

TABLE No. 1—EXPERIMENTS SEED TREATMENT FOR CONTROL OF BUNT OF WHEAT AND SMUT OF OATS

Wheat (Marquis)

Treatment	Germination per cent			Per cent average	Date seeded	Date harvested	Per cent smut present	Yield per acre in bush.
	Soil	Sand	Plates					
Indian Head Experimental Farm—								
Formaldehyde	86	96	97	93·0	May 19	Aug. 28	0·0	53·33
Copper carbonate dust	90	.....	94	92·0	"	"	0·4	54·0
Copper sulphate and lime	94	98	97	96·3	"	"	0·7	58·66
No treatment (check)	96	90	98	94·6	"	"	5·5	53·66
Lacombe Experimental Farm—								
Formaldehyde	67	90	81	79·3	May 1	Aug. 31	0·0	26·33
Copper carbonate dust	100	82	99	93·7	"	"	0·6	25·33
Copper sulphate and lime	91	90	99	93·3	"	"	2·2	25·33
No treatment (check)	98	100	99	99·0	"	"	16·9	25·33
Rosthern Experimental Farm—								
Formaldehyde	82	94	98	91·3	May 8	Aug. 31	0·0	39·33
Copper carbonate dust	98	100	99	99·0	"	"	1·33	39·33
Copper sulphate and lime	98	96	97	97·0	"	"	5·0	38·66
No treatment (check)	100	98	96	98·0	"	"	17·7	34·66
Scott Experimental Farm—								
Formaldehyde	67	90	81	79·3	May 18	Aug. 21	0·0	16·33
Copper carbonate dust	100	82	99	93·6	"	"	0·0	17·33
Copper sulphate and lime	91	90	99	93·3	"	"	tr.	16·56
No treament (check)	100	100	99	99·6	"	"	5·4	18·16
Indian Head Dominion Laboratory—								
Formaldehyde	74	96	43	71·0	May 19	.....	0·0	.....
Copper carbonate dust	90	86	94	90·0	"	.....	1·0	.....
Copper sulphate and lime	94	94	96	94·6	"	.....	2·0	.....
No treatment (check)	90	90	96	92·0	"	.....	15·8	.....

Oats (Banner)

Indian Head Dominion Laboratory—								
Formaldehyde	94	94	93	93·6	.....	.....	0·0	.....
Copper carbonate dust	96	100	94	96·6	.....	.....	1·0	.....
Copper sulphate and lime	100	100	93	97·6	.....	.....	5·6	.....
No treatment (check)	86	100	100	95·3	.....	.....	7·5	.....

TABLE NO. 2—AVERAGES FOR ALL THE STATIONS, INDIAN HEAD, LACOMBE, ROSTHERN, SCOTT AND INDIAN HEAD DOMINION LABORATORY

Wheat (Marquis)

Treatment	Average percentage germination	Average percentage smut present	Average yield per acre in bushels
Formaldehyde	82·78	0·0	33·83
Copper carbonate dust	93·66	0·66	33·99
Copper sulphate and lime	94·90	1·98	34·80
No treatment (check)	96·64	12·26	32·95

It will be seen from the results that in all the experiments the formaldehyde solution gave perfect control. Copper carbonate dust was effective where the percentage of smut was low. Copper sulphate and lime were not so effective, and do not seem worthy of further trial.

Both in the field and in the germination tests in the greenhouse, formaldehyde markedly retarded growth. The percentage of germination averaged about 10 per cent higher with copper carbonate dust than with formaldehyde. It does not seem safe to draw any conclusions from the yields. They are too close to be significant.

In the experiments the seed was placed in a container with the dust and shaken thoroughly by hand. It was found in the experiments in Australia that when a machine was used for dusting with the copper carbonate dust the grain was free from smut, while hand treated seed showed a small amount of smut. It may be that machine treatment would have given better results in the experiments described. The seed was however shaken thoroughly by hand treatment.

It seems advisable to test out dusting with copper carbonate another year, as the dusting method has many advantages over the wet method. The grain can be treated in advance of seeding without injury, and there is no seed injury or retarded growth. The wetting of the seed and danger to germination by freezing before seeding is also eliminated and there is less danger of reinfection from smutty sacks, etc.

On the other hand the cost of the materials for treatment is increased. The materials for copper carbonate treatment would cost at least about 2 to 3 cents per bushel of seed, while the formaldehyde would cost less than a cent per bushel at present prices. The cost of labour would however probably be less in the dust treatment.

A request from a firm in the United States to test Seed-O-San, a dust for seed treatment, and Chlorophol, a substance to be used in solution, was complied with. Both of these substances were tested for the control of smut. A gas treatment by the "Gas Grain Pickler" method was tested last year, (See Division of Botany Report, page 68, 1922) and found unsatisfactory. A further test was made this year. The results of these experiments are given in Table No. 3 as well as the results of germination tests of the treated seed. It will be seen from the results given in table No. 3, that Seed-O-San and Chlorophol were not very effective in controlling smut, and the gas treatment was unsatisfactory.

TABLE No. 3—EXPERIMENTS IN SEED TREATMENT FOR CONTROL OF BUNT OF WHEAT

Treatment	Germination percentage			Average	Date seeded	Date harvested	Percentage smut present	Yield per acre
	Soil	Sand	Plates					
Indian Head Experimental Farm—								
Seed-O-San	90	80	96	88·66	May. 19	Aug. 28	3·1	60·66
Chlorophol	96	98	97	97·0	"	"	1·8	61·33
No treatment (check)	96	90	98	94·6	"	"	5·5	53·66
Rosthern—								
Seed-O-San	96	98	98	97·33	May. 8	Aug. 31	6·83	35·33
No treatment (check)	100	98	97	98·33	"	"	17·7	34·66
Scott—								
Gas treatment	87	.....	90	88·5	May 18	Aug. 21	3·0	16·66
No treatment (check)	98	100	99	99·0	"	"	5·4	18·10
Indian Head Dominion Laboratory—								
Seed-O-San	92	86	90	89·33	May 19	Aug. 25	4·8	.....
Chlorophol	94	88	96	92·66	"	"	3·6	.....
Gas treatment	75	88	94	85·6	"	"	11·3	.....
No treatment (check)	90	90	96	92·0	"	"	15·8	.....

Further tests were made with copper carbonate mixed with various substances, as infusorial earth, talc, etc. If the mixtures were found effective the addition of these substances would reduce the cost.

All these mixtures were also prepared and supplied by Mr. Arthur Kelsall of the Dominion Entomological Laboratory at Annapolis Royal, N.S., who furnished the following information. They were all made up so that they contained 15 per cent of metallic copper. The copper carbonate used was the commercial product mentioned previously. The following is a list of the mixtures used:—

Copper carbonate (comm.), hydrated lime; 15 per cent metallic copper ·75 pounds copp. carb., ·25 pounds hydrated lime.

Copper carbonate (comm.), infusorial earth; 15 per cent metallic copper ·75 pounds copp. carb., ·25 pounds inf. earth.

Copper carbonate (comm.), talc.; 15 per cent metallic copper ·75 pounds copp. carb., ·25 pounds talc.

Dehydrated copper sulphate, infusorial earth; 15 per cent metallic copper ·43 pounds dehyd. copp. sulp., ·57 pounds infus. earth.

Dehydrated copper sulphate, talc.; 15 per cent metallic copper, ·43 pounds dehyd. copper sulphate, ·57 pounds talc.

The unmixed materials used were also generously furnished by Mr. Kelsall. A list follows:—

Dehydrated copper sulphate, 35 per cent metallic copper.
Bordeaux mixture (commercial) 12 per cent metallic copper.
Magnesium Bordeaux mixture (commercial) 20 per cent metallic copper.
Sulphur dust.
Bacterized sulphur dust.

The sulphur was superfine, 95 per cent passing through a 200 mesh to the inch screen. The dehydrated copper sulphate was the compound $CuSo_4 . H_2O$, as this compound is more practical to make and handle than the strictly anhydrous material.

It will be seen from table No. 4, that the mixtures were not as efficient as copper carbonate dust alone. A number of other substances were tested, including sulphur. The results are given in table No. 4. The sulphur reduced the smut to a considerable extent and seems worthy of further test, owing to its

cheapness, though the results obtained in this experiment cannot be regarded as satisfactory.

The nickle carbonate dust was sent by Dr. J. H. Faull to the Division of Botany to be tested for smut control. It was forwarded here by the latter for additional tests.

TABLE No. 4—EXPERIMENTS IN SEED TREATMENT FOR CONTROL OF BUNT OF WHEAT

Treatment	Average germination percentage	Date seeded	Percentage of smut present
Indian Head Dominion Laboratory—			
Formaldehyde solution	70·0	May. 19	0·0
Copper carbonate and lime	90·3	"	3·1
Copper carbonate and infusorial earth	93·66	"	1·6
Copper carbonate and talc	96·0	"	2·5
Copper sulphate	91·66	"	0·8
Copper sulphate and infusorial earth	87·00	"	1·3
Copper sulphate and talc	90·33	"	1·0
Bordeaux mixture dust	96·0	"	3·3
Magnesium Bordeaux dust	89·0	"	2·3
Sulphur dust (bacterized)	90·66	"	9·1
Nickle carbonate dust	90·66	"	3·3
Sulphur dust	90·66	"	3·5
Sulphur dust	91·0	"	2·5
Check	88·0	"	15·8
Oats (Banner)			
Formaldehyde solution	93·66	"	0·0
Copper carbonate	96·66	"	1·0
Copper carbonate and talc	98·66	"	6·3
Copper carbonate and lime	97·66	"	5·6
Copper carbonate and infusorial earth	98·33	"	6·9
Seed-O-San	99·66	"	7·9
No treatment (check)	95·33	"	7·5

As formaldehyde solution injures seriously the germination of Liberty oats, even with the troublesome presoak method, a number of dusts and other substances were tested for smut control, hoping to find effective control without seed injury. A set of experiments was carried out at Lacombe in co-operation with the Superintendent, Mr. F. H. Reed. The result of the experiments at Indian Head and Lacombe are given in table No. 5. The materials used were the same as those already described.

TABLE No. 5.—EXPERIMENTS IN SEED TREATMENT FOR CONTROL OF SMUT OF LIBERTY OATS

	Treatment	Germination per cent			Average	Date seeded	Date harvested	Per centage of Smut present	Yield per acre in pounds
		Soil	Sand	Plates					
Indian Head Dom. Lab.	Formaldehyde	4	24	82	36·66	May 19	.....	0·0	.....
	Chlorophol	64	86	85	78·33	" 19	.....	39·6	.....
	Copper carbonate	52	88	94	78·0	" 19	.....	1·	.....
	Copper sulphate plus lime	94	92	97	94·33	" 19	.....	4·9	.....
	Copper sulphate plus infus earth	60	90	89	79·66	" 19	.....	3·5	.....
	Seed-O-San	78	84	98	86·66	" 19	.....	37·1	.....
	No treatment (check)	68	66	99	77·66	" 19	.....	60·8	.....
Lacombe.... Exp. Farm	Formaldehyde	19	16	44	26·33	May 2	Aug. 22	0	1,260
	Pre-soak formaldehyde	20	60	79	53·	" 2	" 12	1·5	1,040
	Copper carbonate	52	88	89	76·33	" 2	" 11	10·	960
	Copper sulphate plus lime	71	76	85	77·33	" 2	" 11	20·	780
	No treatment (check)	32	62	95	63·	" 2	" 12	93·	420

It will be noticed that though the germination of the Liberty oats was severely injured by the ordinary formaldehyde treatment, yet at Lacombe this grain stooled freely, and thus outyielded the other plots. This result was probably exceptional, and due to a favourable fall. It will be seen that this plot was late in maturing.

Copper carbonate dust treatment gave no seed injury, and fairly effective control. It seems probable that if the seed was not heavily smutted, dusting with copper carbonate would prove effective in controlling smut in Liberty oats without seed injury.

Experiments for Smut Control at the Dominion Experimental Farm, Kentville, N.S., in 1922

Experiments were carried out by W. S. Blair, Superintendent of the Dominion Experimental Farm at Kentville, at the suggestion of the Division of Botany, Ottawa. A summary of these experiments is included here:—

OUTLINE OF EXPERIMENTS

The varieties of oats used were Liberty (hull-less) and Irish King. The latter variety was obtained from a farmer and was known to be from a field showing much smut the previous season. The other variety was grown at Kentville. These were treated on the day of seeding, June 10. The formaldehyde treatment was by spraying with a strong solution (equal parts water and formaldehyde). In the dust treatments two to three ounces per bushel were used. The area was uniform and a good seed-bed and ample moisture were obtained. The plots were $\frac{1}{20}$th acre each. The seed was sown with a seed drill. The stand was good throughout and so far as could be determined the germination on all the plots was the same as on the control plot. Samples were taken from the centre of each plot and the smutted and healthy heads counted with results as tabulated. The plots were threshed and the yields per acre as given obtained.

Experiments in Smut Control of Oats Dominion Experimental Farm, Kentville, N.S.

Irish King Oats (hulled)

—	No. of heads counted	No. of smutted heads	Percent smut	Yield per acre in bushels
Copper sulphate and lime (Wet treatment)	902	50	5·54	30·0
Copper carbonate dust	856	56	6·54	37·94
Copper sulphate and lime dust	958	173	18·06	36·47
Nickel carbonate	705	39	5·53	36·47
Formaldehyde Spray	1,000	0	0·0	40·88
Seed-O-San	826	227	27·48	35·30
Chlorophol	965	132	13·68	32·94
Check	915	180	19·67	32·95

Liberty Oats (hull-less)

Copper sulphate and lime (Wet treatment)	1,000	7	0·7	26·76
Copper carbonate dust	636	6	·94	27·06
Copper sulphate and lime dust	684	26	3·8	26·47
Nickel carbonate	1,220	20	1·64	24·7
Formaldehyde spray	1,080	5	·46	24·1
Seed-O-San	2,352	899	38·22	
Chlorophol	2,557	740	28·94	
Check	959	409	42·6	17·06

Of the dust treatments copper carbonate gave the best results, in the case of hull-less oats practically eliminating smut, and giving almost as good control as the spray treatment with formeldehyde and the wet treatment with copper sulphate and lime. In hulled oats none of the treatments used were effective except the formaldehyde spray.

Experiments on the Control of Western Rye Grass Smut, *Ustilago Agropyri* Clinton

The experiments for the control of Western Rye grass smut were continued (See Division of Botany Report for 1921, Page 102, and 1922, Page 67). As in previous years the ordinary formalin treatment gave complete control. Experiments were carried out at Saskatoon in rows 16 feet long, one row for each treatment. Owing to the dry summer the rows did not head very abundantly. The results of the experiments are given below:—

No. of row	Treatment	Total number of heads	No. of smutted heads	Per cent smut
1	Formalin	232	0	0·0
2	Copper carbonate	415	44	10·6
3	Check	280	69	24·64

Control experiments have now been carried on for five years, and in every experiment the ordinary formalin treatment gave perfect control of this smut and there was no seed injury evident. Copper carbonate dust which was tried this year for the first time was unsatisfactory.

Germination of the Spores of Oat Smut

The spores of oat smut, *Ustilago levis* (K. & S.) Magn. were collected at Rosthern from sheaves that had been exposed during the winter without protection. These were tested for germination in hanging drops of water. The average of several tests gave 19 per cent germination. From these tests it is evident that the spores of oat smut readily survive the winter in Northern Saskatchewan.

Preliminary Studies of Root-rots of Cereals Caused by *Fusarium* spp.

Observations made during the summers of 1921 and 1922 show a general distribution of root rot trouble in the cereal crops of the prairie provinces. Considerable of this root rot is caused by fungous parasites; in some cases the injury may be very slight, yet in other cases the damage done reached proportions of real economic significance. In the observations of the writer it was noted that species of fungi of the genus *Fusarium* were responsible in a large measure for much of this trouble. In the past two seasons several different types of *Fusaria* were isolated from wheat and oat plants suffering apparently from root rot. Whether all of these will prove to be true pathogens remains for further investigation.

In the summer of 1921 a *Fusarium* sp. was isolated from oats which were suffering from a severe attack of root rot. It was thought wise to determine if possible the pathogenicity of this species before going into a more detailed study of the problem, as it is of considerable importance to know whether one is actually working with a true pathogen. Forthwith, a number of experiments were

carried out during the winter of 1921-22, using the species originally isolated from oats. At the same time cultural and morphological studies of this particular species have been carried on, but as it has not been definitely identified, these are not contained in this preliminary report; it is hoped, however, to soon have this species identified and thus put the work on a specific basis.

INOCULATION EXPERIMENTS

Method.—The regular five-inch greenhouse pots filled with ordinary potting soil were used. These were sterilized by placing in the autoclave and subjecting them to fifteen pounds pressure for from thirty to forty-five minutes, on three successive days. The seeds to be used were surface sterilized; this was done by first washing the seeds in alcohol (95 pr cent) or absolute synthol, then submerging them in bichloride of mercury (1-1000) for five minutes, after which they were washed three times in sterile water. The seeds to be planted in the control pots were immediately planted after the final wash. Those to be treated were inoculated after the final wash. For inoculating the seed a suspension of the *Fusarium* conidia was used. To make a suspension sufficient sterile water was taken, depending upon the number of seeds to be inoculated, about ten cubic centimeters for each thirty seeds. To this water the conidia were added, taking them from the sporodochial masses growing on vigorous agar culture, to make a fairly dense suspension. The seeds to be inoculated were immersed in this suspension and the whole slightly agitated, then with sterile forceps the seeds were removed and planted and the suspension poured over them. In the controls sterile water was poured over the seed to make equal moisture conditions.

Records.—After the plants had reached a height of from three to four inches the first notes and counts were taken. Then, if it was thought necessary, further notes were taken later.

Experiment 1

A comparison in susceptibility of four common varieties of oats to a *Fusarium* sp. isolated from oats. See Fig. 6: 1, 2 and 3.)

Exp. 1 TABLE No. 1

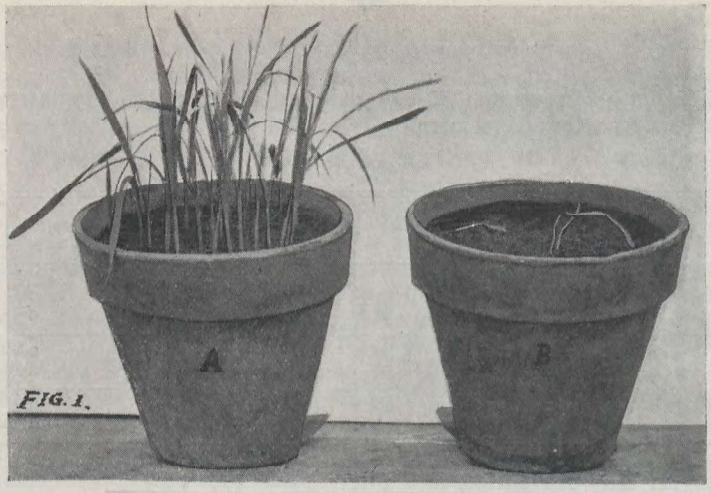
Variety	—	Number of seeds used	Plants normal	Plants affected	Plants doubtful	Seed failing to germinate
Banner	Treated pot...	30	8	11	0	11
	Control pot...	29	27	0	0	2
Victory	Treated pot...	31	0	6	0	25
	Control pot...	29	29	0	0	0
Ligowo	Treated pot...	30	2	10	0	18
	Control pot...	30	28	0	0	2
Gold Rain	Treated pot...	30	8	8	0	14
	Control pot...	30	30	0	0	0

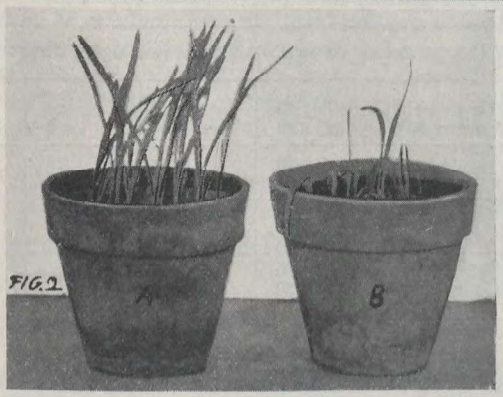
Experiment 2

A duplication of Experiment 1. First notes taken twelve days after seeding. Second notes taken a few days later.

Exp. 2 — Table No. 2

Variety	—	Number of seeds used	Plants normal	Plants affected	Plants doubtful	Seed failing to germinate
Banner	Treated pot...	33	20	10	0	3
	Control pot...	29	26	0	0	3
Victory	Treated pot...	30	18	11	0	1
	Control pot...	31	27	0	0	4
Ligowo	Treated pot...	30	24	6	0	0
	Control pot...	30	30	0	0	0
Gold Rain	Treated pot...	30	15	4	0	11
	Control pot...	30	29	0	0	1
Second Notes Taken a Few Days After the Above Were Taken						
Banner	Treated pot...	33	16	14	0	3
	Control pot...	29	26	0	0	3
Victory	Treated pot...	30	13	16	0	1
	Control pot...	31	27	0	0	4
Ligowo	Treated pot...	30	16	14	0	0
	Control pot...	30	30	0	0	0
Gold Rain	Treated pot...	30	15	4	0	11
	Control pot...	30	29	0	0	1





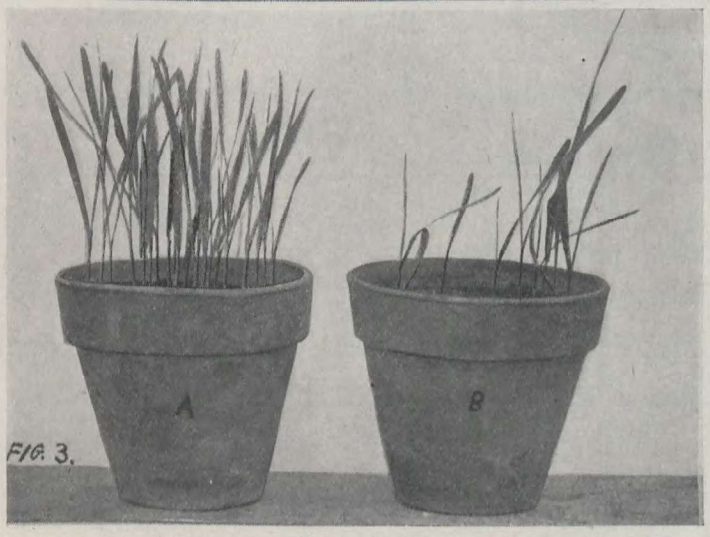


FIG. 6.—(1-3).

Fig. 1.—Victory oats: (A) control pot, (B) treated pot, seed inoculated with a *Fusarium* sp. Note the poor germination and wilted plants. (From Exp. 1).

Fig. 2.—Ligowo oats: (A) control pot, (B) treated pot, seed inoculated with a *Fusarium* sp. (From Exp. 1).

Fig. 3.—Gold Rain oats: (A) control pot, (B) treated pot, seed inoculated with a *Fusarium* sp. (From Exp. 1).

Experiment 3

Moisture relations. Four sets of pots were used. Each set included two pots, one inoculated and the other held as a control. They were watered throughout the experiment as follows:—

Set No. 1.—Watered normally, according to requirements.

Set No. 2.—Watered once each 24 hours, in the evening.

Set No. 3.—Watered twice; morning and night.

Set No. 4.—Watered beyond requirements and kept covered with a bell jar.

TABLE No. 3

Exp. 3—First Notes

Variety Ligowo	—	Number of seeds used	Plants normal	Plants affected	Plants doubtful	Seed failing to germinate	Remarks
No. 1.....	Treated pot...	30	13	17	0	0	
	Control pot...	30	28	0	0	2	
No. 2.....	Treated pot...	30	12	11	0	7	
	Control pot...	30	30	0	0	0	
No. 3.....	Treated pot...	30	16	10	0	4	
	Control pot...	30	27	0	1	2	The doubtful plant was backward but not wilted.
No. 4.....	Treated pot...	30	26	4	0	0	
	Control pot...	30	26	0	0	4	

Exp. 3—Second notes

No. 1.....	Treated pot...	30	12	18	0	0	
	Control pot...	30	27	0	1	2	The doubtful plant was retarded in growth.
No. 2.....	Treated pot...	30	10	13	0	7	
	Control pot...	30	28	0	2	0	The doubtful plants were retarded in growth.
No. 3.....	Treated pot...	30	14	12	0	4	
	Control pot...	30	27	0	1	2	The doubtful plant was retarded in growth
No. 4.....	Treated pot...	30	5	25	0	0	
	Control pot...	30	26	0	0	4	

Experiment 4

A comparison experiment to determine the susceptibility of barley and wheat to a root rotting *Fusarium* sp. originally isolated from oats. Table 4. The pots used in this experiment were re-seeded in an attempt to determine whether the parasite remains any length of time in the soil in a virulent state. The seeds were surface sterilized by the usual method before each re-seeding. Table 5 gives the results of the first re-seeding, and as barley and wheat were still negative only the pot seeded to oats was continued. Table 6 gives the results of two continued re-seedings of oats which gave negative results, and so were discontinued.

Exp. 4

TABLE 4.

Variety	—	Number of seeds used	Plants normal	Plants affected	Plants doubtful	Seed failing to germinate	Remarks
Oats.....	Treated Pot No. 1.....	10	0	4	4	2	
	Treated Pot No. 2.....	10	3	5	1	1	
	Control pot...	10	9	0	0	1	
Barley.....	Treated Pot No. 1.....	10	8	0	2	0	
	Treated pot No. 2.....	10	6	0	0	1	3 plants were injured.
	Control pot...	10	9	0	0	1	
Wheat.....	Treated pot No. 1.....	10	9	0	0	1	
	Treated pot No. 2.....	10	9	0	0	1	
	Control pot...	10	10	0	0	0	

Exp. 5.

TABLE 5

Variety	—	Number of seeds used	Plants normal	Plants affected	Plants doubtful	Seed failing to germinate
Oats.....	Treated pot No. 1.....	10	9	0	0	1
	Treated pot No. 2.....	10	0	9	0	1
	Control pot...	10	8	0	0	2
Barley.....	Treated pot No. 1.....	10	10	0	0	0
	Treated pot No. 2.....	10	8	0	0	2
	Control pot...	10	9	0	0	1
Wheat.....	Treated pot No. 1.....	10	9	0	0	1
	Treated pot No. 2.....	10	10	0	0	0
	Control pot...	10	10	0	0	0

TABLE 6

Variety	Second reseeding	Plants normal	Plants affected	Plants doubtful	Seed failing to germinate
Oats.....	First test. Notes taken 20 days after re-seeding.....	8	0	0	2
	Third re-seeding. Last test. Notes taken 15 days after re-seeding.....	10	0	0	0

EXPERIMENT 5

A comparison experiment of oats, barley and wheat, similar to Experiment 4.

TABLE NO. 7

Exp. 5.

Variety	—	Number seeds used	Plants normal	Plants affected	Plants doubtful	Seed failing to germinate	Remarks
Oats.....	Treated pot No. 1.....	30	19	7	0	4	
	Treated pot No. 2.....	30	18	8	0	4	
	Control pot...	30	26	0	1	3	The doubtful plant was backward but did not show signs of wilt.
Barley...	Treated pot No. 1.....	30	25	4	0	1	
	Treated pot No. 2.....	30	19	9	0	2	
	Control pot...	30	24	0	3	3	The doubtful plant was backward but did not show signs of wilt.
Wheat...	Treated pot No. 1.....	30	20	9	0	1	
	Treated pot No. 2.....	30	15	8	0	7	
	Control pot...	30	20	0	8	2	The doubtful plant was backward but did not show signs of wilt.
	SECOND NOTES 3 DAYS LATER						
Oats.....	Treated pot No. 1.....	30	12	14	0	4	The plant which appeared backward at the first note taking had recovered at this date.
	Treated pot No. 2.....	30	12	14	0	4	
	Control pot...	30	27	0	0	3	
Barley...	Treated pot No. 1.....	30	20	9	0	1	
	Treated pot No. 2.....	30	17	11	0	2	The plants which were backward at the first note taking had recovered at this date.
	Control pot...	30	27	0	0	3	
Wheat...	Treated pot No. 1.....	30	19	10	0	1	
	Treated pot No. 2.....	30	15	8	0	7	Most of the backward or doubtful plants had recovered, the remaining two did not show root rot trouble.
	Control pot...	30	26	0	2	2	

CONCLUSIONS

This work being of a preliminary nature, and consequently incomplete, no definite conclusions can be drawn. The pathogenicity of this *Fusarium* sp., for oats, wheat and barley, has been quite clearly shown in the foregoing tables. From time to time the organism was recovered from the treated plants and used again for inoculating in following experiments, and as the cultural char-

acteristic and root rot produced agreed in every case, we feel fairly confident of having worked with a pure culture. At times, plants in the control pots would be backward in growth, or their roots might reveal slight discolorations of a suspicious nature; to isolate this organism from such sources, however, always resulted in failure. Experiment 3, table No. 3, gives an indication of moisture relations. Experiment 5, tables No. 4, 5 and 6, was an attempt to determine how long the parasite might remain in the soil after one inoculation and continuous reseeding. The oats were the only ones to be affected in the second and third reseeding.

From our experiments and cultural studies suggestions have been obtained which should help in carrying on this investigation of the *Fusarium* problem to some definite conclusions. (This study and report was made by P. M. Simmonds.)

Plant Disease Survey

Some time was given to a plant disease survey. A summary of this work is included in "A Survey of the Prevalence of Plant Diseases in Canada," compiled by Mr. F. L. Drayton of the Division of Botany, so that it does not seem necessary to report on this work here, except to note some of the more important or new diseases.

The Rhynchosporium leaf spot of barley, caused by *Rhynchosporium Secalis* (Hein.) Davis was present at Edmonton on the barley plots of the Agricultural College. It was rather local in occurrence, but seemed to be quite vigorous. It was noticed on a few plants in the same locality the previous year. This disease has given trouble in California and is present in the Northern Mississippi Valley district. From the observations it seems probable that it may become prevalent in Western Canada.

Coryneum Blight of Cherries. A blight was very severe on sand cherries in the orchard of the Agricultural College at Saskatoon. The leaves and fruit were very severely attacked. The fungus present was determined as *Coryneum Beyerinckii* Oud. This blight has been causing damage for several years in this orchard. It would seem from these observations that it may prove a serious enemy of cherry growing on the prairies.

Plum Pockets caused by *Exoascus Pruni* Fuck. This disease was very prevalent in Western Canada from Winnipeg to Saskatoon. In some orchards the fruit was practically all destroyed. It was prevalent the preceding year in many orchards. It seems probable that when plums become more common in Western Canada this disease will be very troublesome. There was a marked development in many cases of abnormal and diseased twigs on the cherries. The sand cherries were also severely attacked by powdery mildew (*Podosphaera Oxyacanthae* (D.C.) DeBary.

Stem Rust of Wheat (*Puccinia graminis Tritici* (Pers.) Eriks. & Henn.). A considerable time was spent in a field survey to determine the time of first appearance of stem rust and its spread, and from this if possible to get information on the source of infection in the spring.

Stem Rust of Wheat (*Puccinia graminis Tritici* (Pers.) Eriks. & Henn.) collected in southern Manitoba on July 10 by Mr. H. Groh; on the same date collections were made by Mr. W. E. Lake at Morden. Collections were made at Melville, Sask., on July 12. It was found in all fields examined in southern Manitoba and Saskatchewan about a week later, but not severe. In the first week of August collections were first made at Saskatoon and Rosthern, and rust was general in northern Saskatchewan, though only a few pustules here and there in each field by the second week. Late in the season rust was present at Edmonton on very late wheat, but the main crop showed no rust. A few pustules were found at Lacombe in Alberta on heavily irrigated land, but none

elsewhere. There was a considerable development of rust in southern Saskatchewan, but little injury was done by stem rust this season. This was probably due to the dry weather that prevailed in July. Not since 1915 has wheat been less injured by rust in Western Canada.

Blight of Durum Wheats. In several fields Durum wheat was found to be severely attacked by *Helminthosporium sativum* (P.) K. & B. It attacks the heads causing a blight, the nodes also are attacked. This is very common where Durum wheat is grown in the heavier lands, especially during wet seasons. Durums have a tendency to lodge and when this occurs the disease is very severe. This fungus frequently attacks the roots and causes a rootrot. From the observations made this year and several preceding years, it seems probable that Durum wheats are more likely to suffer from this and several other diseases than common wheat in Western Canada. For these reasons Durum wheat seems unsuitable, except in the drier districts.

Determination of Plant Diseases

Quite a number of samples of diseased plants, vegetables, etc., were sent in to the laboratory for determination of the cause of the disease. Among these were quite a number of samples of wheat showing black basal ends. These were tested by planting after surface sterilization. *Helminthosporium sativum* (P.) K. & B. was present in the majority of the seeds. In some cases *Alternaria* sp. was obtained. A considerable number of the samples gave *Bacterium atrofaciens* McCulloch, the causal agent of basal glume rot. It would seem from this work that the most common causes of black ends in wheat are *Helminthosporium sativum, Bacterium atrofaciens and Alternaria* sp. Black end is especially common on Durum wheats. Inoculations on wheat heads with the spores of *Helminthosporium sativum* were carried on by Mr. A. W. Henry in the laboratory and greenhouse when a post-graduate student in the University of Saskatchewan. His results showed that this fungus readily produced black ends.

A *Heterosporium* was found to be associated with a disease of Columbine sent in from Saskatoon and Regina. It was also found associated with a disease of pinks, and was isolated from discolored heads of wheat.

A number of fruits and vegetables affected with forms of storage and transit rots, were brought into the laboratory from time to time for examination. The following seemed to be the most important.

Brown rot (*Sclerotinia cinerea* (Bon.) Wor.) and Black Mold *Rhizopus nigricans* were commonly found on peaches, plums and apples. Peaches were quite severely affected with this fungus both alone and associated with Black Mold (*Rhizopus* sp.) This latter fungus appeared to be a very destructive parasite, especially on over-ripe peaches, and was more commonly found than the Brown Rot fungus. A few simple tests were made to determine the spread of Black Mold, when peaches were wrapped in paper. The ordinary fruit wrapping paper gave very little if any protection, but a good wax paper did inhibit distinctly the spread of this fungus. *Rhizopus* also appeared commonly on decaying plums, prunes, apricots and watermelons.

Blue Mold (*Penicillium* sp.) was the chief cause of decay in lemons, oranges and grapefruit.

Gray Mold (*Botrytis* sp.) was found associated with decaying tomatoes and grapes. In some specimens of tomatoes it appeared to be a rather destructive parasite.

Gloeosporium Musarum C. & M. was present on discoloured and partly decayed bananas.

Sclerotinia Rot (probably *Sclerotinia libertiana* Fcl.). This was a common cause of the decay of cabbage and celery in transit and storage.

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

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

Fire Blight (*Bacillus amylovorus* (Burr.) Trev.)

In a general survey of the fruit tree diseases of British Columbia, Fire Blight stands out as one of the most serious. The climatic conditions that in most places necessitate irrigation, the careful cultural practices producing rapid growth in the trees, and the fact that the orchards are still young are the chief factors which account for its unusual severity. On the other hand, however, owing to the fact that the various communities are isolated because of the mountainous nature of the country, and also owing to the varying success of campaigns for eradication in these communities, the disease is much more pronounced in some localities than in others. There even occur two districts from which the disease has never yet been reported, namely, Keremeos and Creston.

During the past year, encouraging results have followed a very active general campaign on the part of the growers. This campaign, which was organized and carried through by the Provincial Horticulturist and his staff and assisted in by Dominion officials, was a very fine step forward. Following a series of lectures at which the necessity of a unified effort was emphasized, a system of inspection was inaugurated whereby every grower's orchard was given a thorough inspection by a qualified official, whenever that grower announced that he had completed, as far as possible, the eradication of cankers. The results obtained, although not by any means perfect, have assisted very materially in reducing the losses—especially in those communities where the disease had been only moderately severe.

Experimental Work.—From the amount of investigational work already carried out, the introduction of a cure for Fire Blight seems improbable. It is true that preventive measures have been perfected for the control and elimination of the disease, but even these are so arduous and exacting that growers have in many cases given up the cultivation of susceptible fruits, rather than carry out the work entailed. The greatest hope seems to lie in the introduction of a variety which will combine commercial value and Blight resistance. It is for this reason, therefore, that investigational work during recent years has been most active along these lines. The policy of this laboratory is to follow up these advances and to further this investigation by the introduction and development of new resistant varieties. In accordance with this policy, there has been set out this year a small orchard consisting of two species, one Chinese and the other Japanese. Four resistant varieties which have been perfected by American investigators are expected in the Spring. Seeds have also been obtained from India of two varieties whose resistance to Blight will be tested as soon as plants can be grown therefrom.

In addition to the above mentioned work, experiments are also carried out from time to time on minor questions arising in connection with the disease. An account of those worked on during the year follows.

To Determine the Size of Pruned Twig in which the Disease Can Overwinter.

Owing to a number of inquiries concerning the necessity of destroying small winter prunings affected with Fire Blight, it was thought advisable to get some definite data on the size of pruned limbs which would hold over the live bacteria until activity was renewed in the trees.

Accordingly, diseased limbs were pruned at different dates during the winter and kept in the open until Spring. The first prunings were made in November

and the limbs selected varied in size from one inch to ·25 inches in diameter. In March and April, isolations were made from these. The method of isolating the bacteria was to remove with a flamed scalpel, a small piece of cambium at the junction point between diseased and healthy tissue. This was then placed on a slant tube of potato agar and the cultures incubated at room temperatures. In three or four days, characteristic colonies of *Bacillus amylovorus* appeared. The pathogenicity of the cultures obtained in these experiments was tested out during the summer months on young pear seedlings in cheesecloth cages. Infection occurred on all succulent branches inoculated. The organism was then re-isolated on potato agar and is being kept alive in the laboratory.

Cultures were obtained from prunings of all the different dates including those taken in November. The size of the pruning had apparently, no effect on the ability of the organism to overwinter therein. It was found that a twig as small as ·25 inches in dimater, pruned in November, contained live bacteria as late as April 26. Cultures set up after this date, failed to give any growth of the organism. The twigs by this time, however, had become much dried and shrivelled.

The Longevity of *Bacillus amylovorus* in Honey

There has often been expressed by growers a belief that the Fire Blight organism must overwinter in other ways than in hold-over cankers. It has been asked if it were possible for the organism to live a sufficient time in honey to overwinter in it. It was decided, therefore, to run a series of experiments to test out its longevity. Test tubes containing a small quantity of extracted honey were inoculated with a loopful of bacteria. From these test tubes, isolations were made by taking a loopful of the honey and spreading it out on potato agar in slant tubes. These were then incubated at room temperatures. In from three to seven days, characteristic colonies of *Bacillus amylovorus* appeared. Four different sets of such inoculated test tubes of ten tubes each were used. Bacteria from the first two of these sets were obtained from cultures on potato agar that had been transferred several times after their isolation from the plant. · For the other two sets, bacteria were obtained from cultures that had just been set up from inoculated apples used in another experiment. These latter cultures appeared much more vigorous than those used in the previous cases. In the first two sets the bacteria were all dead by the end of the sixth day; in the latter sets the organism is yet alive. Of these, the former was inoculated on January 9 and the latter on January 29. The greatest length of time, up to the present, that the culturc has remained alive is from January 9 to February 26. The honey of the first set of the cultures was sterilized previous to the inoculation. The remaining three sets were not sterilized. The last set was heated to a point beyond which it did not re-crystallize when cold. Isolations were pure in all cases except one where a foreign yellow bacterium appeared. Cultures set up from checks were sterile.

To Determine the Longevity of *Bacillus amylovorus* in the Mature Fruit

Owing to the recent legislation by the Government of Australia against the importation of apples, pears, and other fruits susceptible to Fire Blight, a suggestion was made by the Dominion Botanist to determine the possiblity of mature fruit carrying the disease a sufficient length of time to be a detriment to industries in a foreign country by the shipping to such country of infected fruit. To determine this possibility, experiments were carried out on three varieties of apples; namely, Rome Beauty, Jonathan and Grimes Golden, a box of each being used. The apples were inoculated on October 24 and November 13. The method of inoculation was to puncture deeply the flesh of the apple with a platinum needle plentifully smeared with the organism. The point of inoculation was marked with a circle of ink. Inoculated apples were then wrapped and

placed in ordinary storage. At intervals, usually of seven days, three apples of each variety were taken out and isolations made from these. The method of isolation was to cut away the skin and outer tissue at the point of inoculation with a flamed scalpel. A small piece of flesh through which the needle had passed in inoculation was then taken out and placed on a slant tube of potato agar. These cultures were incubated at room temperatures. Checks were also set up at each isolation, consisting of a piece of tissue removed in the same manner as for the other cultures but taken from the opposite side of the apple.

To date, March 1, 203 cultures have been set up and in every case characteristic cultures of *Bacillus amylovorus* have been obtained.

In connection with these experiments, an interesting point noted was, that whenever an inoculated apple chanced to have been rotted by a fungus, particularly *Penicillium expansum,* the bacteria oozed from the point of inoculation in a small drop.

Powdery Mildew (*Podosphaera leucotricha* (E. and E.) Salm.)

In the fruit growing regions of the Pacific Northwest, Powdery Mildew is recognized as an important disease of apples. Not only does it do considerable damage to the foliage and tender twigs, but it also attacks the fruit, giving to it a russety, network appearance which considerably lowers its market value.

The severity of the disease varies greatly from year to year. In British Columbia in 1921, considerable alarm was aroused among the fruit-growers because of the quantity of fruit found to be affected. In 1922, however, the disease was almost wholly absent.

Experimental Work.—The general prevalence and severity of the disease during the summer and fall of 1921 were such that it appeared necessary that some definite control measures would have to be undertaken. Two series of experiments were, therefore, outlined and carried out during the spring and early summer of 1922.

The purpose of these experiments was to determine, first, the comparative value of lime sulphur with and without a casein spreader; second, the comparative value of lime sulphur and a new spray known as colloidal sulphur; third, the number of applications of each of these sprays necessary to procure efficient control.

As has been pointed out, the absence of the disease throughout the whole season prevented any definite results being obtained from these experiments.

PHYSIOLOGICAL DISORDERS

Since the establishment of this laboratory, by far the greater number of inquiries concerning diseased fruits have been made on diseases that are of a physiological nature. The exceptional amount of such trouble appears to be due, in the final analysis, to lack of rainfall coupled with weather conditions producing at times extremely rapid evaporation from the leaf surfaces.

Occasional days of extremely low humidity, high temperature, and considerable wind velocity occur during the summer throughout the entire fruit growing area. Such times as these make sudden demands on the tree for a very large quantity of water. To meet this demand, it is essential, first, that there be a sufficient supply of moisture in the soil, and second, that the entire root system absorb at maximum capacity. If for any reason the root absorbing surfaces have been decreased, whether through mechanical injury, frost, drought, or water injury caused by excessive irrigation, trees so handicapped are unable to function normally even though the soil moisture at the time appears adequate.

A study of the conditions seems to show that the injury to the root system may occur at a time considerably previous to that at which the evidence of such

injury appears. The tree, apparently, suffers no marked ill effects from this injury and seems to function in a normal way until such time as one of these exceptional demands is made upon it.

Just why we have the different types of diseases and why these diseases show up in certain orchards and not in others under seemingly similar conditions, is not always easy to explain. The number of factors that play a part in the normal or abnormal growth of a fruit tree are so great that it is only after an exact study of all of these, for each particular case, that we can hope to give an answer to the question of just how each particular injury was brought about.

There are presented in this report accounts of the various diseases met with during the year which appear to be caused by the conditions mentioned above.

Drought Spot of Apple *(See figs. 7 *a-c*).—This disease is an injury to the fruit, appearing soon after it has set. At first, (*a*) small, water-soaked blisters appear, from which oftentimes exude small drops of juice. These blisters soon lose their water-soaked appearance, the skin shrinks and wrinkles and the spot becomes somewhat depressed. When spots coalesce, a considerable irregular area of the fruit is often covered. (*b*) Cross sections show that the tissue directly beneath the epidermis is broken down and brown in colour. As the apple grows, the epidermis over the diseased area turns brown and becomes cracked. (*c*) When once an apple is affected, it is unable to outgrow the primary injury and such a fruit is rendered unmarketable. During the season of 1922, a very considerable amount of such injury occurred and, in certain of the badly affected orchards where an estimate was calculated, losses ran as high as 69 per cent.

Drought Spot of Pear (fig. 8*a*).—This trouble is in appearance somewhat similar to that occurring on the apple and did considerable damage in a few orchards.

Drought Spot on Apricot (fig. 8*b*).—This injury, while apparently due to causes similar to those causing Drought Spot on apple and pear, seems also to be aggravated by the action of the sun, as the russeting occurred only on the sunny side of the fruit. The injury occurred, however, on apricots growing amid very unfavourable soil conditions and an examination of the root system showed that a large number of the minute roots were injured.

Drought Spot of Prunes and Plums.—In a few orchards, an injury similar to that described by an American investigator** and called by him Drought Spot or Gum Spot occurred. This disease appeared about mid-season and is characterized by the occurrence of drops of gum on the surface of the fruit, under which the flesh appears water-soaked and transparent.

Drought Spot of Cherry.—A peculiar breaking down of the flesh of the cherry occurred in one district, being due, apparently, to climatic and soil conditions. The injury occurred on Napoleon cherries just a few days before picking time. It is characterized by a brown sunken area near the blossom end of the fruit. Soil conditions and cultural practices in the orchard were extremely poor.

A breakdown in Pears (fig. 9*a*).—An injury of pears caused by the breaking down of tissue at the calyx end was responsible for a considerable loss of fruit in one of the larger pear orchards in the Penticton district. The flesh around the calyx end of the pear was completely broken down and appeared as a firm brown rot, the surface of which was somewhat depressed and was marked off from the healthy tissue by a distinct line. The dead tissue extended a considerable distance into the fruit. In a few cases, the fruit appeared somewhat

*Vide Güssow, H. T. Drouth injury to McIntosh Apples, Phytopath. 8. 490-491, fig., 1918.

**H. P. Barss "Physiological Disorders of Developing Fruits" Third Crop Pest and Horticultural Report, 1915-20 Oregon Agric. Coll. Exper. Station.

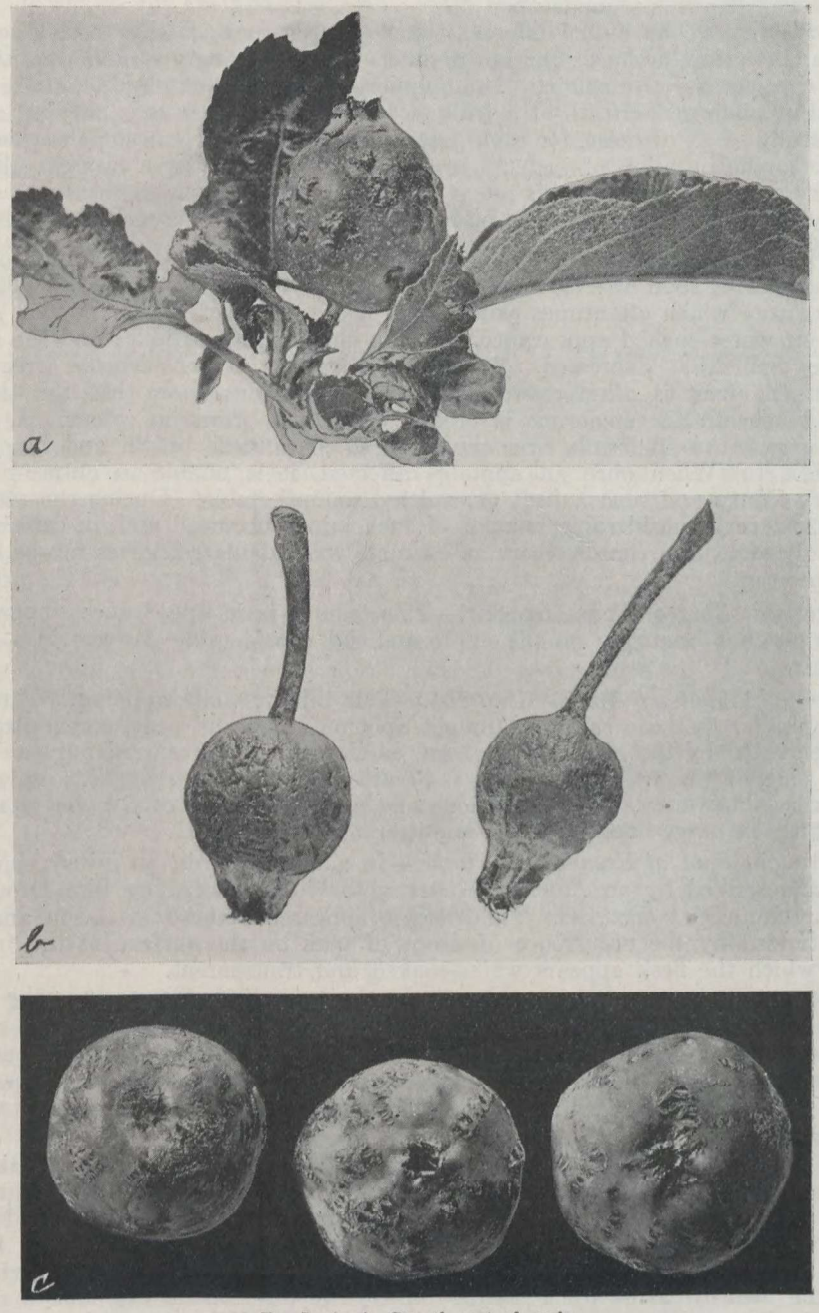


FIG. 7.—(*a-c*).—Drouth spot of apple.

Photo H. R. McLarty.

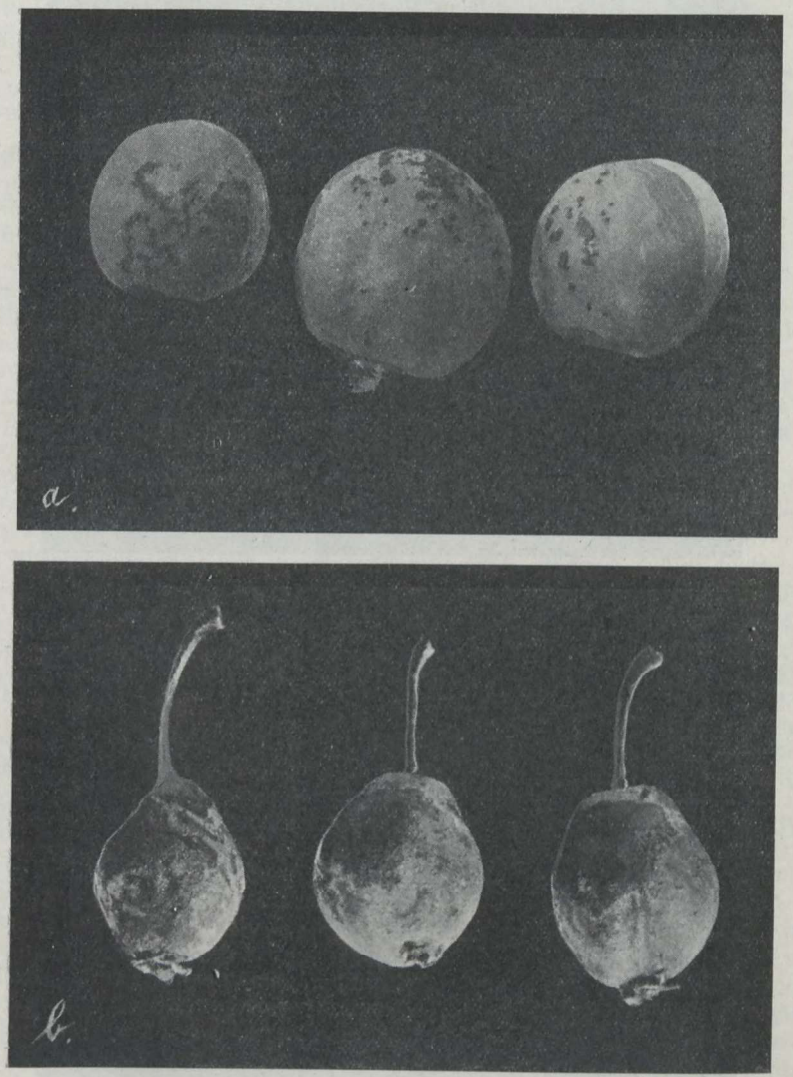


FIG. 8 (*a-b*).—*a*. Drouth spot of apricot and *b*. of pear.
Photo H. R. McLarty

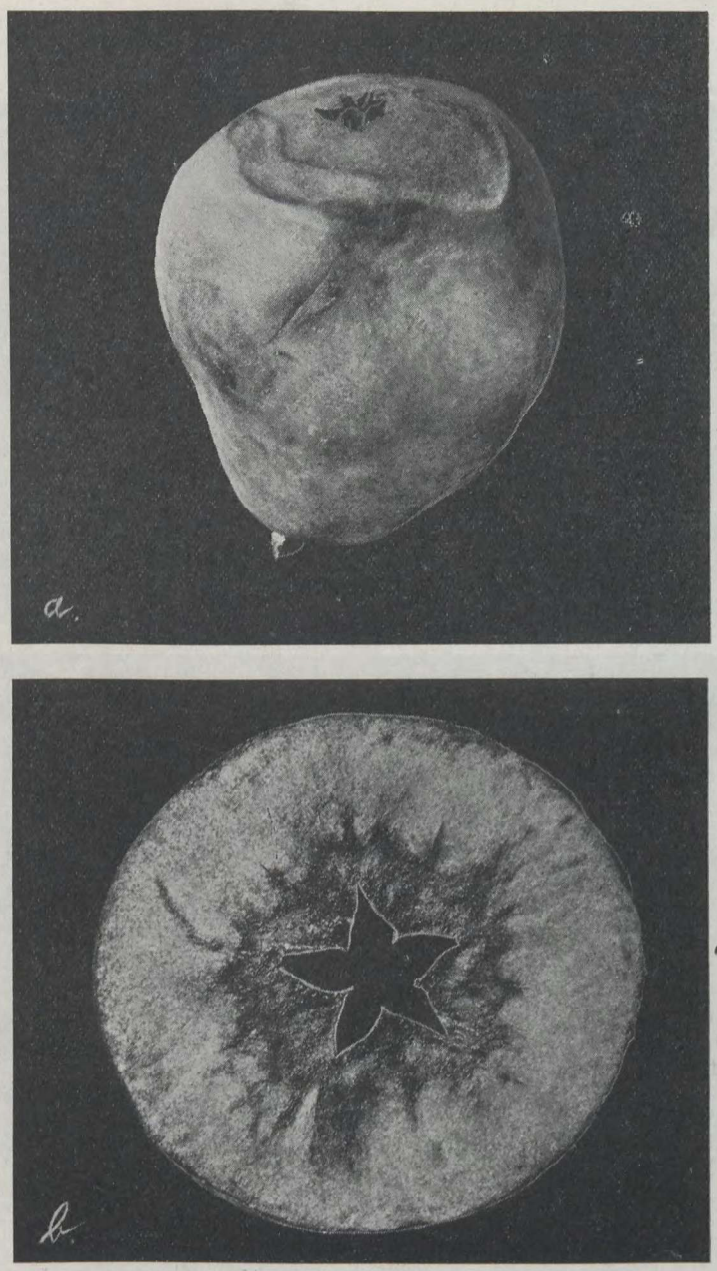


FIG. 9 (*a-b*).—*a*. Breakdown in pears. *b*. Apple core rot.
Photo H. R. McLarty

differently, there being several brown spots around the calyx end and in this tissue a large number of stone cells. Many cultures were set up from the dead tissue, but in every case these remained sterile.

In the five-acre block of Anjou pears where the injury occurred, soil conditions and moisture supply seemed all that could be desired. An examination of the roots that were intact showed them to be in a normal, healthy condition.

Until the Fall of 1921, the orchard was kept in sod. At that time, manure was applied and the whole ploughed down. It would seem possible that this injury was caused by an excessive loss of root surface due to the ploughing. The exceptional manner in which the disease was scattered seemed to indicate that certain trees suffered more in this respect than their neighbours.

Apple Core Rot (fig. 9*b*).—Particular attention was attracted during the past year, to the Salmon Arm district, owing to the losses caused by a disease called by the growers Core Rot of apple. It is estimated that about thirty per cent of the Wealthy variety was a total loss and several other varieties suffered to an almost equal extent. (See frontispiece). The disease appeared some time after the fruit was set, but just when, it is difficult to say. Some growers state that they noticed the injury at thinning time, while others affirm that it appeared a short time before the fruit was picked.

The trouble is characterized by a breaking down of tissue within the fibro-vascular ring. The amount of tissue affected varies greatly. In slight cases, the injury occurred as spots of broken down cells. These were brown and spongy or corky in texture and were scattered throughout the core area. When the apple was badly affected, practically the whole core area was involved. In such cases as the latter, some varieties also showed a slight external evidence of the disease, consisting of minute elevations in the epidermis. These occurred chiefly around the calyx end of the fruit and were quite noticeable to the touch. The flesh of the diseased apples, outside of the fibro-vascular ring, appeared normal but evidenced a certain rubbery texture when bitten into. They also lacked somewhat in crispness and were rather flat in taste.

Where trees were known to be affected, experience in picking led the growers to adopt a general plan of cutting into a few apples whenever beginning a new limb. Where a number of diseased apples were found, the fruit from the limb was usually discarded, but where the apples cut into appeared sound, the fruit from that limb was gathered and usually proved to be in a healthy condition.

Experimental Work.—This year, affected apples were not put on the market, but it was felt that some experiments should be carried out to determine whether the injury would develop further in storage. Two boxes of Jonathan and one of McIntosh taken from diseased orchards were kept in storage at the Summerland Experimental Station. At the end of their usual storage period, all apples were cut open for examination. These apples were picked late and as a result, the Jonathans were badly affected with Breakdown. It could not be concluded, however, that the Breakdown was aggravated by the Core Rot injury. Although the majority of these apples were affected with both Breakdown and Core Rot, several that were badly affected with Core Rot showed no symptoms of Breakdown, and vice versa. In the McIntosh, no Breakdown occurred and the Core Rot injury appeared to be no more serious than when the apples were placed in storage.

STORAGE DISEASES

Jonathan Breakdown.—Breakdown, Flesh Collapse, Brown Heart and Internal Browning are names given to a storage disease or diseases of apples that have become very prevalent during recent years. The trouble is very wide-spread, being reported from Australia, New Zealand, United States and

Canada. No very accurate data are available on the extent of the losses, but all investigators report that these are serious. In the Okanagan valley of British Columbia, the losses have been so severe that, at a recent meeting of the fruit growers of the province, a resolution was presented that the Provincial Government be asked to appoint an expert for the sole purpose of investigating this trouble.

The disease is characterized by a breaking down and browning of the flesh of the apple. The skin remains in perfect condition and there is no external evidence of the disease except that the apple appears abnormally spongy when squeezed in the hand. The trouble within varies greatly in its severity. From a slightly diseased condition, which is characterized by a narrow band of brownish tissue in the flesh, and which runs parallel with the skin of the fruit, there occur all gradations to the final stage, where the whole fruit is involved and the interior becomes a soft brown mass. The trouble appears after the apples have been picked and before they are placed on the market for consumption.

A considerable amount of investigation has been carried out on internal browning of apples in storage, but, so far, the exact cause has not been established. In general, the results of these investigations may be summed up as follows:—

(1) That the degree of maturity at picking time has a marked influence on the time before which the disease will appear in storage.

(2) That certain storage conditions are much better than others in retarding the appearance of the trouble.

(3) That the disease is inherent in the apple when it comes from the tree and is the result of an unbalanced condition in the fruit, due to some irregularity in its nutrition.

Scald.—As the tonnage of apples being held in storage increases every year, the importance of scald is coming more and more to the front. Experience in the Pacific Northwest has shown that the losses sustained from this disease are as severe as those from all the other storage diseases combined.

Experimental Work.—Owing to the probability of heavy losses being suffered as the tonnage of apples in storage increases, it was thought advisable to introduce a new oiled wrap, perfected by D. F. Fisher of the U.S. Department of Agriculture, and to give it a commercial test in some of our storage houses. Boxes of apples were, accordingly, wrapped in this paper and placed in storage in Penticton, Summerland, and in the storage building on the Summerland Experimental Station. Up to the present, March 10, apples so packed have remained in perfect condition and their maturity is considerably less than apples from the same orchards kept in the ordinary wrap under identical conditions. These apples are being kept for the late Spring market and records will be kept as to their freedom from scald after removal from storage houses.

Jonathan Spot.—This trouble was exceptionally severe this year on Jonathan and many other varieties.

VEGETABLE DISEASES

At present, the vegetable industry of the interior of British Columbia, while not as large as the fruit industry, is nevertheless, of very considerable importance. Lack of time, however, has prevented the devotion of as much attention as desirable to the diseases of these crops.

Western Yellow Blight of Tomato.—A limited examination was made of tomato plants affected with Western Yellow Blight. This disease which is peculiar to the Pacific States has now become very wide-spread in its occurrence, extending from Mexico to the southern parts of British Columbia. The losses,

under favourable climatic conditions are extremely severe, being at times practically one hundred per cent. This year, in the southern parts of interior British Columbia at Keremeos, Osoyoos and Oliver, the losses ranged from fifteen to thirty per cent of the plants. The description of this disease given by M. B. McKay, of the Oregon Experimental Station points out very well the symptoms of the disease.*

Experimental Work.—Diseased plants were collected from Keremeos, Osoyoos and Oliver districts and cultures of diseased roots were set up on potato agar. In 26 cultures, 17 were *Fusarium spp.* 6 *Rhizoctonia spp.*, 2 *Bacteria* and 2 *Verticillium spp.*

Blossom End Rot of Pepper (fig. 10*a*).—This disease was very severe in one very large plantation, causing a loss at the beginning of the season of about forty-five per cent. As the season advanced, however, losses were not so great.

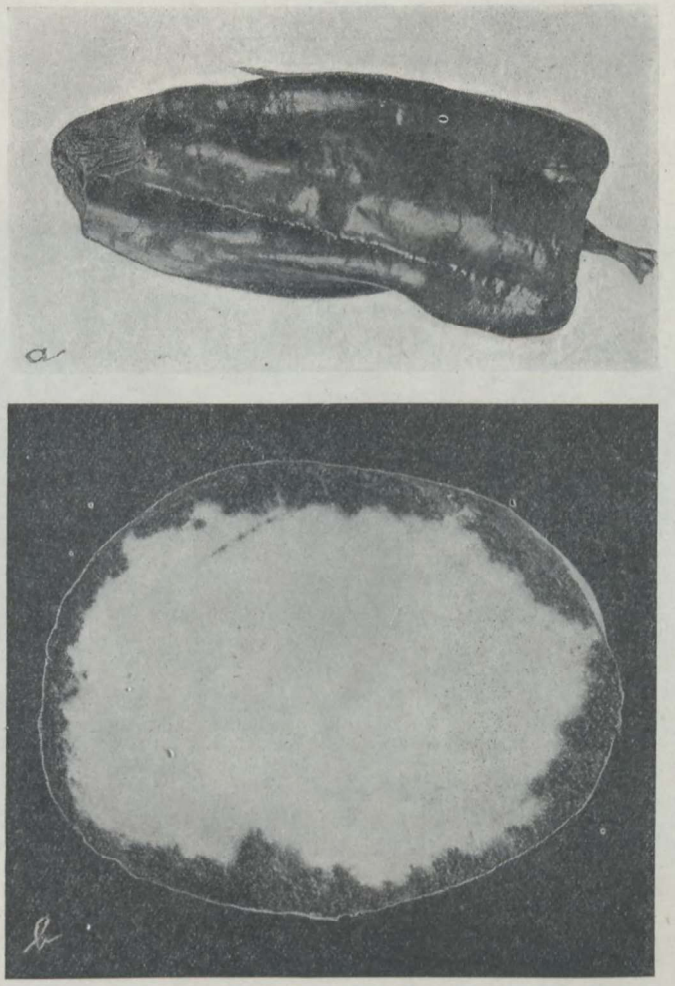


FIG. 10 (*a-b*).—*a*. Blossom end rot of peppers. *b*. Internal browning in potaotes.
Photo H. R. McLarty

* M. B. McKay, "Western Yellow Tomato Blight" Third Crop Pest and Horticultural Report, 1915-20. Oregon Agric. Coll. Exper. Station.

Internal Browning of Potato (fig. 10*b*).—A breakdown occurred in the flesh of potato tubers in the Kelowna district this year. The trouble does not seem to be due to a parasitic fungus, as cultures set up failed to produce any indications of a causal organism. It seems probable that the injury is due to unbalanced moisture relation in the soil.