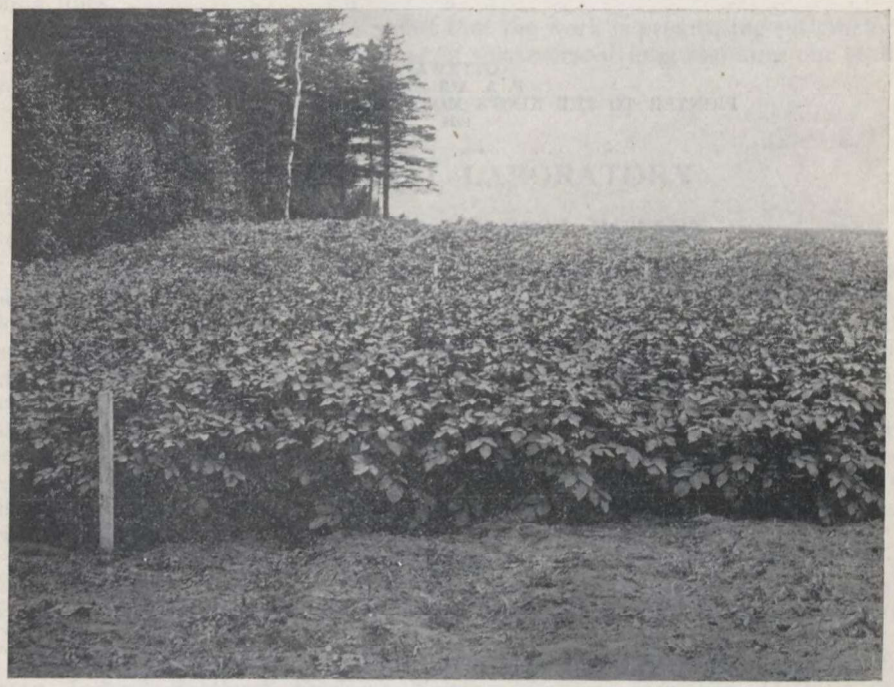
DOMINION OF CANADA
DEPARTMENT OF AGRICULTURE
DOMINION EXPERIMENTAL FARMS

# DIVISION OF BOTANY

## REPORT OF THE DOMINION BOTANIST

H. T. GÜSSOW

## FOR THE YEAR 1923



"The use of certified seed potatoes is the secret of success."

Printed by authority of the Hon. W. R. Motherwell, Minister of Agriculture, Ottawa, 1924

OTTAWA
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1924

# DIVISION OF BOTANY

**Report of the Dominion Botanist, H. T. Güssow, for the Year Ending March 31, 1924**

The present report covers the main lines of work carried on during the year at the Central Laboratory, Ottawa, and under the D.I. and P.A. and nine plant pathological laboratories maintained under the appropriation under this Act.

During the year the Dominion Botanist attended an important international conference on plant pathology and economic entomology, which was held at Wageningen, Holland, at which principally questions relating to international plant disease legislation were discussed. The problem of control of plant diseases already within a country is difficult enough; in consequence great attention is required to prevent the introduction of new diseases and pests by vegetation imported from abroad.

A visit has been paid during the year to every one of the field laboratories of which there are now nine in number from coast to coast, in order to check up the progress of the work, to discuss problems requiring immediate attention and to organize, where necessary, the work along the most practical and economic lines.

It is gratifying to be able to report that the work is progressing satisfactorily and that with the filling of a number of vacancies of long standing our staff is now nearly complete.

## A.—CENTRAL LABORATORY

### ECONOMIC AND GENERAL BOTANY

Much of the work was of the usual routine description dealing with requests for information on a great variety of topics of interest to farmers and others. Some dealt with the possibilities underlying the culture of mint, ginseng, golden seal, Seneca snakeroot and other medicinal plants; others dealt with wild rice, and wild celery and their propagation as an attraction for wild ducks; some inquiries related to dasheen, sage brush, Mexican rubber plant, and the possibilities of silk culture in Canada; there were also various miscellaneous inquiries relating to the effect of Virginia creeper on trees, use of cat tails, Borneol camphor, germination of hickory nuts, improving the colour of plants by the use of chemicals, the effect of ultraviolet rays on the growth of wheat, and requests for literature dealing with the wild flowers and ferns of Canada.

A number of mounted specimens of wild currant (*Ribes* sp.) were received for incorporation in the herbarium, which were collected by Mr. A. T. Davidson while conducting investigations on White Pine Blister Rust in British Columbia.

Seeds were exchanged with the following countries: United States, Uruguay, Ireland, Scotland, England, Norway, Sweden, Denmark, Holland, Belgium, France, Germany, Switzerland, Italy, Poland, Hungary, Czecho- Slovakia, Roumania, Transcaucasia, China, and New South Wales.

During the year 1,928 packets of seed and six rooted plants were received while 2,520 packets of seed and sixty-nine specimens of rooted plants and

cuttings were sent out. Among the specimens received were fifty-seven varieties of wheat, oat, etc., which were obtained from the Botanical Garden at Tabor, Czecho-Slovakia, for the purpose of testing by the Cereal Division of the Experimental Farms Branch.

Of the twelve Osigian mulberry trees planted in the Arboretum in the spring of 1922 about half were dead, although they were protected from the severity of the winter by coverings of dead leaves and straw wrapped around them. Of the survivors several had produced vigorous shoots from near the ground level.

A test was made to determine whether wild rice could be grown on marshy land instead of in water which is its regular habitat. Though the plot selected was scarcely wet enough to produce a vigorous growth still a few plants produced ripe seed and the results seem encouraging.

Experiments of a physiological nature to determine the relation of plants to varying amounts of light were continued. Among the plants used for these experiments were wheat, rye, flax, hemp, soy bean, tomato, buckwheat, sunflower, and others. In addition to varying the period of natural daylight by the use of darkened covers placed over the pots in the greenhouse, electrical illumination was also used at night.

The first experiments on the use of electric light as an aid to natural daylight in stimulating the growth of plants appear to have been made by Prof. L. H. Bailey, of Cornell University, in the year 1891. He used a protected electric arc light in a greenhouse during half the night and found that the growth of lettuce was accelerated by two weeks.

During the last two years a number of experiments have been made along this line by various investigators. Dr. Harvey, of the University of Minnesota, grew a large number of plants under electric illumination only, natural daylight being excluded, and found that in most cases they ripened perfect seeds.

It is, however, as an adjunct to daylight during the winter months that artificial illumination is likely to find its greatest use. The electric illumination was employed on several nights each week and the lamp burned on these nights from sunset to sunrise. In some cases the lamps were turned on for five nights per week but in the majority of cases the number was less than this.

As the result of these experiments it is not yet clear what is the most beneficial period of illumination for each species of plant. Apparently it depends on the natural length of daylight and probably to some extent on the temperature of the greenhouse. Where the period of natural daylight was less than twelve hours it was found that electrical illumination in most cases promoted the rate of growth and hastened the time of flowering. Where the other conditions were the same it was found that winter wheat headed out twenty-seven days earlier and winter rye forty-five days earlier under the additional illumination. (Plate 1.) In the case of tomato the plants grown under electrical illumination in addition to daylight were somewhat shorter but attained a greater weight than those grown under an average of twelve hours of daylight. There was no difference, however, in the period of flowering as both sets came into bloom on the same date.


PLATE I

ABOVE: Winter Wheat, Winter Rye and White Mustard grown under ordinary daylight plus electrical illumination at night. BELOW: The same grown under daylight only.

To ascertain the effect of light and temperature on the time of heading out of winter wheat and winter rye the seeds of these two species were sown in pots in the greenhouse at intervals of about a week from March 5 to April 23, 1923. As soon as the weather became suitable the plants were removed from the pots and set in the open ground. For comparison one row of each was also sown in open ground on April 30.

As might have been expected those sown first headed out the same season, while the plants derived from the later sowings as well as those sown in the open ground did not head out before winter set in.

A new edition of the Bulletin on Medicinal Plants (now No. 36, New Series) was published during the year. (J.A.)

In addition to the above work, good progress was made on studies of certain weeds and control measures, and on a Canadian weed survey project; while the usual service in plant identification and correspondence upon weed matters was maintained. The work under the latter head was, in fact, considerably heavier than usual, owing to interest aroused by a questionnaire prepared in connection with the survey. Not only were the resulting reports frequently accompanied by specimens of weeds, or by inquiries requiring specific answers, but in every case the occasion was regarded as an opportune one for giving detailed information on the particular weeds shown to be of most concern to the correspondent. Accordingly, separate articles on some of the more frequently reported weeds were prepared for use in mimeographed form, and the appropriate selection of them was mailed to each of the nearly 1,200 farmers who responded. A copy of the departmental Bulletin No. 4, New Series, on "Weeds and Weed Seeds," was also mailed in many cases. Other articles were prepared for the press, and several addresses on weed topics were delivered during the year.

No less than 140 species of weeds alone were sent for identification, those most commonly received being orange hawkweed, field horsetail, perennial sow thistle, field bindweed, Russian pigweed, chicory, cut-leaved nightshade, toadflax, common groundsel and cow parsnip. This does not necessarily mean that these were of more consequence than others, but rather that they were not well known, and gave the impression, sometimes only too well founded, of being dangerous. Some well-known weeds, like couch grass and Canada thistle, were as often written about, but only to learn the best means for their control. Poison ivy was another plant very frequently inquired about during the summer months, both for its identification, and regarding its extermination from about the home, or more usually the summer cottage.

A number of inquiries related to sweet clover poisoning, which recent investigations in Ontario by officers of the Ontario Veterinary College have traced pretty definitely to the presence of certain moulds on poorly-cured hay, under conditions probably not even yet sufficiently understood.

The usual number of cases of horse-tail poisoning were reported without adding anything however, except confirmation, to what we have already stated in previous reports, notably that for the year ending March, 1922. Horses are quite evidently the usual victims.

Several correspondents were interested in the Canadian distribution of plants inducing hay fever, i.e., ragweed, pigweed, goldenrod, Russian thistle, etc. These, we were able to state, are all widely spread in Canada, ragweed most seriously in southwestern Ontario, and Russian thistle in the lighter soils of southern Saskatchewan and Alberta and southwestern Manitoba. Goldenrod, although everywhere common in one or another of its species, is probably not such a serious contributing factor as is popularly supposed, since its pollen is not wind-borne like that of the really responsible plants.

One correspondent near Kamloops, B.C., submitted a sample of sorghum which had caused the sudden death of four head of cattle, when with some others, they were turned on to it for the first time. The development of the crop had been severely checked by drought, and it was upon the resumption of growth following rains that they were pastured on it with the resulting fatalities. The owner was advised at once that a poison normally present in the plant in harmless amount, can increase under those conditions so as to render it dangerous. When a sample was analyzed later by the Division of Chemistry, showing an exceptionally high percentage of prussic acid, so that two to four pounds of this sorghum might be expected to be fatal, this conclusion was well substantiated.

The Canadian weed survey as it is now under way may be considered under several heads.

(1) *Weed Questionnaire.*—Early in the year several methods of obtaining information were tried, and the results secured were utilized in arranging a tentative list of worst weeds for the Dominion taken as a whole. We were then granted space in "Seasonable Hints" for July, for what would be a much wider appeal. The list prepared as above indicated contained the names of twelve weeds arranged in order of apparent importance. Returns were received from nearly 1,200 farmers, from almost as many points in all the provinces, which when compiled indicated that in their estimation the weeds named should be listed as follows: Canada thistle, 655 reports; couch (quack, twitch) grass, 623 reports; wild mustard, 603 reports; wild oats, 528 reports; lamb's quarters, 509 reports; perennial sow thistle, 443 reports; stinkweed (penny-cress), 419 reports; redroot pigweed, 378 reports; bindweed (wild morning-glory), 376 reports; ball mustard, 308 reports; common ragweed, 253 reports; Russian thistle, 216 reports. Compilation by provinces brought out much valuable information on the standing in each of these weeds, which we have not space to give here.

There were also other weeds reported to a total of 130. Some of these, had they found a place in the list circulated, would have been more frequently mentioned than some that were there. Since they were not so listed a few of them are here arranged in their own order of frequency reported; Wild buckwheat, ox-eye daisy, tumbling mustard, orange hawkweed, blue bur, hare's-ear mustard, foxtail (yellow and green), shepherd's purse, bladder campion, chickweeds, Russian pigweed, buttercup, sweet grass, dock (curled, etc.), wild carrot, dandelion, etc.

An average of about five names appeared on each report, and it may fairly be supposed that the farmer who would show enough interest to respond at all, would be reasonably competent to express an opinion on what are his principal pests. As a matter of fact there were occasionally evidences of mistaken naming among the less generally known weeds, but the amount of error with most of them is not believed to be serious.

The replies to several other questions asked in the questionnaire regarding soil, drainage, rotation of crops, and methods of weed control practised, were usually a valuable feature of the reports returned, but have not yet been put in shape to use.

(2) *Assembling Records.*—So far this has consisted in listing for each weed all authentic records obtainable, whether based on determinations made in the course of correspondence, on specimens in the herbarium, or on collectors' published lists. Together with entries from the season's field notes, these amount now to something like 8,000 separate place records for a little over 200 weed species. Some thousands of records from earlier correspondence are also on file, and will soon be incorporated with the above. The records gathered can be grouped geographically, in relation to regional types of agriculture, etc.,

to show not only past and present distribution, but habit and reaction to various factors as well. Already it is clear that some weeds are much less uniformly distributed over their known range than others, and it will be our purpose to more closely delimit the areas infested by each. Isolated occurrences, which may be but the fore-runners of wider distribution, will also be shown up for what they are, so that more timely action for their eradication can be instituted.

(3) *Field Work.*—With objects not essentially different from the foregoing, several trips were taken in Quebec and Ontario. As a result some information on weed floras is now on file for over 100 townships in these two provinces. Nearly 150 different weeds were met with, some in most places where there was an opportunity to list them, others only occasionally or in certain zones. It is obvious that only a small percentage of the weeds in any place will ever come to our notice except through our own field observations, and yet some of them may be steadily gaining a status which will shortly make them alarming. During this season localities previously unsuspected, were found for Russian pigweed (*Axyris amarantoides*), perennial ragweed (*Ambrosia psilostachya*), coltsfoot (*Tussilago Farfara*), marsh elder (*Iva xanthifolia*), Western wheat-grass (*Agropyron Smithii*), and others, mostly weeds of importance where well established. At one place the cultivated globe thistle (*Echinops*) has taken firm hold in the sod for quite a distance from the garden where it started. In another locality rough-fruited cinquefoil (*Potentilla recta*), a weed seldom mentioned in weed bulletins, has spread through a whole neighborhood as far as the soil is light enough to suit its tastes, although it was known until a few years ago only along one fence, where eradication measures were difficult to apply. Similar instances might be multiplied to show what is going on with some one or more weeds in every neighbourhood in the country, no one realizing in most cases that an opportunity exists to nip a new danger in the bud.

## FOREST PATHOLOGY

### WHITE PINE BLISTER RUST

*In Eastern Canada.*—As in previous years a check was kept upon the distribution and severity of rust in the several eastern provinces. In Prince Edward Island the disease was again present at Charlottetown on cultivated black currents. Very little white pine was found on the Island and none was infected. In Nova Scotia rust on *Ribes* was present in the same general localities as reported last year and in addition infected pines were found at River John, Weymouth, and Springfield. Infection of *Ribes* was found to be fairly general in the southeastern part of New Brunswick and diseased pines were observed at Fredericton and Little Shemogue. Most of the cankers both on these trees and those found in Nova Scotia were four years old. Rust seems to be firmly established in the Maritime Provinces.

In Ontario most of the work was done in Renfrew county and the District of Nipissing bordering on the Ottawa river, where rust reaches its northern limit of distribution in this province. The disease is known to have been present on *Ribes* in this section for at least four years but no infected pines have ever been found. In examining one of the points of infection known since 1919—Pembroke—this year (1923) over 1,100 young white pines growing close to diseased *Ribes* were carefully gone over but none were infected. In some cases infected *Ribes* were growing in the shade of small pine trees and, although the latter were examined with particular care, no infections were apparent. Diseased

*Ribes* were found in ten new localities in Renfrew and Nipissing and also at several points across the Ottawa river in Quebec.

*In British Columbia.*—The work of the present season was for the most part confined to the interior of the province and consisted mainly in scouting to determine the distribution of rust. Unfortunately, the disease was found to be widely spread.

Briefly, it may be said that in the interior white pine belt rust is present throughout the valley of the Arrow lakes; it has also been found at Nelson, on Kootenay lake. In the Dry Belt, which had been expected to prove an effective barrier to the dissemination of rust from the coast, infected *Ribes* were commonly found. At Merritt infection was very severe. This town is about 80 miles distant from the nearest known pine infection and 30 miles from the nearest known five-leaved pine, there being a small stand of white-barked pine (*Pinus albicaulis*) on the top of mount Kanaka to the southwest.

In view of the fact of the wide distribution of rust in the interior and the lack of evidence of importation of either pine or *Ribes*, the possibility that the fungus had spread from the coast by means of aeciospores suggested itself. The production of aeciospores was very heavy in the coastal section during the years 1916, 1917, 1918, and the age of the pine infections found at Canoe, Revelstoke, and Beaton corresponds to this, as they mostly originated in 1917. Further evidence tending to support this view was obtained when infected cultivated black currants were found at McLachlan bay, which is about 210 miles northwest of Vancouver and about 110 miles north of the limit of white pine upon the coast. It is also about 100 miles west of the limit of white-barked pine. The probability of the occurrence of planted five-leaved pines in this unsettled country is very slight. To account for the presence of rust in this remote locality one must either accept the hypothesis of long distance, aecial spread or else assume that the fungus has reached this point by uredinial spread and is perpetuating itself by overwintering. That this fungus can live over from one year to another under the conditions obtaining in the Eastern United States and Canada has been conclusively demonstrated, and there is no reason to suppose that such would not be the case upon the Pacific coast where conditions are, if anything, more favourable for this mode of passing the winter. As yet there is insufficient evidence to justify a conclusion as to which of these explanations is the correct one to account for the occurrence of rust so far beyond the range of five-leaved pines.

A point of interest in connection with the life-history of this fungus was noted when closed blisters were collected on March 17 near Murrayville, in the Fraser valley. This is apparently much earlier than this stage of development has been previously observed in North America, although, according to Spaulding,* closed blisters occurred on the same date in 1918 in France. As a further illustration of how widely the life-history of rust differs under western conditions from the usual sequence of events as they occur in Eastern Canada, it may be mentioned that on October 28 a fruiting canker on a white pine was observed at Nakusp, on Upper Arrow lake.

Last year a small white-barked pine (*P. albicaulis*) growing in the arboretum of the provincial university at Point Grey was observed to be affected with rust in the swelling stage. During the past summer numerous pycnia were produced and on April 8 of this year aecia began to break through the bark of the stem, spreading up the branches of the growth of 1919.

As usual the provincial Forest Branch co-operated with us in carrying on our field work and valuable assistance was also given by the Air Board through

*Spaulding, Perley. Investigations of the White-Pine Blister Rust. U.S., D. A. Bull. 957: 1-100. Fig. 1-13, pl. 1-6. 1922.

the Jericho Beach Air Station at Vancouver. Certain of the Vancouver daily newspapers continued to take an interest in our work and desirable publicity was accorded it in this way.

## INVESTIGATIONS ON DECAYS OF BALSAM FIR (*Abies balsamea* Mill.)

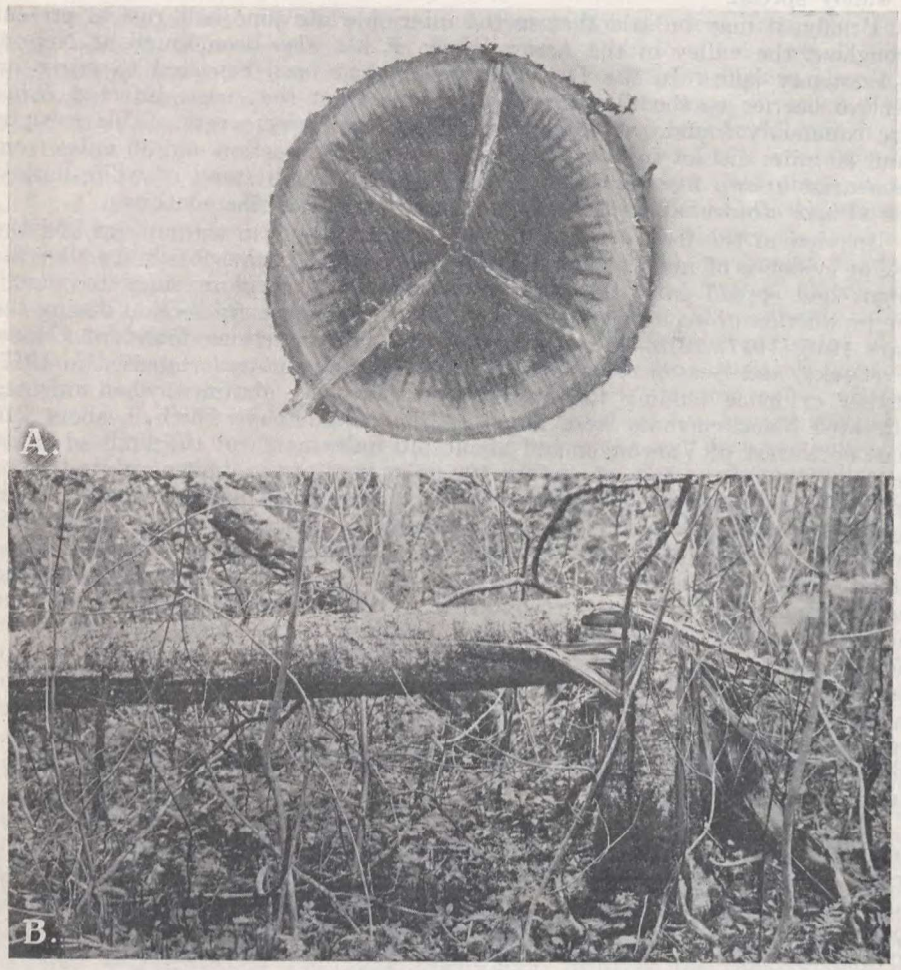


PLATE II

(*a*) Red heart rot of Balsam (*Stereum sanguinolentum*) section of trunk showing disease entering through dead branch stubs.

(*b*) Feather rot on Balsam (*Poria subacida?*) prevalent cause of wind fall.

During the past summer a study of the decays of balsam was made upon the limits of Price Brothers & Company in the Lake St. John district of Quebec. This company is planning to place a portion of their holdings under forest management and they realize that, in order to do so intelligently, it is necessary to have definite information in regard to the fungous diseases affecting the tree species, especially balsam, occurring on their limits. As the supply of virgin timber becomes less year by year and at the same time more and more remote from

centres of population where it can be converted into pulpwood or lumber, the question of the prevention of all forms of loss possible becomes important. It is known in a general way that young trees of any species are immune from the attack of wood-destroying fungi until they reach a certain age which represents a stage in their development at which, owing to certain factors, conditions are such that it is possible for these fungi to infect the trees and to establish themselves firmly in their hosts. The object of the study, then, was principally to determine the influence and value of these unknown factors upon the amount of decay. Some of the principal factors are age, rate of growth, and presence of injuries.

The area in which this study was carried out is about 30 miles north of Chicoutimi, on lac Epinette, an expansion of the Shipshaw river, which flows south into the Saguenay river between Chicoutimi and Kenogami. The forest there is a virgin uneven-aged stand of the balsam-birch type, the percentage composition being as follows: balsam, 64; spruce, 6; and birch, 30. Since the principal object of the study was to determine the age at which decay becomes of economic importance, trees of all ages were cut and analyzed. Complete notes were taken both in regard to the area in general and in regard to the individual trees selected for analysis. Each tree was cut to a uniform stump height and the age, height, diameter, degree of suppression or dominance, total volume, volume of decay and many other notes were recorded. In all 525 trees were analyzed in this way and when the information thus secured has been interpreted many valuable data in regard to the pathology of this stand will be available.

It was soon found that in this particular area there were but two important decays of balsam. Brief descriptions of these follow.

*Feather rot.*—This is a butt rot and while there is usually some cull in the first log on account of it, it is more important as a contributory cause to windthrow of affected trees. In the early stages of decay the wood is a yellowish buff colour, later turning lighter. Small, longitudinal holes occurring in concentric circles soon appear in the annual rings causing them to separate from each other. Small black spots are usually found throughout the decayed wood. In extreme decay the wood becomes a mass of water-soaked shreds and when a handful of this pulp is taken from the butt it has a feathery appearance. At this stage, especially in trees which have been windthrown, irregular cavities are often found and these are lined with dense layers of white mycelium. The causal fungus seems to fruit infrequently, but in several instances *Poria subacida* Peck has been found in association with this type of decay.

*Red heart rot of balsam.*—This form of decay is usually confined to the main stem and large branches above the first log, though occasionally it has been found extending down to ground level. This was the most serious rot found in balsam; it not only is the cause of a large amount of cull in the woods and loss from sinking during the drive, but it is the principal cause of the stubs or " chicots " which occur so commonly in balsam stands. Available information indicates that it occurs consistently throughout the range of its host.

The affected wood is reddish brown in colour and until the later stages of decay it remains firm and heavy, due to the presence of an abnormal amount of water. In its most characteristic form this decay shows a solid centre of rot with numerous radiating arms extending out from the main body of affected wood. These rays may be as much as two inches in length and half an inch in width and as the sound wood forms a light background for them they are very conspicuous. In many cases, however, the decay occurs simply as a solid mass. In quite an early stage of decay white mycelial sheets are often found in the decayed wood and these persist until the advanced stages of decay. When the

rot is well advanced the wood becomes light brown in colour, lighter in weight, and friable. The decayed wood, however, retains its form and a complete heart rot of the affected tree does not occur. Infection occurs almost invariably by way of branch stubs.

In a recent paper Faull and Mounce* have ascribed the cause of this decay to *Stereum sanguinolentum* Alb. et Schw., and I have found much field evidence in support of this view.

In addition to the decays of balsam already described, one case of partridge rot due to *Trametes Pini* Fries was observed.

As birch forms an important part of the stand in which this study was carried out some observations on the pathology of this species were made. Both paper birch (*Betula alba* var. *papyrifera* (Marsh.) Spach.) and yellow birch (*Betula lutea* Michx.) occur in this district. Twenty-five average trees were selected, felled, and examined for decay. The heartwood of every tree was badly rotted and in nearly every case the decay extended throughout most of the trunk. There were two fungi responsible for this condition of the trees, i.e., *Fomes fomentarius* Fr. and *Fomes igniarius* Fr. Decay caused by the former was most prevalent, being present in 71 per cent of the trees examined; decay caused by *Fomes igniarius* occurred in 8 per cent of the trees and in 21 per cent both types were found.

*Fomes fomentarius* was found to have entered its hosts almost exclusively by way of dead branches and branch stubs in the crown, while the decay caused by *Fomes igniarius* usually originated in side branch stubs or cracks in the trunk.

The average age of these trees was 169 years and the average D.B.H., 15·0″. They were obviously overmature and under a proper system of forest management would probably have been taken out when about 100 years old; in this way much of the present decay would have been avoided. (A. W. McC.)

## NITRO CULTURE DISTRIBUTION

Pending the transfer of this service to the new Division of Bacteriology, to which it now properly belongs, the division has for the last time continued the distribution during the past year. During the period of approximately ten years in which this work has been carried on by the division, some 20,000 cultures were distributed, which enabled many a farmer throughout the Dominion to establish stands of useful nitrogen collecting plants for which the cultures were prepared.

## FLAX WILT

In 1922, this disease was observed for the first time at the Central Experimental Farm in experimental plots of the Cereal Division. On June 4 there was a rainfall of 1.06 inches, succeeded by a week of hot weather. On June 9, with the flax about six inches high, the disease was first noticed; plants were wilting and dying in a strip about twenty feet wide running diagonally across two rows of plots. An examination of the diseased plants and subsequent study revealed the presence of the fungus causing flax wilt, *Fusarium Lini* Bolley.

The diseased strip followed clearly the course of least resistance, continuing along the channels of natural drainage. This feature, combined with the fact that the disease made its first appearance five days after a heavy rain, would seem to indicate that the infection originated in one of the plots on the

*Faull, J. H. and Irene Mounce. *Stereum sanguinolentum* as the cause of "sapin rouge" or red heart rot of balsam. Paper read before the fifth annual meeting of the Canadian Branch of the American Phytopathological Society, Kingston, December, 1923.

higher ground. From this centre of primary infection, secondary infections developed in adjoining plots in all directions, and by the end of the season twenty-nine one-fortieth-acre plots were affected.

In the diseased area, one selection, 891 D, showed decided resistance, and this observation was confirmed in pot experiments, when plants of this type grown in diseased soil remained free from the trouble. (F.L.D.)

## POTATO INSPECTION AND CERTIFICATION

(See Frontispiece)

Notwithstanding the application of a higher standard for field inspection than any previously applied, a larger percentage of fields submitted passed both field inspections and became eligible for certification.

During the growing season, 9,681 acres were inspected, (*a*) as nearly as possible at the blossoming period and (*b*) about three weeks later. This means that in the space of about seven weeks the acreage named was inspected twice, making 19,362 acres in all.

The average amount of disease present in the fields which were accepted for certification, subject to tuber inspection, was: blackleg, 0.36 per cent; leaf roll, 0.42 per cent; mosaic, 0.62 per cent; and wilts, 0.064 per cent. These averages are considerably lower than those for 1922, when they were 0.47 per cent; 0.65 per cent; 1.06 per cent, and 0.14 per cent respectively.

The number of fields rejected as a result of disease or other disqualifying conditions was 853, these fields containing an acreage of 2,581¾. While it was found that the rejections were attributable to a variety of causes, yet by far the largest contributor to the failure of fields to attain the standard is still mosaic. This disease, although apparently not so generally prevalent as in 1922, was nevertheless responsible for the rejection of 440 fields submitted for inspection. The presence of foreign varieties was also the cause of the rejection of 139 fields. This is a cause for which there is not much excuse, for the presence of foreign varieties may as a rule be traced to lack of care on the part of the grower by failing to keep the stock intended for seed purposes entirely separate from other stock while in storage, or by getting part of his crops mixed at harvest time.

Although a large number of varieties of potatoes were included in the applications for inspection, the Irish Cobbler and Green Mountain varieties exceeded in acreage that of all other varieties combined. Of the total of 9,681 acres inspected, 4,303¾ were of the Green Mountain and 3,650 of the Irish Cobbler varieties.

At the time of writing, consignments have gone forward from New Brunswick, Prince Edward Island, Nova Scotia and Northern Ontario to various points in the United States and in this country, the particulars of which are as follows:—

| | No. bushels |
|---|---|
| From New Brunswick to points in the United States | 15,105 |
| From New Brunswick to Ontario | 6,029 |
| From Prince Edward Island to points in the United States | 208,783 |
| From Northern Ontario to Southern Ontario | 1,268 |
| From Northern Ontario for use by the Provincial Department of Agriculture, Toronto | 676 |
| From Nova Scotia to Bermuda | 20,411 |

The great value, as an adjunct to the work of the inspection service, of an organization among the growers for the establishment of markets for certified seed is exemplified by the figures of the shipments made to the United States from Prince Edward Island. It must, of course, be borne in mind that the

whole of the available seed has been shipped, it being invariably disposed of in the fall, whereas in the other provinces large shipments are held over until the following spring, but nevertheless Prince Edward Island has, through the activities and business acumen of the Prince Edward Island Potato Growers' Association, forged ahead during the past two or three years, and has procured reliable markets in the United States, where the reputation of Canadian certified seed potatoes originating in that province has now become so well known that during the past year the demand far exceeded the supply.

It will be noted that the seed trade between Nova Scotia and Bermuda was maintained. The amount shown in the above list, i.e., 20,411 bushels, was all of the Garnet Chili variety, this and Bliss Triumph being the only varieties in demand. Owing to the apparently high susceptibility of the former to leaf roll when planted in Bermuda, only those fields in Nova Scotia which are found to be practically free from the disease and, in addition, isolated from other fields of potatoes, are accepted by the Bermuda Department of Agriculture.

Reference was made in the report for 1922 to the difficulty and confusion experienced owing to the lack of knowledge on the part of growers desirous of purchasing certified seed potatoes of the appearance of the official certification tag issued in accordance with the regulations governing the inspection, and in order to obviate this as far as possible an illustration of the tag was published in the report; so that, taking into consideration the wide distribution of the annual reports, it may be assumed that the appearance of the tag is now fairly common property among growers and purchasers of certified seed potatoes.

Furthermore, during the past year a clause was inserted in the revised general regulations under the Destructive Insect and Pest Act designed to prevent the use of unauthorized certification tags, which had been in several instances practised in the past, often with unpleasant complications resulting. For the general information of growers and purchasers of certified seed potatoes the clause referred to is quoted herewith:—

"In the case of potatoes for which such certificates are required, no person shall be allowed to sell or offer, advertise, expose, or hold in possession for sale, for seed purposes, any potatoes in any manner or form described or designated as certified, inspected, registered, selected or disease-free seed potatoes unless such potatoes are contained in sacks, barrels, or other containers, to each of which shall be durably attached a certificate stating that any such potatoes contained therein have been inspected in the field and after harvest by an inspector under the Destructive Insect and Pest Act and have been found sufficiently vigorous and free from serious diseases, other pests, foreign varieties, mechanical injury, or other blemishes, to warrant them being classed as Extra No. 1 Certified Seed Potatoes. All such certificates shall bear the grower's name or number, as well as a copy of the official seal of the Plant Disease Inspection Service of the Department of Agriculture, Canada."

The duties of the district inspectors in Prince Edward Island, Nova Scotia and New Brunswick, were considerably increased during the year owing to a decree issued by the Government of Cuba, demanding that an official certificate of freedom from disease accompany all shipments of potatoes imported from Canada. Accordingly, for the period from September 1 to December 31 certificates were issued by the officials referred to, covering the shipment from Canada to Cuba of over 300,000 bushels. (G.P.)

## DISEASES OF TOBACCO

The work on tobacco diseases (by arrangement with the Tobacco Division) was carried on under the direction of the Dominion Botanist by Mr. T. G. Major, Tobacco Specialist. During the growing season a series of trips through the tobacco districts of Ontario and Quebec was made and data were taken regarding the occurrence and prevalence of the various diseases. In Ontario the most important troubles were mosaic and *Thielavia* root-rot. One case of

*Fusarium* wilt was observed. There was no disease of outstanding importance in Quebec, although mosaic and *Thielavia* root-rot were general. The so-called "rusts" did very little damage, due, probably, to the dry weather which prevailed. Damping-off was quite prevalent in seedbeds in Quebec.

## B.—FIELD LABORATORIES

Reports of Dominion Field Laboratories at Charlottetown, P.E.I., and Fredericton, N.B., are being omitted owing to a change of personnel at these laboratories.

At Ste. Anne de la Pocatière, Que., there has been established this year a new field laboratory. A suitable building has been erected for the laboratory, which is now being equipped. The laboratory is situated in one of the oldest agricultural districts in Canada. Heretofore little plant pathological work was carried on in the province of Quebec. There is much extension work to be done and urgent local pathological problems to be dealt with.

It is hoped that this laboratory will soon help to serve the needs of the farmers and fruit growers of the community.

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

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

### RASPBERRY MOSAIC

Raspberry mosaic is still economically the most important disease in the Niagara peninsula, although there appear to be good grounds for believing that some decided success in the control of this disease has been met with as the result of the extension, educational and certification services that have been carried on by this laboratory.

During June and July the first inspections were carried out, while the second inspections were not started till the first of August. Every patch, with the exception of those in the London district, that was fit for certification after the second inspection received a third inspection the latter part of September or the first of October. As a result of this last inspection one patch at Stoney Creek had to be thrown out on account of too much leaf curl. Immediately following this third inspection the list of growers having certified stock was sent out. Some 1,000 lists were sent to growers who we knew were especially interested in the raspberry situation. An article was also put in some of the daily papers stating that the list of growers having certified stock for sale could be obtained upon writing to this laboratory. In addition to the 1,000 sent out, we have had requests so far from about twenty-five additional growers.

The average amount of mosaic found in the districts under examination is 7½ per cent, and varies from 0·7 per cent at Campden and Smithville to 18 per cent at Clarkson. This average is much lower than would be secured by taking into consideration all the plantations of any district, excepting possibly London. The reason for this is the fact that most of the figures given were secured from the work of the raspberry certification service, in which we deal with the cleanest and best patches to be found. The average of all patches in any district except London would be from 15 to 20 per cent mosaic. In the Jordan Station and Vineland districts raspberries are grown very extensively in a commercial way, and to almost the same extent around St. Catharines and Stoney Creek.

*Rate of Spread of Mosaic during 1923.*—Two raspberry patches were plotted in September, 1922, and again September, 1923, to ascertain the amount and rate of spread of the disease and how such is affected by spraying. The first patch was about five years old in 1923 and had been given two sprays in each of the years 1922 and 1923, but was not rogued. The first spray (lime sulphur 1:9, with nicotine sulphate 1 pint to 100 gals.) was applied when the most advanced buds on Cuthberts were projecting from one-eighth to three-quarters inch. This was the time when practically all the aphid eggs had hatched. The second spray (Bordeaux with nicotine sulphate, ⅜ pt. to 40 gals.) was given after blossoming. The plantation contained a total length of 1,775 feet in 1922 and had 335 feet or 18·8 per cent mosaic. In 1923 it had 402 feet or 22·6 per cent mosaic, showing a spread of 3·8 per cent.

The second plantation was about the same age as the first, but was neither sprayed nor rogued, and contained four rows of a total length of 1,514 feet. In 1922 it had 181 feet of mosaic or 11.9 per cent, and in 1923 there were 260.5 feet of mosaic or 17·2 per cent, which shows an increase of 5·3 per cent.

From the above results it would appear that spraying to keep down the aphids did not very materially check the spread of mosaic.

Two other plantations were partly plotted and have been under close observation by the St. Catharines Laboratory during the last two seasons. One field contained about four acres of raspberries of various ages, being partly two, three and four years old. No spraying had been done, but the mosaic, 2·6 per cent, was carefully rogued in 1922. In 1923, 12 per cent mosaic was present, showing an increase of 9·4 per cent.

The other field was two years old in 1923 and is the same plantation which was reported upon in the last annual report as having shown no spread during 1922. The mosaic in 1923 had increased from 1.1 per cent to 2.6 per cent, i.e., an increase of 1·5 per cent. There are three conditions which possibly account for the small spread in this patch:—

(1) The sources of infection were few and scattered.

(2) No plantations of diseased raspberries were near.

(3) The smaller bushes of a young patch do not offer the same opportunities for contact and consequent spread as the larger bushes of older patches.

In general throughout the Niagara peninsula the spread of mosaic appears to have been as great if not greater this year than last.

"*Aphis rubiphila*" was present throughout the season on raspberry leaves. In July a number of counts were made in different patches and an average of five aphids per leaf was found. In September the average was seven aphids per leaf. The distribution of the insects was fairly general and uniform over the patches. In one year old plantations, however, some bushes may be heavily infested and others not at all; the reason probably being that the insects cannot spread until the plants have grown large enough to come in contact with one another.

*Symptoms.*—In three plantations this year a small percentage of very faintly mottled plants was observed. However, the young patches which were set out from these showed a considerable percentage of definite mosaic. Later in the season the mosaic showed up more definitely in the older patches. It was found that each of these fields was being heavily fertilized and it would appear that under such conditions the mosaic symptoms may be obscured for a considerable time. The disease in these cases seemed to show first as a faint mottling toward the tip of the canes.

Young shoots in September and October this year generally showed a blotchy mottling quite distinct from mosaic, but in some cases rather confusing since healthy and diseased bushes alike sometimes produced shoots very similar in appearance. The leaves were blotchy rather than mottled as in mosaic, and the blotches chiefly occurred along the larger leaf-veins. Plants showing these symptoms have been set out in plots at Vineland in order that their development may be studied.

*Selection-in-Leaf.*—There are many plantations of raspberries having from 3 to 10 per cent mosaic from which very good stock may be secured. Such patches having above 3 per cent mosaic are now discarded in our certification service. In the fall of the year, after young suckers have sprung up between the rows and before severe frosts have wilted the foliage, stock may be selected, dug and directly set out into new plantations or heeled in for spring use. All shoots showing signs of any mottling may be avoided at this time, and it is also possible to keep five feet or more from any mosaic showing in the rows. It is not intended that the selection-in-leaf method shall take the place of certified stock, but rather that this method shall be a supplementary control measure projected in an endeavour to get as many clean patches as possible set out and thereby decrease the prevalence of mosaic. We have secured seven growers to try the selection-in-leaf method this fall.

*Control.*—With one exception the certified stock of last year has given very good results, and it is hoped to profit by each year's experience, and gradually to build up a high reputation for such stock. The purchase of this stock together with careful rogueing for the first two years should give satisfactory control.

Growers are urged to become acquainted with the mosaic symptoms and to rogue diseased plants whenever they appear. It is this procedure which is keeping leaf curl so well under control, and the same method must be extended to mosaic. Persistent and repeated rogueing during the first year is especially important and should not be neglected by the grower. Rogueing commercial plantations older than two years is hardly advisable unless there is only a trace of mosaic present.

*Further Recommendations.*—(1) The purchase of a few hundred plants of the best certified stock obtainable to form a nursery plot or row is recommended where a grower cannot afford to buy a larger amount of stock. This plot can be given special care, kept free from disease and allowed to produce the maximum number of shoots for use in setting out new plantations. A single row treated in this way will produce enough stock for a good sized plantation. This plan should be of special value to extensive raspberry growers. The nursery row should be distant at least 100 feet from any other raspberries, wild or cultivated.

(2) All growers who wish to set out new raspberry plantations and whose old patches are at all badly diseased are advised to purchase certified stock. If a grower prefers to use his own stock he should get in touch with the Plant Pathologist at St. Catharines, who will inspect his plantation and advise him whether or not his patch is suitable for the selection-in-leaf method. If it is, the method will be demonstrated. If it is not, the purchase of certified stock will be strongly recommended. All growers who contemplate setting out new patches are urged to communicate with us and receive help in their efforts towards eliminating mosaic.

## CERTIFIED RASPBERRY STOCK

This year thirty-four growers with a total acreage of forty-two acres received certificates stating that their plantations of raspberries were sufficiently free from disease to be used for planting purposes.

We have discontinued the use of the term Certified Disease-Free Stock for two reasons: (1) because it is manifestly impossible that all this stock shall be literally disease-free, (2) this statement, backed up by the Government as it was, has caused, in two or three cases, severe criticism from farmers of the district. We are, therefore, calling such stock " certified stock," and stating that it is substantially free from disease, and therefore is suitable for planting purposes.

Every grower whose plantation was certified was required to sign a statement to the effect that only stock from the Government certified plantation would be offered for sale as certified stock, his name being placed on a list which was widely distributed.

This list was divided into two sections, "A" and "B." The stock under "A" came from plantations that showed before rogueing *considerably less* than 1 per cent mosaic; only about $\frac{1}{8}$ to $\frac{1}{2}$ per cent would be the average amount of mosaic present. This stock should therefore be exceptionally good. The stock under "B" came from patches that showed *considerably less* than 3 per cent mosiac before rogueing. In fact 1 to $1\frac{1}{2}$ per cent would be the average per cent of mosiac. The percentage was arrived at from three to four counts made in various parts of the plantation, and was in no case based on the average for the entire plantation, as we considered this would not be justifiable. Many plan-

tations show much more mosaic in one end than the other and an average percentage of the whole plantation would be very low, while actually there are sections of a very high mosaic content.

If we had used for certified stock plantations showing 3 per cent mosaic before rogueing, as was done last year, our acreage of certified stock would have been increased to 55 acres, but we decided it was far better to have less stock which was undoubtedly of good quality, than to take a chance as was done last year, and have some of the stock give bad results. In the light of last year's experience we have taken particular pains to get good stock. To this end (1) we have not certified any plantation which had 3 per cent mosaic present, although our present regulations permit the certification of plantings with 5 per cent mosaic; (2) all percentage figures were based on three counts to the acre. That is, in an acre planting three counts were taken in various parts of the field, generally at both ends and at the centre. In a three-acre plantation nine counts in various parts of the field were taken, etc. Experience early in the summer showed us the necessity of this method and in the future this method of arriving at percentage figures will be closely followed. The average of the field as a whole, or three counts to a plantation, irrespective of size, as the regulations now call for, in many cases will not give anything like a true percentage figure of the mosaic present.

The forty-two acres of certified raspberry stock available this fall is made up as follows:—Cuthbert, 28½ acres; Marlboro, 11 acres; Herbert, 1 acre; St. Regis, ¾ acre; Erskin Park, ¼ acre; La France, ¼ acre; Brighton, ¼ acre.

The demand for this stock appears to be greater than ever, and warrants a more extensive scouting after healthy patches in districts outside the peninsula. For instance if we could find two or three more districts as free from mosaic as London, we believe that the demand would be met and the direct result would be many more clean patches with a yearly decrease of mosaic. The more certified stock set out, and carefully looked after, the sooner this disease will be under control.

### RECOMMENDATIONS FOR 1924

(1) No plantation with over 3 per cent mosaic shall be certified.
(2) All percentage figures are to be the average of three counts to the acre, taken at various parts of the field, such as both ends and the centre. A two-acre planting would therefore require six counts, etc.
(3) By articles in the papers, attendance at growers' meetings, or any other suitable means to impress upon the farmers the absolute necessity for the continuous rogueing of their raspberry plantations. This of course refers to one- and two-year-old patches and especially to one-year settings.

Mosaic bushes should immediately be dug up root and all when first observed. If they are not rogued they are a further source of infection to surrounding bushes and patches. The grower must treat mosaic as he does leaf curl and rogue whenever any mosaic is noted. If the average grower would treat mosaic in this way the sources of infection would be kept down to a minimum, the possibility of spread would be greatly lessened and the chances of good stock coming from such a plantation would be greatly increased. Many growers are already treating mosaic in this way.

This practice presupposes a knowledge of mosaic, but most of the growers in this district at least have a pretty fair idea of mosaic now, and in any case no one would be far astray if he dug up all bushes that showed signs of mottling and were without doubt unhealthy. An unhealthy bush is better out of the plantation in any case.

(4) An especial effort should be made in 1924 to locate clean patches outside the peninsula, and to demonstrate to the growers of such districts mosaic symptoms and control measures.

## RASPBERRY LEAF CURL

The prevalence of raspberry leaf curl in the Niagara peninsula is without doubt on the wane. There is, however, a yearly occurrence of it in most districts, but generally speaking the number of such bushes in a plantation is very small. The percentage present ranges from 0·7 to 7 per cent, with the average around 1 to 2 per cent. We have found only three patches having 7 per cent curl, and the great bulk of the patches inspected would not show greater than 2 per cent curl. It was invariably the case that the high percentage of leaf curl was found on farms where systematic rogueing was not practised. Wherever systematic rogueing is continuously carried out from early spring till fall the disease has become of little importance. It is of course true that a certain monetary loss is sustained yearly in the removal of the rogued bushes. This yearly loss would be not greater than 2 per cent in three-quarters of the plantations. In the other quarter it would range from 3 to 7 per cent, with, however, a yearly decrease until the loss is negligible where careful systematic rogueing is carried out.

In the Stoney Creek district, two plantations with 6 and 7 per cent curl respectively were under observation. In both cases no rogueing had been done last year and the percentage increases this year were 3 and 4·2 per cent respectively.

In the London, Belleville, Clarkson, and Milton districts, considerable curl was encountered because in many cases rogueing was not systematically carried out.

We have made a special effort this summer to inform the grower of the necessity that rogueing for leaf curl must start early in the spring as soon as symptoms are apparent, and be carried out faithfully all summer until late fall. Whenever a leaf curl bush is noticed in the plantation it must be dug out immediately. Observations show that where such systematic rogueing has been in force two or more years the disease is pretty well under control and the yearly loss due to removal of bushes has been decreased from 5 or 6 per cent to practically the zero point.

In the spring of 1922 two small patches were rogued and plotted for experimental plots on rate of spread of leaf curl. This spring these plantations were inspected and again plotted. This fall both these plantings were ploughed under by the grower, so that no future results will be obtainable from these experiments.

The results from the first experiment showed that in 1922 there was an average of 8·73 per cent leaf curl, while in 1923 there was only 0·83 per cent as the result of rogueing operations. In other words a decrease of 7·9 per cent curl was brought about by rogueing operations in one year's time. Or again rogueing operations were 90·5 per cent efficient.

The results from the second experiment showed that in 1922 there was an average of 4·16 per cent leaf curl, while in 1923, as a result of rogueing there was only 1 per cent leaf curl present. That is, a decrease of 3·16 per cent leaf curl is apparent, or in other words rogueing was 76 per cent efficient.

From observations in numerous fruiting plantations where systematic rogueing has been practised, the same yearly decrease in amount of leaf curl is noticed. In plantations where no, or very little rogueing has been done a yearly increase is to be expected, and is generally found to be the case.

## RASPBERRY CANE DISEASES

This year the red and black raspberry plantations have suffered considerably from cane disease. The first symptoms are the discoloration of the cane with the bottom leaves falling first. Generally the tip leaves remain attached for a considerable time, while the rest of the cane becomes a blue-black colour and devoid of leaves. The very tip of the cane remains brown, as do the adherent leaves. In some cases the canes are blue for almost their entire length and circumference, in other cases for only a short distance, or along one side only. In some cases a brownish-blue cast is apparent in place of the decided blue. In most cases the entire plant was defoliated; occasionally, however, one or more canes appeared healthy, while the remainder were decidedly diseased. No fruiting bodies of any sort have been observed in the field.

These symptoms suggest the blue stem disease as described by Lawrence, 1912. But when one considers that this disease has been very prevalent this year throughout the entire peninsula on Cuthberts, with some plantations having as high as 10 per cent infection, and that up to last year it had never been reported for this district, and last year was reported in a few plantations of *black raspberries only*, it becomes hard to understand how such a prevalence could have become established in one year's time.

However isolation, cultural and histological studies have shown conclusively that this disease is caused by a *Verticillium* sp. of the *Acrostolagmus* type. The organism isolated from red raspberries is practically identical with the blue stem organism described by Lawrence in 1912 as *Acrostolagmus caulophagus*. The author is of the opinion, however, that this organism should be placed in the genus *Verticillium*, and that *Acrostolagmus* should be discarded as being superfluous. This same view was set forth by Carpenter* 1918. It is quite likely that this raspberry organism will eventually be shown to be either *Verticillium Dahliæ* Kleb. or *V. albo-atrum* R. and B.

Further work is being carried on with this organism in an endeavour to further identify it, establish its parasitism and ascertain its range of hosts. Control measures are also being considered.

In one case where this *Verticillium* disease was very bad this year on red raspberries (Cuthbert) the grower had previously planted to potatoes and tomatoes. His potato crop was very poor and upon investigation we have found that the *Verticillium* wilt was present amongst his potato crop three years back. It would appear, therefore, to be a wise precaution not to plant raspberries where wilted potatoes had previously been grown within the last five years at least. There are indications that the wilt is less destructive on heavy soil than on a lighter sandy loam.

## STRAWBERRY DISEASES

During 1923 the strawberry root rot and mildew caused considerable loss in certain strawberry-growing sections. Two growers estimated one-half loss of crop due to a combination of these two troubles. The leaf spot and leaf scorch, although generally present, were not so abundant as usual and hence caused no great appreciable loss of crop. Of all the troubles perhaps the black root has been the most prevalent and has caused the greatest damage. Several patches which appeared very promising in the spring were ploughed under this fall as a result of the black root trouble.

In the past this root trouble has been put down by pathologist and grower alike to winter injury, either directly due (1) to a severe winter, (2) a too early removal of the mulch, or (3) to the alternate freezing and thawing of early spring. From observations made this summer we have ascertained that

*C. W. Carpenter—Wilt diseases of Okra. In Jour. Agr. Res. Vol. 12, No. 9, 1918.

this trouble has been prevalent in (1) mulched and unmulched plants, (2) where mulch was removed, and where it was not entirely removed, but the plants were allowed to force their way up through, and (3) in patches that have wintered over, and in *new settings* that have not wintered. Also there appear to be two types of this trouble as follows:—

(1) Type I. True winter injury—which is found in old and new patches alike.

(2) Type II. This type has been found only in new settings that have come from patches which have wintered over, but do not, however, show any signs of the disease.

*Symptoms.*—In both the above types, however, the symptoms are the same. The first external sign is a browning or bronzing of the leaf with sometimes a slight curling of the margin, the whole having a somewhat rigid appearance. Later, however, all parts above ground become dry, crisp and dead. The roots in all types, upon examination, show a characteristic browning or blackening of the internal core of the root tissues. This discoloration first starts as small brown spots, which gradually enlarge until the whole root system becomes involved.

TYPE II (IN NEW SETTINGS)

A grower at St. Catharines has had this trouble for four consecutive years in new settings. He has tried sets from various sources, and invariably the disease has showed up, although the patches from which the sets came did not show the presence of this trouble. This tends to show that in this case at least winter injury is not the cause of the injury. If it were, then we would expect to see the parent patches, which had wintered, and from which the sets came, show the presence of this disease. However, they did not. And another thing, none of these new settings showed any recovery after the hot period of summer weather was over. In the case of winter injured plants a slight recovery at least is often apparent.

Inoculation tests have been carried out with bacteria isolated from the internal core of "black root" strawberry plants, but so far no definite results have been obtained.

## CHERRY—BROWN ROT BLOSSOM BLIGHT

The brown rot blossom blight on cherries has caused for some years past a decided annual loss to cherry growers. This year it was especially severe in low-lying, poorly air-drained orchards. Unsprayed trees in various parts of the peninsula showed blossom infection ranging from 25 to 85 per cent. The worst cases of blossom blight appeared to be in orchards some distance from the lake. Orchards along the lake shore invariably showed on the whole a somewhat smaller percentage of infection.

As there appears to be no satisfactory spray schedule for the control of blossom blight in use in the peninsula, and as this disease causes a considerable yearly loss, an experiment was projected in an attempt to get some first-hand information on blossom blight control.

Mr. McD. of St. Catharines very kindly consented to let us use his small sour cherry orchard of ninety trees for this experiment.

A dormant spray ($\frac{1}{8}$ lime sulphur) was applied before any signs of the swelling of the buds was apparent.

A pre-blossom spray ($\frac{1}{40}$ lime sulphur, lead arsenate mixture) was applied as buds were showing white.

A blossom spray (Bordeaux mixture) was to have been applied while trees were in full bloom but due to a misunderstanding this spray was applied two days after the previous one. Following are the results:—

| | Blossom Blight |
|---|---|
| (1) Dormant spray | 63% |
| (2) Pre-blossom | 77% |
| (3) Two days later | 60% |
| Check trees | 76%–85% |

Percentage figures are the average of three to four counts of 200 to 250 blossoms. Each count was taken at different parts of the tree, such as low, high and centre.

## PEACH LEAF CURL

The value of dusting as opposed to spraying for control of peach leaf curl was tried out in the three following experiments:—

### EXPERIMENT I

The following applications were applied on April 12, 1923, in an Elberta orchard at Niagara-on-the-Lake.

| Applications | Rows | Per cent Curl present |
|---|---|---|
| Copper dust 25 per cent Cu | 1 and 2 | 10.2 |
| Lime sulphur 1:20 | 3 and 4 | 6.7 |
| Soluble sulphur 12:35 | 5 and 6 | 14.5 |
| Lime sulphur 1:7 | 7 and 8 | 7.25 |

### EXPERIMENT II

Two complete rows in an Elberta orchard at Vineland were dusted with the same 25 per cent copper dust, the rest of this orchard received the 1:7 lime sulphur spray.

| | Per cent Leaf Curl |
|---|---|
| 1:7 lime sulphur spray | 5.2 |
| 25 per cent copper dust | 34.20 |

### EXPERIMENT III

Four rows of an Elberta peach orchard at Grimsby received the 25 per cent copper dust, while the remainder received the 1:7 lime sulphur spray.

| | Per cent Leaf Curl |
|---|---|
| Lime sulphur | 6.0 |
| Copper dust 25 per cent | 47.9 |
| Check trees in each of the above experiments averaged | 65.4 |

From the three experiments the average per cent of curl present on dusted trees was 30·7 per cent, while on sprayed trees it was only 6·15 per cent.

Although in experiments II and III the dust fell down badly, however fairly good control was obtained in experiment I where only 10.2 per cent curl was present on dusted trees.

The apparent difference in the efficacy of dust in these cases may to some extent be due to the fact that a light breeze was blowing when the dust was applied at both Vineland and Grimsby orchards, whereas the air was quite calm when the application was put on at the Niagara-on-the-Lake Farm.

# REPORT OF DOMINION FIELD LABORATORY OF PLANT PATHOLOGY, WINNIPEG, MAN.

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

LIST OF PROJECTS

Although the present Pathologist in Charge did not assume his duties at this laboratory until the middle of April, the late spring and the generous co-operation of the Botany and Field Husbandry Departments of the Manitoba Agricultural College at seeding time enabled a start to be made on the projects which demanded attention most urgently. The following projects were begun:—

I. Oat Stem Rust Investigations.
II. Varietal Resistance of Oats to Crown Rust.
III. Epidemiology of Black Stem Rust.
IV. Experiments on the Control of Cereal Smuts.
V. Rhamnus Survey.
VI. Barberry Survey.
VII. Root Rots of Wheat.

## OAT STEM RUST INVESTIGATIONS

The imperative need of a thorough investigation of the oat rust problem is evidenced by its seriousness. Oat rust has become the most disturbing factor in one of Manitoba's best agricultural projects, the growing of oats. The general and profitable use of oats as a late crop is being more and more abandoned because of its increasing uncertainty due to apparently increasing ravages of oat rust. Moreover, that large area of higher elevation near the Riding mountains, where a slightly shorter season than on the plains makes wheat growing somewhat uncertain, is finding the oat crop, on which it relied to so great an extent that it is known colloquially as the oat country, damaged by rust to such a marked and apparently increasing extent that the mattter gives them much concern. Much the same condition exists in Saskatchewan where oats are grown to a still greater extent and, unless an industry that adds about one hundred and fifty million dollars on an average every year to our national wealth is to be seriously handicapped, it is imperative that a solution be found for the rust problem.

The investigations carried on this year have been largely to determine (1) what biologic forms of *Puccinia graminis Avenae*, the causal organisms of oat rust, are present in Canada, and (2) to determine the resistance to these strains of all the oat varieties obtainable.

Only five biologic strains of the oat rust organism have been described up to the present (Jour. Ag. Res. *24;* 12; 1013-1019, 1923).

Two of these moreover were not of American origin. These two, however, are extremely virulent forms and to them the varieties that are otherwise resistant are entirely susceptible. Consequently it is a matter of immediate importance to determine whether or not those forms exist in Canada. Obviously the question cannot be definitely settled in one year, but the evidence accumulated this season seems to indicate that such forms either do not exist with us or are extremely rare. The differential varieties, White Russian and Richland, were grown at Winnipeg, and through the courtesy of Superintendents Leslie, McKillican and McKenzie, at the Morden, Brandon and Indian Head Experimental Farms, as well. These varieties are resistant to all but the two

virulent forms mentioned above. In these field trials, these varieties proved resistant in every case, although a large number of other varieties grown along with them rusted heavily in all cases, except at Morden where most of the varieties matured before they had much opportunity to become infected.

In addition to these field tests, over sixty collections of oat rust from Western Canada and adjoining parts of United States have been cultured in the greenhouse, and the reaction of the varieties, White Russian and Richland, to them determined. These were resistant in every case, thus further supporting the indication of the field tests that the two virulent forms to which these varieties are susceptible are either absent or extremely rare with us.

Eighty-four oat varieties were included in a field test of varietal resistance at Winnipeg, and about one-quarter as many at Morden, Brandon, and Indian Head. Although some of the varieties escaped injury to a greater or less extent through earliness, none but White Russian and Richland displayed any real inherent resistance.

The varieties White Russian CI 1614, Richland CI 787, and Heigira Rustproof C. I. 1001, have proved resistant in green house trials to all the collections of oat rust obtained from either United States or Canada. Of these resistant varieties, White Russian is a side-oat and Richland a selection out of Kherson, a variety which has not met with much approval in Western Canada. The third variety, Heigira Rustproof, unfortunately is not pure for rust resistance and although selections are being made toward that end sufficient seed will not be available for yield tests before another year at best. Consequently it would not seem that we could hope for much from the varieties of oats that have resistance. However, in Richland we have a variety that is of the open-panicle type, with marked resistance and requisite earliness.

In addition to these more directly practical aspects of the oat rust problem, a detailed study of the more technical but equally essential phases is also being carried on. The number, nature and constancy of the biologic forms of the oat rust organism are being investigated as well as the mode of infection and the nature of resistance to them.

## VARIETAL RESISTANCE TO CROWN RUST

Eighty-four varieties of oats, belonging to six species of *Avena,* were grown in rod rows at Winnipeg this year.

While there was considerable variation in the severity with which the different varieties became infected, it seemed to depend almost entirely on the relative maturity of the varieties rather than on their resistance. Unfortunately, too, the varieties White Russian and Richland, which were very resistant to stem rust, were completely susceptible to crown rust. None of the eighty-four varieties under observation had sufficient resistance to warrant the hope that it would be of any marked value in controlling crown rust. Further attempts will be made next year to find varieties resistant to crown rust and the varieties that rusted least this year will be grown again to get a better idea of how much can be hoped for from them.

## EPIDEMIOLOGY OF BLACK STEM RUST

The most interesting problems relating to the epidemiology of black stem rust in Manitoba are those concerning the overwintering of the urediniospores and the source of the inoculum responsible for the early infections.

Although a large number of germination tests were made, no viable urediniospores were found after the first week of May, and for some time previous to that only an occasional spore had been found to germinate. Field evidence in general also supported the idea that the early summer infections this year did not come from over-wintered urediniospores.

In the field the rust appeared first on wheat and subsequently on various grass hosts. A light scattering of primary infections appeared practically simultaneously over a surprisingly large area and the indications were that the inoculum had been wind borne from some section considerably farther south.

When once established the rust developed with extreme rapidity and, within three weeks after it first appeared, the central and southern parts of the province were involved in an epidemic which culminated in the loss of almost 50 per cent of the crop.

Barberries rusted rather generally this year, but the infection was not as severe as usual. It was also later in appearing, due no doubt to the backward spring. Pycnia were found first at Winnipeg on May 31, and aecia opened first on June 5. Conditions immediately following this were unfavourable to rust development and as a result the rust spread slowly from barberries wherever observed, and the local epidemics initiated were not significantly in advance of the general epidemic.

## THE CONTROL OF CEREAL SMUTS

In co-operation with Dr. G. R. Bisby, Pathologist at Manitoba College.

The following treatments were carried out with wheat, oats and barley. Formaldehyde sprinkle; formaldehyde spray; copper carbonate, 2, 4, and 6 ounces per bushel; sulphur, 6 ounces per bushel; nickel carbonate, 2 to 4 ounces per bushel; Seed-O-San, 1 ounce per bushel; Seed-O-San plus copper carbonate, 2 ounces per bushel; dehydrated copper sulphate and lime, 2, 3, and 4 ounces per bushel; copper sulphate dip; Semesan, one part to 200 of water for 10 minutes and 20 minutes, and Semesan, one part to 400 of water for 10 and 20 minutes. Unfortunately with the wheat and barley where smut appeared at all, even in the checks, it did so in such small percentages that the results were of very little value. It does not seem desirable to base any general conclusion on them in the above instances.

Slightly better results were obtained with oats, though even here they were still far from satisfactory, the infection on three checks running only three, three, and twelve per cent respectively. From these results it was evident that Seed-O-San, nickel carbonate, and Semesan, as used in this experiment, were ineffective in satisfactorily controlling oat smut. Formaldehyde, copper carbonate, and the copper sulphate dip all gave perfect control.

Three plots, each consisting of three eighteen-foot rows, were planted with seed from each treatment and the plots were systematically replicated. Yield data on the central sixteen feet of each middle row were taken. It was found, however, that there were no differences in yield between the checks and the treated plots or between plots differently treated which could be considered really significant in relation to the probable error involved.

The effectiveness of copper carbonate is of primary interest in the light of the possiblity of it replacing formaldehyde in general use. The advantages of such a dry treatment are obvious, but it must be remembered that in this case only a small seed lot was treated and the powder was thoroughly distributed over the grain. The effectiveness of the treatment would probably depend altogether on the efficiency with which the copper carbonate dust was spread over the grain, and it seems doubtful if the treatment would prove satisfactory in practice without some special apparatus, such as a revolving drum or barrel, to insure all the grain being thoroughly dusted.

## BUCKTHORN SURVEY

With the placing of the European buckthorn, *Rhamnus cathartica*, on the Noxious Weed list came the necessity for accurate information as to its

prevalence and distribution in Manitoba. Accordingly a survey of the cities and towns of the province was undertaken in conjunction with cereal diseases survey and potato inspection. All those associated with this laboratory, as well as Mr. I. L. Conners of the Brandon Laboratory, co-operated on the project.

A survey of some of the better residential sections of Winnipeg indicated that the European buckthorn has been used rather extensively in hedges and in small clumps. In the district surveyed about sixty plantings were discovered.

From the work of the summer it would seem that the European buckthorn is very largely confined to three or four of the larger towns, and that outside of these only occasional plantings are likely to be found.

## BARBERRY SURVEY

A barberry survey was carried on in conjunction with the buckthorn survey. This involved considerable resurvey, but that seemed desirable as a check on the efficiency of the previous survey and served to give an indication as to the efficacy of our present means of eradication. Barberries were located in four of the twenty-seven towns surveyed, namely, Carman, Stonewall, Shoal Lake, and Gimli. In each of the first two towns only a single bush was found, while two were found in Shoal Lake and an eighty-foot hedge at Gimli.

In the section of Winnipeg surveyed this year twenty-eight barberry plantings, representing two fifty-foot hedges and thirty-three individual bushes, were located. The finding of so many barberries in a section of the city previously surveyed indicates the desirability of completing a resurvey of the entire city. This must be combined with more vigorous efforts to get rid of those already located.

## ROOT ROT INVESTIGATIONS

From the survey work of this summer, it is evident that root rot diseases of wheat are of much greater significance economically than is commonly supposed. As a rule the only cases that attract attention are those in which plants are killed in rather sharply delimited areas; however, it seems probable that this is the less serious aspect of the case and that greater aggregate damage may be done by the apparently very general, milder infections, which reduce yields appreciably by materially reducing the root system of the plants involved, without producing any well-marked symptoms above ground. Practically nothing has been done on this problem in Manitoba, yet its importance justifies a complete investigation of all its phases.

The plots of the various rotation experiments at Manitoba Agricultural College offered an unusually good place to begin a study of this problem, of the organisms involved, the extent to which they are present and their pathogenicity. Through the courtesy of Professor Ellis, of the Field Husbandry Department, these plots were made available to us after harvest. Wheat stubble was collected from plots which had grown wheat for one, two, three, four, and five years consecutively, as well as from plots where wheat followed corn, flax, peas, beans and a large number of other crops.

Pure culture isolations from all these various samples are being carried on to find out what pathogenic organisms are present and to compare the fungous flora of the roots from various rotations. This should indicate whether continuous cropping of wheat or cereals results in an accumulation in the soil of root-rotting organisms which would seriously affect the yield. Greenhouse studies on the pathogenicity of the organisms recovered from the wheat roots will reveal which ones are most virulent and the conditions under which most damage will be done.

Although the work is only nicely begun it is already evident that a very large number of roots on many of the plots are infected by one or more root-rotting organisms and that, among these, members of the genera *Helminthosporium* and *Fusarium* predominate. Mr. F. J. Greaney is devoting the major portion of his time to this study and it is hoped that many valuable data may be accumulated by spring.

*Plans for Next Year.*—Practically the same projects will be carried on next year. It is hoped, however, that each of them may be considerably broadened and that a marked expansion in the field experiments will be found possible.

## REPORT OF DOMINION FIELD LABORATORY OF PLANT PATHOLOGY, BRANDON, MAN.

(I. L. Conners, Plant Pathologist, Officer in Charge)

The present officer took charge of the Dominion Field Laboratory of Plant Pathology at Brandon, Man., in July. On account of the lateness of the season no field experiments were conducted.

### EXPERIMENTAL WORK

Experimental work on the factors influencing parasitism of the wheat bunt fungus (*Tilletia Tritici*) was undertaken in November at the Dominion Field Laboratory of Plant Pathology, University of Saskatchewan, Saskatoon, Sask. A report on this investigation will be made later.

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

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

Plant diseases in the territory served by this laboratory have, during the past season, showed some variations from the normal which seem, perhaps, worthy of mention. Considered generally, the orchards came through the winter in fairly good condition. In some cases, the severe frosts of early winter caused damage to peach and apricot trees, and in the north, some apple trees were frozen severely around the crown and trunk.

A disfigurement of apricots and peaches appeared for the first time since the laboratory was established. This injury is characterized by large sunken areas on the surface of the fruit, somewhat similar to the effect produced by worms eating out portions of the young fruit. Closer examination, however, has shown that the injury is not due to the action of insects. A careful examination of roots on all affected trees showed that they had been winter injured, and it would appear that the injury on the fruit has been brought about by the injury in the root. (Plate 3, fig. b.)

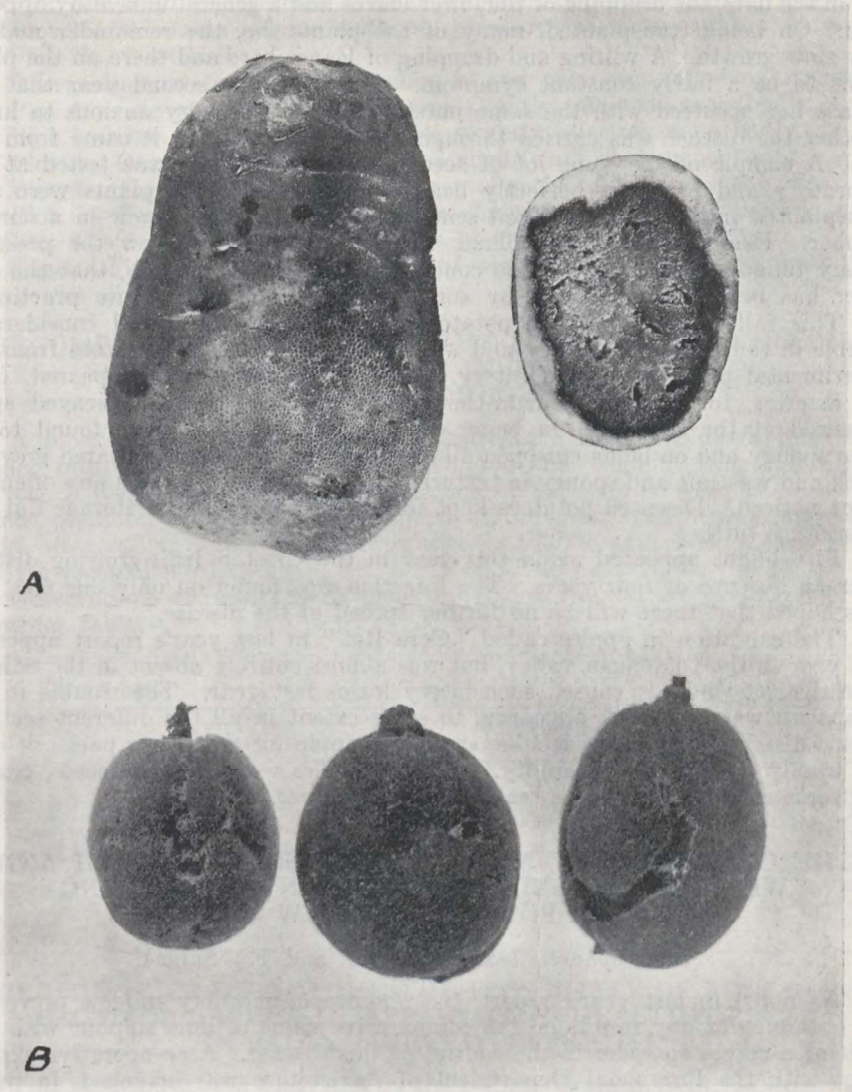


PLATE III

(*a*) Potato breakdown from Invermere, B.C.
(*b*) Effect of winter injury of root on fruit of peaches.

An exceptionally wet spring favoured apple scab in the northern regions at Salmon Arm, Enderby and Vernon. Owing to financial difficulties, many growers in these districts failed to apply the usual sprays, and as a result, many suffered very considerable losses.

During July an epidemic of soft rot occurred on all susceptible vegetables from Kelowna south. Considerable loss was brought about, especially to celery, turnips and cabbage, but the setting in of hot, dry weather checked the advance before more serious damage was done.

An unfamiliar disease of tomato was met with during the season. The symptoms of the disorder are a complete checking of growth while the plants are

still in the flats, the dropping of the lower leaves and a general unhealthy appearance. On being transplanted, many of the plants die, the remainder making very slow growth. A wilting and dropping of leaves here and there on the plant seems to be a fairly constant symptom. As this is the second year that the disease has occurred with the same nurseryman, he was very anxious to know whether the disease was carried through the seed or whether it came from the soil. A sample of the same lot of seed used in his seeding was tested at the laboratory and produced perfectly healthy plants. Healthy plants were also transplanted into a sample of soil sent in by him and these grew in a normal manner. Examination of the plants themselves failed to show the presence of any fungus or nematode. The conclusion temporarily held is, that the disorder has been brought about by some unfavourable green-house practice.

This fall, a breakdown in potatoes (Plate 3, fig. a) caused considerable trouble in the Invermere valley and was also noted on a few potatoes from the experimental plots at the laboratory. Affected potatoes often appeared, from the exterior, to be quite sound, though in some cases small decayed spots appeared at the surface. On being squeezed the potatoes were found to be quite spongy and on being cut open all tissue inside the cortex appeared greyish-black and was soft and spongy in texture. In a few cases only was any offensive odour noticed. Diseased potatoes kept for considerable time in storage did not deteriorate further.

Fire blight appeared again this year in the Creston fruit-growing district after an absence of four years. The infection was found on only one tree and it is hoped that there will be no further spread of the disease.

The condition in apples called " Core Rot " in last year's report appeared this year in the Okanagan valley, but was almost entirely absent in the Salmon Arm district where it caused such heavy losses last year. The trouble in the Okanagan was scattered, appearing to some extent in all the different sections of this district. While the trouble spoils the apple for the better packs, it does not wholly prevent its saleability. Affected apples were, in some cases, crated, and some return at least was realized by the grower.

## THE COMPARATIVE VALUE OF LIME SULPHUR WITH AND WITHOUT A CASEIN SPREADER, IN CONTROLLING POWDERY MILDEW

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

As noted in last year's report, the absence of powdery mildew prevented the obtaining of any results on the comparative value of lime sulphur with and without a casein spreader in the control of this disease. A co-operative experiment with the Provincial Department of Agriculture was arranged, in which the cost of materials and applications of the spray was borne by the provincial department and the methods of procedure and making of observations were left to this laboratory.

A block of full-grown apple trees was chosen and divided into seven plots of four trees each. Lime sulphur at a strength of 1-35 was applied in two sprays and 1-40 was used in a third spray. The spreader used was one put out by the Oliver Chemical Company. The plots received sprays as follows:—

Plot No. 1.—Lime sulphur with spreader, three sprays, pink, calyx, and two weeks after calyx.

Plot No. 2.—Lime sulphur with spreader, two sprays, pink, calyx.

Plot No. 3.—Lime sulphur with spreader, one spray, pink.

Plot No. 4.—Lime sulphur without spreader, three sprays, pink, calyx, and two weeks after calyx.

Plot No. 5.—Lime sulphur without spreader, two sprays, pink, calyx.
Plot No. 6.—Lime sulphur without spreader, one spray, pink.
Plot No. 7.—Check.
Observations were made September 1, and gave the following results:—
Plot 1.—One and two tips to a tree slightly affected, none badly.
Plot 2.—One and two tips to a tree slightly affected, none badly.
Plot 3.—One and two tips to a tree slightly affected, none badly.
Plot 4.—Eight and ten tips to a tree slightly affected, none badly.
Plot 5.—Four and five tips to a tree slightly affected, none badly.
Plot 6.—Twenty and thirty tips to a tree affected, a few badly.
Check—Fifty per cent of tips affected, some badly, but for the most part, injury was slight.

## THE COMPARATIVE VALUES OF LIME SULPHUR AND COLLOIDAL SPRAY KNOWN AS COSAN IN THE CONTROL OF POWDERY MILDEW

A block of 18 three-year-old Jonathan apple trees was used, this being divided into three plots of six trees each, for lime sulphur, colloidal sulphur and check respectively. Three applications of each spray were given at 250 pounds pressure, the spray being applied at the pink stage, calyx, and three weeks after calyx. Lime sulphur was used in the strength 1-40, Cosan in the strength recommended, 1-500.

Observations of results were made on August 15, and are presented in the following table:—

| Lime Sulphur | | Cosan | | Check | |
|---|---|---|---|---|---|
| Tree | Twigs affected | Tree | Twigs affected | Tree | Twigs affected |
| No. 1 | 0 | No. 1 | 0 | No. 1 | 17 |
| No. 2 | 1 | No. 2 | 2 | No. 2 | 5 |
| No. 3 | 0 | No. 3 | 7 | No. 3 | 5 |
| No. 4 | 1 | No. 4 | 2 | No. 4 | 12 |
| No. 5 | 1 | No. 5 | 1 | No. 5 | 9 |
| No. 6 | 1 | No. 6 | 1 | No. 6 | 17 |
| Totals | 4 | | 13 | | 65 |

## EXPERIMENT TO DETERMINE THE POSSIBILITY OF FIRE BLIGHT BACTERIA LIVING IN APPARENTLY HEALTHY FRUIT IN BADLY LIGHTED DISTRICTS

This experiment was suggested by the results obtained from the experiment to determine the longevity of *Bacillus amylovorus* in mature fruit. It was thought that it might be possible for the bacteria to remain in a dormant condition in the calyx end of the fruit during the growing season, and yet become a danger centre for infection should that fruit later be rotted by a fungus during storage.

Apples including Delicious, Jonathan and McIntosh, and pears including Boussock, Anjou, Flemish Beauty and Bartlett were collected from orchards in which fire blight was very severe. A total of 321 isolations was made from such fruit and all cultures kept, in which there appeared bacterial growth at all similar to *Bacillus amylovorus*. These were later tested on young pears on the experimental plots of the laboratory, along with tested fire blight cultures, inoculations from both cultures being made under practically identical conditions. Some twenty-three cultures were selected from the 321 for the test.

Of this number, none of the twenty-three proved capable of infecting the trees. The inoculation from the tested cultures produced the disease in every case. The experiment is being continued, being of particular interest because of the Australian embargo against Canadian fruit, owing to prevalence of fire blight.

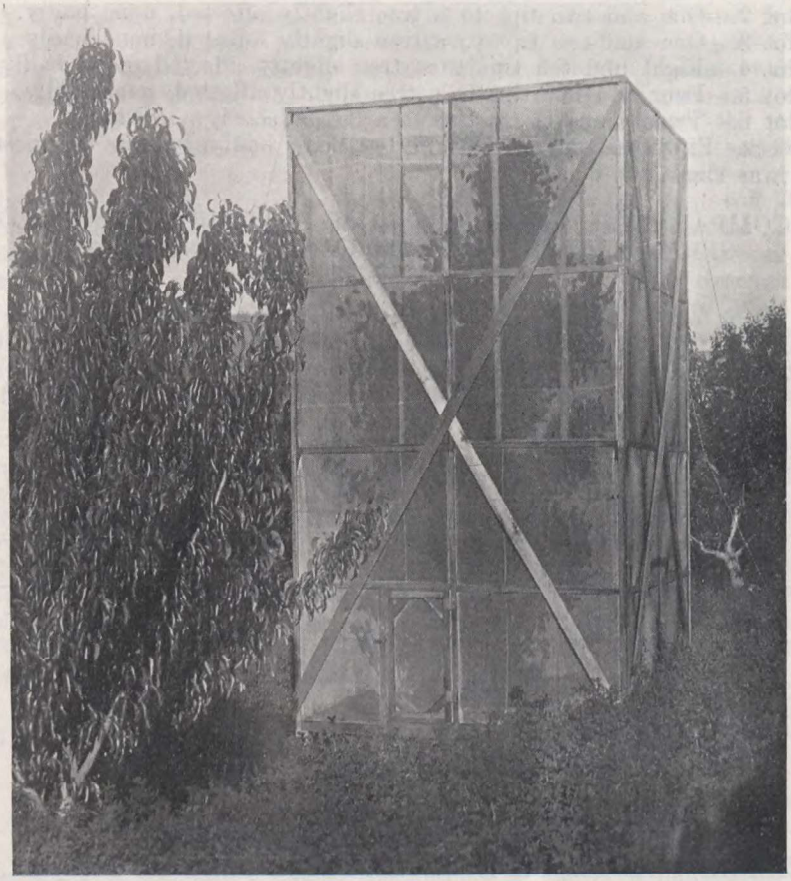

PLATE IV
Fire blight investigations, caged pear tree.

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

Owing to the difficulty of handling a disinfectant when cutting for fire blight in the winter time, growers often neglect its use. A search through available literature failed to locate any experimental results stating whether or not infection could be spread by tools if these were not disinfected when used in cutting during the dormant season. An experiment to collect data on this subject was outlined and the first year's results are presented herewith.

A seven-year-old Winter Bartlett tree was chosen for the experiment and over this was built a cage lined with mosquito screen wire and cheesecloth. Every precaution was taken absolutely to prevent the entrance of any insects,

including the building in of a solid floor and the packing around the trunk with oakum. (Plate 4.) At the times of inoculation, the tree was yet dormant and remained so for about one month after the last inoculation.

The experiment was divided into three parts:—

First, to attempt to produce infection by cutting through live cankers, so proven by laboratory cultural tests, with shear or saw and immediately cutting off with the same tool a twig or branch.

Second, to attempt to produce infection by dipping the pruning tool into a distilled water dilution of live bacteria and then removing a twig or branch, the tool being dipped after each cut.

Third, to attempt to produce infection by pouring some of the distilled water dilution over the pruning implement, then dipping the tool into mercury bichloride 1-1000 and then pruning.

The summary of results obtained was as follows:—

First part.—Seventy inoculations made March 6 and 7, with no resulting infections.

Second part.—Twenty-five inoculations made March 14, with ten infections.

Third part.—Twenty-five inoculations made March 14, with one infection.

This experiment is being continued.

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

This year an experiment has been begun on the W. Meek Ranch, Salmon Arm, having for its purpose the investigation of those factors which have to do with the prevention of corky core (core rot), which caused heavy losses in this district during the season 1922.

A plot of ground approximately two acres in extent, of uniform slope and soil, and planted to Wealthy apples has been taken over. The plot chosen is one where the whole crop was a loss during the season of 1922. This plot has been subdivided into four smaller plots, each consisting of two rows with eight trees to a row. That the proposed cultural conditions for each plot may not at any time interfere with those of the one adjoining, each is separated from the one next by one buffer row of trees. The several plots are now being placed under different cultural conditions, in order, if possible, to ascertain whether such conditions may prevent the recurrence of the disease. In those plots where water is being applied by irrigation, the purpose is to supply only sufficient water to protect against any injury to the tree from drought. Through the courtesy of the city of Salmon Arm, water from the city system has been granted at a nominal rate for these experiments. To ascertain when water should be applied, soil moisture determinations are made each week.

The proposed cultural conditions are as follows:—

Plot No. 1.—A cover crop of hairy vetch with water. Plot No. 2.—Clean cultivation, plus water. Plot No. 3.—Clean cultivation with the addition of manure and water. Plot No. 4.—Clean cultivation and manure only; no water.

As it is intended that this experiment be continued for a number of years, it is thought advisable to withhold the publishing of results until all the data can be gathered.

## A SURVEY OF SOIL MOISTURE CONDITIONS IN THE OKANAGAN VALLEY, AUTUMN 1923

Periodically, in these fruit-growing areas, certain physiological disorders occur in varying degrees of severity. Sometimes it is winter injury in its dif-

ferent forms; sometimes drought spot, punk, corky core, breakdown or similar effects on the fruit. While it is held by many that the majority of these are due to unbalanced water relations in the tree, yet very little accurate information concerning these water relations seems available. With the hope that some information along such lines will be of great assistance in the explanation of the outbreak of such disorders, a start has been made this year by this laboratory in the collection of soil moisture data for these districts.

It was found in making these collections that the general method of taking soil samples would possibly not give a fair determination of the soil moisture relation to the tree. Owing to the extremely wide variation in the types of soil in which the trees are grown, examination showed that their root systems varied greatly in the depth at which they were situated. For example, in orchards where a gravel layer existed as little as one foot beneath the surface, the fibrous root system of the tree was altogether located above the gravel layer. On the other hand, where trees were growing in clay, the roots were found very much deeper. It was decided therefore, that a more exact determination of the water relation between the soil and the tree was to be obtained by taking soil samples from the area where the main fibrous root system existed.

The determination of the soil moisture from the samples collected, brings out in a very distinct way the wide fluctuations that occur in soils throughout the fruit-growing districts, the lowest soil moisture percentage being 1.50 and the highest 35.48.

It is hoped that a fuller survey of these conditions can be carried out in the near future.

## WORK ON COLLAR ROT

The prevalence of collar rot and the many inquiries that have been received point to the importance of an educational campaign for its prevention. Many growers are now systematically going over their orchards, examining the crown of every tree, and cutting out dead areas as they find them. These surveys have strengthened greatly the recommendations repeatedly given by this laboratory that every orchardist should make such a survey. It is with great surprise that the orchardist finds apparently healthy trees to be quite badly diseased at the crown.

To assist the growers in this work, and also to get material for educational purposes, several trees have been treated and photographs taken of the methods of doing the work found to be most satisfactory under conditions here. From these photographs, lantern slides have been made and an educational lecture prepared. (Plates: 5, 6, 7.)

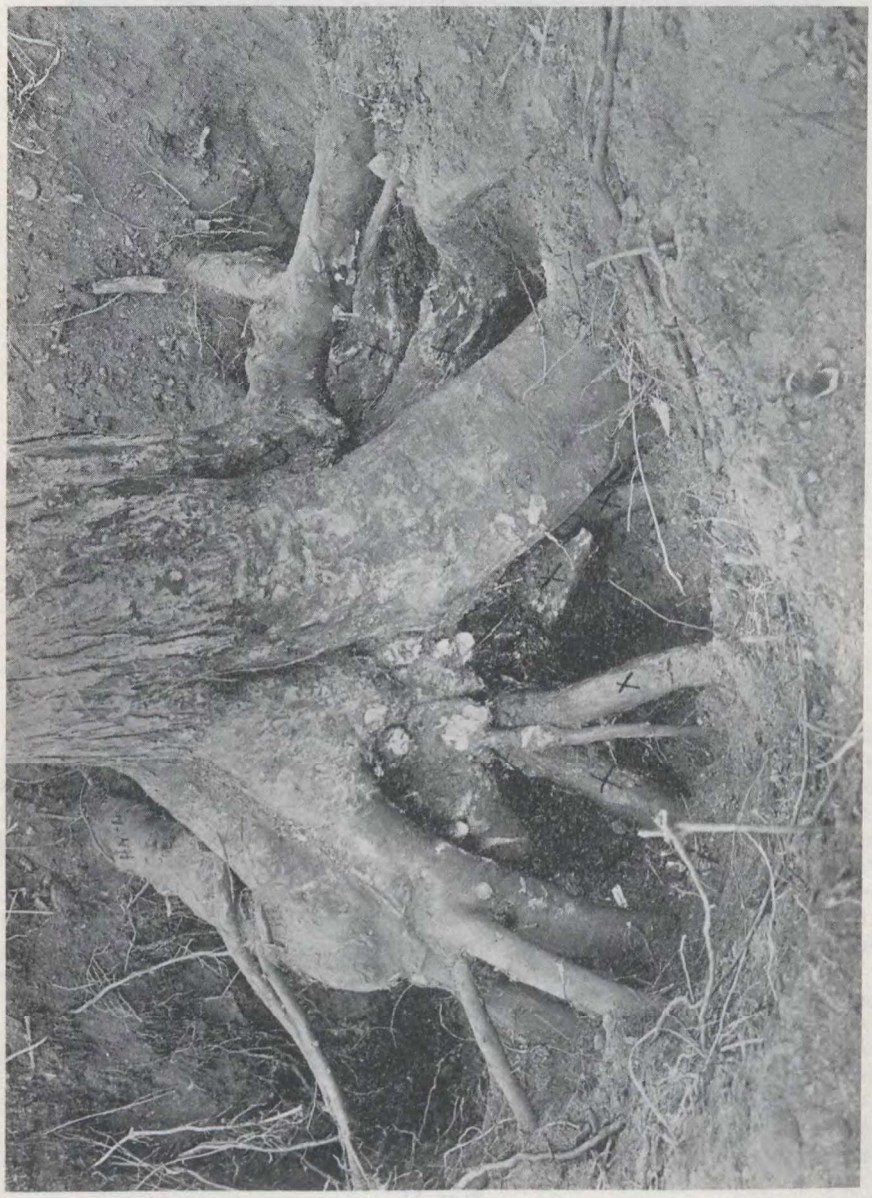

PLATE V

Tree with Collar Rot. Upper roots sound, those marked x dead. Tree doomed unless attended to. No visible symptoms in foliage at this stage.

PLATE VI

BELOW: Portion of root showing rhizomorphs of shoe string fungus *Armillaria mellea*. ABOVE: The same magnified showing penetration of root.

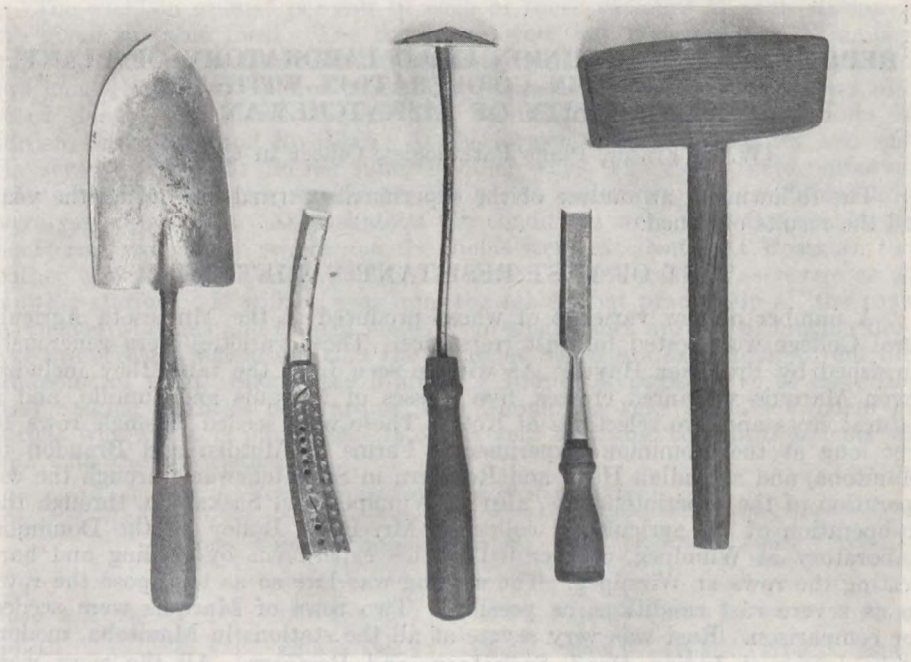

PLATE VII
Tools used in treating collar rot of fruit trees.

## PACOLIN AND CARBOLIC ACID TREATMENT OF SOILS IN THE PREVENTION OF POTATO SCAB

During the season of 1922 an experiment was carried out at the Invermere Experimental Station for the control of potato scab by treating the soil with Pacolin, a coal tar product, and crude carbolic acid. As the results obtained were promising, it was suggested by the Director of the Experimental Farms that a duplicate experiment be carried out this year at this laboratory.

The arrangement agreed upon with the Invermere Station was that the experiment be carried out again both at this laboratory and at the Station. The seed potatoes were supplied by Invermere, and, in order that the disinfectants used here and at Invermere might be of the same quality exactly, these also were supplied from one stock purchased by the Invermere Station.

The general plan of the experiment was as follows: In one plot, the soil was treated at the time of planting with four strengths of each disinfectant, namely 45 c.c., 90 c.c., 135 c.c., and 180 c.c. of disinfectant on a 30-foot row. In a second plot, the same four strengths were applied at earthing up. In applying the disinfectant it was thoroughly mixed with sufficient clean sand to make it spread readily and the mixture was sown by hand along the row and hoed in. In order to give an additional test the experiment was carried out in duplicate at the Summerland laboratory; in one case on high land, in the other on low-lying land where in previous years potatoes were very badly diseased. The variety of potato used in these experiments was the Wee McGregor.

*Results.*—Neither disinfectant showed any marked ability to control the disease. These results are similar to those obtained at the Invermere Station this year. Some of the potatoes showed a very severe amount of scab.

## REPORT OF THE DOMINION FIELD LABORATORY OF PLANT PATHOLOGY IN CO-OPERATION WITH THE UNIVERSITY OF SASKATCHEWAN

(W. P. Fraser, Plant Pathologist, Officer in Charge)

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

### TEST OF RUST RESISTANT VARIETIES.

A number of new varieties of wheat produced at the Minnesota Agricultural College were tested for rust resistance. These varieties were generously furnished by Professor Hayes. As will be seen from the table they included seven Marquis x Kanred crosses, five crosses of Marquis and Iumillo, and a natural cross and two selections of Kota. These were seeded in single rows 16 feet long at the Dominion Experimental Farms at Morden and Brandon in Manitoba, and at Indian Head and Rosthern in Saskatchewan, through the co-operation of the superintendents, also at Winnipeg and Saskatoon, through the co-operation of the agricultural colleges. Mr. D. L. Bailey, of the Dominion Laboratory at Winnipeg, co-operated in this experiment by seeding and harvesting the rows at Winnipeg. The seeding was late so as to expose the rows to as severe rust conditions as possible. Two rows of Marquis were seeded for comparison. Rust was very severe at all the stations in Manitoba, moderately severe at Indian Head, Saskatoon, and Rosthern. All the rows were examined when ready for harvesting by the pathologist in charge at Saskatoon. Mr. D. L. Bailey aided in this examination at Morden, Winnipeg, and Brandon.

An estimate of the percentage of rust present was made and the results are given in the accompanying table.

ESTIMATED PERCENTAGE OF RUST ON VARIETIES OF WHEAT

| Experimental Stations | Date sown, 1923 | Date examined, 1923 | 1 Marquis, M.A. 1239 | 2 Marquis x Kanred—11-18-8 | 3 Marquis x Kanred—11-18-10 | 4 Marquis x Kanred—11-19-7 | 5 Marquis x Kanred—11-15-57 | 6 Marquis x Kanred—11-15-58 | 7 Marquis x Kanred B2-5 | 8 Marquis x Kanred B8-11 | 9 Kota Natural Cross 11-19-4 | 10 Kota 255M | 11 Kota 30f | 12 Marquis x Iumillo 11-15-43 | 13 Marquis x Iumillo 11-15-44 | 14 Marquis x Iumillo 11-15-51 | 15 Marquis x Iumillo 11-15-55 | 16 Marquis x Iumillo 11-15-59 | 17 Marquis, Ottawa 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Morden | May 10 | Aug. 1 | 55 | 55 | 55 | 50 | 45 | 70 | 60 | 75 | 30 | 20 | 15 | 10 | 15 | 20 | 20 | 15 | 60 |
| Winnipeg | " 17 | " 3 | 60 | 60 | 65 | 55 | 70 | 70 | 70 | 70 | 40 | 25 | 15 | 5 | 5 | 20 | 20 | 10 | 75 |
| Brandon | " 22 | " 20 | 75 | 75 | 75 | 45 | 70 | 80 | 75 | 75 | 75 | 45 | 45 | 8 | 10 | 10 | 45 | 20 | 75 |
| Indian Head | " 15 | " 24 | 65 | 65 | 70 | 45 | 50 | 70 | 50 | 65 | 15 | 10 | 10 | 7 | 10 | 25 | 30 | 20 | 60 |
| Saskatoon | " 20 | Sept. 5 | 75 | 50 | 40 | 20 | 25 | 50 | 35 | 40 | 20 | 20 | 25 | 15 | 10 | 15 | 25 | 15 | 65 |
| Rosthern | " 19 | " 4 | 30 | 10 | 25 | 10 | 15 | 30 | 15 | 20 | 10 | 5 | 5 | 5 | 5 | 5 | 15 | 10 | 45 |

It will be seen from this table that the Marquis x Iumillo hybrids were markedly resistant at all the stations. Had they been seeded early they would probably have been practically free from rust. The straw was strong, and the heads in appearance resembled Marquis. The Marquis x Kanred crosses proved susceptible.

The yield in grams* per row of each of these varieties at each station is here given in table form. The conditions were not favourable at Winnipeg, Brandon, and Indian Head for late seeded grain; the season was wet and the rows lodged and also suffered from other diseases beside rust. Sparrows also caused damage at Indian Head. The conditions were more favourable at Morden, Saskatoon, and Rosthern. At the former the season was dry and rust very severe. The rows did not suffer in other ways. The yields there represent, as far as single rows are significant, the yields under dry soil conditions and severe rust prevalence. At Saskatoon the conditions were very favourable for wheat; rust was not so severe and the yields were excellent. At Rosthern the weather was dry in the early part of the season. Rust was not as severe as at the other stations. It will be seen from the tables that practically all the rows out-yielded Marquis and though yields from single rows are not of much value, there are at least indications that the varieties tested are satisfactory from the standpoint of yield. Should the Marquis x Iumillo hybrids prove to have the bread making qualities of Marquis, they should be very valuable wheats in districts where rust is prevalent. It seems very desirable that further tests be made with these varieties.

YIELD IN GRAMS PER ROW OF SIXTEEN FEET

| | Row No. | Morden | Winnipeg | Brandon | Saskatoon | Rosthern | Indian Head | Average |
|---|---|---|---|---|---|---|---|---|
| Marquis, M.A. 1239.... | 1 | 239·8 | 312·3 | 125·0 | 549·4 | 276·5 | 190·4 | 282·23 |
| Marquis x Kanred, 11-18-8..... | 2 | 291·0 | 240·2 | 139·0 | 798·3 | 518·8 | 191·0 | 363·05 |
| Marquis x Kanred, 11-18-10..... | 3 | 260.2 | 195.3 | 198.2 | 651.3 | 391.8 | 273.4 | 328.36 |
| Marquis x Kanred, 11-19-7..... | 4 | 316.4 | 214·0 | 153·7 | 598·2 | 396·8 | 202·2 | 313·55 |
| Marquis x Kanred, 11-15-57..... | 5 | 302·3 | 141·5 | 178·2 | 601·0 | 313·8 | 174·7 | 285·25 |
| Marquis x Kanred, 11-15-58..... | 6 | 213·9 | 101·8 | 228·5 | 612·2 | 348·8 | 281·7 | 297·81 |
| Marquis x Kanred, B2-5..... | 7 | 280·5 | 175·0 | 184·0 | 665·8 | 435·8 | 145·5 | 314·43 |
| Marquis x Kanred, B8-11..... | 8 | 279·0 | 179·3 | 142·0 | 678·7 | 453·6 | 450·8 | 363·90 |
| Kota Natural Cross, 11-19-4..... | 9 | 278·2 | 153·3 | 221·3 | 465·2 | 359·8 | 238·3 | 286·01 |
| Kota, 255-M..... | 10 | 345·2 | 207·0 | 233·2 | 694·2 | 308·8 | 197·5 | 330·98 |
| Kota, 30f..... | 11 | 332·0 | 216·8 | 265·5 | 717·3 | 353·3 | 190·9 | 345·96 |
| Marquis x Iumillo, 11-15-43..... | 12 | 350·7 | 242·0 | 203·5 | 711·2 | 339·3 | 165·5 | 335·36 |
| Marquis x Iumillo, 11-15-44..... | 13 | 324·0 | 225·5 | 207·0 | 740·2 | 370·8 | 375·9 | 373·90 |
| Marquis x Iumillo, 11-15-51..... | 14 | 299·7 | 262·0 | 266·7 | 729·2 | 439·8 | 203·2 | 366·77 |
| Marquis x Iumillo, 11-15-55..... | 15 | 298·3 | 232·0 | 294·0 | 636·2 | 414·2 | 264·5 | 356·53 |
| Marquis x Iumillo, 11-15-59..... | 16 | 284·7 | 207·0 | 266·0 | 625·2 | 370·5 | 192·9 | 324·38 |
| Marquis, Ottawa 15... | 17 | 198·0 | 88·5 | ..... | 617·0 | 360·5 | 301·8 | 313·16 |

In addition the other varieties that have been tested for several years were seeded in rows at the same stations as the new varieties, through the co-operation of the staff of the various stations. The results were the same as in previous years. The Durums, Iumillo, Acme, Monad and Pentad (D-5) showed marked resistance. Kota was the only one of the bread wheats that was resistant. While a considerable amount of rust develops on it, especially if it is allowed to remain uncut after maturity, yet the attack is always so late that practically no injury is done to the grain. The estimated percentage of rust on these rows will be found in the accompanying table.

* 1 oz. avoirdupois=28.35 grams.

Iumillo has proved practically immune to stem rust under greenhouse and field tests for a number of years. This lends support to the view that the crosses of Marquis and Iumillo will continue to prove resistant. This season a strain of rust to which Kanred is susceptible was prevalent. This probably accounted for the severe rusting of the Marquis x Kanred crosses.

ESTIMATED PERCENTAGES OF RUST AT THE VARIOUS STATIONS

| Experimental Stations | Date sown, 1923 | Date examined, 1923 | 18 Kubanka, C.I. 1440 | 19 Kubanka, C.I. 4063 | 20 Arnautka, C.I. 1493 | 21 Arnautka, C.I. 4064 | 22 Arnautka, C.I. 6236 | 23 Mindum, C.I. 5296 | 24 Acme, C.I. 5284 | 25 Monad, C.I. 3320 | 26 D-5 (Pentad) C.I. 3322 | 27 Kahla, C.I. 5529 | 28 Peliss, C.I. 1584 | 29 Iumillo, Selection | 30 Kubanka, Ottawa A | 31 Haynes, C.I. 2874 | 32 Marquis, Ottawa 15 | 33 Power, C.I. 3697 | 34 Ruby, Ottawa 623 | 35 Kitchener, C.I. 4800 | 36 Red Bobs, C.I. 6255 | 37 Preston, C.I. 3081 | 38 Kota, C.I. 5878 | 39 Prelude, Ottawa 135 | 40 Early Red Fife, Ottawa 16 | 41 Kanred, C.I. 5146 | 42 Little Club, C.I. 4066 | 43 White Spring, C.I. 3686 | 44 Khapli, C.I. 4013 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Morden | May 10 | Aug. 1 | 20 | 30 | 35 | 35 | 40 | 20 | 5 | 5 | 5 | 30 | 20 | 2 | 30 | 65 | 65 | 65 | 55 | 65 | 65 | 45 | 20 | 20 | 70 | 0 | 75 | tr | 0 |
| Winnipeg | " 17 | " 3 | 50 | 60 | 60 | 65 | 60 | 45 | 7 | 5 | 5 | 55 | 45 | tr | 70 | 80 | 75 | 85 | 65 | 75 | 75 | 85 | 40 | 60 | 85 | 0 | 75 | 0 | tr |
| Brandon | " 22 | " 20 | 15 | 35 | 70 | 70 | 70 | 60 | 10 | tr | tr | 65 | 50 | tr | 65 | 75 | 75 | 75 | 65 | 75 | 50 | 65 | 45 | 50 | 75 | tr | 65 | tr | tr |
| Indian Head | " 15 | " 24 | 35 | 45 | 40 | 35 | 50 | 45 | 5 | 5 | 5 | 70 | 40 | 0 | 70 | 45 | 55 | 60 | 40 | 70 | 30 | 60 | 5 | 30 | 60 | 0 | 50 | 0 | tr |
| Saskatoon | " 20 | Sept. 1 | 25 | 30 | 45 | 45 | 50 | 45 | 10 | 5 | 5 | 60 | 45 | tr | 60 | 75 | 65 | 65 | 20 | 75 | 40 | 55 | 20 | 30 | 75 | 0 | 75 | 0 | 0 |
| Rosthern | " 19 | " 4 | 20 | 25 | 20 | 20 | 20 | 20 | 0 | 0 | 0 | 25 | 0 | 0 | 35 | 50 | 45 | 40 | 20 | 50 | 25 | 3 | 5 | 10 | 60 | 0 | 50 | 0 | 0 |

tr. = "trace."

## PHYSIOLOGICAL VARIETIES OF STRAINS OF RUST ON WHEAT

Work on the physiological varieties or strains of stem rust on wheat was continued in the greenhouse in 1923. In determining the strains use was made of the keys, and the differential wheat hosts that are listed by Stakman and Levine in Technical Bulletin No. 8, Minnesota Agricultural College. Determination of the collections of wheat rust made in 1922 was completed. From these collections of 1922 the following strains were determined:—

XVII—From Winnipeg, Deloraine and Morden in Manitoba, and Alameda, Canora, Rosthern (2 collections), Wadena, Saskatoon, Wolseley, Prince Albert, Lanigan, Watrous in Saskatchewan, and Lethbridge and Vermilion (2 collections) in Alberta.

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

III—From Killarney, Morden and Napinka in Manitoba, and Indian Head (2 collections), Alameda, Arcola, Yorkton, Rouleau and Saskatoon in Saskatchewan.

IX—From Clavet, Rouleau and Arcola in Saskatchewan.

XI—From Winnipeg in Manitoba, and Davidson and Saskatoon in Saskatchewan.

XVIII—From Outlook and Saskatoon in Saskatchewan.

XXXVI—From Rouleau and Melfort in Saskatchewan.

XXXIV—From Saskatoon in Saskatchewan.

From collections made in 1923 the following strains were determined:—

II—From Saskatoon in Saskatchewan.

III—From Winnipeg in Manitoba, Carlyle, Rosthern, Muenster and Saskatoon in Saskatchewan, and from Wainwright in Alberta.

XI—From Winnipeg in Manitoba and Rosthern in Saskatchewan.
XVII—From Brandon in Manitoba, and Estevan, Carlyle, Battleford, Shellbrook and Rouleau in Saskatchewan, and Edmonton and Wainwright in Alberta.
XXI—From Brandon in Manitoba, Battleford and Shellbrook in Saskatchewan, and Edmonton in Alberta.
XXXIV—From Carlyle and Watrous in Saskatchewan.

Since this work was begun in 1919 ten strains in all have been found to occur in the Prairie Provinces of Western Canada, as follows: II, III, IX, XI, XII, XVII, XVIII, XXI, XXXIV, XXXVI. It is very probable that a number of others occur.

Judging from the collections, XVII is usually the most prevalent and the most widely distributed. XXI was most common in 1922. Strain III was quite prevalent in 1922 and 1923; this strain readily attacks Kanred and was probably responsible for the severe rust attack of the Marquis x Kanred crosses last season. Strain IX was prevalent in 1919 and Emmer rusted heavily. Since then it has only been collected occasionally and Emmer in the field has been practically free from rust. The prevalence of strain III is noteworthy, as it readily attacks Kanred and probably was responsible for the severe attack on the Marquis x Kanred crosses this season. As far as tested the strain present on these crosses was III.

## WINTERING OVER OF THE UREDINIOSPORES OF STEM RUST

Germination tests were made of the urediniospores of stem rust on wheat. The first test, from wheat wintered under natural conditions at Saskatoon, gave a low percentage of germination, less than one per cent. Tests on April 4, with spores from wheat wintered at Rosthern, gave negative results, though spores from beneath the sheath of barley gave a germination of about one-half per cent.

Extensive tests about the first of May of spores from unthreshed wheat sheaves left out during the winter at Sintaluta gave negative results. Wheat seedlings were also inoculated with similar spore material, with negative results.

In the spring and early summer susceptible grasses were carefully observed by the field men for the appearance of stem rust. If the rust lives over in the grasses by mycelium or spores, it was expected that rust would appear on them first. Observations have been continued for a number of years, and every season rust was collected first and in a more advanced stage on wheat than on grasses. This year, however, the first collection of stem rust in Saskatchewan, except what could be directly traced to the barberry, was made by Mr. C. E. Maguire at Rouleau in southern Saskatchewan. This infection was on *Hordeum jubatum* L. It was rather severe, and indicated that rust had been present for some time. The infection was very local. No barberries could be located in the vicinity, nor could rust be found in the neighbouring wheat fields. The early appearance on Wild Barley, *Hordeum jubatum* and its severity at the time of collecting suggested the possibility of wintering over on that grass, but infection may have come from wind blown spores as the rust was in a more advanced stage on wheat further south, though not prevalent. Two days later a few pustules were collected at Estevan which showed teliospores.

## SPREAD AND SEVERITY OF RUST IN SASKATCHEWAN AND ALBERTA

Stem rust was epidemic in southern Manitoba. It was reported in southern Saskatchewan about the same time as in Manitoba. It was first collected on barberries at Saskatoon on May 28. At this time the aecia were opening and the spores being dispersed. The barberries were removed in a few days. Rust

was present on the neighbouring grasses on June 29. Rust was plentiful on *Hordeum jubatum, A. tenerum* and *A. Smithii,* within a radius of five and ten feet and sparingly on *H. jubatum* and *A. Smithii* at twenty-five feet. One pustule was found on *Hordeum jubatum* sixty feet distant. Susceptible grasses extended to a much greater distance but no rust was found. Tests in the greenhouse showed rust to be one of the wheat forms.

An examination on July 25 showed a very heavy infection of the susceptible grasses near where the barberries were removed, and stem rust could easily be found in all directions 200 to 300 yards distant, and a pustule or two were collected one-half mile distant from the barberries. Wheat and barley fields were about a mile distant, but no infection could be found on them till rust was general in the district.

As previously stated stem rust, except what could be traced directly to the barberry, was first collected in Saskatchewan on *Hordeum jubatum* on July 9. Further south it was found on wheat at Milestone, Midale, and Estevan. At the latter place a few pustules were in the black stage so it must have been present some time previously. In southeastern Saskatchewan the rust was found to be present here and there on a few plants of wheat. About one per cent were infected at Carlyle and Antler. On July 14 rust was collected at Indian Head on wheat. Secondary infection had taken place. Traces of rust were found at Saskatoon on the 19th and at Rosthern on the 20th. Rust was present all over northern Saskatchewan by the last of the month. Traces of rust were observed at Vegreville on August 10, and only two pustules could be found at Edmonton on the 11th. Further south at Camrose and Wainwright traces of stem rust were found on the 13th and 14th. Rust developed all over Saskatchewan, becoming severe and doing injury in the south and east on late grain, but not much in the north. It extended throughout Alberta showing a greater development than in any previous year. There was a considerable development at Scott, Lacombe, and southward, but it did little injury owing to its late appearance. There was less rust in northern Alberta than in any other district. A survey was made of the Peace River district at Grande Prairie and other points and no cereal rusts found. This is the second season that a survey was made of this district without collecting cereal rusts. This is the most northerly district in Canada where wheat is grown extensively and the seed has all been introduced from southerly districts where rust occurs. These observations support the view that rust is not seed borne.

## BARBERRY SURVEY

This was continued in the province of Saskatchewan. A few bushes were located in Saskatoon, Battleford, Prince Albert, and Regina which had been overlooked in previous surveys. The most of these were destroyed by the owners of the property on which they grew on being asked to do so. In some cases the owners promised to destroy them, but the places were not visited to see that this had been done. It is planned to do this early next season. Some of the barberries in Saskatoon showed very heavy infection. The spread of rust from these is described under the spread of stem rust.

## SEED TREATMENT FOR SMUT CONTROL

Through the co-operation of the Dominion Experimental Farms at Lacombe, Scott, Rosthern, and Indian Head, experiments were carried out on the smut control of bunt of wheat. The seed used was the same at all the stations. It was obtained from the grain inspector at Fort William. Unfortunately it was a mixture of varieties, but was very badly smutted. All the seed was treated at the Dominion Laboratory at Saskatoon and forwarded to the various stations;

seeding and other operations, including harvesting and threshing, were done by the Experiment Stations. The estimate of smut percentages was made by members of the Dominion Laboratory at Saskatoon, except at Indian Head, where the counts were made by the Farm staff.

OUTLINE OF EXPERIMENTS

*Seed.*—Mixed varieties of wheat, very badly smutted, obtained from the grain inspector at Fort William, Ont. The same seed lot was used at all the stations.

*Treatment and Method.*—Formaldehyde solution, 1-320, dipped five minutes, drained, covered one hour. The formaldehyde was tested at the Department of Chemistry, University of Saskatchewan, and the solution made up to proper strength.

*Treatment.*—The seed was treated in a small hand machine until thoroughly coated with the dust.

*Copper Carbonate*—A commercial form of copper carbonate dust was used (copper equivalent 17-18 per cent). This was supplied by the Corona Chemical Division of the Pittsburgh Plate Glass Company of Milwaukee. It was applied at the rate of 3 ounces per bushel.

*Semesan*—0.25 per cent solution. Seed soaked one hour. (The Semesan was supplied by E. I. DuPont de Nemours Company.)

*Copper Sulphate and Calcium Carbonate*—Monohydrated copper sulphate mixed with equal parts of calcium carbonate. This was applied at the rate of 3 ounces per bushel in the same way as with copper carbonate.

*Sulphur Dust*—The sulphur was superfine, 95 per cent passing through a 200 mesh to the inch screen. It was applied by a machine at the rate of 6 ounces per bushel.

*Chlorophol*—0·3 per cent solution, seed soaked one hour.

*Check*—No treatment.

*Estimate of Smut*—The amount of smut present was estimated by selecting 100 heads from ten different places in each plot and the percentage based on the amount of smutted heads present in the 1,000 heads, except at Indian Head, where the number of heads counted in each plot was 300. Where only a trace or no smut is reported the whole plot was carefully examined.

*Smut Present*—In the wheat the smut present was *Tilletia Tritici* (Bjerk.) Wint. In the oat experiments it was *Ustilago levis* (L. & S.) Magn.

*Yield*—The yield is given in bushels and pounds per acre.

*Size of Plots*—All the plots were one-fortieth of an acre, seeded in duplicate at all the stations.

*Moisture*—The moisture content of the soil at seeding time was abundant at all the stations.

| | | Date seeded | Date ripe | Percent smut present | Yield per acre |
|---|---|---|---|---|---|
| | | | | | bush. lbs. |
| Indian Head | Formalin | May 8 | Aug. 30 | 0 | 13 30 |
| | Copper carbonate | " 8 | " 30 | 0 | 17 10 |
| | Semesan | " 8 | " 30 | 0 | 15 35 |
| | Copper sulphate and alcium carbonate | " 8 | " 30 | 0 | 16 15 |
| | Sulphur dust | " 8 | " 30 | 0·3 | 16 20 |
| | Chlorophol | " 8 | " 30 | 0·15 | 15 25 |
| | Check | " 8 | " 30 | 4·0 | 12 25 |
| Lacombe | Formalin | April 28 | Sept. 6 | 0 | 48 40 |
| | Copper carbonate | " 28 | " 6 | 1·0 | 51 .. |
| | Sulphur dust | " 28 | " 6 | 7·3 | 47 40 |
| | Check | " 28 | " 6 | 46·0 | 33 .. |
| Rosthern | Formalin | May 3 | Sept. 4 | tr. | 21 20 |
| | Copper carbonate | " 3 | " 4 | tr. | 22 20 |
| | Semesan | " 3 | " 4 | tr. | 26 .. |
| | Check | " 3 | " 4 | 5·6 | 21 20 |
| Scott | Formalin | May 8 | Sept. 4 | tr. | 45 30 |
| | Copper carbonate | " 8 | " 4 | 0·7 | 44 10 |
| | Copper sulphate and calcium carbonate | " 8 | " 4 | 0·5 | 46 40 |
| | Check | " 8 | " 4 | 45·0 | 25 40 |

The same seed lot of wheat was used at all the stations, but it will be seen from the table that the smut percentage in the check plots ranges from 4 per cent at Indian Head to about 45 per cent at Scott and Lacombe. Moisture was abundant at all the stations so that other factors, as the soil temperature, were probably responsible for this result.

It will be noticed that all the treatments used gave good control of smut except sulphur dust at Lacombe where the checks showed a high percentage of smut. Formaldehyde, as usual, gave the best results. There was a considerable amount of seed injury from this treatment that was hard to understand as the same treatment in previous years gave no injury. None of the other treatments produced any injury to germination, either in germination tests or in the field. From these and previous tests it is evident that the dust treatments with copper carbonate will be effective when the seed is not very heavily smutted. If it is ever necessary to use badly smutted grain the formaldehyde solution should be used. Monohydrated copper sulphate mixed with calcium carbonate also gave good control, but this has not yet been tested fully enough.

The experiments also indicate that semesan and chlorophol are effective, but both require the soaking of grain for one hour, which makes the handling and seeding of grain in large quantities difficult. (In last year's test chlorophol was not found to be effective. The solution was too weak. This was due to an error in the directions sent with the chlorophol.)

The yields in bushels per acre are given. They are too close to be of much significance.

Germination tests were made of the treated seed soon after drying. The accompanying table gives the results. This shows that none of the treatments injured the germination except formaldehyde solution. The soil used seems to have been infected with fungi as the germination of all the samples was much reduced, including the check. A much more marked reduction took place in the seed treated with formaldehyde. This indicates that formalin treatment weakens the resistance of the seedlings to soil fungi. With copper carbonate, chlorophol and semesan the germination in soil was higher than the check and indi-

cates that these substances, especially semesan and chlorophol may be of value for seed treatment where soil fungi are troublesome.

Experiments were also carried out with hulless oats (Liberty) for the control of smut. As formaldehyde solution of the ordinary strength seriously injures germination, it is desirable that some other treatment be found. In all the experiments the formaldehyde treatment was modified by presoaking, or by washing the grain after treatment. This resulted in lessening the seed injury, but the smut was not satisfactorily controlled. The other treatments used gave better control, but from these and previous experiments copper carbonate dust seems to be the most satisfactory treatment for Liberty oats. It does not injure the seed and if properly applied at the rate of 3 or 4 ounces per bushel will effectively control smut in Liberty oats.

The method of treatment, size of plots, method of estimating smut, etc., were similar to those described in the outline of experiments, except that the formaldehyde treatment was modified as described and the seed lots were different at each station. The results of the experiments are given in the accompanying table.

GERMINATION TESTS OF WHEAT IN CO-OPERATIVE EXPERIMENTS FOR SMUT CONTROL

Tested Immediately after Treatment

| Treatments | Number of grains tested | Percentage | |
|---|---|---|---|
| | | Plates | Soil |
| Formalin | 500 | 84 | 22·7 |
| Copper carbonate | 500 | 91·1 | 75·9 |
| Semesan | 300 | 91·8 | 88·1 |
| Copper sulphate plus copper carbonate | 300 | 93·1 | 75·0 |
| Sulphur dust | 200 | 93·0 | 61·5 |
| Chlorophol | 200 | 93·0 | 89·7 |
| Check | 500 | 91·1 | 68·2 |

SEED TREATMENT FOR SMUT CONTROL, LIBERTY OATS (HULLESS)

| | | Percentage | | Date seeded | Date ripe | Per cent smut present | Yield in lbs. |
|---|---|---|---|---|---|---|---|
| | | Plate test | Soil test | | | | |
| Indian Head | Formalin | 88·5 | 33·5 | May 8 | Sept. 5 | 13·8 | 1075 |
| | Copper carbonate | 86·0 | 69·0 | " 8 | " 5 | 0·8 | 1170 |
| | Semesan | 90·5 | 82·0 | " 8 | " 5 | 0·8 | 1285 |
| | Copper sulphate and calcium carbonate | 84·5 | 84·0 | " 8 | " 5 | 0·35 | 1305 |
| | Sulphur dust | 95·0 | 72·5 | " 8 | " 5 | 0·15 | 1285 |
| | Chlorophol | 94·5 | 88·0 | " 8 | " 5 | 3·3 | 1250 |
| | Check | 94·5 | 71·5 | " 8 | " 5 | 20·1 | 1060 |
| Scott | Formalin | 71·5 | 17·5 | May 8 | Sept. 4 | 1·6 | 2090 |
| | Copper carbonate | 75·0 | 51·5 | " 8 | " 4 | 0 | 2200 |
| | Check | 87·5 | 57·0 | " 8 | " 4 | 62·5 | 910 |
| Rosthern | Formalin | 90·5 | 33·0 | May 9 | Aug. 16 | 5·9 | 1620 |
| | Copper carbonate | 88·5 | 70·5 | " 9 | " 16 | tr. | 1860 |
| | Semesan | 91·0 | 89·5 | " 9 | " 16 | 1·0 | 1880 |
| | Check | 94·0 | 70·5 | " 9 | " 16 | 22·0 | 1680 |
| Lacombe | Formalin | 88·5 | 16·5 | April 28 | Aug. 20 | 1·9 | 2200 |
| | Copper carbonate | 82·5 | 46·0 | " 28 | " 19 | tr. | 2320 |
| | Semesan | 83·0 | 74·5 | " 28 | " 18 | tr. | 2440 |
| | Check | 90·5 | 59·5 | " 28 | " 18 | 35·3 | 1720 |

Experiments were carried out on smut control of wheat with small plots at the Dominion Laboratory at Indian Head and with rod rows at Saskatoon. A number of dust and wet treatments were tried with the object of getting data, so that the most promising might be tested on a larger scale next season. The check did not show a high percentage of smut, so the results were not as suggestive as was hoped. The results, however, seem to indicate that under the conditions of the experiment many substances in the form of dust will control smut. They indicate also that Furfural and Izal solutions, as used in the experiments, are not effective.

The seed lot was the same as used in the co-operative experiments with the Experimental Farms and the method of treatment, etc., were also the same. The size of the plots, however, at Indian Head was about 1/200 of an acre and three rod rows were seeded at Saskatoon.

The results of the experiments are given in the accompanying table.

SEED TREATMENT FOR SMUT CONTROL, WHEAT

| Plot No. | Treatment | Indian Head: 1/200 acre plots. — Per cent smut | Saskatoon: Three rod rows — Per cent smut |
|---|---|---|---|
| 1 | Formaldehyde, 1-320, dip 5 mins. cover 1 hour, dry | 0 | 0 |
| 2 | Formaldehyde spray 1-1, rate 1 qt. to 50 bush | 0 | tr. |
| 3 | Formaldehyde sprinkle, 1-320 | 0 | 0 |
| 4 | Copper sulphate solution | 0 | 0 |
| 5 | Semesan, soaked 1 hour, ·25% sol | 0 | 0 |
| 6 | Chlorophol, soaked 1 hour, ·3% sol | 0 | 0 |
| 7 | 610 dust, Corona, 2 oz. per bush | 0 | 0 |
| 8 | 620 dust, Corona, 2 oz. per bush | 0 | 0 |
| 9 | Copper carbonate dust, 2 oz. per bush | 0·16 | 0 |
| 10 | Copper carbonate dust, 3 oz. per bush | 0 | 0 |
| 11 | Copper carbonate dust, 4 oz. per bush | 0 | 0 |
| 12 | Copper carbonate (pure) 3 oz. per bush | 0 | 0 |
| 13 | Copper carbonate, 3 oz. per bush. on badly smutted grain | 0·16 | 0 |
| 14 | Copper carbonate, 3 oz. per bush. (grain moderately smutted) | 0·16 | 0 |
| 15 | Copper carbonate and infus. earth, 3 oz. per bush | 0·5 | 0 |
| 16 | Monohydrated copper sulphate, 3 oz. per bush | 0 | 0 |
| 17 | Monohydrated copper sulphate and calcium carbonate, 3 oz. per bush. | 0·16 | 0 |
| 18 | Monohydrated copper sulphate and calcium carbonate, 5 oz. per bush. | 0·16 | 0 |
| 19 | Sulphur dust, superfine, 4 oz. per bush | 0·66 | 0 |
| 20 | Sulphur dust, superfine, 6 oz. per bush | 0·83 | 0 |
| 21 | Sulphur dust, superfine, 8 oz. per bush | 0·16 | 0 |
| 22 | Inoculated sulphur, 6 oz. per bush | 0·5 | tr. |
| 23 | Inoculated sulphur, 8 oz. per bush | 0·16 | 0 |
| 24 | Nickel carbonate, 3 oz. per bush | 0·16 | 0 |
| 25 | Monohydrated copper sulphate and lime, 3 oz. per bush | 0·16 | 0 |
| 26 | Seed-O-San, 1 oz. per bush | 0·66 | 4·0 |
| 27 | Furfural, ·08% solution, dip 5 mins. cover 1 hour | 5·5 | 1·6 |
| 28 | Furfural, ·16% sol. dip 5 mins. cover 1 hour | 3·8 | 1·8 |
| 29 | Furfural, ·16% sprinkle, cover 1 hour | 3·8 | 0·4 |
| 30 | Furfural, ·16% dip 5 mins. cover 1 hour | 3·6 | 0·8 |
| 31 | Furfural, ·5% solution, dip 5 mins. cover 1 hour | 3·0 | 2·0 |
| 31a | Izal, ·15% solution, dip 5 mins. cover 1 hour | 1·3 | 1·6 |
| 32 | Check. No treatment | 5·5 | 2·4 |

Experiments were also made with Liberty oats and in a general way the same results were obtained as in the co-operative experiments previously described. They confirmed the conclusions there stated that copper carbonate dust is the most satisfactory treatment for hulless oats. They also showed that furfural solutions, under the conditions of the experiment, are ineffective. The results are given in the accompanying table.

SEED TREATMENT FOR SMUT CONTROL, HULLESS OATS (LIBERTY)

| Plot No. | Treatment | Indian Head: 1/200 acre plots — Per cent smut | Saskatoon: Three rod rows — Per cent smut |
|---|---|---|---|
| 1 | Formaldehyde, dip 5 mins. cover 30 mins. wash in water and dry... | 1 | tr. |
| 2 | Chlorophol, soak 1 hour, ·3% sol.... | 3·8 | 3·9 |
| 3 | Copper carbonate, 3 oz. per bush.... | 1 | tr. |
| 4 | Copper carbonate, 6 oz. per bush.... | 0·1 | 0 |
| 5 | Seed-O-San.... | 30·3 | 21·2 |
| 6 | Sulphur dust, 6 oz. per bush.... | 1·4 | tr. |
| 7 | Sulphur dust, inoculated, 8 oz. per bush.... | 1·7 | tr. |
| 8 | Monohydrated copper sulphate and calcium carbonate, 4 oz. per bush. | 4·1 | tr. |
| 9 | Furfural, ·08% solution, dip 5 mins. cover ½ hour.... | 70·6 | 36·0 |
| 10 | Furfural, ·16% solution, dip 5 mins. cover ½ hour.... | 73·6 | 36·2 |
| 11 | Furfural, ·04% solution, dip 5 mins. cover ½ hour.... | 72·8 | 26·0 |
| 12 | Check. No treatment.... | 79·6 | 48·7 |

Experiments with hulled oats (Banner) were also carried out at Indian Head. The seed was artificially smutted. It will be noticed that most of the substances gave control except the solutions of furfural. The results are given in the table form.

SEED TREATMENT FOR SMUT CONTROL, HULLED OATS (BANNER)

Indian Head—Size of plots—1/200 acre

| Plot No. | Treatment | Per cent smut |
|---|---|---|
| 1 | Formaldehyde, 1-320, dip 5 mins. cover 1 hour.... | 0 |
| 2 | Formaldehyde spray 1-1, 1 qt. to 50 bush.... | 0 |
| 3 | Copper carbonate dust, 3 oz. per bush.... | 0·4 |
| 4 | Copper carbonate, 5 oz. per bush.... | 0 |
| 5 | Chlorophol, ·3% solution, soak 1 hour.... | 0·2 |
| 6 | Semesan, ·25% solution, soak 1 hour.... | 0·4 |
| 7 | Monohydrated copper sulphate and calcium carbonate, 4 oz. per bush.... | 0·8 |
| 8 | Sulphur dust, 6 oz. per bush.... | 0 |
| 9 | Inoculated sulphur dust, 6 oz. per bush.... | 0 |
| 10 | Furfural, ·125%, dip 5 mins. cover ½ hour.... | 19·3 |
| 11 | Furfural, ·25%, dip 5 mins. cover ½ hour.... | 25·8 |
| 12 | Check. No treatment.... | 22·4 |

Experiments were also tried with barley, which was obtained from seed naturally infected with covered smut, *Ustilago Hordei* (Pers.) K. & S. The experiment was only on a small scale and the percentage of smut in the check was not high, so the results are of little significance. Formaldehyde solution alone gave satisfactory control. The results are given in table form.

SEED TREATMENT FOR SMUT CONTROL, BARLEY (JUNIOR)

Laboratory Field, Indian Head—Size of Plots—1/200 acre

| Plot No. | Treatment | Per cent smut |
|---|---|---|
| 1 | Formaldehyde solution 1-320, dip 5 mins. cover 1 hour.... | 0 |
| 2 | Copper carbonate dust, 3 oz. per bush.... | 2·0 |
| 3 | Chlorophol, ·3% solution, soak 1 hour.... | 1·4 |
| 4 | Furfural, ·25% solution, dip 5 mins. cover 1 hour.... | 1·4 |
| 5 | Check. No treatment.... | 6·6 |

Germination of spores of oat smut, *Ustilago levis* (K. & S.) Magn. Material of oat smut collected May 23rd from smutted heads standing in the field all winter were tested for germination in 5 per cent sugar solution. The tests showed an average germination of 35 per cent.

### THE "TAKE-ALL" DISEASE OF WHEAT

The "take-all," root-rot or foot-rot of wheat attacks also barley, rye and many of the common wild grasses. Oats are not susceptible. The disease has been troublesome in Australia, New Zealand and Europe for some years. In 1920 it was first reported in North America from New York state (though it was doubtless present for some time). Since then it has been found in Oregon, Arkansas, and Indiana, in all cases on winter wheat.

Specimens of diseased wheat were sent by a farmer to Indian Head. Mr. P. M. Simmonds, the pathologist there, recognized the wheat was attacked by something different from the usual root-rot. As there was not sufficient of the fungus present on the stem and roots to make a determination of the cause of the trouble, the letter and specimens were sent to the laboratory at Saskatoon as the diseased grain came from northern Saskatchewan. Owing to bad roads it was not possible to visit the place till near harvest time. A large number of specimens were collected and a recent study of these in the laboratory showed abundant mycelium and spore cases of the fungus (*Ophiobolus cariceti* (Berk. & Br.) Sacc.) which causes the take-all disease of wheat.

## REPORT OF THE DOMINION FIELD LABORATORY OF PLANT PATHOLOGY, INDIAN HEAD, SASK.

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

This laboratory was opened on July 1, 1923. Field work including the rust survey and general plant disease survey occupied the attention of the pathologist in charge most of the time during the summer months. The smut experiments and rust row tests, outlined at the Saskatoon Laboratory and carried on here, were given attention and the necessary notes taken from time to time. Observations and notes were made on all the crops grown on the Experimental Farm. Plant disease specimens and plants were collected and preserved for future study and reference. Letters of inquiry and plant disease specimens were received occasionally from farmers; these were answered giving as far as possible the desired information and an attempt was made to visit all farms from which suspicious plant disease specimens were received. Because of inadequate laboratory facilities for winter work at Indian Head all work was transferred to the Saskatoon Laboratory on November 1. Culture and greenhouse work, discontinued during the summer, have been carried on at Saskatoon. All plant disease notes taken during the summer were sent to F. L. Drayton at Ottawa, pathologist in charge of plant disease survey. Wheat stem rust survey notes and notes on the smut experiments were sent to W. P. Fraser, pathologist in charge of the Saskatoon Laboratory, and are included in the report from that laboratory. In future the writer will be able to give more time to a study of the root-rot of cereals caused by *Fusarium spp.* and *Helminthosporium sativum*, as well as to continue investigations with stem rust in co-operation with the other laboratories.

### FUSARIUM STUDIES

In continuing the studies of the culture referred to in last year's reports, a single spore isolation was made from that culture and the resulting pure strain was used in all the work, except where otherwise mentioned. This culture was made from a single five-septate macroconidium. In culture it represents quite closely *Fusarium culmorum* W. Smith, but the conidia do not compare favourably with those of *F. culmorum*. We feel that it has not been sufficiently studied in comparative morphology to give it a definite determination. A study of its morphology is being continued. In isolations made from cereals showing root rot, this type was obtained from oats collected at Saskatoon, Moose Jaw, Swift Current, Sask., and Beaverlodge, Alta., from wheat collected at Hawarden and Tisdale, Sask. The collection from Tisdale showed considerable growth at the nodes from which it could be readily isolated. It was also isolated from blighted heads of wheat collected at Saskatoon and Brandon from specimens sent in, and from blighted heads of *Briza maxima* collected in Manitoba. Other types were isolated from oats collected at Saskatoon and Moosomin; from wheat collected at Saskatoon, Scott, Annaheim, Shaunavon, Sask., Edmonton, Alta., and from a specimen sent in from Treesbank, Man. It is apparent that several species of *Fusarium* are associated with root rot of cereal crops and head blight or scab in the Canadian west as has been the case in other countries. As this type was originally isolated and studied and as it appears to be prominent at least as a cause of root rot, the study of it in particular has been continued.

*Germination Studies.*—In order to throw more light on the pathogenesis of this species it was thought advisable to conduct some tests to determine the optimum temperature for its development. Germination tests were made at

all the available temperatures. Conidia were taken from sporodochia of young and vigorous cultures and suspended in distilled water using special slides with deep depressions. The conidia were examined before each test to see if they appeared normal. Several sets were run at each temperature, using as a check each time a set at room temperature. The temperatures used were 8 to 10 degrees centigrade, obtained in a refrigerator; room temperature, which probably averaged 23 degrees centigrade; and from 23 degrees to 37 degrees centigrade by adjusting an incubator. Although the tests were not exhaustive they appear to show that the optimum temperature lies between 23 and 25 degrees centigrade. At 28 degrees the percentage germination is great, but the growth is not so rapid as at the lower temperatures—the same being true at 30 and 33 degrees. In one case germination was obtained at 37 degrees but the germinating spores were quite abnormal in appearance, assuming somewhat the characteristics of chlamydospores; also the germ tubes were greatly distorted and after reaching a length of 60 microns no further growth was made even at room temperature. To compare the growth on slghtly acid potato dextrose agar, plates were planted in the centre with as near as possible the same amount of inoculum, which was taken from a vigorous agar slant culture. These were kept at room temperature for 24 hours to become established, then each set was placed at its proper temperature. From these tests the same temperature influence was suggested as in the germination tests. After 110 hours at room temperature the diameter of the colony measured 9 centimeters; at 25 degrees 7 centimeters; and at 8 to 10 degrees 3 centimeters. The most normal growth was obtained at room temperature. It has been well known for some time that *Fusaria* can readily live over the winter, but in order to determine the effect of low temperatures on cultures, several special cultures were made and put outside during the winter. The culture medium used was made by sterilizing wheat grains after they had been soaked in water overnight. These were inoculated and after becoming established were placed outside. In such a culture we had an abundance of conidia and mycelium. One set of cultures was placed outside February 22, 1923, and brought in March 30, 1923. They were not exposed to sunshine and were not protected by snow. During the time they were outside the lowest temperature was —36 degrees and the highest +40 degrees Fahrenheit. There was considerable variation throughout this period although the temperature generally remained below freezing point. Transfers from the cultures after being brought in gave an apparent normal growth. Several other strains similar to the above likewise were tried for a much longer time and in every case a normal growth was obtained after it was brought in. In an examination of the conidia of one of these strains it was found that most of them had apparently developed chlamydospores which germinated readily in tap water over night. Conidia without chlamydospore formation did not germinate.

*Inoculation Tests.*—Tests were made from time to time to test the pathogenicity of this *Fusarium* strain. The following experiment shows its virulency, after growing in culture for over a year, being transplanted from time to time to keep it vigorous. Four popular varieties of oats were used, namely, Gold Rain, Victory, Banner and Ligowo. The seed to be planted was surface sterilized. Thirty seeds were planted in each pot. Three pots were used for each variety. The seed in two was inoculated and the remaining one left for control. The inoculum was made from a potato dextrose agar culture twenty days old, using conidia scraped from sporodochia. These were suspended in sterile water to make a fairly dense suspension. Estimated 500 conidia to a 2 mm. loop. The seeds to be inoculated were submerged in this suspension, sown and then some of the suspension poured over them. The seeds for the control pots were treated likewise with sterile water.

*Observations made during the Experiment.*—First definite symptoms appeared 12 days after seeding, some plants were falling over although not definitely discoloured. The temperature of the greenhouse where the experiment was run would average slightly below 70°F., which was too low for the maximum development of the fungus. The results are given as follows:—

AFTER 12 DAYS

| Variety | Pot No. | Per cent emergence | Plants wilted | Doubtful | Normal |
|---|---|---|---|---|---|
| Gold Rain | 1 | 90 | 0 | 3 | 24 |
| | 2 | 100 | 0 | 1 | 29 |
| | Check | 100 | 0 | 0 | 30 |
| Victory | 1 | 100 | 5 | 1 | 24 |
| | 2 | 100 | 1 | 6 | 23 |
| | Check | 100 | 0 | 2 | 28 |
| Banner | 1 | 100 | 0 | 1 | 29 |
| | 2 | 90 | 3 | 0 | 24 |
| | Check | 96·6 | 0 | 2 | 27 |
| Ligowo | 1 | 100 | 3 | 0 | 27 |
| | 2 | 100 | 2 | 1 | 27 |
| | Check | 100 | 0 | 6 | 24 |

NOTES AFTER 16 DAYS

| | | | | | |
|---|---|---|---|---|---|
| Gold Rain | 1 | ..... | 3 | 18 | 6 |
| | 2 | ..... | 1 | 2 | 27 |
| | Check | ..... | 0 | 0 | 30 |
| Victory | 1 | ..... | 5 | 14 | 11 |
| | 2 | ..... | 9 | 8 | 13 |
| | Check | ..... | 0 | 0 | 30 |
| Banner | 1 | ..... | 3 | 6 | 21 |
| | 2 | ..... | 2 | 6 | 19 |
| | Check | ..... | 0 | 2 | 27 |
| Ligowo | 1 | ..... | 4 | 0 | 26 |
| | 2 | ..... | 9 | 6 | 15 |
| | Check | ..... | 0 | 0 | 30 |

NOTES AFTER 30 DAYS

| | | | | | | % of wilt |
|---|---|---|---|---|---|---|
| Gold Rain | 1 | ..... | 10 | 3 | 14 | .. |
| | 2 | ..... | 2 | 2 | 26 | 25 |
| | Check | ..... | 0 | 0 | 30 | .. |
| Victory | 1 | ..... | 6 | 1 | 23 | .. |
| | 2 | ..... | 15 | 12 | 3 | 35 |
| | Check | ..... | 0 | 4 | 26 | .. |
| Banner | 1 | ..... | 3 | 1 | 26 | .. |
| | 2 | ..... | 3 | 2 | 22 | 15 |
| | Check | ..... | 0 | 0 | 29 | .. |
| Ligowo | 1 | ..... | 5 | 2 | 23 | .. |
| | 2 | ..... | 10 | 0 | 20 | 25 |
| | Check | ..... | 0 | 0 | 30 | .. |

After twenty days Banner was farther advanced and more vigorous than the other varieties. This variety also shows the least percentage of wilt, with Victory showing the most. The fungus was recovered from typical lesions taken from the wilted Victory plants. The percentage wilt showing in these four varieties in last year's experiments are:—

| | |
|---|---|
| Gold Rain | 61·6 |
| Victory | 78·8 |
| Banner | 62·0 |
| Ligowo | 70·0 |

Here also it will be seen that Victory appeared to be most severely affected in the inoculation experiments. In observations on all experiments conducted it was noted that Victory and Ligowo almost invariably show the first signs of wilt and that the other varieties are more able to throw off the attack. This would seem to suggest varietal resistance. It is intended to investigate this further.

*Soil Inoculation*—Inoculation of the soil to produce seedling blight. An ordinary gardener's transplanting box of wood 18½ by 10½ by 4 inches was thoroughly washed out and filled with sterilized soil. A culture of this species, grown on sterilized wheat grains, when growing vigorously and sporulating freely, was incorporated into this soil. About 110 grams of such a culture was used. The box was then allowed to stand for a few days, after which it was sown with 60 surface sterilized seeds of Ligowo oats. Seedling blight was readily produced in this way, the following notes being made from this test.

FIRST NOTES: NINE DAYS AFTER SEEDING

| Seed Sown | Plants normal | Doubtful | Wilted | Did not emerge |
|---|---|---|---|---|
| 60 | 36 | 9 | 12 | 3 |
| | NOTES AFTER 13 DAYS | | | |
| .. | 15 | 13 | 29 | 3 |

It will be seen that seedling blight and wilt of oats are readily produced in this way, but it is not considered as good a test for the parasitism of a species as the use of a pure conidial inoculum. (Atanasoff, D., Journal of Agricultural Research, Volume XX, No. 1, page 23, refers to this method of soil inoculation as producing an unnatural condition.) The introduction into the soil of such a quantity of mycelium and culture medium produced an absolutely unnatural condition undoubtedly in favour of such a fungus as a *Fusarium*.

*Field Experiment.*—A small field test was made to test the pathogenicity of this strain. The seed was inoculated in the same way as for the greenhouse tests, using a suspension of conidia. Seed for two rod rows was thus treated. One row was left as a check. The experiment was in a sandy loam which was very dry at the time of sowing. Only a few plants manifested symptoms of seedling blight, but with this exception very little variation was noted between the check and inoculated rows. At harvest time there was very little difference, except the treated rows revealed more root rot and less tillering than the check. From these roots the typical fungus was readily recovered. The field test, however, was certainly not conclusive; the fungus apparently did not make much headway until late in the season.

*Symptoms.*—In the greenhouse inoculation experiments a splendid opportunity was given for the study of seedling blight. Oats were inoculated and then the action of the parasite was observed. When the plants have reached a height of from one to two inches, the affected plants can be distinguished by their lighter shade of green and if severely affected this will approach a light yellow. Such plants will in all probability reveal streaks of brownish discolorations appearing on the coleoptile. These brownish discolorations mark the progress of the fungus from the point of infection. If the seeds have been inoculated, that is, submerged in a suspension of the conidia, these will adhere to the surface of the seed and be prepared to attack the plumule and coleorhiza as the seed germinates. The parasite grows through the plumule and into the

enclosed leaf, involving the entire stem, as revealed by histological examinations. As soon as this stage is reached the leaf, which may have reached a height of from four to five inches, will rapidly change colour, starting usually at the top and along the side at about the same time, and a short while the entire leaf is discoloured, usually at first an indistinct brown, then a distinct brown as the leaf falls over and dries up. Sometimes the seedling does not appear above ground, having been completely killed immediately after emerging as is evidenced, when such seeds are dug up, by the short sprout and seed being entirely covered with the fungus growth, in this case a pink to red growth, which seems to be characteristic of the fungus studied. As soon as the seedling starts to show discoloration of the leaf, and if it is removed from the soil, washed and examined, it will undoubtedly reveal distinct lesions on the coleoptile particularly, usually near the seed; here it will be deeply discoloured, a distinct brown to black, sunken and shrivelled. The seminal roots will be brown in colour, generally necrotic and in all probability rapidly losing their functional qualities. The unaffected plants have a clean sheath and stem throughout, with a greater root development, and a second leaf appearing, and are about twice as large as the plants from the inoculated seed. If the plant is only slightly affected and can produce secondary roots it may under favourable growing conditions throw off the effect of the parasite and reach maturity, but there is a probability that the attempted stools will be killed and only a single stalk will be the result. As the primary roots have been killed and the plant has to rely on its secondary and subsequent roots, it may suffer somewhat from drought on account of an insufficient deep root system. The rhizome of the affected plants shows invariably the most evident symptoms of parasitic invasion. It is slender, discoloured and appears slightly prolonged when compared with unaffected plants of the same age. Later when the plants are examined after reaching maturity, it will be found that the root system in general is necrotic. The roots are not well developed and are easily broken. The tillering node appears in most cases to be severely affected so that some of the tillers are blighted. Observations go to show that plants may be quite severely affected yet in general appearance they are not very abnormal; such infections may be serious or not noticeable, depending on the weather. Excessive moisture conditions primarily may cause such plants to suffer severely from stalk rot and consequent lodging.

## DOMINION PLANT DISEASE SURVEY

During the year the fourth survey report has been prepared and multigraphed. To the numerous collaborators we desire to express our appreciation for the help given, without which it would not have been possible to secure the many valuable data on the distribution of plant diseases in Canada.

Owing to the necessity of curtailing Government reports, we refrain from publishing a résumé of the survey this year. It is hoped, however, that at some future date we may be able to publish a check list of the pathogenic fungi of the Dominion of Canada which will be a most desirable and useful contribution to mycological knowledge. Anyone interested may secure a mimeographed copy of this year's survey report by applying to us.

# EXPERIMENTAL PROJECTS BEING CONDUCTED ON THE CENTRAL EXPERIMENTAL FARM AND AT THE VARIOUS LABORATORIES BY THE DIVISION OF BOTANY

## FOREST PATHOLOGY

*(B. 1 to 5—Ottawa)*

Project No.

B. 1. Needle blight of white pine.
B. 2. White pine blister rust.
B. 3. *Armillaria* root rot.
B. 4. Investigation of the rate of deterioration of balsam and spruce killed by the spruce budworm.
B. 5. Investigation of brown rot of balsam.

## FRUIT DISEASE INVESTIGATIONS

*B. 11 to 19—St. Catharines, Ont.*
*B. 30 to 39—Summerland, B.C.*

B. 11. Seasonal history of the brown rot fungus.
B. 12. Comparative tests of the more practical spraying and dusting schedules for apples on a commercial scale.
B. 13. Leaf curl of raspberry.
B. 14. Tests of spray mixtures and dusts on plums and cherries.
B. 15. Mosaic disease of raspberry.
B. 16. Blue stem of raspberry.
B. 17. Certification of disease-free raspberry stock.
B. 18. Comparative tests of spray and dust applications for the control of peach leaf curl.
B. 19. Tests as to time of application of sprays for the control of brown rot.
B. 30. Longevity of *Bacillus amylovorus* in pruned limbs of pear during the dormant season.
B. 31. The value of casein spreader in the control of powdery mildew of apples.
B. 32. Lime-sulphur vs. colloidal sulphur in the control of powdery mildew of apples.
B. 33. Blight-resistant pear varieties.
B. 34. Spread of fire blight during winter pruning.
B. 35. Longevity of *B. amylovorus* in mature fruit.
B. 36. Longevity of *B. amylovorus* in boxed fruit.
B. 37. Longevity of *B. amylovorus* in honey.
B. 38. Physiological diseases.
B. 39. Value of oiled wraps in the storage of apples.

## GRAIN DISEASE INVESTIGATIONS

*B. 51 to B. 61—Saskatoon, Sask.*
*B. 62 to B. 64—Indian Head, Sask.*
*B. 70 to B. 78—Winnipeg, Man.*
*B. 79 to B. 81—Brandon, Man.*
*B. 53, B. 61, B. 82 to B. 84, B. 162—Saskatoon, Indian Head, Winnipeg, Brandon, and Ottawa.*

B. 51. Western rye smut.
B. 52. Wintering over of uredospores of stem rust.
B. 53. Common Barberry survey.
B. 54. Strains of stem rust of wheat in Western Canada.
B. 55. Seed treatment of cereals for smut control.
B. 56. Life history of stem rust.
B. 57. Hosts of the stem rust.
B. 58. Effect of spraying and dusting on stem rust.
B. 59. Wheat variety test for rust resistance.
B. 60. Root rot and blight of cereals caused by *Fusarium* sp.
B. 61. Buckthorn survey and observations to show relation.
B. 62. *Helminthosporium* root rots of grain.
B. 63. *Fusarium* root rots of grain.
B. 64. Strains of stem rust of wheat.

Project No.

B. 70. Biologic specialization of *Puccinia graminis Avenae.*
B. 71. Varietal resistance of oats to smut.
B. 72. Uniform rust nurseries.
B. 73. The constancy of biologic forms of *Puccinia graminis Avenae.*
B. 74. The epidemiology of cereal rusts in Manitoba.
B. 75. Investigations on sunflower rust.
B. 76. Seed treatment for the control of bunt of wheat.
B. 77. Seed treatment for the control of barley smuts.
B. 78. Seed treatment for the control of oat smut.
B. 79. Seed treatment of grain for smut—dust.
B. 80. Seed treatment of grain for smut—formalin.
B. 81. Seed treatment of grain for smut—new substances.
B. 82. *Helminthosporium* disease of winter wheat.
B. 83. Varietal resistance of oats to crown rust.
B. 84. Root rots of wheat.

## VEGETABLE DISEASE INVESTIGATIONS

*B. 101 to B. 120—Charlottetown, P.E.I.*
*B. 131 to B. 134—Fredericton, N.B.*
*B. 151 to B. 156—Ottawa, Ont.*

B. 101 and B. 102. Black leg of potatoes.
B. 103 to B. 105. Common scab of potatoes.
B. 106. Effect of hill selection of potatoes—Irish Cobbler.
B. 107. Effect of hill selection of potatoes—Green Mountain.
B. 108. Late blight of potatoes.
B. 109. Leaf roll of potatoes.
B. 110. Effect of using immature seed—Irish Cobbler.
B. 111. Effect of using immature seed—Green Mountain.
B. 112. Mosaic disease of potatoes.
B. 113 to B. 115. Black scurf of potatoes.
B. 116. Seed potato development—Irish Cobbler.
B. 117. Seed potato development—Green Mountain.
B. 118 and B. 119. Streak disease of potatoes.
B. 120. Wilt disease of potatoes.
B. 131. Common scab of potatoes.
B. 132. Leaf roll of potatoes.
B. 133. Mosaic disease of potatoes.
B. 134. Leaf spots of potatoes.
B. 135. Forcing immature potatoes.
B. 136. Club root of turnips.
B. 151. Common scab of potatoes.
B. 152. Effect of hill selection of potatoes—Irish Cobbler.
B. 153. Effect of hill selection of potatoes—Green Mountain.
B. 154. Seed potato development—Irish Cobbler.
B. 155. Seed potato development—Green Mountain.
B. 156. Effect of using sets from different parts of the tuber.
B. 157. Experiments to test the efficiency of seed treatments in disinfecting potatoes affected with common scab.

## MISCELLANEOUS

*B. 161 to 165—Ottawa*

B. 161. Distribution of nitro-culture.
B. 162. Plant Disease Survey.
B. 163. Seed potato inspection and certification.
B. 164. Determination of susceptibility of resistance of Barberry hybrids (at C. E. Farm) to *Puccinia graminis.*
B. 165. Study of gladiolus diseases.

## ECONOMIC BOTANY

*B. 171 to 173—Ottawa*

B. 171. Effect of light upon plant growth.
B. 172. Effect of light upon germination of seeds.
B. 173. Dominion Weed Survey.