DOMINION OF CANADA
DEPARTMENT OF AGRICULTURE
DOMINION EXPERIMENTAL FARMS

# DIVISION OF BOTANY

## PROGRESS REPORT OF THE DOMINION BOTANIST

H. T. GÜSSOW

FOR THE YEARS 1931 to 1934, INCLUSIVE

Suspected virus disease of sweet cherries.

Printed by Authority of the Hon. Robert Weir, Minister of Agriculture,
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## EXPERIMENTAL FARMS BRANCH

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# Progress Report of the Dominion Botanist for the years 1931 to 1934

## INTRODUCTION

The continuity of the Reports of the Dominion Botanist has been interrupted for a period of years, viz.: from 1931 to 1934 inclusive, which has given rise to many inquiries from institutions, libraries and individuals who have been in receipt of this report for many years.

It is hoped that the present report, which briefly summarizes the work of the Central Laboratory at Ottawa and the ten branch laboratories throughout the Dominion for that period, will assist in restoring the lost continuity.

In many cases extensive progress reports or complete results on some of the projects have been published in scientific and technical journals. All such instances have been clearly indicated by abstracts and literature references.

H. T. GÜSSOW,
*Dominion Botanist.*

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## ECONOMIC BOTANY

### Project Group No. 10.00

*In charge:* John Adams; *Central Laboratory:* Ottawa.

During the four years under review there were the usual requests relating to information on the culture of medicinal plants and many other miscellaneous species of economic importance. As usual a large number of plants were received from all parts of Canada for identification and possible uses.

Several visits were paid to farms on which cattle had died presumably as the result of eating poisonous plants.

Various requests were received from all parts of the country relating to literature dealing with the wild plants of Canada. In this connection mention may be made of a list of the "Flowering Plants and Ferns of Prince Edward Island" which was published during the year 1933 as the result of collaboration with the members of this Division.

During the period covered by this review the number of packets of seeds received in exchange from foreign countries amounted to 2,171, 2,869 and 2,731 and 3,601 respectively while 4,802, 6,980, 6,808 and 7,551 packets were sent out in return. Among the seeds received there were 46 packets of species of *Triticum* and *Secale* for the University of Saskatchewan, 21 packets of species of *Aegilops* for the University of Alberta, 274 packets of *Avena* sp. and 510 packets of *Triticum* sp. for the use of the Cereal Division at Ottawa, 71 packets for the Division of Forage Plants, Ottawa, 54 packets of various species of the family *Solanaceae* for inoculation experiments at the Laboratory of Plant Pathology at Fredericton, and 367 packets for the use of the National Research Council in connection with investigations on poisonous plants.

For the convenience and information of visitors to the arboretum large labels with the names in English, Latin and French were attached in 1933 to such of the trees and shrubs as were natives of this country.

During the year 1932 another section of the "Bibliography of Canadian Plant Geography" covering the five-year period from 1926 to 1930 was published.

At the request of the Consolidated Paper Corporation, Limited, a visit was paid in August 1933 to the Island of Anticosti for the purpose of investigating the possibility of the successful propagation of wild rice, arrowhead, cat-tail and other plants for the feeding of muskrats, which had recently been introduced. At the same time a large number of the wild plants occurring on the island were collected of which 25 species were additions to the flora of Anticosti. A list of these was published in the "Canadian Field Naturalist" for April, 1934.

A further visit was paid to Anticosti Island at the end of August and beginning of September, 1934, primarily for the purpose of observing the growth of various cereals of which the seeds had beeen obtained from botanical gardens in Europe. These were secured in consequence of a report that the growing season was insufficient for the ripening of cereal grains. It was found that during 1934 one variety of oats, one of rye, and 3 of barley, all of European origin, had ripened sufficient seeds to continue the experiment on a larger scale in 1935. A large collection of plants was made including seaweeds, fungi, of which 32 species were additions to those previously known, and also ferns and seed-plants; a considerable number of the last group had not been recorded

previously. A short visit was also made in September 1934 to various points in the Gaspé Peninsula where observations were made on the distribution of many species of weeds.

The damage incurred by the trees and shrubs in the arboretum as a result of the severe winter of 1933-1934 was very pronounced. No less than 111 individuals were either killed outright or so severely damaged as to leave little hope of ultimate recovery. Those most affected belonged to the genera *Crataegus, Cupressus, Juniperus, Pyrus,* and *Quercus.*

### B. 10.01. MAINTENANCE OF REFERENCE HERBARIUM OF THE WILD PLANTS OF CANADA

*In charge:* E. W. Hart; *Central Laboratory:* Ottawa.

The herbarium contains approximately the following Canadian plant specimens:—

| Families | Genera | Species | Mounts |
|---|---|---|---|
| 144 | 832 | 3,182 | 14,789 |

of these the following were added in 1933 and 1934:—

| Families | Genera | Species | Mounts |
|---|---|---|---|
| 3 | 30 | 343 | 3,381. |

A new introduced plant *Lepidium latifolium* L., a native of Europe, was found in Quebec City, and is well established.

Approximately 3,371 plants, received from many parts of the Dominion, were identified.

A monograph of goldenrods of Canada and Newfoundland is being written. Fifty-three species and their varieties have been described and the species illustrated.

In connection with this work a collection of living plants has been started. Twenty-seven species are now growing at the Central Experimental Farm.

### B. 10.05. ORCHARD POLLINATION INVESTIGATIONS (BOTANICAL)

*In charge:* Herbert Groh; *Central Laboratory:* Ottawa.

These studies were brought to a conclusion, and their results published as Bulletin 162 New Series, Apple Pollination Studies. Botanical surveys recorded several hundred species of plants in close proximity to poison dusting operations, and secured the flowering dates of those blooming during the six weeks most critical for bees. Evidence was obtained to indicate that dandelion is one of the worst sources of early poisoning of bees; yellow rocket and wild radish being later sources. Alsike clover, ground ivy and other species are responsible for trouble locally. It was found, however, that bees also secure poison, independently of either apple or weed bloom, by freely sipping water after enforced confinement by bad weather.

### B. 10.06. SURVEY FOR EASTERN PASTURE IMPROVEMENT

*In charge:* Herbert Groh; *Central Laboratory:* Ottawa.

Approximately 400 fields and plots at eight Experimental Stations in Eastern Canada, have received inspection in from one to seven years. Surveys have been essentially reconnaissance in method, with reliance placed largely on frequency and position in the survey lists to indicate relative prevalence, together with increasing use of such percentage estimates as can be obtained by means of the practised eye. In limited time information of equal value could be secured in no other way.

Over 200 species of useful and more or less weedy plants are recorded from these pastures; some in one or two, and some in all; some restricted geographically, some by other growth relations, and some by the pasture treatments used.

A study of lists has shown a marked reduction in the number of species under the influence of fertilizers, and some also with rotated as compared with continuous grazing. This reduction is found to consist chiefly in monopolization of space by invigorated useful species at the expense of weedy ones.

White clover and moss are among the most promptly and sharply affected species, increase of the former under well-managed grazing suppressing the latter. Some evidence is accumulating to indicate that white clover is in turn supplanted in a few years by increase of Kentucky blue and other grasses responding readily to fertilizers. Couch grass is one of these. Buttercup and dandelion maintain themselves very well under fertilizing, while ox-eye daisy and orange hawkweed diminish in importance.

In view of the continuance of this work and its slowly cumulative value, a more detailed report on it can well be postponed until more ample data are at hand.

### B. 10.07. REDWATER DISEASE BOTANICAL SURVEYS

*In charge:* Herbert Groh; *Central Laboratory:* Ottawa

These surveys were undertaken to learn whether any plants occurring could be held responsible for redwater disease of cattle in the lower Fraser Valley of B.C., or could furnish any clue to its cause. Careful analysis of over 100 survey lists comprising about 600 species of plants absolved all from any reasonable suspicion. Bracken, which has been frequently held under suspicion, was found to be characteristically associated with the occurrence of the trouble, but only, it is believed, as an indicator of some soil or other condition not yet determined clearly. Soil analyses and feeding experiments were recommended, and have been provided for at a farm leased by the Department.

### B. 10.08. PHENOLOGICAL INVESTIGATIONS

*In charge:* Herbert Groh; *Central Laboratory:* Ottawa

Continuing from work started in Nova Scotia orchards, records of flowering and fruiting periods of weeds and other plants are being secured at Ottawa and wherever opportunity is afforded. At Ottawa dates for over 700 species are now on file.

## WEEDS AND POISONOUS PLANTS

### Project Group No. 11.00

### B. 11.01. IDENTIFICATION AND ERADICATION OF POISONOUS PLANTS

*In charge:* Herbert Groh; *Central Laboratory:* Ottawa

The plants chiefly receiving attention are horsetail and poison ivy, the former from a life history standpoint and both for control. These studies are incomplete, but experiments for control by sodium chlorate spraying are still giving too variable results for general recommendation. It would seem that the depth of rooting in different habitats makes a great difference. A list of several hundred plants reputed poisonous or otherwise injurious and a bibliography of about 1,500 references are now fairly complete.

### B. 11.02. WEED SURVEY OF THE DOMINION

*In charge:* Herbert Groh; *Central Laboratory:* Ottawa

Each year extends the survey into new areas, providing gradually for a Dominion-wide weed perspective that could be obtained in no other way so efficiently. While being further rounded out to cover all agricultural regions, local and provincial lists are being prepared, and papers on the range and prevalence of individual weeds have been published. New weeds are located

each year, and one weed, dog mustard *(Erucastrum gallicum)* until now unrecognized, has been found to have a range already from the Atlantic provinces to Alberta and from the international boundary to the Peace river.

Methods of presenting the mass of records accumulating have been further elaborated, and for some provinces these data are now transferred to charts where their significance can be taken in at a glance.

### B. 11.08. COMMON MILK WEED ASCLEPIAS SYRIACA L. GENERAL STUDY

*In charge:* Herbert Groh; *Central Laboratory:* Ottawa

These studies are of life history and control. Reasons are being sought for the especial prevalence of the weed in Eastern Ontario, and its absence, except for one known infestation, east of New Brunswick. An interesting peculiarity is its proneness to teratological aberrations. Both by seed and vegetatively, milk weed is found to be well equipped for invasion of farm land. Experiments with sodium chlorate have secured good kills of stalks, but not, as yet, sufficient destruction of the root system to prevent recovery.

### B. 11.09. STUDIES IN SEED GERMINATION BEHAVIOUR

*In charge:* Herbert Groh; *Central Laboratory:* Ottawa

Sufficient seed is collected and stored for tests over a number of years of over 60 of the common weeds. Standardized methods are employed in co-operation with the Seed Branch Laboratory, for tests at maturity, at monthly intervals for a time, and at yearly, and to date, two-yearly intervals.

Germination has been found to be generally higher at one year than immediately at maturity, and at two years still better. Annuals in particular were often low at the first test. In general annuals germinated lower percentages than biennials and perennials higher. There is remarkable diversity in species behaviour, which is apt to follow family lines. Fuller report may well be delayed.

## CEREAL DISEASE INVESTIGATIONS

### Rusts: Project Group No. 20.00

### B. 20.02. EPIDEMIOLOGY OF CEREAL RUSTS

*In charge:* B. Peturson; *Laboratory:* Winnipeg, Man.

Slides exposed in Southern Manitoba during the summers of 1931, 1932, 1933, first intercepted stem rust spores in the first week of June, and during the summer of 1934 in the second week. In comparison with previous years the spore count of the slides was low, being least in 1933. In the vicinity of Winnipeg viable stem rust spores were found to a height of 14,000 feet in the summer of 1931. During the summer months of the four years under review, the Prairie Provinces experienced unusual drought conditions. The paucity of stem rust inoculum, and the early ripening of the crop owing to the drought were responsible for the very limited development of stem rust in the Prairie Provinces. None of the other cereal rusts did any appreciable damage, except leaf rust of wheat in certain parts of Manitoba during the first three years.

### B. 20.04. VARIETAL RESISTANCE OF OATS TO CROWN RUST

*In charge:* B. Peturson; *Laboratory:* Winnipeg, Man.

During the past five years over 400 named varieties of oats, and fifty-six strains produced at the Dominion Rust Research Laboratory, Winnipeg, were tested for resistance to crown rust (*Puccinia coronata* Cda. var. *Avenae* Erikss. and Henn.). Most of the named varieties tested proved susceptible, but the

varieties Bond, Victoria and Pampa showed high resistance both in the seedling and in the adult stage to all forms of crown rust known to occur in Canada. Forty-five of the strains mentioned above proved highly resistant to all these forms of crown rust, both in the seedling and in the adult stage.

### B. 20.06. PHYSIOLOGIC SPECIALIZATION IN PUCCINIA GRAMINIS PERS. VAR. AVENAE ERIKSS. AND HENN.

*In charge:* W. L. Gordon; *Laboratory:* Winnipeg, Man.

(1) Gordon, W. L., and J. N. Welsh. Oat stem rust investigations in Canada. Sci. Agric. *13:* 228-235. 1932. (2) Gordon, W. L. A study of the relation of environment to the development of the uredinial and telial stages of the physiologic forms of *Puccinia graminis Avenae* Erikss. and Henn. Sci. Agric. *14:* 184-237. 1933.

During the three-year period, 1931-33, two hundred and sixty-three collections of oat stem rust obtained from eight provinces were cultured in the greenhouse. The most prevalent physiologic forms each year in Canada have been forms 1, 2 and 5. That is, Group I has predominated. This group includes the three least virulent forms. Group II was isolated but once from the provinces, British Columbia, Manitoba, Ontario, Quebec and Nova Scotia. Physiologic form 8 was isolated once only during the period 1931-33. The results of the physiologic form survey carried on during the three-year period 1931-33 indicate that the more virulent forms of oat stem rust are not becoming more prevalent in Canada.

### B. 20.07. THE CONSTANCY OF PHYSIOLOGIC FORMS

*In charge:* Margaret Newton and T. Johnson; *Laboratory:* Winnipeg, Man.

(1) Newton, Margaret, and T. Johnson. Specialization and hybridization of wheat stem rust, *Puccinia graminis Tritici* in Canada. Dom. of Canada, Dept. Agric., Bul. 160 New Series, 1932. (2) Johnson, T., M. Newton, and A. M. Brown. Hybridization of *Puccinia graminis Tritici with Puccinia graminis Secalis and Puccinia graminis Agrostidis.* Sci. Agric. *13:* 141-153. 1932. (3) Johnson, T., and M. Newton. Hybridization between *Puccinia graminis Tritici* and *Puccinia graminis Avenae.* (Accepted for publication, Proceedings World's Grain Exhibition and Conference, Regina, Vol. II). (4) Johnson, T., M. Newton, and A. M. Brown. Further studies of the inheritance of spore colour and pathogenicity in crosses between physiologic forms of *Puccinia graminis Tritici.* Sci. Agric. *14:* 360-373. 1934.

*(a)* Genetic Studies of Physiologic Forms of *Puccinia graminis* Pers. var *Tritici* Erikss. and Henn.

Studies on the nature of the inheritance of urediospore colour and pathogenicity in crosses between certain physiologic forms have been continued. A study of selfed $F_1$, $F_2$, and $F_3$ cultures originating from crosses between an orange and a greyish-brown strain of rust indicates that the inheritance of urediospore colour has a Mendelian basis. The inheritance of pathogenicity is more complex and there is some evidence, in certain crosses, of a cytoplasmic influence.

(*b*) Studies in Hybridization Between Varieties of *Puccinia graminis* Pers.

Crosses of the *Tritici* with the *Secalis, Agrostidis* and *Avenae* varieties have for the most part resulted in hybrids showing pathogenically a considerable degree of intermediacy between the parental varieties. A selfing of one of the *Tritici-Secalis* $F_1$ hybrid forms (form 70) produced an $F_2$ generation composed of several physiologic forms which, with one exception, exhibit an intermediacy between the two parental rust varieties as expressed by their comparatively low virulence on wheat and rye varieties and their ability to attack barley varieties to a moderate extent.

### B. 20.11. STUDY ON THE SEXUAL BEHAVIOUR OF PUCCINIA GRAMINIS

*In charge:* J. H. Craigie and A. M. Brown; *Laboratory: Winnipeg, Man.*

(1) Brown, A. M. Diploidisation of haploid by diploid mycelium of *Puccinia Helianthi* Schw. Nature (London) *130* (3287): 777. 1932. (2) Craigie, J. H. Union of pycniospores and haploid hyphae in *Puccinia Helianthi* Schw. Nature (London) *131* (3297): 25. 1933.

Urediospores of *P. Helianthi* Schw. were sown on the leaves of sunflower plants in the immediate vicinity of haploid pustules of this rust. From these spores diploid pustules arose which later coalesced with the haploid pustules. Following coalescence, aecia began to develop in the haploid pustules, thus indicating that the uredial mycelia had diploidised the haploid mycelia.

Two types of hyphae protrude through the ostioles of pycnia of haploid pustules of *Puccinia graminis* Pers. and *P. Helianthi,* (*a*) the well-known paraphyses and (*b*) flexuous hyphae. Unions made by means of short tubes between pycniospores and flexuous hyphae have been found in sections of haploid pustules of *P. Helianthi* in which the nectar had been previously intermixed.

### B. 20.12. SULPHUR DUSTING FOR THE PREVENTION OF CEREAL RUSTS

*In charge:* F. J. Greaney; *Laboratory:* Winnipeg, Man.

(1) Greaney, F. J. Field experiments on the prevention of cereal rusts by sulphur dusting (1930-1932). Sci. Agric. *14:* 496-511. 1934. (2) Greaney, F. J. Studies in cereal diseases. XI. The prevention of cereal rusts by the use of fungicidal dusts. Dom. of Canada, Dept. Agric., Bul. 171 New Series, 1934.

Field experiments to determine the most effective and practical method of dusting with sulphur for the control of leaf rusts and stem rusts of wheat and oats were made in 1930, 1931, and 1932, at Winnipeg, Manitoba. Relatively light applications of sulphur dust well-timed and properly applied almost completely prevented the development of cereal rusts, as they did also the development of the minor leaf and stem spotting diseases of wheat and oats.

Yield and grain quality were significantly improved by dusting. In 1930, a severe rust year, dusting increased the yield of Marquis wheat 24·3 bushels per acre, or approximately 400 per cent, and the quality of the grain was improved from "Feed Wheat" weighing 40 pounds per bushel to "1 Hard" weighing 61 pounds per bushel. By preventing crown rust and stem rust in 1930 dusting increased the yield of Victory oats 45 bushels per acre, or 153 per cent.

Of the dusts tested, Kolodust gave the most effective rust control. The fungicidal effectiveness of sulphur increased in proportion to the fineness of the dust particles. The effect of sulphur on the degree of rust infection, and on the consequent grain quality and yield, was least with light infrequent applications. Sulphur dust applied at the rate of 30 pounds per acre and at 5-day intervals, during periods of from 4 to 5 weeks, gave the most satisfactory results in preventing cereal rusts. The dusting method is recommended for the use of experimentalists, seed growers, and grain exhibitors, wherever destructive epidemics of cereal rusts occur.

### B. 20·13. THE SEASONAL DISTRIBUTION OF PHYSIOLOGIC FORMS OF PUCCINIA GRAMINIS VAR. TRITICI IN CANADA

*In charge:* Margaret Newton and T. Johnson; *Laboratory:* Winnipeg, Man.

Newton, Margaret, and Thorvaldur Johnson. Specialization and hybridization of wheat stem rust, *Puccinia graminis Tritici,* in Canada. Dom. of Canada, Dept. of Agric., Bul. 160 New Series, 1932.

From 1919, when the first physiologic forms were isolated in Canada, until the present, fifty-one physiologic forms of stem rust have been isolated from cereals and grasses. A study of field collections of wheat stem rust in Canada has shown that, during the years 1931-33, the physiologic forms attacking the

durum wheats have been on the increase. In 1931 they constituted 45 per cent of the total collections; in 1932, 56 per cent; and in 1933, 70 per cent. From 1926 to 1932, form 36, a form which does not attack the durum wheats, has been the prevailing form in Canada. In 1933, form 21 and 34, both of which attack the durum wheats, have been collected twice as frequently as form 36.

### B. 20.14. THE TESTING OF HYBRIDS AND NEW WHEAT VARIETIES FOR RUST RESISTANCE

*In charge:* Margaret Newton and T. Johnson; *Laboratory:* Winnipeg, Man.

During the years 1931, 1932 and 1933, 62 wheat varieties and hybrids were tested in the seedling stage to four physiologic forms of *Puccinia glumarum* var. *Tritici* Erikss. and Henn. Of these wheats, Garnet, Iumillo, Marquillo, Marquis, and a South American wheat, Americano 44d = 22210, were highly resistant to all these forms, while Hard Federation and Vernal Emmer were resistant only to one form, a form collected at Olds, Alberta.

Twenty-one of these varieties were tested also in later stages of development to at least one form and most of them to three or four forms. It was found that Acme, Arnautka, Black Persian, H-44-24, Hope, Kanred, Mindum, and Pentad became progressively more resistant as they approached maturity.

### B. 20.16. PHYSIOLOGIC SPECIALIZATION IN PUCCINIA CORONATA VAR. AVENAE

*In charge:* B. Peturson; *Laboratory:* Winnipeg, Man.

Collections of crown rust of oats (*Puccinia coronata* Corda var. *Avenae* Erikss. and Henn.) obtained from widely separated localities in Eastern and Western Canada during 1931, 1932, 1933 and 1934 were cultured in the greenhouse. Out of a total of 324 cultures studied, nine distinct physiologic forms were identified. On a basis of the isolations, forms 1, 2, 3, and 4 were of common occurrence, while forms 5 and 24, and two other forms, A and B, which do not appear to correspond to any of the forms hitherto described, were quite rare.

### B. 20.18. A STUDY OF THE OVER-WINTERING AND SOURCES OF INOCULUM OF YELLOW STRIPE RUST IN ALBERTA

*In charge:* G. B. Sanford; *Laboratory:* Edmonton, Alta.

Sanford, G. B., and W. C. Broadfoot. Epidemiology of stripe rust in Western Canada. Sci. Agric. *13:* 77-96. 1932.

The known distribution of stripe rust in Canada has been outlined and various factors of climate and hosts discussed in relation to its incidence, particularly in Alberta. Stripe rust has appeared first each year in Southern Alberta during July, on *Hordeum jubatum* in low wet places. It becomes general on the upland there, during late August, and in Central Alberta, toward the middle of September. The direction of progress each year has been northward. The evidence shows that stripe rust rarely persists through the winter in the uredo stage and when it does it apparently perishes under prevailing conditions early in the spring, as the green rusted foliage dies. No evidence was obtained that stripe rust may be perpetuated from one season to another by dormant mycelium. It is suggested that the annual appearance of stripe rust in Alberta originates from wind-borne uredospores brought into Southern Alberta during June or early July from the stripe rust areas of the states of Washington, Idaho and possibly Montana. Apparently such uredospores do not originate in the central and eastern part of Southern British Columbia. The late and slow development of stripe rust in Central Alberta may be due chiefly to adverse winds which hinder the drift of inoculum from the southern part of the province. The evidence shows that conditions associated with inadequate

rainfall have been more important in restricting the development of stripe rust in certain parts of Alberta than have any differences in temperature during August and September. Dews are very important in the development of stripe rust during late August and September in Alberta. The scarcity of stripe rust in Central Saskatchewan, in a season of normal rainfall, apparently cannot be explained on the basis of temperature or of lack of susceptible hosts, for these conditions are similar to those of Zone 1 in Alberta, where this rust develops annually. It might be explained better by insufficient inoculum from Alberta in time to produce noticeable infection before the hosts mature or are injured by frost. Present indications are that the annual incidence of stripe rust in Alberta presents a close analogy to that of *Puccinia graminis* var. *Tritici* on wheat in Western Canada.

Sanford, G. B., and W. C. Broadfoot. The relative susceptibility of cultivated and native hosts in Alberta to stripe rust. Sci. Agric. *13:* 714-721. 1933.

*Hordeum jubatum* is, unquestionably, the principal host in the initiation, development and spread of stripe rust in Alberta, being extremely susceptible, widely distributed and prevalent. As such it appears to be the most suitable host for epidemiology studies in nature. *Agropyron dasystachyum,* because of its uniform susceptibility, and fairly common distribution in Zone I, Southern Alberta, where stripe rust develops first, and also its occurrence in the same zone in East Central Alberta, appears to be next in importance to *H. jubatum. A. Griffithsii* might be given equal rank for the same reason, but it does not seem to be as common as the former host. *A. Richardsoni* is, on the whole, as susceptible as *A. dasystachyum* and may be an important host in the central and eastern parts of Zone 1. Collections from nature differed widely in susceptibility, some being very resistant or immune, while others were very susceptible. *A. Smithii,* although moderately susceptible, can hardly be classed as important in the distribution of stripe rust since it indicated only slight susceptibility under the most favourable conditions for test, and in nature its reaction is usually negative or only slightly susceptible. *A. tenerum,* as it exists in nature in Alberta, appears to be moderately susceptible, and often apparently very resistant or immune. Only one plant of *A. repens* was found rusted. This was very susceptible. All plants of a selection of *Bromus ciliatus* were very susceptible. Apparently *A. repens, A. elongatum, A. Dagnae* and *A. pungens,* which were rusted, have not been reported previously as hosts for *Puccinia glumarum.* The varieties of wheat, as now commonly grown in Alberta, are resistant or immune for practical purposes. These include Marquis, Reward and Garnet.

### B. 20.19. STUDIES ON YELLOW STRIPE RUST (PUCCINIA GLUMARUM) IN WESTERN CANADA

*In charge:* Margaret Newton, T. Johnson and A. M. Brown;
*Laboratory:* Winnipeg, Man.

Newton, Margaret, T. Johnson and A. M. Brown. Stripe rust in Canada. (Abstract) Phytopath. *23:* 25. 1933.

Stripe rust has been collected without difficulty in British Columbia and Alberta. It is less prevalent in Saskatchewan, but collections have been made as far north as Saskatoon and as far east at Whitewood, which is 102°W. longitude, or a little beyond the eastern limit reported for this rust in the United States.

The reactions of wheat varieties to stripe rust were profoundly influenced by temperature. At 25·5°C., all the hosts tested to the different physiologic forms were completely resistant, while at 13°C. many were completely susceptible.

Two physiologic forms have been found in Canada, a virulent one at Duncan, British Columbia, and a much less virulent one at Olds, Alberta. Both of these forms have been isolated from material sent in from the United States.

A number of wheat varieties which are susceptible in the seedling stage have been found to develop considerable resistance in later stages of growth. The *Hordei* variety of this rust has not been isolated so far in Canada.

### B. 20.20. THE RELATION BETWEEN RUST INFECTION AND THE YIELD OF CEREAL CROPS

*In charge:* F. J. Greaney; *Laboratory:* Winnipeg, Man.

Greaney, F. J. Method of estimating losses from cereal rusts. (Accepted for publication, Proceedings World's Grain Exhibition and Conference, Regina, Vol. II).

During the eight years, 1925 to 1932, field experiments were made each season to determine the value of sulphur dusting for the control of cereal rusts. The data accruing from those experiments in which the amounts of rust on individual plots were varied by sulphur dustings at different rates and intervals were used to estimate the annual loss in yield and grain quality due to stem rust (*Puccinia graminis* Pers.). The method followed was to correlate rust percentage and yield, and rust percentage and weight per measured bushel, in a single standard variety. Each year the results were summarized in the form of correlation coefficients and regression equations. It was found that the regression of yield, and of weight per measured bushel, on percentage rust was linear, indicating that uniform increases in rust result in uniform reductions in yield and in grain quality. It was possible then to determine the reduction in yield, and in weight per bushel of grain, for each 10 per cent of stem rust. Values so obtained were used in calculating the annual field losses, due to stem rust, in Manitoba and Saskatchewan. The method was used also to estimate losses in yield and grain quality due to leaf rusts, and to some of the other diseases of cereal crops.

Estimates based on acreage, yield, and price statistics, indicate an average annual loss in yield to wheat in Manitoba and Saskatchewan during the eight years 1925 to 1932 of 15·5 per cent. This represents an annual loss of 37,396,000 bushels valued at $34,438,000. The average annual loss to oats in Manitoba and Saskatchewan in 1930, 1931 and 1932 was 11·1 per cent, or 13,525,000 bushels, estimated to be worth $2,624,000. Losses in yield and grain quality from rusts of wheat and oats, even at moderate grain prices, amount to at least $40,000,000 annually in the three Prairie Provinces of Canada.

### B. 20.21. A STUDY OF THE RELATION OF THE ENVIRONMENT TO THE DEVELOPMENT OF THE UREDIAL AND TELIAL STAGES OF THE PHYSIOLOGIC FORMS OF PUCCINIA GRAMINIS VAR. AVENAE

*In charge:* W. L. Gordon; *Laboratory:* Winnipeg, Man.

Gordon, W. L. A study of the relation of environment to the development of the uredinial and telial stages of the physiologic forms of *Puccinia graminis Avenae* Erikss. and Henn. Sci. Agric. *14:* 184-237. 1933.

The relation of certain environmental factors, particularly temperature, to the development of the uredial and telial stages of the various physiologic forms has been studied. The various studies were carried on, with few exceptions, at controlled temperatures within the range 12° to 28°C. The types of uredial infection, produced by forms 1, 3, 4 and 5, on the differential host Joanette strain were profoundly changed by temperature. All the physiologic forms developed teliospores more rapidly on both seedlings and mature plants at relatively high (24° to 28°C.) than at low temperatures (12° to 16°C.).

B. 20.22. A PHYSIOLOGICAL STUDY OF THE EFFECTS OF ENVIRONMENTAL FACTORS ON THE REACTIONS OF PUCCINIA GRAMINIS PERS. VAR. TRITICI ERIKSS. AND HENN. ON TRITICUM SPECIES

*In charge:* T. Johnson; *Laboratory:* Winnipeg, Man.

Johnson, T. A study of the effect of environmental factors on the variability of physiologic forms of *Puccinia graminis Tritici* Erikss. and Henn. Dom. of Canada, Dept. Agric., Bul. 140 New Series, 1931.

Some varieties of wheat when infected by certain physiologic forms of stem rust are highly resistant at temperatures of 60°F. or below, but quite susceptible at temperatures above 75°F. Certain physiological studies were undertaken in an attempt to discover the cause of this behaviour.

A comparison was made of the sugar content and osmotic pressure in Mindum wheat, the reaction of which varies with temperature, and Marquis wheat, whose reaction is unaffected by temperature conditions when these varieties were grown at 60°F. and 75°F. Both sugar content and osmotic pressure were found to be considerably higher in Mindum at the lower temperature than at the higher. In Marquis this was also the case, but the differences were slighter. In view of the similarity of the results for the two varieties, it is thought that sugar concentration and osmotic pressure cannot account for the rust resistance of Mindum at low temperatures.

B. 20.24. A STUDY OF THE PHYSIOLOGY OF PUCCINIA TRITICINA ERIKSS.

*In charge:* Margaret Newton and T. Johnson; *Laboratory:* Winnipeg, Man.

In 1931, a study of physiologic specialization in leaf rust of wheat was begun. Difficulties were encountered in the work of identifying physiologic forms: some of the differential varieties were found to be impure, while others varied in their reaction according to the temperature prevailing. As a result of a study on the effect of different temperatures on the reaction of the differential varieties to several physiologic forms, it was established that the differential varieties fall into three groups on the basis of their reaction to this rust at different temperatures: Malakoff, Norka, Loros, Mediterranean, and Democrat are rather constant in reaction at temperatures from 13° to 24°C.; Carina, Brevit, Webster, and Similis, when infected by certain physiologic forms, are susceptible at lower temperatures (about 15°C.), but resistant at higher temperatures (about 24°C.); Hussar tends to be rather resistant at the lower and susceptible at the higher temperature.

B. 20.25. THE ECONOMIC SIGNIFICANCE OF BUCKTHORN AND ITS RELATION TO CROWN RUST

*In charge:* I. L. Conners; *Central Laboratory:* Ottawa, Ont.

It has been demonstrated that the European buckthorn (*Rhamnus cathartica*) may initiate epidemics of crown rust (*Puccinia coronata*) on oats in Carleton and adjacent counties, wherever escaped buckthorns were found. In areas, where conditions are favourable for the spread of crown rust, such as exist as Merrickville on the Rideau river, oats can no longer be grown profitably over a period of years on account of severe losses from crown rust. In other areas serious rust damage seemed limited to oats growing in close proximity to the bushes, but it is probable that in some years the crown rust would be epidemic throughout an escape area or beyond. In the Antrim area escaped bushes have been found one and a half miles from the original hedge. The escapes grow chiefly along fence rows and about the edges of fairly dense woods, and are naturally more abundant and older in close proximity to the original

planting. Whether or not eradication is practical, there is a distinct need for varieties resistant to crown rust. Escaped barberries were also found, but their role in initiating epidemics of stem rust on cereals was not established.

### B. 20.26. STUDIES ON THE NATURE OF DISEASE RESISTANCE IN CEREALS

*In charge:* Margaret Newton; *Laboratory:* Winnipeg, Man.

#### I. *The reactions to rust of mature and immature tissues*

(M. Newton and A. M. Brown—Winnipeg, Man.)

(1) Newton, Margaret and A. M. Brown. Studies on the resistance of wheat and oats to stem rust. (Abstract) Phytopath. *23:* 25. 1933. (2) Newton, Margaret and A. M. Brown Studies on the nature of disease resistance in cereals. I. The reactions to rust of mature and immature tissues. Can. Jour. Res. *11:* 564-581. 1934.

A study has been made of the reactions of mature and immature tissues of wheat, oats, and barley to different cereal rusts. In varieties and strains which, when inoculated in the seedling stage in the usual way with *Puccinia graminis* Pers. produce a "1" type of pustule, it has been found that, if the different parts of the culm are inoculated by injection with a suspension of urediospores before the plants come into head, the young rapidly-growing parts are very susceptible while the older more mature parts are highly resistant. A similar result was obtained with plants possessing mature plant resistance. The young rapidly-growing parts are also susceptible to a number of rusts which are not natural parasites of the particular cereals. For example, *P. graminis* var. *Tritici* Erikss. and Henn. will attack oats and rye. As the susceptible parts grow older they become as resistant as the rest of the plant.

#### II. *Physiological studies.* (T. Johnson—Winnipeg, Man.)

Johnson, T., and O. Johnson. Studies on the nature of disease resistance in cereals. II. The relationship between sugar content and reaction to stem rust of mature and immature tissues of the wheat plant. Can. Jour. Res. *11:* 582-588. 1934.

Analyses to determine the sugar content of mature and immature tissues of four wheat varieties possessing mature-plant resistance and three varieties susceptible to stem rust revealed much greater amounts of sugar in the immature than in the mature regions of the plants. However, as all the varieties, irrespective of whether they do or do not possess mature-plant resistance, showed much the same difference in the sugar content of their young and older tissues, it does not seem likely that there is any direct relation between sugar content and reaction to rust. Osmotic pressure determinations showed that osmotic values are considerably higher in the young than in the older tissues of all the varieties tested.

## Smuts: Project Group No. 21.00

### B. 21.01. CONTROL OF BUNT OF WHEAT BY SEED TREATMENT

*In charge:* W. F. Hanna and W. Popp; *Laboratory:* Winnipeg, Man.

Hanna, W. F., and W. Popp. The overwintering of bunt spores in Western Canada. Sci. Agric. *13:* 636-637. 1933.

Since 1930 there has been a progressive decrease in the incidence of bunt of wheat in Western Canada. In the first four months of the grain year 1933-34, only 0·5 per cent of the durum wheat graded smutty as compared with 17 per cent in 1930. New Improved Ceresan gave satisfactory control of bunt of wheat when applied to the seed at the rate of one-half ounce per bushel. It also improved seed germinability when applied shortly before seeding. Prolonged storage following treatment with this dust reduced germinability especially when

the moisture content of the seed was high. Experiments have shown that under certain conditions bunt spores may overwinter in Western Canada and cause infection of spring-sown wheat.

### B. 21.03. DETERMINATION OF VARIETAL SUSCEPTIBILITY OF OATS TO LOOSE AND COVERED SMUT

*In charge:* W. F. Hanna and W. Popp; *Laboratory:* Winnipeg, Man.

During the period 1931-34, 18 species and varieties of oats were tested in field plot experiments for resistance to *Ustilago Avenae* (Pers.) Jens. and *U. levis* (K. and S.) Magn. Separate inoculations were made with collections of spores obtained from several places in Western Canada. All of the varieties of oats reacted in the same way to the two species of smuts from which it may be concluded that the smut collections belonged to the same physiologic form.

### B. 21.05. CONTROL OF LOOSE AND COVERED SMUT OF COMMON OATS BY SEED TREATMENT

*In charge:* W. F. Hanna and W. Popp; *Laboratory:* Winnipeg, Man.

Of the dusts tested in field plot experiments during the period 1931-34, Ceresan and New Improved Ceresan gave the best control of loose and covered smuts of oats.

### B. 21.07. CONTROL OF LOOSE SMUTS OF WHEAT AND BARLEY BY SEED TREATMENT

*In charge:* W. F. Hanna and W. Popp; *Laboratory:* Winnipeg, Man.

Hanna, W. F., and W. Popp. Experiments on the control of loose smut of wheat by seed treatment. (Accepted for publication, Proceedings World's Grain Exhibition and Conference, Regina, Vol. II.)

The efficacy of the hot water treatment in controlling loose smut in Reward wheat, and the effect of the treatment on seed germination have been investigated. The germinability of hot water treated Reward wheat has been improved by dusting it with copper carbonate subsequent to treatment. The heating of both dry and presoaked seed at controlled temperatures in an electric oven failed to eliminate loose smut. Efforts have been made to control loose smut by soaking the seed in different solutions at room temperature. Potassium iodide solutions used in this way reduced the percentage of loose smut in Reward and Ceres wheat but did not eliminate it.

### 21.08. VARIETAL REACTIONS OF WHEAT AND BARLEY TO COLLECTIONS OF LOOSE SMUT

*In charge:* W. F. Hanna and W. Popp; *Laboratory:* Winnipeg, Man.

Forty-three varieties and selections of wheat, and 9 varieties of barley have been inoculated by hand to determine their resistance to loose smut. Of the standard varieties of wheat tested, Preston is the only one which has proved to be resistant to all the physiologic forms of *Ustilago Tritici* (Pers.) Rostr. with which it was inoculated. Up to the present, Trebi barley has remained immune to *U. nuda* (Jens.) Rostr.

### B. 21.09. REACTIONS OF WHEAT VARIETIES TO BUNT

*In charge:* W. F. Hanna and W. Popp; *Laboratory:* Winnipeg, Man.

Since 1930, 140 varieties and selections of wheat have been tested in field-plot experiments for resistance to bunt. The selections were supplied by the Cereal Division, Ottawa, the University of Alberta, the sub-committee on Plant

Breeding of the Associate Committee on Cereal Diseases, and the cerealists at the Dominion Rust Research Laboratory. Many of the selections possessed a high degree of resistance to stem rust.

### B. 21.10. REACTIONS OF BARLEY VARIETIES TO COVERED SMUT

*In charge:* W. F. Hanna and W. Popp; *Laboratory:* Winnipeg, Man.

Two physiologic forms of covered smut of barley have been found. One of these was found to give a much heavier infection on O.A.C. 21 and White Hulless than the other one.

### B. 21.11. PHYSIOLOGY AND SEXUALITY OF USTILAGO AVENAE AND U. LEVIS

*In charge:* W. F. Hanna and W. Popp; *Laboratory:* Winnipeg, Man.

Popp, W., and W. F. Hanna. Studies on the physiology of the oat smuts. Sci. Agric. *15:* 424-434. 1935.

Plants inoculated with single monosporidial cultures of *Ustilago Avenae* or *U. levis* failed to produce smutted heads. Plants inoculated with two monosporidial cultures of opposite sex of *U. Avenae* or *U. levis,* or with a culture of *U. Avenae* and one of opposite sex of *U. levis* produced smutted heads. Heads infected with *U. Avenae* or with the hybrid (*U. Avenae* x *U. levis*) contained echinulate chlamydospores; those infected with *U. levis* contained smooth chlamydospores. The factor for echinulate spore was found to be dominant over that for smooth spore. The appearance of smutted heads, whether "covered" or "loose," is not always a reliable indication of the kind of chlamydospores which they contain. However, plants inoculated with cultures bearing the factor for echinulate spore produce a higher proportion of heads of the "loose" type than do those inoculated with cultures bearing the factor for smooth spore. There is evidence that the appearance of smutted heads is determined by the conditions under which the plants are grown as well as by the genetic constitution of the smut-fungus attacking them. The sporidia of *U. Avenae,* like those of *U. levis,* are of two kinds (+) and (—); the sporidia of the one species mate without difficulty with sexually opposite sporidia of the other species. Segregation for sex and cultural characters was found to occur at either the first or the second division of the chlamydospore-nucleus. No significant difference was found in the ability of *U. Avenae, U. levis,* $F_1$ (*U. Avenae* x *U. levis*), $F_2$ (*U. Avenae* x *U. levis*), and $F_1$ (*U. Avenae* x *U. levis*) x *U. levis spores* to germinate, but sporidia of the $F_1$ (*U. Avenae* x *U. levis*) spores, as compared with those of the others, are much less capable of growth on artificial media.

### B. 21.12. PHYSIOLOGY AND SEXUALITY OF TILLETIA TRITICI AND T. LAEVIS

*In charge:* W. F. Hanna; *Laboratory:* Winnipeg, Man.

Hanna, W. F., Physiology of the fungi causing bunt of wheat. (Accepted for publication. Proceedings Fifth Pacific Science Congress, Victoria and Vancouver.)

An outline is given of the world distribution of *Tilletia Tritici* and *T. laevis.* Physiologic forms of these species are considered in relation to: (1) Parasitism. (2) Morphology. (3) Physiology. (a) Trimethylamine content of spores. (b) Cultural characters. (c) Spore germination. (d) Temperature for infection. There is considerable variation in the average number of sporidia produced by spores of different bunt collections. The numbers produced by individual spores of one collection of *T. Tritici* varied from 4 to 21, and odd numbers of sporidia occurred as frequently as even numbers. When pairs of sporidia of *T. Tritici* from the same spore or from different spores are placed side by side on non-nutrient agar of pH 5·2 or 6·0, approximately 50 per cent of them conjugate, indicating that the sporidia belong to two sexual groups. Both *T. Tritici* and *T.*

laevis have been found to be heterothallic. Primary conidia are binucleate and diploid, whereas secondary conidia are uninucleate and haploid. Hybridization occurs readily between the two species.

## Root Rots: Project Group No. 22.00

### B. 22.02. STUDY OF "TAKE ALL" (OPHIOBOLUS GRAMINIS) OF WHEAT

*In charge:* P. M. Simmonds; *Laboratory:* Saskatoon, Sask.

Russell, R. C. Studies of take-all and its causal organism, ***Ophiobolus graminis*** Sacc. Dom. Dept. Agric., Bul. No. 170 N.S. 1934.

Take-all, caused by *O. graminis*, was discovered in Saskatchewan in 1923 and experimental work on it was begun immediately. The symptoms of the disease and the characteristics of the causal organism have been found to agree with the descriptions of these given by investigators in other countries except that the symptoms produced under dry conditions are somewhat different. Penetration of the host by *O. graminis* is described in detail. Host range studies show that most of our cereals and cultivated grasses as well as many of the grass species found in the prairie sod of this region are more or less susceptible to this fungus. On the other hand oats, corn and any of the species outside of the grass family which were tested proved to be very resistant. One hundred varieties of wheat belonging to eight sub-species of *Triticum* were found to be about equally susceptible to *O. graminis*. The fungus remained viable in soil in pots kept free of vegetation for a period of one year in the greenhouse and two years out doors and subsequently infected wheat sown in this soil. Different isolates were found to vary greatly in their ability to attack wheat. Certain ones varied considerably in their pathogenicity at different periods. The effect of soil moisture and temperature upon the disease appeared to vary somewhat according to the state of other environmental conditions. On the average a relatively low soil moisture content (35-40 per cent of the moisture-holding capacity of the soil) and a relatively high temperature (22°C.) were found to favour heavy infection of wheat seedlings artificially inoculated. The fungus proved to be a vigorous parasite over a fairly wide range of moisture and temperature conditions. Of the cultural practices tested the only ones which were shown to have much effect on take-all were crop rotation and depth of seeding. As a method of controlling the disease the use of crop rotations, in which summer-fallow and crops highly resistant to *O. graminis* are alternated with wheat, is strongly recommended for this region.

### B. 22.05. STUDY OF THE ROOT-ROT PROBLEM OF WHEAT AND BARLEY CAUSED BY HELMINTHOSPORIUM SATIVUM IN SASKATCHEWAN

*In charge:* P. M. Simmonds; *Laboratory:* Saskatoon, Sask.

Sallans, B. J. Methods of inoculation of wheat with ***Helminthosporium sativum,*** P.K. and *B.* Sci Agric. *13:* 515-527. 1933.

Methods of inoculating wheat with *H. sativum* to produce seedling infections were reviewed and studied. The age of the culture of *H. sativum* on an oat hull medium is important, young cultures being much more virulent than older cultures. The addition of sterile medium or autoclaved inoculum to the uninoculated soil resulted in a serious reduction of emergence when the soil was unsterilized. Sterilized soil thus treated supported normal plants. Seed treated with a spore suspension of the fungus was found on drying to give higher disease ratings than when sown while still wet. This was shown to be due to a period of incubation when the spores germinated before drying was complete. It was found that by increasing the period of incubation to eighteen or twenty-seven hours

at 24°C. high percentages of infection could be obtained. It was suggested that uniform inoculations may be obtained by this method if the technique is standardized.

Other work under this project during the past four years may be summarized as follows: The relative pathogenicities of 106 isolates of *H. sativum* collected chiefly in Saskatchewan on wheat were compared in 3 greenhouse tests on Marquis at the University of Wisconsin. Twenty-two representative isolates were studied further in three tests on Marquis and two on Reward. As a result four of the 22 isolates were shown to be relatively innocuous, while the other 18 were definitely pathogenic. Fourteen of these on the average of all trials were remarkably uniform as to pathogenicity. Two were slightly more pathogenic and two somewhat less so.

Depth of seeding tests in 1933 and 1934 indicate that wheat sown deep is more subject to injury than wheat sown to about 2 inches. This seemed to be the optimum depth under average conditions of soil moisture in this province. Dates of seeding tests have usually shown that early seeding results in relatively little infection by *H. sativum*. Late seeding usually results in higher degrees of infection, though this is subject to considerable variation from relatively little to very considerable injury depending on soil temperature and moisture conditions and possibly on the microflora of the soil.

Artificial inoculations of wheat during the past three years indicate that Reward is more subject to injury from *H. sativum* than is Marquis. The effect on Ceres is somewhat intermediate, while Mindum gave similar results to Marquis.

Field studies on common root-rot, in which *H. sativum* and *Fusarium* spp. are concerned have shown increases in the incidence of this disease from 5 to 10 per cent in early June up to 80 to 100 per cent in late July. Subcrown internode lesions appear to be more significantly correlated with reduction in yield of grain than lesions on other underground parts. Reductions in yield due to severe subcrown internode lesions have varied from 30 to 45 per cent as compared to lesion free or slightly lesioned plants in the past 3 years. Similar lesions classed as moderate resulted in reductions of 15 to 20 per cent on the same basis. These reductions in yield are due to three factors, namely: fewer kernels per plant, smaller kernels, and somewhat fewer tillers per plant. In the fields studied over the three years the percentages of plants classed as having severe subcrown internode lesions varied from about 10 to 35 per cent, and plants placed in the moderate lesion class comprised about 12 to 30 per cent.

### B. 22.06. A STUDY OF THE ANNUAL FUNGOUS FLORA OF THE BASAL PARTS OF THE WHEAT PLANT

*In charge:* P. M. Simmonds; *Laboratory:* Saskatoon, Sask.

In 1931 isolations were made from crown and roots of Marquis wheat plants collected at Morden, Winnipeg, Indian Head, Saskatoon, Swift Current and Edmonton. Mostly *Helminthosporium sativum* and *Fusarium* spp. were obtained. In 1932 isolations were made only from plants grown at Saskatoon. Besides the above mentioned fungi each season a few colonies of *Alternaria, Rhizoctonia, Botrytis* and many *Rhizopus* and *Penicillium* colonies appeared on the plates.

### B. 22.07. ROOT-ROT SURVEY FOR MANITOBA

*In charge:* J. E. Machacek and F. J. Greaney; *Laboratory:* Winnipeg, Man.

During the years 1931-34, inclusive, annual surveys of the cereal growing districts of Manitoba were made in order to determine the prevalence of root-rot diseases in cereals. Data were obtained on soil types, method of cropping, climatic conditions, and variety of grain, and attempts were made to correlate

variations in these factors with the intensity of disease development. Ecological conditions apparently do not materially influence root-rot development in the crop except when they are such as may be detrimental to plant growth in which cases the amount of disease is increased. Definite varietal differences with regard to susceptibility to root-rots have been observed, but no totally resistant variety has as yet been discovered. The *Helminthosporium-Fusarium* type of root-rot is by far the most prevalent in Manitoba. Take-all has not been found since 1930, while the browning disease was observed in 1933 for the first time in this province, and in 1934 it was present in many fields.

### B. 22.08. A CO-OPERATIVE CROP ROTATION STUDY FOR THE CONTROL OF TAKE-ALL AND FOR THE TESTING OF VARIETAL RESISTANCE UNDER FIELD CONDITIONS

*In charge:* R. C. Russell; *Laboratory:* Saskatoon, Sask.

The portion of the field devoted to rotation tests was all sown to wheat in 1931. It was found that the amount of take-all present throughout the field was increasing with successive crops of wheat.

In the wheat variety tests Reward appeared to be somewhat more susceptible than Garnet, Marquis or Mindum.

These results concluded our study of these particular phases of the take-all problem.

### B. 22.09. CO-OPERATIVE CROP SEQUENCE STUDY FOR THE CONTROL OF ROOT-ROT OF WHEAT

*In charge:* G. B. Sanford; *Laboratory:* Edmonton, Alta.

Broadfoot, W. C. Studies on foot and root-rot of wheat. III. Effect of crop rotation and cultural practice on the development of foot-rot of wheat. Can. Jour. Res. *10:* 95-114. 1934.

The following conclusions are drawn from a uniform, co-operative, crop sequence study at seven stations in Western Canada, viz., Morden, Indian Head, Swift Current, Scott, Lethbridge, Olds and Vermilion, from 1928 to 1932, inclusive (a total of 28 station-years). Foot-rot damage of wheat is significantly reduced where wheat alternates with summer-fallow in a two-year rotation, where it follows summer-fallow in other rotations, alternates with oats in a two-year rotation, follows oats in a three-year rotation, follows sweet clover in a three-year rotation, or where wheat is sown late. It is increased where wheat follows wheat, barley, or western rye grass.

Broadfoot, W. C. Studies on foot and root-rot of wheat. IV. Effect of crop rotation and cultural practice on the relative prevalence of *Helminthosporium sativum* and *Fusarium* spp. as indicated by isolations from wheat plants. Can. Jour. Res. *10:* 115-124. 1934.

The crown and root tissue from 43,305 of 47,360 plants examined in this investigation yielded *Helminthosporium sativum, Fusarium culmorum* and other *Fusarium spp.*, either alone or in combination with these or other fungi and bacteria. It was the exception for any mature plant, the surface tissue of which was disinfected, to be free from fungi or bacteria. None of the various crop sequences or cultural practices used in this study appeared to significantly affect the relative prevalence of either *H. sativum* or *Fusarium* spp., as indicated by isolations from the crown tissue of wheat. However, as there was a marked tendency at certain stations each year for *H. sativum* or *Fusarium* spp. to predominate, it was concluded that certain factors of the environment were more effective than the crop sequence in modifying the relative prevalence of the two fungi mentioned in the crown and root tissue of wheat plants.

### B. 22.10. PATHOGENICITY TEST IN FIELD OF FIVE ROOT-ROTTING FUNGI ON WINTER WHEAT

*In charge:* G. B. Sanford; *Laboratory:* Edmonton, Alta.

Broadfoot, W. C. On the pathogenicity of *Wojnowicia graminis*. Phytopath. *23:* 1001-1002. 1933.

Based on 28 isolates of *W. graminis* it was concluded that this fungus was not significantly pathogenic to winter or spring wheat in the seedling stage.

### B. 22.11. THE DEGREE OF PATHOGENICITY MOST FREQUENTLY FOUND IN ROOT-ROTTING FUNGI IN ALBERTA

*In charge:* G. B. Sanford; *Laboratory:* Edmonton, Alta.

Sanford, G. B., and W. C. Broadfoot. On the prevalence of pathogenic forms of *Helminthosporium sativum* and *Fusarium culmorum* in the soil of wheat fields and its relation to the root-rot problem. Can. Jour. Res. *10:* 264-274. 1934.

A total of 227 isolates of *Helminthosporium sativum* and 286 of *Fusarium* sp. (*culmorum* type) were obtained from the diseased crown tissue of wheat stubble in five fields located in the black soil belt of Central Alberta, and an attempt was made to determine their relative virulence on wheat seedlings and on mature plants. The experiment was carried out under greenhouse conditions, with a range of soil temperature. Sterilized, artificially infested soil in open pot culture was used. The results indicated that the *Helminthosporium* isolates were as a rule moderately to weakly pathogenic, and that most of the *Fusarium* isolates were only weakly pathogenic to wheat plants in the seedling stage. Some isolates of each pathogen exhibited extreme virulence, but judging from the results on seedling plants, virulent strains were rather rare in the fields studied. On mature plants both fungi showed about equal degrees of virulence, which was on the whole weak, and the results were not considered significant for the purpose of the study. Isolates having a greater degree of virulence were obtained from certain fields than from others. In view of the great susceptibility of seedling plants in sterilized re-infested soil and the variable results, presumably caused by association effects of contaminants of the soil in open pot culture, it was concluded that the object of the study could not be attained by means of data based on the seedling stage, or by the technique employed. The possibility of significant results being secured in sterilized re-infested soil, protected from contamination, and based only on mature plants, is discussed in relation to the root-rot problem.

### B. 22.13. RELATION OF THE ASSOCIATION OF BACTERIA AND FUNGI TO THE PATHOGENICITY OF ROOT-ROTTING FUNGI

*In charge:* G. B. Sanford; *Laboratory:* Edmonton, Alta.

Sanford, G. B., and W. C. Broadfoot. Studies of the effects of other soil-inhabiting micro-organisms on the virulence of *Ophiobolus graminis* Sacc. Sci. Agric. *11:* 512-528. 1931.

A study has been made of the effects of the association of fungi and bacteria and their filtrates on the pathogenicity of *O. graminis* on wheat seedlings grown in sterilized soil. This study involved 26 cultures of fungi and 40 cultures of bacteria, nearly all of which were isolated from the soil. Data are given to show that 6 living cultures of fungi and 15 living cultures of bacteria suppressed the pathogenicity of *O. graminis* to a degree varying from almost zero to a 10 per cent infection rating, this being the range arbitrarily set for the control class. Seven cultures of fungi and 8 cultures of bacteria gave intermediate control, which class indicated an infection rating ranging from 10 to 20 per cent. The remaining cultures giving less protection than this were placed in the no control

class. The data support the view that the toxicity of the living cultures or of their filtrates was the chief factor in suppressing the virulence of the pathogen. The data show that many soil-inhabiting fungi and bacteria are clearly effective in suppressing the pathogenicity of *O. graminis* in soil culture.

Broadfoot, W. C. Studies on foot and root-rot of wheat. II. Cultural relationships on solid media of certain micro-organisms in association with ***Ophiobolus graminis*** Sacc. Can. Jour. Res. *8:* 545-552. 1933.

The antagonistic and compatible growth relationships of 66 cultures of bacteria and fungi, most of which were from the soil, towards *O. graminis* on potato dextrose agar and Molisch's salt peptone agar, were compared with the effect of each on the virulence of this pathogene on wheat seedlings in open pot culture. Of the 21 cultures which controlled the virulence of *O. graminis* in the soil, only 15 of these were antagonistic on potato dextrose agar, while of the 45 cultures which gave intermediate or no control, 17 were compatible and 28 were decidedly antagonistic. From data secured indirectly, the antagonism or compatibility of the micro-organisms toward *O. graminis*, observed on potato dextrose agar, did not seem to depend on active alkali or acid more than on other metabolic products. The study apparently demonstrates that the growth reaction of various micro-organisms and *O. graminis*, associated on the two solid media used, is not a reliable indication that the same micro-organism will or will not suppress the virulence of this pathogen on wheat in soil in open pot culture.

Sanford, G. B. Some soil microbiological aspects of plant pathology. Sci. Agric. *13:* 638-641. 1933.

The role of other soil-inhabiting micro-organisms in affecting the occurrence of certain important soil-borne diseases, including the root-rots of cereal crops, common scab, and stem canker of potatoes are discussed in the light of experimental evidence.

### B. 22.17. HISTOLOGICAL STUDY OF ROOT-ROTS OF WHEAT DURING THE POST-SEEDLING STAGE

*In charge:* G. B. Sanford; *Laboratory:* Edmonton, Alta.

Robertson, H. T. Maturation of foot and root tissue in wheat plants in relation to penetration by ***Ophiobolus graminis***. Sci. Agric. *12:* 575-592. 1932.

The morphological changes associated with the aging of the tissue in the roots and base of wheat plants and penetration by *O. graminis, Helminthosporium sativum* and *Fusarium* sp. were examined, with particular reference to *O. graminis*. Lignified tissues increased with advancing age, reaching a maximum in about 40 days in pot culture. Such increase occurred chiefly in the xylem, pericycle, fibres of the vascular bundle sheaths and subepidermal layers of the cortex, which became much thickened with age. Increases in lignification was coincident with a marked falling off in infection by *O. graminis* after 40 days under greenhouse conditions, and appeared at times to prevent further progress of the root-rotting fungi. Penetration of the crown, which usually occurs before marked lignification takes place, invariably appears to be from the subcoronal internode and particularly from the crown roots, "Lignitubers," which appear to be growth reactions of the cell wall, are commonly associated with penetration by *O. graminis*, but similar structures were not observed in the case of *H. sativum* or *Fusarium* sp. Discoloration of the base or roots of wheat plants are frequently caused by drought. Penetration by *O. graminis* usually may be identified by histological methods, but this appears to be impossible in the case of *H. sativum* and *Fusarium* sp.

Tyner, L. E. Studies on the effect of environmental factors on the pentosan content of wheat plants in relation to foot-rot. Proceedings World's Grain Exhibition and Conference, Regina, Vol. II.

According to qualitative and quantitative chemical analyses of the plant tissue of wheat, the pentosan content was greater at the higher light intensities. No difference was noted regarding soil temperature, but an inverse relation existed regarding soil moisture. The relation of pentosan content to natural resistance is being studied.

### B. 22.19. STUDIES ON THE PATHOGENICITY OF ROOT-ROTTING FUNGI

*In charge:* F. J. Greaney and J. E. Machacek; *Laboratory:* Winnipeg, Man.

Many different fungi, including species of *Fusarium, Helminthosporium, Alternaria, Pythium,* and *Rhizoctonia,* have been isolated from diseased basal parts of cereal plants collected from fields in Manitoba during the last three years. The pathogenicity of these fungi to cereals has been studied. Considerable variability in the pathogenicity of these fungi was observed. Of the various species of *Fusarium* studied, *F. culmorum* (W.G. Sm.) Sacc. was the most pathogenic. A wide range of pathogenicity was also observed among the different strains of *Helminthosporium sativum* P., K., and B.

### B. 22.21. DOES THE WHEAT PLANT BECOME MORE SUSCEPTIBLE TO THE FOOT-ROTTING FUNGI WITH INCREASING AGE?

*In charge:* G. B. Sanford; *Laboratory:* Edmonton, Alta.

Broadfoot, W. C. Studies on foot and root-rot of wheat. I. Effect of age of the wheat plant upon the development of foot and root-rot. Can. Jour. Res. *8:* 483-491. 1933.

Studies were made to determine whether, in sterilized inoculated soil, Marquis wheat plants became more or less susceptible during the post-seedling stage to *Ophiobolus graminis, Helminthosporium sativum,* and *Fusarium culmorum.* While it was found that the plants in the seedling stage were more susceptible than at later stages, there was, with the technique used, no evidence that the plants become more or less susceptible during the post-seedling stage. The reasons for indefinite evidence on this important question are given. In sterilized soil, in open pot culture, inoculum of *O. graminis* was definitely more virulent when alone than when mixed singly or in combination with *H. sativum, F. culmorum* or *Leptosphœria herpotrichoides.* The virulence of all pathogens mentioned decreased progressively in sterilized soil, the greatest decrease taking place during the first 40 days, after which they were only slightly pathogenic and at the end of 120 days inoculum of *O. graminis* was practically impotent. The virulence of the inoculum when added to unsterilized soil was greatly reduced in contrast with that in sterilized soil, and after 10 days it was practically at a minimum. These results emphasize the necessity of protecting inoculated sterilized soil against contamination by other micro-organisms in critical studies made in soil. They also throw light on the much recognized difficulty of producing foot-rot in the field by prepared inoculum added to such soil.

### B. 22.23. STUDIES ON THE EFFECTS OF ASSOCIATION ON SOME ROOT-ROTTING ORGANISMS

*In charge:* J. E. Machacek and F. J. Greaney; *Laboratory:* Winnipeg, Man.

Greaney, F. J., and J. E. Machacek. Studies on the control of root-rot diseases of cereals caused by *Fusarium culmorum* (W.G. Sm.) Sacc. and *Helminthosporium sativum* P., K., and B. II. Pathogenicity of *Helminthosporium sativum* as influenced by *Cephalothecium roseum* Corda in greenhouse pot tests. (Accepted for publication, Scientific Agriculture).

In lesions on diseased crowns and roots of cereals several different fungi were usually found to occur, although it frequently happened that among diseased material collected in a field a single fungus predominated. In the case

of discoloration of the seed in wheat, however, only a single fungus could be recovered from any individual kernel, although the presence of any one of several fungi would produce the same symptoms. These types of association were studied in various ways. The experimental results, on the whole, indicated that the pathogenicity of root-rotting fungi is reduced when saprophytic fungi are associated closely with them, and that several degrees of tolerance or antagonism may be found. The production by the saprophyte of a substance toxic to the pathogen, whereby spore germination and growth mycelium in the latter is reduced or prevented, appears to be a large factor in the reduction of disease on cereal seedlings grown in soil containing a mixture of parasite and saprophyte.

B. 22.24. THE INFLUENCE OF ENVIRONMENTAL FACTORS ON THE PATHOGENICITY AND CULTURAL CHARACTERISTICS OF CERTAIN SPECIES OF ROOT-ROTTING FUNGI

*In charge:* F. J. Greaney and J. E. Machacek; *Laboratory:* Winnipeg, Man.

(1) Greaney, F. J., and J. E. Machacek. The production of a white fertile saltant of *Helminthosporium sativum* by means of ultra-violet radiation. Phytopath. *23:* 379-383. 1933. (2) Machacek, J. E., and F. J. Greaney. The effect of mechanical seed injury on the development of foot-rot in cereals. Can. Jour. Res. *8:* 276-281. 1933.

Common root-rot, caused by *Fusarium culmorum* (W.G. Sm.) Sacc. or *Helminthosporium sativum* P., K., & B., was found to develop best at about 30°C. The disease developed, however, at a considerably lower temperature. Greenhouse and field experiments have clearly demonstrated that mechanical injury to the seed of cereals promotes the development of seedling blight and root-rot in the crop, often causing considerable reductions in yields. Exposure of cultures to ultra-violet light has been found to affect the rate of growth, cultural characters and the frequency of saltation in *H. sativum*. A fertile albinistic strain of *H. sativum* was thus produced. This strain was found similar to the parent in pathogenicity.

B. 22.25. A STUDY OF SEED TROUBLES IN RELATION TO ROOT-ROT OF CEREALS

*In charge:* P. M. Simmonds; *Laboratory:* Saskatoon, Sask.

Mead, H. W. Studies of methods for the isolation of fungi from wheat roots and kernels. Sci. Agric. *13:* 304-312. 1933.

The "Washer" method of treatment for isolations from roots and seeds gave consistently good results. Saponin solutions and alcohol were used in conjunction with sterile water in the washer and they facilitated wetting of the material previous to washing. Hydrogen peroxide permitted good growth from roots and seeds but the original strength of the solution was difficult to maintain. Calcium hypochlorite, when freshly made, was satisfactory for isolation purposes, but the time of treatment (20 minutes) was not long enough to give complete sterilization of the seeds. Mercuric chloride in water or alcohol was not completely satisfactory as a disinfectant for isolation work with roots and seeds but it effected very good sterilization of the seeds and did not injure their germinative capacity seriously. One-hundredth normal silver nitrate solution was found to be of no use for isolation purposes, but it proved very satisfactory for the preparation of sterile seedlings.

Routine examinations of samples of cereal seeds sent in were conducted. Several methods were devised for the examination of seed to determine the presence of disease-producing organisms or other pathological evidence. Most of the foreign wheat samples sent in for the World's Grain Exhibition, Regina, were examined. From one sample spores of *Urocystis Tritici* were obtained. Some preliminary histological studies of discoloured barley seeds were undertaken. A *Helminthosporium* species frequently isolated from barley seed is being studied.

## B. 22.26. METHODS OF FOOT-ROT CONTROL IN CEREALS

*In charge:* J. E. Machacek and F. J. Greaney; *Laboratory:* Winnipeg, Man.

Machacek, J. E., and F. J. Greaney. Studies on the control of root-rot diseases of cereals caused by *Fusarium culmorum* (W.G. Sm.) Sacc. and *Helminthosporium sativum* P., K., and B. III. Effect of seed treatment on the control of root-rot and on the yield of wheat. (Accepted for publication, Scientific Agriculture).

Several methods for the control of cereal root-rot diseases were investigated, including (1) the selection of resistant varieties, (2) the application of fungicides to the seed and the growing plant, (3) the application of fungicides to the soil, and (4) the use of fertilizers as plant-growth stimulants. The first and fourth methods appear to be the most promising. The application of fungicides to the seed is of some value as it protects the seedling from attack by soil fungi, while the application of fungicides to the soil, although it has yielded very promising results, appears to be too costly for general use in Western Canada.

## B. 22.27. MISCELLANEOUS STUDIES IN THE ROOT-ROT PROBLEM OF CEREALS

*In charge:* P. M. Simmonds; *Laboratory:* Saskatoon, Sask.

Simmonds, P. M. and B. J. Sallans. Further studies on amputation of wheat roots in relation to diseases of the root system. Sci. Agric. *13:* 439-448. 1933.

Seminal root amputations during the seedling period are injurious as indicated by a reduction in yield and a tendency towards delayed maturity. The severance of the subcrown internode during this time is likewise harmful. Crown root amputations on the other hand cause little reduction in yield but appear to encourage the maturing processes. During the seedling period and up to about midseason the seminal roots appear to be most important. Amputations of these cause severe injury early in the season with decreasing severity as the operations are made later. They constitute during this period the chief absorbing system. The reactions caused by crown root amputations are quite the opposite, with the severest injury after midseason, when apparently these roots become the principal absorbing system. Crown root amputations, however, just before maturity are less injurious than those made just previous to that time. At midseason the seminal and crown root systems are of equal importance. The potentialities of the wheat plant to replace amputated crown roots are well demonstrated when crown roots are cut off at weekly intervals. Furthermore the plant may produce seed when dependent almost entirely upon the seminal roots. The interpretation of some of the results in their application to a better understanding of root diseases is briefly discussed.

Simmonds, P. M. and B. J. Sallans. Some observations on the growth of Marquis wheat with special reference to root development. (Accepted for publication, Proceedings World's Grain Exhibition and Conference, Regina, Vol. II.).

Results of a study of the growth of Marquis wheat at Saskatoon and Indian Head during the seasons of 1931 and 1932, are given. It is shown that dry weather interfered noticeably with growth during the period of investigation. In 1931 the data on yield show a distinct reduction and general growth features reflect the same reaction. In 1932 the yield was below normal but much better than for 1931. Records are given on the increase in height, the number of culms and the number of roots along with supplementary notes. Particular attention was given to the study of root development. It is shown that the general mode of root growth was the same for each location each season. The seminal root system was well developed while the crown root growth was feeble. The maximum penetration for seminal roots was slightly over three feet. Plants grown free from competition show a well developed crown root system. The plants receive, it would appear, a great deal of support from the seminal system especially during dry periods.

The work was continued during the summer of 1934 when the root systems of wheat plants attacked by root-rots were excavated and studied. Dr. R. C. Russell assisted in this investigation. Three types of root-rot diseases were studied, common root-rot caused by *Helminthosporium sativum* and *Fusarium* spp., take-all caused by *Ophiobolus graminis* and browning root-rot caused by *Pythium* spp. Diseased and check plants growing under natural field conditions were examined at the seedling stage, at midseason and just prior to maturity. In common root-rot lesions were conspicuous at the crown and adjacent regions; the roots appeared to be only moderately affected. There was a reduction in size of both root and shoot of diseased plants in comparison with their checks and, in so far as this could be measured, a reduction in yield. In the case of take-all root-rot, as the season advanced, the seminal root system of attacked plants was almost invariably destroyed. Later the crown roots were invaded. Frequently diseased plants were bleached and blighted before maturity. In browning root-rot the symptoms (retarded growth, brown and dead lower leaves) were conspicuous during the seedling stage. A laboratory examination of the root system was necessary, however, to reveal the extent of infection. Affected plants were rarely killed. They never completely recovered from the effects of the attack and usually were two weeks or so later in ripening than neighbouring healthy plants. Besides the general weakness caused by the debilitating nature of the disease with resultant loss in yield, the lateness in ripening pre-disposed the plants to rust and frost.

### B. 22.28. STUDIES OF THE ROOT-ROTS OF OATS AND WHEAT CAUSED BY FUSARIUM EQUISETI AND COLLETOTRICHUM GRAMINICOLUM

*In charge:* G. B. Sanford; *Laboratory:* Edmonton, Alta.

Sanford, G. B. ***Colletotrichum graminicolum*** (Ces.) Wils. as a parasite of the stem and root tissues of *Avena sativa*. (Accepted for publication, Scientific Agriculture).

Field symptoms of a root-rot of oats (*Avena sativa*), which is common in certain parts of Alberta, were described, and the disease reproduced, from an isolate from affected field plants, under greenhouse conditions. A pathohistological study of tissue of seminal roots, underground portion of the stem, adventitious roots, crown and culm revealed extensive penetration, and the phenomena for each case were outlined. With the exception of a transient compatibility of host and pathogen, there is complete and early collapse of the cells of the cortex and endodermis, in seminal roots and rhizome, with attendant disintegration of the hyphae. The cells of all mechanical and conducting tissue are penetrated and, as a rule, extensively plugged, but the hyphae do not disintegrate. The evidence is that the early browning of the leaves and stunting of the plants described is caused mainly, if not wholly, by the practical destruction of the seminal roots and severe injury to the stem below ground level. The tendency toward recovery of affected plants is coincident with the development of adventitious roots, which, as a rule, are not severely penetrated.

## Other Cereal Disease Projects: Project Group No. 23.00

### B. 23.02. MAINTENANCE OF FUNGOUS DISEASES IN FIELD PLOTS FOR EXPERIMENTAL PURPOSES

*In charge:* F. J. Greaney and J. E. Machacek; *Laboratory:* Winnipeg, Man.

Greaney, F. J. and J. E. Machacek. Studies on the control of root-rot diseases caused by ***Fusarium culmorum*** (W.G. Sm.) Sacc. and ***Helminthosporium sativum*** P., K., and B. I. Field methods with root-rot diseases. (Accepted for publication, Scientific Agriculture).

Several methods of introducing root-rotting fungi into field soil have been tested. For *Fusarium culmorum* (W. G. Sm.) Sacc., the best results were ob-

tained when the spores of the fungus were applied to the seed grain before seeding, but for *Helminthosporium sativum* P. K. and B., the application of spores to the seed combined with the placing of actively-growing mycelium into the soil gave the greatest amount of disease. The study of these methods emphasized the value of correct plot arrangement and the application of modern statistical methods to the interpretation of field results.

The process of selecting and breeding strains of cereals resistant to root-rot are being continued in co-operation with the Cereal Division. The results have been very encouraging, and they indicate that significant differences exist between the reactions of wheat varieties to common root-rot.

### B. 23.03. EFFECT OF FERTILIZERS ON THE INCIDENCE AND SEVERITY OF CEREAL DISEASES

*In charge:* F. J. Greaney and J. E. Machacek; *Laboratory:* Winnipeg, Man.

The results of field experiments designed to study the influence of different manurings on the development of root-rot diseases caused by *Fusarium culmorum* (W. G. Sm.) Sacc. and *Helminthosporium sativum* P. K. and B. on wheat have shown that nitrogeneous fertilizers lengthen the growth period of Marquis wheat from 3 to 7 days, while applications of superphosphate hasten maturity. In general, the use of phosphatic and nitrogeneous fertilizers induced early, rapid growth, and resulted in a vigorous root development. The least amount of root-rot occurred in plots having a complete fertilizer (N.P.K.), where growth was most vigorous. Potassium and phosphorus when applied singly reduced the amount of leaf rust infection on wheat, while the development of leaf rust was apparently unaffected by applications of nitrogen. The severity of stem rust was increased by nitrogeneous fertilizers.

### PSEUDO-BLACK CHAFF OF REWARD WHEAT

*In charge:* W. C. Broadfoot and H. T. Robertson; *Laboratory:* Edmonton, Alta.

Broadfoot, W. C., and H. T. Robertson. Pseudo-black chaff of Reward wheat. Sci. Agric. *13:* 512-514. 1933.

It has been observed that the glumes of Reward wheat may often be discoloured in a manner, which, upon superficial examination, resembles the true black chaff disease caused by *Bacterium translucens undulosum.* Cases occur where it may be difficult for some to distinguish with certainty whether this discoloration is black chaff or not. The conclusions from a cultural and histopathological study were that the discoloration was not a disease, but a reaction of genetic factors carried by Reward wheat, modified by the environment, especially light.

## DISEASES OF FORAGE CROPS

### Roots: Project Group No. 30.00

### B. 30.01. RESISTANCE OF VARIETIES OF TURNIPS TO CLUB ROOT

K. A. Harrison, Kentville, N.S.

Club root resistance of several strains of swedes and turnips was determined on inoculated soil in 1931. A selection of "The Bruce" was the most resistant turnip. Selections of Herning Strain Bangholm and Wilhelmsberger showed greater resistance than the local Bangholm selections. In 1932 the inoculated area was used by the Experimental Station for testing resistance of selfed lines and in 1933 and 1934 was used by the laboratory in a co-operative experiment with the Fredericton laboratory to test the effect of calomel and corrosive sublimate on club root control.

D. J. MacLeod, Fredericton.

Thirty-six varieties of turnips were tested. Of these only Marienlyst and Yellow Tankard showed satisfactory resistance to club root. Twenty-six selections from commercial varieties and nine crosses developed at the Fredericton Experimental Station in 1929 were also tested. Of these only one cross—the White X Bangholm Sludsgaard—maintained a satisfactory degree of resistance to the disease.

## B. 30.32. THE NATURE, CAUSE, AND PREVENTION OF BROWN HEART IN TURNIPS

Hurst, R. R. Observations on the brown heart disease of turnips. Sci. Agric. *14:* 679-686. 1934.

Turnip brown heart, a physiological disorder, has been under investigation since 1928 when it was found to be responsible for losses amounting to $50,000 in Prince Edward Island alone. Its destructiveness in 1934 showed an increase over previous years.

Typical symptoms may be found in turnips ranging in size from seedlings to large roots. Brown heart is detected only by cutting into the turnip. It is recognized as a well-defined brownish and mottled central area frequently characterized by concentric rings, a condition varying with the intensity of the attack. Freshly cut affected turnips are water-soaked in appearance. Excessive attacks may be associated with a saprophytic rot. When cut longitudinally the affected area is shown to follow the fibrous tissue and to converge towards the base of the turnip. Brown heart turnips have a decidedly bitter taste and when cooked are usually found to be woody. The condition has been reported in Europe as well as in the United States where it is referred to as dark centre, water core and black heart. It has been demonstrated experimentally and otherwise that the presence of lime in the soil favours brown heart. Increases in brown heart in turnips varied in direct proportion to the amount of lime in use. Brown heart is retarded appreciably by applications of manure to turnip land, although it has not been demonstrated that manure alone will accomplish much towards solving the problem where land is abundantly of the brown heart type. Applications of manure at the rate of 40 tons per acre were most beneficial. There has been some evidence, derived experimentally, to show that brown heart increases as the season advances. The presence or absence of the disease is not governed by the chemical reaction of the soil.

Borax proved highly beneficial used at the rate of one pound per acre, and increasingly so up to 15 pounds per acre. On the laboratory plots borax was applied mixed with fertilizer and alone, with no particular advantage to either method. On a commercial basis control was less positive when the borax was mixed with the fertilizer and applied by means of a machine seeder. The quality of turnips improved with increases in borax applications.

MacLeod, D. J., and J. L. Howatt. The control of brown heart of turnips. (Abstract) Sci. Agric. *15:* 435. 1935.

Sodium tetraborate (borax) applied in dry form directly in the drill at the rate of 10 pounds per acre effected satisfactory control of brown heart.

The efficacy of the treatment was not materially affected when applications were made in combination with chemical fertilizer, barnyard manure, ground limestone, sulphur and diatomaceous earth. Calcium fluoride at the rate of 40 pounds per acre interfered with the efficacy of the borax treatment. Applications of sodium chloride favoured the development of brown heart.

Nutritional studies with sand cultures showed that boron is essential to the growth of the turnip. Borax at the rate of 10 pounds per acre did not decrease the yield of turnips and had no apparent effect on a subsequent crop of oats.

Preliminary tests revealed that brown heart affected turnips have a more negative oxidation-reduction potential and less starch than healthy ones. This supports the view that the hydrolysis of carbohydrates is a reduction.

## Clovers: Project Group No. 31.00

### B. 31.02. A STUDY OF THE "DYING BACK" OF ROOTS OF SWEET CLOVER IN WESTERN CANADA

*In charge:* G. B. Sanford; *Laboratory:* Edmonton, Alta.

Sanford, G. B. A root-rot of sweet clover and related crops caused by *Plenodomus Meliloti* Dearness and Sanford. Can. Jour. Res. *8:* 337-348. 1933.

The occurrence, hosts and symptoms of a hitherto undescribed root rot of *Melilotus, Medicago* and *Trifolium,* and the relation of temperature and the reaction of substrate to growth of the pathogen *Plenodomus Meliloti* are discussed, and its pathogenicity demonstrated. It is suggested that the disease be called "brown root-rot." Evidence is that the hosts mentioned are susceptible only during the winter and early spring dormancy stage. Normal roots of sweet clover, when frozen at -4° C. for four days and subsequently kept at 2-3°, 9° and 16° C., did not become susceptible. The brown root-rot disease is distinct from true winter injury resulting from insufficient hardiness to cold. The temperature range for vegetative growth and pycnidia of *P. Meliloti* is from 0° to 27° C., with optimum between 15° and 17° C. Increasingly good growth occurs from 2° C. to optimum temperature. Severe lesions are produced at 2-3°, 9° and 16° C. The optimum pH value for growth in potato dextrose decoction is about 6·2, the other limits being approximately pH 3·2 and 8·2. Soils with an alkaline reaction apparently are unfavourable. The disease is characterized by brown lesions, on or within which are an abundance of black to dark brown pycnidia. These bodies, 0·5 to 2 mm. in longest diameter, may have one or more spore-bearing chambers. Each chamber may have one to several ostioles, through which the one-celled spores, averaging 5·2 x 2·84 μ exude. The hyphae do not bear spores. Dissemination of the pathogen by seed would not seem to be of practical importance. Control by crop sanitation is recommended, at least until more resistant varieties are available.

### B. 31.03. A STUDY OF THE DEVELOPMENT OF CORK IN ROOTS OF TRIFOLIUM, MELILOTUS, AND MEDICAGO AS AFFECTED BY TEMPERATURE, HUMIDITY, TIME, VARIETY, ETC., IN CONNECTION WITH RESISTANCE TO PATHOGENIC SOIL FUNGI

*In charge:* G. B. Sanford; *Laboratory:* Edmonton, Alta.

Cormack, M. W. On wound cork in roots of *Medicago* and *Melilotus.* (Accepted for publication in Proceedings World's Grain Exhibition and Conference, Regina, 1935.).

The incidence of wound cork in roots of *Medicago* and *Melilotus* was studied, with particular reference to the influence of the temperature and moisture content of the soil, the age, condition, and variety of the plants. The rapidity of wound cork formation was greatly influenced by soil temperature, with which it was directly correlated. Wound cork was completely inhibited at 1° C., formed in eighteen days at 9° C., and in eight days at 18° C. Dry soils were slightly more favourable than moist soils for wound cork development, but the difference was not very significant in these studies. Wound cork formed more rapidly in roots of young plants of *Melilotus* during the first season, than in roots of over-wintered plants during the second season. This difference was not apparent in *Medicago.* Wound cork was retarded in roots of *Medicago* and *Melilotus* that had been frozen, and did not form in non-growing roots. There was no

significant difference among varieties of *Medicago* and *Melilotus* in ability to form wound cork, but marked variability occurred in roots in different plants of the same variety.

Cormack, M. W. On the invasion of roots of *Medicago* and *Melilotus* by *Sclerotinia* sp. and *Plenodomus Meliloti* D. and S. Can. Jour. Res. *11:* 474-480. 1934.

The invasion of roots of *Medicago* and *Melilotus* by *Sclerotinia* sp. and *P. Meliloti* was studied, with particular reference to the effectiveness of wound cork in arresting the progress of these pathogens. Both pathogens are apparently capable of penetrating through the uninjured external cork covering of the roots and also through any subsequently formed wound cork layers. Killing of the root tissues and retardation of wound cork development in advance of hyphal invasion was caused by both pathogens. No explanation can at present be offered as to why the advance of *P. Meliloti* is checked and that of *Sclerotinia* sp. is definitely slower after good growth begins in the spring.

B. 31.05. A STUDY OF NATURAL RESISTANCE IN VARIETIES OF SWEET CLOVER AND ALFALFA TO VARIOUS ROOT ROTTING FUNGI

*In charge:* G. B. Sanford; *Laboratory:* Edmonton, Alta.

Sanford, G. B., and M. W. Cormack. On varietal resistance of *Medicago* and *Melilotus* to root-rots caused by *Sclerotinia* sp. and *Plenodomus Meliloti* D. and S. (Accepted for publication in Proceedings World's Grain Exhibition and Conference, Regina, 1935.)

In general, varieties of both alfalfa and sweet clover are distinctly more susceptible to *Sclerotinia* and *P. Meliloti* immediately following the winter dormancy period than during the summer period. Alfalfa is much more resistant than sweet clover is to the culture of *Sclerotinia* used, either following winter dormancy or during summer. With regard to *Sclerotinia* sp. the data indicate that certain varieties of alfalfa and sweet clover are more resistant than others are, and this was more definite in the case of sweet clover than with alfalfa, although *Medicago* plants seemed to possess marked resistance. Varieties of sweet clover belonging to the *M. officinalis* group appeared less susceptible than those of the *M. alba* group. Maccor and two strains of Alpha were very susceptible. Definite information regarding resistance to *P. Meliloti* was not obtained due to methods.

## Other Forage Crops: Project Group No. 32.00

B. 32.01. SCLEROTINIA SCLEROTIORUM WILT OF SUNFLOWERS

*In charge:* K. A. Harrison; *Laboratory:* Kentville, N.S.

Field experiments were continued during 1931 using applications of Bordeaux dust, sulphur and 10 per cent calomel to control the disease. Results were indefinite because of the low percentage of infection on all plots.

Tests to obtain the most resistant variety were made on 100 pure lines of sunflowers. A number were free of the disease but further tests were not possible because of lack of seed. Severe *Septoria* leaf spot eliminated a number of the lines.

Eighteen of sixty-nine sclerotia stored since 1926 (six years) produced mycelium. The fungus mycelium was subjected to pot culture studies. It was definitely proved that the mycelium would live saprophytically in sterilized, but not in unsterilized, soil. It is assumed that other soil organisms inhibit its growth.

## DISEASES OF ORNAMENTAL PLANTS

### Bulbs, Rhizomes, etc.: Project Group No. 40.00

#### B. 40.01. RESEARCH ON DISEASES AFFECTING GLADIOLI

*In charge:* A. J. Hicks; *Central Laboratory:* Ottawa

Field experiments to date indicate that diseased and thrips-infested corms, treated before planting by soaking in a 1-1,000 solution of corrosive sublimate for 3 days, produce strong plants and give an increase of over fifty per cent in the number of corms harvested.

In addition thrips were fully controlled and the total number of corms showing disease lesions after winter storage was a little over three per cent of the whole.

As far as is known, gladiolus corms have never before been treated to prolonged soaking in a 1-1,000 solution of corrosive sublimate. The results of the experiment conducted here indicate that corms are capable of surviving even more stringent treatment than the 3-day soaking referred to above. This being the case, it is logical to assume that a 3-day soak in 1-1,000 corrosive sublimate would be much more effective in the control of disease than the 1-hour and 3-hour treatments which are normally given gladiolus corms before planting.

The experiment was repeated in 1934. In addition to using 1-1,000 corrosive sublimate, Calogreen, a fungicide with a calomel base and calcium hypochlorite were used. Owing to the fact that corms cannot be peeled until late in the winter detailed results of the 1934 experiment are not yet available. A cursory examination of the corms, however, reveals that the results of the experiments are similar to those obtained in 1933.

Drayton, F. L. The gladiolus dry rot caused by *Sclerotinia Gladioli* (Massey) n. comb. Phytopathology *24:* 397-404. 1934.

The dry rot disease of gladioli has been known for several years and its importance appreciated. The causal fungus apparently developed no functional spores and hence was named *Sclerotium Gladioli* by Massey in 1928.

A sexual mechanism has now been discovered that involves the microconidia and the pilose receptive structures developed from a stroma. The sexual interaction of these yields apothecia of the *Sclerotinia* type. The life cycle of the fungus is, therefore, now completely known and its taxonomic relationship can be established.

The historical events of importance in connection with this disease and its pathogen are given.

The resistance and susceptibility of several common ornamental plants are mentioned and a number of new suscepts are recorded. The new combination *Sclerotinia Gladioli* (Massey) is proposed and a detailed emended diagnosis is given.

#### B. 40.02. RESEARCH ON DISEASES AFFECTING BULBS GENERALLY

*A Fungus Occurring on Narcissus Bulbs*

*In charge:* F. L. Drayton; *Central Laboratory:* Ottawa

This fungus was isolated from narcissus bulbs received in Canada from Holland, from material collected at the U.S. Department of Agriculture's Field Station at Babylon, Long Island, and two cultures were received from Dr. Weiss of Washington, D.C.

As far as is known, it does not initiate any disease of the growing plants or the bulbs, but develops sclerotia, 1 to 1·5 mm. in diameter, on the outer papery scales of the bulbs.

In the course of experiments on pathogenicity, narcissus bulbs were planted in pots of soil artificially infested with the fungus growing on wheat grains. While these pots were in a rooting cellar, apothecial fundaments developed from the surface of the soil. Later, when the pots were transferred to a greenhouse, these structures developed into mature, stipitate apothecia, with disks 3 to 4 mms. in diameter. Single ascospores germinated readily, and the culture obtained was identical with those of the original isolates. The apothecia, asci, and ascospores are typical of those found in the genus *Sclerotinia.*

This fungus has never been described, and when some points in connection with its sexual mechanism have been cleared up, it will be named and described.

### *Tulip Botrytis*

*In charge:* W. Newton; *Laboratory:* Saanichton, B.C.

Newton, W., and R. J. Hastings. ***Botrytis Tulipae*** (Lib.) Lind. *I.* The production of conidia as influenced by various factors. Sci. Agric. *11:* 820-824. 1931.

Barley and corn meal and nitrate synthetic agars produced good crops of mycelia but no conidia. Tulip extract and pulp agar, and potato disks produced abundant crops of both mycelia and conidia. In general, media unfavourable for the growth of mycelia induced conidia production. On synthetic media in which the carbon was supplied as tartrate, citrate, acetate, and oxalate salts, the mycelial growths were sparse and abnormal, and relatively abundant crops of conidia were produced.

Low temperatures favoured the production of conidia. Above 25° C. conidia rarely were produced.

Media made unfavourable for mycelial growth by increasing or decreasing the hydrogen ion concentration, became favourable for the production of conidia. At the optimum for mycelial development, pH 4·9, no conidia were produced, but abundant conidia appeared when the initial pH was adjusted to pH 2·5 and pH 8·1.

The production of conidia at 5° C. was favoured by high relative humidities, ninety per cent to one hundred per cent, but at 20° C., lower humidities, around seventy-three per cent, were more favourable.

The conidia upon cultures grown at 20° C., were less variable in size but no significant relationship was found between size and temperature.

Newton, W., R. J. Hastings, and J. E. Bosher. ***Botrytis Tulipae*** (Lib.) Lind. *II.* Bulb dips. Sci. Agric. *13:* 110-113. 1932.

The ratio of the " dosis tolerata " to " dosis curativa " with respect to a one hour dip treatment indicates that mercuric chloride and uspulun are superior to semesan and formalin and that copper sulphate and potassium resin polysulphide are unsuitable dips, the ratios being minus values,

In a greenhouse experiment, mercuric chloride, semesan and uspulun increased the resistance of shoots against soil-borne infection, but formalin exerted no such residual effect. A subsequent field experiment verified this conclusion. Mercuric chloride, semesan and uspulun dips reduced the incidence of soil-borne infection to a greater degree than the formalin dip and a number of dust treatments. Deep planting, eight inches compared with four, lowered the incidence of infection, but the bed compared with the flat system of planting exerted little significant effect.

### *Treatment of Bulbs for Eelworm*

*In charge:* W. Newton; *Laboratory:* Saanichton, B.C.

Newton, W., R. J. Hastings and J. E. Bosher. Sterilization of narcissus bulbs by immersion in silver nitrate-potassium cyanide solution in vacuo. Can. Jour. Res. *9:* 31-36, 1933.

Through the use of a dye solution, evidence was obtained that a liquid disinfectant may be forced into the narcissus bulb parts invaded by nematodes and fly larvae by immersion in vacuo.

An investigation of the lethal properties of solutions against nematodes and their influence upon bulb growth led to the selection of a silver nitrate solution as a promising disinfectant, but owing to instability of silver nitrate in the presence of chlorides and other substances in tap water and in dirt clinging to bulbs, its use had no commercial possibilities. However, when a silver salt was combined with potassium cyanide in the ratio of 1 to 3 by weight, an effective solution of satisfactory stability was obtained.

A solution of silver nitrate 0·05 per cent and potassium cyanide 0·15 per cent by weight, forced into narcissus bulbs by an evacuation process, effectively destroyed bulb nematodes and bulb fly larvae without significant injury to bulb growth under greenhouse conditions.

Field tests with bulbs treated in silver nitrate-potassium cyanide solutions resulted in the reduction of infection from 26·8 to 1 per cent, a 96 per cent control, and no evidence of injury in the foliage or bloom was detected.

Hastings, R. J., J. E. Bosher, and W. Newton. The nematode disease of narcissi and crop sequence. Can. Jour. Res. *8:* 101. 1933.

The characteristic symptoms of nematode infection appeared in barley, oat and wheat seedlings as the sequence of planting the seed in soil infested with the nematode species, *Tylenchus dipsaci* Kühn, from narcissus bulbs. The severity of the infection was greater in barley and oats than in wheat.

Hastings, R. J. The treatment of narcissus bulbs with hot water and the time required to kill the bulb nematode at 110-112°F. Gardeners' Chronicle *94:* 313-314. 1933.

An investigator in Great Britain recently claimed that the bulb nematodes were killed when subjected to a heat treatment at 110° F. for 17 minutes, and suggested that the three hour standard hot water treatment be shortened to two hours. This paper is a criticism of this recommendation on the grounds that in experiments in this laboratory, naked pre-adult larvae of the bulb nematode survived a treatment of 2 hours at 110-112° F., hence a minimum immersion period of three hours at 110-112° F. appears to be required.

Hastings, R. J. and J. E. Bosher. The inspection of narcissus plantations for nematode infestations, U.S.D.A. Plant Disease Reporter *16:* 42-43. 1934.

The " spikkels " are the best evidence of nematode infestation in narcissus. They are mostly found close to ground level on the leaves and scapes, and the best time to search for them is on a dull day when the plants are nearly full grown. Data are presented in support of this conclusion, for an inspection on March 12 revealed only 6·2 per cent of "spikkeled" plants, while on April 4, 51 per cent were found.

Hastings, R. J., and W. Newton. The effect of temperature upon pre-adult larvae of the bulb nematode *Anguillulina dipsaci* (Kühn 1858) Gerv. & V. Ben. 1859, in relation to time and moisture. Can. Jour. Res. *10:* 793-797. 1934.

In a moist environment, a minimum exposure of 120 minutes at 110-113°F. is required to destroy pre-adult larvæ of the bulb nematode, but progressively shorter exposures are required as the temperature is raised. At 116·5-118·5°F. the lethal exposure is 60 minutes, and at 118·5-120°F. an exposure of 30 minutes is required.

In a dry environment, exposure of 150 minutes to temperatures as high as 140°F. are not lethal to pre-adults and the heat treatment does not affect their ability to induce the characteristic symptoms of infestation in barley seedlings.

The pre-adults are more resistant to heat than any other stage in the life history of the nematode. The data suggest that the ineffectiveness of the standard hot water treatment when applied late in the season is due to the fact that the major development of pre-adults takes place after the bulbs are lifted, and also because the masses of dormant pre-adults are often well isolated from the moisture of the bath by the bulb scales and corky basal plate, and are

more resistant to heat in a dry compared with a moist state. It is recommended that the hot water treatment be employed not later than four weeks after lifting, when the lifting is done as soon as the foliage dies down.

A pre-soak is suggested as a possible means of increasing the effectiveness of the standard hot water treatment.

Hastings, R. J. and W. Newton. The influence of a number of factors upon the activation of dormant or quiescent bulb nematodes, *Anguillulina dipsaci* (Kühn 1858) Gerv. & V. Ben. 1859. Proceedings Helminth. Soc. of Wash. *1:* 52-54. 1934.

When dormant pre-adult nematodes are suspended in tap water a much smaller percentage become motile when equal volumes are placed in 14 mm. test tubes compared with 54 mm. syracuse dishes. Further evidence that the amount of the surface of the suspension exposed to air is an important factor in the induction of motility was obtained by the discovery that the recovery of motility in populations progressively decreased with the depth of the solution in which the dormant pre-adults were suspended.

The suspension of pre-adults in an infusion of rotten bulb tissue markedly inhibited the recovery of motility but the inhibition was much less pronounced when the suspensions were maintained in shallow dishes. When air was replaced with carbon dioxide gas over water suspensions in syracuse dishes, the recovery was entirely prevented. The carbon dioxide appeared to injure the nematodes, for, after a 20 hour exposure a transfer to a normal atmosphere did not induce a normal recovery.

Little evidence was obtained that prolonged contact with an infusion of rotten bulbs has a similar effect.

Newton, W., R. J. Hastings, and J. E. Bosher. Nematode infestation symptoms on barley as a means of determining the efficiency of chemicals as lethal agents against *Tylenchus dipsaci* Kühn. Can. Jour. Res. *9:* 37-42, 1933.

Barley is suggested as a detector crop for the presence of living nematodes, *Tylenchus dipsaci,* in soil, owing to rapid development of nematode disease symptoms in barley.

A satisfactory source of inoculum consists of the white masses of coiled nematodes that can be seen when the basal plate is removed from badly diseased narcissus bulbs. These masses remain viable for six months or longer when removed from the bulbs.

Low temperatures and high light conditions favour the development of the nematode disease symptoms in barley seedlings, after nematodes are transferred from a narcissus bulb to autoclaved soil planted with barley. Such barley seedlings were broad-leaved and stocky. Under low light and high temperatures, conditions that favour the development of spindly seedlings, the nematode disease symptoms are inconspicuous or absent.

Few chemicals appear to be lethal to the bulb nematode. Of 100 tested only phenol, silver nitrate, and potassium or sodium bisulphite were lethal at dilute concentrations.

Newton, W., R. J. Hastings, and J. E. Bosher. The control of diseases caused by nematodes. (To be published in the Proceedings of the Fifth Pacific Science Congress, 1933.)

Ethylene dichloride is much more lethal to *Tylenchus dipsaci* than carbon tetrachloride but as a fumigant the latter is included to reduce the fire hazard.

At maximum and relatively low vapour pressures anaesthesia or complete cessation of motility was quickly induced by the vapours of ethylene dichloride and by a mixture of ethylene dichloride and carbon tetrachloride, but at least two hours exposure was required to cause death.

In a 24 hour fumigation period, the lowest lethal concentration was 0·2 cc. ethylene dichloride per liter (15·7 lbs. per 1,000 cu. ft.) and 0·25 cc. of a 3:1 mixture of ethylene dichloride and carbon tetrachloride per liter (21·9 lbs. per 1,000 cu. ft.). This latter amount is approximately 1½ times the charge usually employed as a fumigant against insects.

### *Botrytis Rhizome Rot of Iris*

*In charge:* F. L. Drayton; *Central Laboratory:* Ottawa

Whetzel, H. H. and F. L. Drayton. A new species of *Botrytis* on rhizomatous iris. Mycologia *24:* 469-476. 1932.

A morphological and cultural account of a hitherto undescribed species of *Botrytis*, which is named *B. convoluta* n. sp. Since 1924 it has been observed as the cause of a serious rot of various varieties of rhizomatous iris at Ithaca, N.Y., Washington State, and near Ottawa, Ont. The same fungus has been intercepted by inspectors of the U.S.D.A. Plant Quarantine and Control Administration in shipments of iris plants from France, Germany, England, and Holland.

In the field, affected plants either fail to develop new leaves in the spring, or a few shoots are formed which later turn yellow and die. Pronounced decay of the root system occurs, and the rhizomes are shrivelled and partly or completely rotted.

The sclerotia developed on diseased corms and on artificial media are black and occur in characteristic convoluted agglomerations. The conidia and conidiophores are of the *Botrytis cinerea* type.

Technical descriptions in Latin and English are given.

## Annuals and Biennials: Project Group No. 41.00

### B. 41.02. HOLLYHOCK RUST AND ITS CONTROL

*In charge:* R. R. Hurst; *Laboratory:* Charlottetown, P.E.I.

In 1931 Bordeaux mixture (4-4-40) gave a satisfactory measure of control, although most thorough spraying failed to check the rust entirely. In 1932 Bordeaux-casein mixture gave excellent control of rust, the plants remaining green throughout the growing season. Bordeaux mixture and Bordeaux-casein mixture continued to control rust in 1932 and 1934, the latter being most effective. Lime sulphur spray (1-40) controls the disease but inflicts severe leaf injury. Lime sulphur (1-60) caused some foliage injury but gave good control, especially when applications were continued late into the growing season. Lime sulphur used at the strengths 1-80 and 1-120 were valueless against rust but did not injure the leaves. Copalime liquid gave a fair measure of control. Sulphur dust caused severe leaf injury and failed to check the rust.

In order to combat hollyhock rust successfully, spray applications should be made early in the growing season and continued at 10-day intervals.

A number of hollyhock plants have been found to possess very strong resistance to rust.

### B. 41.04. ASTER WILT AND YELLOWS INVESTIGATIONS IN DISEASE RESISTANCE

*In charge:* D. J. MacLeod; *Laboratory:* Fredericton, N.B.

None of the 55 varieties and strains tested was resistant to yellows. Asters maintained under cotton covered cages remained free from yellows. Asters confined within barriers consisting of cotton mounted on slight wooden frames 4 and 8 feet in height remained practically free from yellows in 1931. Similar barriers failed to hold the disease in check in 1932. A serious and widespread condition resembling yellows was found in carrots and salsify in 1933.

### B. 41.05. ZINNIA WILT

*In charge:* G. E. Woolliams; *Laboratory:* Summerland, B.C.

This is apparently a new disease of zinnia. In the field the disease first appears at about the time the plants are coming into bloom, and newly affected plants continue to appear throughout the remainder of the season. The trouble

is characterized by the sudden wilting of the leaves on a portion or even the whole of the plant. Growth and floral development of the affected parts ceases and death finally ensues. In some cases the disease may be confined to only a part of the plant throughout the whole season; in other cases the disease gradually spreads until the whole plant succumbs. At the time the first wilting appears the roots of affected plants, though apparently normal from the exterior, exhibit a necrosis of the conducting tissues. Later on the whole root becomes blackened and at the ground surface the fruiting bodies of a *Fusarium* may be often found.

Isolations from diseased plants regularly give cultures of a *Fusarium,* and it was found that successful inoculations resulted when the soil temperatures were above 30 degrees C.

## FOREST PATHOLOGY

### Deciduous Trees: Project Group No. 50.00

B. 50.03. HEARTWOOD DECAYS OF POPLAR

*In charge:* C. G. Riley; *Central Laboratory:* Ottawa

On the Petawawa Forest Experiment Station about sixty trees were analysed on six sample plots representing various forest sites. Data were collected for computation of volume of tree and of decay, and detailed descriptive notes regarding the tree, defects, and environment were taken. It is planned to continue this work in 1935.

### Coniferous Trees: Project Group No. 51.00

B. 51.02. WHITE PINE BLISTER RUST IN CANADA

*In charge:* A. W. McCallum; *Central Laboratory:* Ottawa

Field observations during this period have shown that rust has become firmly established in the white pine forests of this country and is slowly but surely causing serious injury, especially to reproduction. For instance, in the country along the Madawaska river, which originally contained magnificent stands of white pine and where now there is excellent reproduction of this species, the disease is widespread both on *Ribes* and pines. All stages of the rust on pine may be seen from young infections to killed trees. This condition can be found in any similar area of white pine in Eastern Canada.

In view of the destructive nature of blister rust, especially as regards young growth, it is gratifying to report that the control of this disease by the eradication of *Ribes* has been undertaken by the Dominion Forest Service on the Petawawa Forest Experiment Station. Following an examination of the station made in May, 1933, a report was submitted upon the conditions found there in regard to blister rust.

The Forest Service appreciated the desirability of taking steps to control the rust and acting upon the recommendations contained in the report undertook in the same year to make a beginning in this work. As this was the first experience of the Forest Service in eradication of *Ribes*, the work was necessarily of an experimental nature, and was done on a small scale. However, during the summer, four square miles of the station was worked over and valuable experience gained. It was found that the number of species of *Ribes* occurring on the station was small and that the number of *Ribes* per acre was also very few. Only three species were found in the natural forest areas, i.e. *Ribes glandulosum, R. Cynosbati* and *R. oxyacanthoides.* On the two square miles of forest land worked over, *Ribes* only averages three per acre. This initial experiment in

eradication of *Ribes* for the control of blister rust should prove to be of the greatest importance, not only in regard to the protection of pines on the Experiment Station, but as an example to other owners of white pine.

### B. 51.03. DECAYS AND OTHER DEFECTS OF JACK PINE (PINUS BANKSIANA LAMB.) IN QUEBEC

*In charge:* C. G. Riley; *Central Laboratory:* Ottawa

Data were collected in all the principal age-classes, forest types and sites on which jack pine occurs in the upper Gatineau watershed. In all, 285 trees on 27 sample plots were analysed. The most common defect in this region is the red stain and white pocket rot commonly attributed to *Trametes Pini* (Thore) Fr. The percentage of affected wood and of infected trees is tabulated by age classes. Other common defects are butt rots, "bayonet crooks" of unknown origin in an extensive 80-year stand, and killing of twigs and leading shoots of younger stands by pitch-mass borers, the larvae of *Petrova* sp. The project is to be continued, to include jack pine throughout its range, as soon as circumstances permit.

### B. 51.05. STUDIES IN PINE RUSTS

*In charge:* C. G. Riley; *Central Laboratory:* Ottawa

The primary objects of the work done to date on this project, are to establish host relationships, and to determine if heteroecism is facultative or not, in certain rusts of *Pinus Banksiana* Lamb. Some two hundred inoculations were made in 1934, including aecial inoculations of pines, the complete results of which will not be known for one or more years. Aecial and pycnial development were observed on about sixty galls caused by *Cronartium cerebrum* (Pk.) H. & L. and *C. pyriforme* (Pk.) H. & L. under natural conditions, and the galls were marked for further observation in subsequent years.

### B. 51.06. DETERIORATION IN INSECT-KILLED SPRUCE IN GASPÉ PENINSULA

*In charge:* A. W. McCallum; *Central Laboratory:* Ottawa

Some preliminary observations on this problem were made in Gaspé in 1932 where the Entomological Branch were making a study of a very serious outbreak of the spruce sawfly (*Diprion polytomum* Hartig). The spruce forests, both black and white, of the whole interior of Gaspé are affected. The new foliage is not eaten until fully grown, and even then, the needles of the previous years are preferred. In regard to the physiological effect upon conifers of the loss of a large proportion of their leaves for successive years, very little is definitely known, but there can be little doubt that if this injury should continue over a period of years, heavy mortality will be the result.

In addition to the sawfly epidemic there is at present in Gaspé an infestation of the eastern spruce bark beetle (*Dendroctonus piceaperda* Hopk.) Damage by this insect is principally confined to white spruce on account of the fact that only large trees are attacked.

The salvage of timber killed either by insects or fire is a matter of considerable importance in Canadian forests. Each year large areas are destroyed by one or the other cause and it is not always possible to take out such timber at once The question of how long it can be left before damage by fungi and insects becomes so extensive that it cannot be profitably logged, is a matter of primary importance. The present killing of trees in Gaspé would seem to provide ideal material upon which to base a study of rate of deterioration, as the history of the killed trees is definitely known. It is planned to begin such a study in 1934.

C. G. Riley.

Paper presented to Annual Meeting, Woodlands Section, Canadian Pulp and Paper Association, Montreal, P.Q., January, 1935. Published as advance reprint from "Proceedings" of this meeting. Also accepted for publication in "Pulp and Paper of Canada."

It has been authoritatively reported that over extensive areas in the Gaspé Peninsula, 46 per cent of the white spruce and 17 per cent of the black spruce have died as the result of bark-beetle attacks. The possibility of salvaging this timber depends largely upon the rate of deterioration due to fungi. Studies conducted in 1934 indicate that two years after death, 0·31 per cent of the merchantable volume of this timber reaches an advanced stage of decay, and that three years after death, 2·96 per cent has reached this condition. Tests conducted by the Forest Products Laboratories of Canada indicate a reduction in yield of sulphite pulp in decayed wood of 28 per cent to 33·5 per cent by volume. Applying the maximum reduction in yield to the volume of decayed wood after three years, (33·5 per cent of 2·96 per cent) the reduction in yield of merchantable volume is shown to be 0·99 per cent. New data will be added after each successive year of deterioration.

## Other Forest Projects: Project Group No. 52.00

### B. 52.02. ARRANGEMENT, INDEXING AND ADDITIONS TO THE COLLECTION OF WOOD-DESTROYING FUNGI

*In charge:* Irene Mounce; *Central Laboratory:* Ottawa

During the years 1931-34, 3,294 specimens were incorporated into the herbarium and 679 specimens sent to various workers. The first two fascicles of Pilat's "Fungi carpathici lignicoli exsiccati" have been received, mounted and indexed, and should prove useful for comparison. We have been fortunate in receiving a large number of specimens from Dr. L. O. Overholts, and from Dr. G. R. Bisby. The latter specimens are duplicates of the ones upon which the records in his "Fungi of Manitoba" are based. Dr. J. H. Faull has been most generous in sharing with this herbarium some five hundred of his Canadian collections of *Polyporaceae,* which were selected as forming particularly interesting or unusual records.

### B. 52.06. PULPWOOD DETERIORATION STUDIES

*In charge:* C. G. Riley; *Central Laboratory:* Ottawa.

(*a*) Deterioration of Pulpwood in Log Jams. (See 15th Ann. Rep., Can. Pulp and Paper Assn., Woodlands Sec., Montreal, Jan. 1933—paper presented to annual meeting). Log jams composed principally of spruce and balsam in the upper Gatineau river, were studied after one and two years duration. It was found that only the exposed logs were seriously decayed, those which were covered by other logs being for the most part well preserved. In the 1-year old log jams, 45 per cent of the surface logs were in an "advanced" stage of decay, 39 per cent of the volume of these being affected. In the 2-year old log jams, 84 per cent of the surface logs were in this condition, 44 per cent of the volume being affected.

(*b*) Deterioration of Pulpwood in Experimental Piles in the Forest. (See paper "Progress Report on Pulpwood Deterioration Studies" presented to Ann. Meet., Woodlands Sec., Can. Pulp & Paper Assn., Montreal, Jan. 1934). A number of one-cord piles of pulpwood, representing four species, treated by different methods and stored under different conditions, are examined annually for the purpose of determining the effects of these factors on rate of deterioration.

(*c*) Paper presented to Annual Meeting, Woodlands Section, Canadian Pulp and Paper Association, Montreal, P.Q., January, 1934. Published as advance reprint from "Proceedings" of this meeting.

Four sets of experimental pulpwood piles made in September, late October, and early December, 1932 and June, 1933, respectively, were examined in November, 1933. At that time decay was either absent or negligible. Sapwood stains were present in some piles. Checking was excessive in September-cut, peeled spruce.

In 1934 the piles were examined again, and measurements and descriptive notes regarding decay were taken. These have not yet been analysed.

## FRUIT DISEASE INVESTIGATIONS

### Pomaceous Fruits: Project Group No. 60.00

B. 60.01. STUDY OF APPLE SCAB DISEASE

*Co-operative*; *Laboratories:* N.S.; N.B.; Que.; Ont.; B.C.

*The Comparative Values of Different Fungicides in the Control of Apple Scab*

*In charge:* G. E. Woolliams; *Laboratory:* Summerland, B.C.

Each year the standard lime sulphur spray, as recommended in the spray calendar, has been compared with new sprays or spray combinations which have shown promise elsewhere of being superior. The following spray materials have been tested—Lime sulphur, Cal-Mo-Sul, calcium monosulphide, sulphur-resin, ferrous sulphate and lime sulphur, cuprous oxide and bentonite clay, lead and calcium arsenate and nicotine sulphate. The value of the following spreaders when added to lime sulphur has been determined: Kayso, fluxit fixator, calcium caseinate, powdered lignin pitch, lethalate and actin. On the whole the standard lime sulphur has given the most efficient control, but the injury caused remains very objectionable. Lime sulphur 1-40 in the pink and 1-80 in the calyx and cover, shows promise of being approximately as efficient, and little spray injury has resulted.

*Spraying and Dusting for Control of Apple Scab*

*In charge:* G. C. Chamberlain; *Laboratory:* St. Catharines, Ont.

With this project attention has been given to modifications of the spray schedule such as the value of various forms of wettable sulphur, half-strength lime sulphur with wettable sulphur and the lime sulphur-iron sulphate mixture, in reducing the spray injury to the foliage and in providing adequate protection against scab infection.

Good control of scab was obtained where lime sulphur 1-40 was used throughout the schedule but this material on some varieties causes considerable foliage injury in the form of dwarfing, distortion and marginal burning which is more marked in some seasons than in others. The addition of four pounds of iron sulphate to lime sulphur 1-40 reduces the extent of foliage injury and gives equal control of scab. Where wettable sulphurs were substituted for lime sulphur 1-40 in the applications following the delayed dormant, though distinctly better foliage was obtained, yet slightly more scab infection resulted as compared to a straight lime sulphur 1-40 schedule. However, the increase in the percentage of foliage infection was not significant in consideration of the much improved foliage on the trees. A schedule in which half-strength lime sulphur (½-40) plus wettable sulphur was substituted for lime sulphur gave generally very satisfactory control and has promise as an alternative spray in the schedule since very little foliage injury follows the use of this material.

*Seasonal Development of Apple Scab*

*In charge:* G. C. Chamberlain; *Laboratory:* St. Catharines, Ont.

The main point of interest in the seasonal development of apple scab in the Niagara Peninsula for the period of 1931-34 was the fact that in 1932 initial ascospore discharge occurred on April 15, the earliest date since records were first taken in 1925, with the initial discharge two weeks in advance of the delayed dormant stage of the host (McIntosh variety). The disease was extremely prevalent, developing rapidly following an active period of discharge when the buds were approaching the pre-pink stage. It is also interesting to note that this year for the first time in this district, scab lesions were observed on the young current year's wood of a few unsprayed McIntosh trees. In 1931 when apple scab was unimportant, initial discharge occurred on May 7 with the host between the pre-pink and pink stage of development. In 1933 initial discharge on April 25 was again in advance of the delayed dormant stage and the disease proved to be quite prevalent especially in poorer sprayed orchards. In 1934 initial discharge on May 9 was a week after the delayed dormant stage and followed the date of the pre-pink spray application. Scab infection in the early season was very unimportant although considerable infection developed late in the season.

*In charge:* J. F. Hockey; *Laboratory:* Kentville, N.S.

The seasonal development of the fungus causing apple scab is of vital importance to the apple orchardists of Nova Scotia. Spraying is influenced by specific information on the condition and stage of development of the fungus. The temperature and precipitation during the three or four weeks preceding the green tip stage of growth of the apple buds have had more influence on perithecial development than during any other period after leaf fall. Severe frosts before autumn defoliation arrested perithecial formation. The period from spore maturity to discharge has varied from one to thirteen days and appeared to be influenced by precipitation alone. Heaviest ascospore discharges have occurred when the mean temperature was 55° F. and precipitation totalled one inch. Slight discharges have been recorded when the temperature was 32° F. Ascospore discharges have extended over periods of from six to twelve weeks.

Three complete cycles of conidial infections occurred in the autumn of 1933 and a fourth infection period caused " storage scab " symptoms to develop on the fruit in storage. The weather from August 24 to October 31 was periodically wet and cloudy and offered favourable environmental conditions for scab development. Fungicidal treatments immediately after harvest, including sulphur and formalin, failed to prevent the appearance of " storage scab " symptoms on the fruit. It was found that eight to twelve weeks' storage of fruit at 32° F. to 36° F. was necessary as an incubation period for storage scab lesions. There was no spread of infection during storage. Symptoms which appeared in storage must have been the result of orchard infections.

*In charge:* C. Perrault; *Laboratory:* St. Anne de la Pocatière, Que.

In 1931 and 1932 liberation of ascopores started May 20 when trees were in the pink stage and ended about the middle of July with maximum intensity during or towards the end of the full bloom period. During the severe winters of 1933 and 1934 the normal development of perithecia has been checked in the orchards of the district.

A small difference was observed in the measurements of *Fusicladium dendriticum* (Wal.) Fel. for the last three years but the difference may be due simply to factors such as temperature and moisture.

*In charge:* K. A. Harrison; *Laboratory:* Kentville, N.S.

Apple scab behaves in a manner best explained by the supposition that physiological specialization of the causal organism exists. A total of 85 cultures have been obtained from lesions on 47 varieties of fruit and foliage. Differences in growth rate, appearance of colonies and microscopical details were apparent in the cultures. Four single spore strains were passed through the host foliage and on reisolation produced similar growth and detail to the parent cultures. Size and shape of spores in cultures were influenced by the temperature of the incubator. Some cultures produced spores at lower temperatures than others.

### *Resistance to Apple Scab*

*In charge:* J. F. Hockey; *Laboratory:* Kentville, N.S.

*Spore Germination Studies with Chemicals*

Spore dilutions containing from 50 to 100 spores were placed in drop cultures of various chemicals and fruit juices and incubated in moist chambers at room temperature. Solutions of normal concentration of chlorides, hydroxides, nitrates, phosphates and sulphates of Na and/or K and/or Ca prevented spore germination. Hydroxides and sulphates prevented spore germination in N. and 0·1N. solutions. Calcium was least toxic in chlorides and nitrates and K most toxic in 0·01N. solutions. In 0·1N. solutions Na was more toxic than K. Mono-, di- and tri-basic potassium phosphates at 0·01N. concentration showed the tri-basic as most toxic. Sulphates of Al, K, Na, Cu, Mg were toxic at all concentrations as well as potassium alum and ammonium iron alum. Commercial tannic acid was toxic when over 0·1 per cent concentration. Malic acid (C.P.) inhibited spore germination in 0·1 per cent and stronger solutions.

By using solutions of sucrose, dextrose, and urea at strengths corresponding with 1 to 15 atmospheres osmotic pressure it was concluded that osmotic pressure in itself was not a limiting factor to spore germination.

Expressed juices of apples showing resistance to scab are more toxic to scab spores than juices from susceptible varieties. Apple peelings were found to contain a greater potency of inhibition than the flesh of the same fruits. Sterilizing the juice removed the toxicity. Expressed juices of apples from single element fertilizer plots were more toxic than those from three element plots. Seasonal and annual variations were found in the expressed juice concentration required to show toxicity to scab spores. The pH of apple juice did not in itself inhibit spore germination.

*Observations on Seedlings*

During the past few years the Experimental Station have accumulated a collection of apple seedlings from a project in breeding for resistance started by this Laboratory, the apple pollination project under Brittain* and the breeding and pollination work done at the Station (Project H827). Observations have been made for three seasons on approximately 6,000 seedlings to note their reaction to the scab fungus. Approximately 10,000 seedlings were rated in 1934. A striking difference in susceptibility to scab is apparent. Some seedlings have not shown any scab lesions on the foliage for two successive seasons, while others have shown extreme susceptibility. Several varieties of apples have consistently thrown more susceptible seedlings than others.

### B. 60.03. CONTROL OF POWDERY MILDEW OF APPLES

*In charge:* J. C. Roger; *Laboratory:* Summerland, B.C.

A severe russetting of the fruit from mildew infection frequently causes severe culling, up to 50 per cent. The purpose of this project is to develop a spray program to prevent this russetting. It has been found that two sprays of

* Brittain, W. H. Apple pollination studies. Can. Dept. Agric., Bul. N.S. 162, 1933.

lime sulphur, or lime sulphur 1-40 with ferrous sulphate 1½-40, applied at the pink and calyx give satisfactory control of this fruit infection even in the years of severest mildew attack.

### B. 60.04. PHYSIOLOGICAL DISORDERS OF APPLES (DROUGHT SPOT, CORKY CORE AND DIE BACK)

*In charge:* H. R. McLarty, J. C. Roger, J. C. Wilcox and I. C. Smith;
*Laboratory:* Summerland, B.C.
Organized under the Physiological Disorders Committee—R. C. Palmer, Chairman.

#### *(a) British Columbia*

A more extensive investigation of these disorders was undertaken in 1931, the problem being attacked from the horticultural, chemical and physiological viewpoints.

On a twenty-three acre orchard in the Kelowna district, irrigation, fertilizer, use of filler, thinning, pruning, root pruning, inarching and rootstock experiments are in operation. The results to date suggest, first, that an inadequate supply of water increases the disease and an adequate supply reduces it, and, second, potash fertilizer is beneficial while nitrogen is detrimental. The other experiments show no conclusive trends. In the chemical investigation analyses of the ash and of the tracheal sap of diseased and healthy trees have been made. Wide variations have been found to exist in the chemical composition of trees growing on different soils. There appears, however, to be a higher calcium content in diseased than in healthy trees. Physiological experiments have had to do (*a*) with the growth response of trees growing in liquid culture when exposed to varying amounts of rootlet killing, and (*b*) with the effect of various salt injections on the control of the disease. It has been shown that trees will absorb through a dead root system and continue to grow for a considerable period of time. No definite results from the salt injections have as yet been indicated.

*(b) Nova Scotia. In charge:* J. F. Hockey; *Laboratory:* Kentville, N.S.

During 1932 and 1933 a survey of over fifty commercial orchards yielded data which indicated that "bitter pit" was frequently a serious problem in Nova Scotia. The disease has been found most prevalent on soils with a hardpan within eighteen to twenty-four inches of the surface, very light sandy soils and soils with a high natural water table. Soil acidity has not been correlated with the development of "bitter pit."

Root samples were collected during the survey and rootlet injury determined in laboratory examination. There appears to be a relationship between rootlet injury and the disease under observation.

The term "bitter pit," as used locally, embraces several physiological disorders of which the predominating one is blotchy cork (Carne). This has been found in commercial orchards on Baldwin, Baxter, Blenheim, Cox Orange, Fallawater, Gravenstein, Ribston, Stark, Twenty-ounce Pippin and several other lesser grown varieties. Internal cork has been found on Wellington, Wolf River, McIntosh and Gravenstein while drought spot has been found on McIntosh. Other "cork" conditions have been found on Stark, Wagener, Duchess and some crab apples.

The work on this project was organized by a local Committee on Physiological Disorders of Apples for 1933. The survey work was continued in a few critical orchards and others visited for the first time. Soil and rootlet conditions

similar to those observed in 1932 prevailed, although there was better rootlet growth in 1933 than in the previous year. Orchard pitting of the fruit was less severe than in 1932, but pitting in storage was quite prevalent.

The Middleton plots started in 1932 in co-operation with the N. V. Potash Co. of Canada, Ltd., showed that a fertilizer ratio of 9-5-7 produced less orchard pitting than other chemical combinations. The 9-5-7 fertilizer at 10 pounds per tree produced less pitting than 20 pounds of this fertilizer or 10 or 20 pounds of this with 10 pounds of fish meal per tree. The two latter combinations produced a very luxuriant foliage with a delayed leaf fall. Single and double element plots produced more pitted fruit than the complete fertilizer. The least amount of pitting was obtained under a straw mulch culture with a three element fertilizer.

Percentage bloom and percentage spurs setting fruit could not be correlated, on the data obtained, with the prevalence of pit. Similarly, thinning of fruit failed to give significant differences in the amount of pit appearing in the apples at harvest. Removing half the foliage from one tree apparently increased the amount of pit from an average of 18 per cent on adjacent trees to 42 per cent on the treated tree.

Drought spot on McIntosh appeared on the fruit a few days after bloom. Fresh symptoms continued to appear throughout the season and also in storage. The disease was most prevalent on fertilizer plots which had received limestone applications and had a neutral to slightly alkaline reaction. Percentage bloom and set showed no significance with the prevalence of the disorder. Corky core appeared in many plots but could not be correlated with drought spot prevalence as it appeared on several plots on which no drought spot was found.

Chemical analyses of the soil from these and adjacent plots were performed by W. A. DeLong and will be reported in a subsequent publication.

Internal cork and corky core were found on Gravensteins in a commercial orchard in which the same condition had previously appeared on Wellington and Wolf River. The entire crop on affected trees was valueless. A subsequent examination of the fruit from fertilizer plots showed the cork condition most prevalent on Gravensteins on lime and slag plots with a neutral to slightly alkaline reaction. Associated with the internal cork was a surface dimpling of the apples resembling fruit affected by aphis. This "dimpling" was also associated with a core flush condition on some plots. It has been previously observed on Wageners but no study of the "dimpling" condition has been conducted.

### *Gravenstein Spot Scald* (Kentville, N.S.)

Hockey, J. F. Gravenstein spot scald. Sci. Agric. *13:* 225-227. 1932. Hockey, J. F., and J. A. Boyle. Gravensteins—Time of picking in relation to spot scald. Sci. Agric. *14:* 608-613. 1934.

The spotting is produced when mature fruit is exposed to light, probably as the result of a photo-chemical reaction. Fruit harvested when starch had disappeared from the core area developed the least spot scald and yielded fruit of larger size, deeper colour and better keeping quality than earlier picked fruit. The iodine test for starch was considered superior to the mechanical pressure tester for determining the picking maturity of this variety.

### *Mouldy Core of Gravensteins* (Kentville, N.S.)

Harrison, K. A. Mouldy core in Gravenstein apples. (Accepted for publication in Scientific Agriculture).

Prevalence of mouldy core is proportional to open cored fruit. Fungi are secondary. The heaviest fruit and prematurely coloured fruit contain the most mouldy core. Seed content can not be correlated with mouldy core. Pollination cannot be considered the fundamental cause of mouldy core.

### B. 60.07. CONTROL OF PERENNIAL APPLE CANKER IN B.C.

*In charge:* H. R. McLarty; *Laboratory:* Summerland, B.C.

McLarty, H. R. Perennial canker of apple trees. Can. Jour. of Res. *8:* 492-507. 1933.

The evidence obtained stresses the importance of the saprophytic phase of the fungus as being sufficiently developed to ensure its existence quite independent of any parasitic action. As a parasite it has been found to be strictly annual in the tissues of the tree. In a canker, each year's infection occurs only on tissue which has been fed on by the woolly aphis. Wherever woolly aphis attack is completely prevented no new infection or spread of old infection, ever occurs. It has been shown also that even if infection has been induced through woolly aphis attack the spread of the infection in the surrounding tissue is dependent on the exposure of these tissues to severe winter temperatures. Control of the aphis constitutes a control of the canker.

### B. 60.11. CROWN ROT IN APPLE TREES

*In charge:* J. C. Roger; *Laboratory:* Summerland, B.C.

The type of crown rot in apple trees prevalent in the Okanagan has been satisfactorily controlled in four experimental orchards through an adjustment of the irrigation practice.

Orchard 1. Ten acres. Twenty-five trees were lost when the experiment was begun. There was no further evidence of the disease after the soil moisture was correctly adjusted.

Orchard 2. Four acres. Forty-six per cent of all trees were affected and an additional 13 per cent had been killed before the experiment was begun. All infection was checked and no new cases occurred.

Orchard 3. Ten acres. Fourteen per cent of the trees were affected. Except in a few cases where the trees were too devitalized, the rot lesions have shown a healthy covering callus, and no new cases have occurred.

Orchard 4. Four acres. Up to the time of the experiment, fifty-nine trees were affected. Since 1929 (start of experiment) only one new case of rot has developed and this in a part of the orchard where it has been difficult to control the moisture.

### B. 60.12. CO-OPERATIVE INVESTIGATIONS OF FUNGICIDES FOR APPLES

*In charge:* J. F. Hockey; *Laboratory:* Kentville, N.S.

(In co-operation with Entomological Laboratory, Annapolis Royal, N.S.)

The main object of these investigations is to obtain the most economical control of apple scab. A summary of the spray work carried on in the province is annually contained in the reports of the Nova Scotia Fruit Growers' Association under the joint or individual authorship of A. Kelsall and J. F. Hockey (quod vide).

*Laboratory and Greenhouse Trials.*—All materials are subjected to greenhouse tests to determine their safety on apple seedling foliage. Many materials are sprayed on glass slides to determine their toxicity to conidia and to note their adhesiveness. These tests eliminate undesirable materials, determine the concentration in which certain sprays may be used with safety, and decrease the number of small plot trials required.

*Experimental Materials.*—Bordeaux mixtures weaker than the 5-20-100 proportion have not been satisfactory for either scab control or the elimination of fruit russetting when used throughout the season.

The iron sulphate-lime sulphur mixture used at 40 per cent strength with calcium arsenate 2½ to 3 pounds has proven successful for three seasons. The

material is very safe on foliage and may be used in humid or damp weather. A lignin pitch spreader improves the spread of the mixture and has no effect on its fungicidal value. The full strength mixture is:—iron sulphate, 10 pounds; lime sulphur, 2½ gallons; calcium arsenate, 4 to 5 pounds; water, 100 gallons.

A New Process White Arsenic developed by Mr. Kelsall has been used in Bordeaux and iron sulphate mixtures up to 1 pound per 100 gallons and has not lessened appreciably the fungicidal value of these sprays.

Many mixtures with zinc, copper, tellurium and other elemental bases have been tried with unsatisfactory results.

*Commercial Materials.*—Many sulphur and copper fungicides have been submitted for trial in the past few years. Most of the sulphur sprays gave satisfactory results in the "pink" and "calyx" applications, but when used throughout the season have not proved as efficient as the iron sulphate-lime sulphur mixture. The other copper fungicides have not been as satisfactory as the Bordeaux mixture.

The following materials were included in the above trials: calcium monosulphide (Cal-Mo-Sul), Flotation Sulphur powder and paste, bentonite sulphurs (Wettex and Kolofog), Sulsol, Magnetic Sulphur, and other wettable sulphurs, Bouisol, Coposil, and prepared Bordeaux powders.

*Comparison of Standard Materials.*—Two optional spray calendars are recommended for Nova Scotia and published for distribution by the Nova Scotia Fruit Growers' Association. One is based on Bordeaux mixture, with "pink" and "calyx" applications of iron sulphate-lime sulphur mixture. The other calendar consists of lime sulphur and iron sulphate-lime sulphur sprays. Six applications constitute a standard calendar. The above calendars with two former calendars composed of lime sulphur and the lime-sulphur-aluminium sulphate mixture have been compared at Kentville and Somerset in standard plots for several years. These four calendars have given better control of scab and insect pests than any commercial materials yet tried.

In the Bordeaux calendar for 1934, the iron sulphate-lime sulphur mixture was recommended for pink, calyx and ten-day applications. The 60 per cent strength has given excellent control for the past two seasons in commercial use and is now one of the most widely used sulphur fungicides.

## B. 60.15. FIRE-BLIGHT INVESTIGATIONS

### *Western Quebec*

*In charge:* H. N. Racicot; *Central Laboratory:* Ottawa.

A co-operative experiment on fire-blight (*Bacillus amylovorus* (Burr.) Trev.) between the Divisions of Botany, Chemistry and Horticulture, and the Entomological Branch.

In March, 1931, it cost, at the wage rate of 25 cents per hour, 58 cents per tree to prune fire-blight infections in severely affected 20-year old Fameuse apple trees. An average of 57·2 infections per tree for the four years 1931-34 was removed or treated in the summer pruning plot compared to an average of 25·6 per tree in the dormant pruning plot. All attempts to isolate *Bacillus amylovorus* from the air have been unsuccessful, except in three cases where Petri dishes with potato dextrose agar were placed underneath apple trees with fire-blight. It is possible in these cases that the organism was carried down on pieces of material too large to be carried in a lateral direction by the air. Under insect-proof cages bees have never carried the fire-blight organism from exuding cankers to blossoms, nor have aphids and ants. Bees have carried the organism from infected blossoms to healthy blossoms, but ants and aphids have not. Pollen atomized with a suspension of *Bacillus amylovorus*, allowed to dry, then used to hand pollinate flowers, in a few cases, infected the flowers.

Rain disseminated fire-blight from cankers to twigs and blossoms in trees under insect-proof cages. No new infections occurred in similar trees in cages with Cel-O-Glass or Windolite roofs. Apple trees growing in sand cultures with excess nitrogen were more susceptible to fire-blight than those growing in solutions deficient in nitrogen. Zinc chloride solutions used as disinfectants for fire-blight cankers on apple trees gave variable results, being effective in only about 50 per cent of the treatments. The breaking off of diseased fruit spurs to control fire-blight in the case of blossom infections has given variable results. To be effective the fruit spurs must be broken off early. The percentage of cankers collected late in winter, from which *Bacillus amylovorus* was successfully isolated, was as follows: 1931, 12 per cent; 1932, 15 per cent; 1933, 50 per cent, and 1934, 60 per cent. Attempts to isolate *Bacillus amylovorus,* in the spring, from hives of bees that had been in or near orchards with severe blossom infection the previous summer, were all unsuccessful. Some of the blossoms of apple trees atomized with a suspension of *Bacillus amylovorus,* after the trees had been sprayed or dusted with Bordeaux mixture, lime-sulphur or dusting sulphur, became infected with fire-blight. Pruning with infected tools during the dormant season did not spread fire-blight. *Bacillus amylovorus* lived 10 days in comb honey, 13 days in extracted honey, and 1 day in sterilized extracted honey.

*British Columbia*

*In charge:* I. C. Roger; *Laboratory:* Summerland, B.C.

In 1933 and 1934 a block of Flemish pear trees severely infected with blight was treated with zinc chloride to prevent spread of the disease during the growing season. In 1933, on a treated block (12 trees), two trees were lost before the treatment was applied, but in the remainder all infections were immediately checked and no secondary infection occurred. In the check block where regular summer cutting methods were used, four trees were totally destroyed and the other three reduced to trunk and main scaffold limbs. Thirty-seven secondary infections occurred in this block. In 1934, on a block of fifty-three trees, forty-eight initial infections occurred. In twenty-three cases the disease was checked before the limb was entirely girdled; in the other twenty-five, although the limbs were girdled, the advance was entirely checked. It is noteworthy that the zinc chloride treatment did not stimulate any sucker growth as did the regular summer pruning.

## B. 60.16. STUDIES IN APPLE STORAGE

*In charge:* J. F. Hockey; *Laboratory:* Kentville, N.S.

### *The Effect of Fungicides Applied in the Orchard on the Fruit in Storage*

A paper by Hockey and Ward* indicated that in some seasons spraying with Bordeaux mixture and the aluminium sulphate-lime sulphur mixture was associated with an increase in the sucrose and total sugar content of some varieties of apples over those sprayed with lime sulphur. During the seasons of 1932 and 1933 a new Bordeaux schedule has been used in which an iron sulphate-lime sulphur mixture replaces the Bordeaux and wettable sulphur on the pink and calyx applications of the previous schedule.

McIntosh and Stark apples were selected from the spray plots from two separated orchards, and sugar determinations made as previously reported. The fruit from plots receiving the lime sulphur or aluminium sulphate mixture

* Hockey, J. F., and R. W. Ward.—Studies in apple storage. I. The effects of fungicides on flavour and sugar content. Sci. Agric. *12:* 709-715. 1932.

had a higher sugar content than the fruit from plots sprayed according to the new Bordeaux schedule. McIntosh apples in the aluminium sulphate plots have had better colour and higher sugar content annually. The iron sulphate mixture caused an appreciably poorer colour development and lower sugar content in all varieties. It has been definitely shown that the standard strength iron sulphate mixture has a depressing effect on the sugar content of fruit harvested at the commercial picking time, and also from later pickings.

*Influence of Leaf Area and Location on Limb on Sugar Content*

Several investigators have shown that leaf area affects the sugar content of apples. It has been suggested that the greater the leaf area per apple the greater the sugar content and size of the apple. Leaves and fruit on one limb of a Wagener tree were picked spur by spur, and the foliage planimetered. The apples were stored individually, and removed for analysis after about four months.

Based upon the data obtained from our analysis, which can only be considered as representative of a condition which occurred for this season, it was noted that the fruit with the greatest sugar content was at the terminal end of the branch. The sugar content of the fruit nearest the trunk was also considerably higher than that of the fruit in the centre of the limb.

*General Storage Conditions*

The samples of fruit for general storage work showed little or no difference in firmness throughout their storage period. Very little rot or other pathological condition developed. Pressure tests taken at fortnightly intervals showed no significant differences between plots, in fact, under local conditions, gave only a picture of the mechanical condition of the fruit. The storage life, while dependent on firmness, is influenced more by the physiological condition of the fruit.

## Stone Fruits: Project Group No. 61.00

A SUSPECTED VIRUS DISEASE OF SWEET CHERRY (Frontispiece)

*In charge:* H. R. McLarty; *Laboratory:* Summerland, B.C.

In October, 1932, attention was drawn to a peculiar disease of sweet cherry in the Nelson district by Mr. J. W. Eastham, Provincial Plant Pathologist. The most outstanding characteristics are: the mottling of leaf colour, the crinkling of the leaves, the frequent occurrence of a shot-hole condition in the leaf, and the stunting of twig growth. The fruit of affected trees was reported as being small in size and poor in quality. In a survey of the Nelson district in 1934, the disease was found on trees in four city lots in the city of Nelson, and at Boswell and Creston in two commercial plantings. The trouble has not been found in the Okanagan district.

In seventy inoculations with the expressed sap from diseased twigs no infection resulted. One tree, on which diseased scions were grafted in 1933, developed in 1934 typical symptoms of the disease.

### B. 61.01. INVESTIGATIONS ON BLACK KNOT OF PLUMS AND CHERRIES

*In charge:* L. W. Koch; *Laboratory:* St. Catharines, Ont.

Koch, L. W., Investigations on the black knot of plums and cherries, I. Development and discharge of spores and experiments in control. Sci. Agric. *13: 9:* 576-590. 1933.
Koch, L. W., Investigations on the black knot of plums and cherries, II. The occurrence and significance of certain fungi found in association with *Dibotryon morbosum* (Sch.) T. & S. Sci. Agric. *15: 2:* 80-96. 1934.
Koch, L. W., Investigations on the black knot of plums and cherries, III. Symptomatology, life history and cultural studies of *Dibotryon morbosum* (Sch.) T. & S. (In press.)
Koch, L. W., investigations on the black knot of plums and cherries, IV. Studies in pathogenicity and pathological histology. (In press.)
Koch, L. W., Studies on the overwintering of certain fungi parasitic and saprophytic on fruit trees. Can. Jour. Research *11:* 190-206. 1934.

An intensive investigation of black knot has yielded considerable new information concerning the disease. Ninety-three per cent of all knots observed in the Niagara Peninsula became visible during the fall of the season of infection. Some of both natural and artificially-produced knots completed their life cycles within a year after infection, while others required two years or longer. Nearly all of both natural and artificially-produced knots originated only on current season wood. The imperfect stage of *Dibotryon morbosum* (Sch.) T. & S. was proved for the first time to be a *Hormodendrum* sp. A chlamydosporous stage has also been proved to develop on certain occasions. The period of ascospore discharge of *D. morbosum* on *P. domestica* was shown to lie between March 23 and June 7. Conidia are produced during summer and fall. Numerous fungi are consistently associated with black knots in all but the most incipient stages. Observations and infection experiments indicated that *Cephalothecium roseum* Corda, in particular, exerts an important measure of natural biologic control over *D. morbosum.* More than 95 per cent control was obtained in blocks of trees subjected to a combined program of pruning and the application of a dormant spray consisting of either 3 per cent oil emulsion with 3·6·40 Bordeaux or 1:8 lime sulphur, followed by two later sprays consisting of 1:40 lime sulphur. The surgical removal of knots on larger branches proved successful.

### B. 61.02. FALL SPRAYING FOR CONTROL OF PEACH LEAF CURL

*In charge:* G. C. Chamberlain; *Laboratory:* St. Catharines, Ont.

In 1932 and 1933 further evidence was secured that adequate control of peach leaf curl may be obtained by spraying with lime sulphur 1:8 at favourable opportunities during the winter months provided care is taken not to spray when the temperature is below 37°F., or when there is a possibility of freezing temperatures before the spray dries on the trees. The disease was extremely severe on unsprayed trees in 1932 and 1933 with up to 100 per cent of the leaves affected while there was only a trace to 14 per cent infection in the blocks receiving spray applications during the winter months in these years. In 1931 and 1934 leaf curl disease was not present in the orchard. The winter of 1933-34 was the most severe experienced in the Niagara Peninsula for many years, and considerable winter injury occurred. There did not appear to be any greater injury, however, in the blocks sprayed in November and December than those sprayed in the spring, or in the unsprayed blocks.

### B. 61.04. SHOT-HOLE DISEASE OF SOUR CHERRIES

*In charge:* L. W. Koch; *Laboratory:* St. Catharines, Ont.

Spraying experiments to control shot-hole were conducted in 1931 and 1932. Comparatively little shot-hole infection developed in the sour cherry orchard during either 1931 or 1932. Largest cherries were harvested in both years from the blocks which received the first spray at the time of ¾ petal fall. A

measurement in 1932 of 1,000 Early Richmond cherries in each sprayed block gave an average of 14·2 mms. in the "$\frac{3}{4}$ petal fall" block, compared with a diameter of 13·3 mms. in the "shucks" block. Cherries picked from trees sprayed with Bordeaux were somewhat smaller than those which received lime sulphur.

### B. 61.05. PEACH SCAB INVESTIGATIONS

*In charge:* G. C. Chamberlain; *Laboratory:* St. Catharines, Ont.

The object of this project was to ascertain the preferable spray material and schedule for satisfactory control of peach scab disease. The results indicate that in seasons favourable for the disease two applications of wettable sulphur are necessary to effect control. The first application should be made at the time most of the shucks are free from the fruit, and a second, two weeks later. Wettable sulphur proved the preferable fungicide compared with calcium monosulphide or zinc sulphate.

### B. 61.06. PEACH CANKER INVESTIGATIONS

*In charge:* R. S. Willison; *Laboratory:* St. Catharines, Ont.

Willison, R. S., Peach canker investigations, I. Some notes on incidence, contributing factors and control measures. Sci. Agric. *14:* 32-47. 1933.

Cankers on the peach originate from wounds or dead areas. The length of the period of open cultivation has a marked effect upon the incidence of peach canker, for example: in an orchard set out in 1928, in a plot cultivated until June 15 each year, the average number of cankers per tree to date is 11·2; cultivated until July 15, 16·5; and cultivated until August 15, 44·2. Fall pruning induces canker development to a much greater degree than does pruning at any other time of the year. In some seasons, leaf scar infections are responsible for a large number of cankers. Inoculation experiments conducted at short intervals over a period of two years indicate (1) that *Valsa cincta* Fr. is highly pathogenic during the dormant season and produces perennial cankers, (2) that *Valsa leucostoma* Fr. has not proved to be pathogenic under the conditions of the experiment, (3) that *Sclerotinia fructicola* (Wint.) Rehm. (*S. americana* (Worm.) Nort. & Ez.) is capable of causing necrosis in the bark particularly during the growing season, but not of producing perennial cankers.

### B. 61.07. PHYSIOLOGICAL DISORDERS IN THE APRICOT

*In charge:* H. R. McLarty; *Laboratory:* Summerland, B.C.

Two severely diseased orchards were secured, one in 1927 in the Penticton and the other in 1929 in the Summerland district, where experiments in the control of irrigation water were conducted. By adjusting the amounts of water and the frequency of application, the soil moisture has been maintained as near as possible at an optimum condition for tree growth. By 1931, the disease had disappeared from both orchards, and during the period since, each place has borne, except for winter frosts, good crops of fine quality fruit. From the Penticton orchard, which has approximately seven acres in apricots, there were harvested in 1933 thirty-five tons and in 1934 twenty-six tons of clean fruit. When this orchard was taken over for experiment the crop was almost an entire loss owing to the presence of drought spot.

### B. 61.08. THE CONTROL OF BROWN ROT OF PEACHES IN TRANSIT

*In charge:* R. S. Willison; *Laboratory:* St. Catharines, Ont.

(In co-operation with the Dominion Fruit Branch and the Cold Storage Department, the Ontario Agricultural College, Guelph, Ontario.)

On the basis of data obtained in three successive years from experimental shipments of peaches to the Canadian West and to England, the following measures have been found effective in the control of brown-rot during long-

distance transportation: (1) the careful handling of the fruit, (2) the use of an efficient spray or dust, (3) the prompt packing and cooling of the fruit, as a delay of twenty-four hours has resulted in a much higher percentage of rot. Some newly developed sulphur sprays which do not mark the fruit and may be applied just before or during harvest gave satisfactory control in 1934. Peaches grading " hard-ripe " or very slightly greener were shipped satisfactorily and attained good quality. Peaches destined for England should be large, well-selected, properly treated and clean, and should be wrapped and packed with wood wool in single layer boxes which should be bundled.

## Small Fruits; Project Group No. 62·00

### B. 62.01. RASPBERRY INSPECTION AND CERTIFICATION

*Prince Edward Island*, R. R. Hurst, in charge

During the years 1931 to 1933 inclusive, certification was granted to one raspberry plantation comprising three acres of the Viking variety. In 1934 inspection was requested and made for four plantations comprising a total of three acres. Two of these plantations qualified for certification, certificates being awarded accordingly.

Certification tags issued since 1931 were as follows:—

| Year | Number of shipments | Number of plants |
|---|---|---|
| 1931 | 10 | 53,200 |
| 1932 | 17 | 57,054 |
| 1933 | 38 | 25,477 |
| 1934 | 22 | 8,136 |

*Nova Scotia*, J. H. Hockey, in charge

Raspberry culture is limited to a comparatively small number of growers in Nova Scotia. Requests have been received for the inspection of several young plantings during the past three years but the majority of the growers have not been interested in propagating certified stocks on account of the limited demand for such plants. Certified stock of both Herbert and Viking varieties are available in the province.

*Quebec*, H. N. Racicot, in charge

The results of the inspection service for the certification of raspberry plantations in the province of Quebec are given in summary form:—

| — | Number of plantations inspected | Area inspected (arpents) | Number of plantations certified | Area certified (arpents) |
|---|---|---|---|---|
| 1931 | 53 | 35 | 31 | 24·5 |
| 1932 | 63 | 52 | 38 | 30 |
| 1933 | 73 | 73 | 65 | 68 |
| 1934 | 80 | 85 | 59 | 68 |

*Ontario*, G. C. Chamberlain, in charge

In 1932 new regulations[1] governing the production of certified raspberry canes came into effect in Ontario and resulted in increasing and improving the planting stocks being distributed under the certification scheme. In 1931 the total

[1]Berkeley, G. H., Raspberry inspection service and Canadian certified raspberry stock. Dom. Dept. of Agric. Pamphlet No. 139 N.S.

number of canes shipped under the certification tags equalled 315,825; in 1932, 569,500; in 1933, 539,125; in 1934, up to November 30, 468,850. Viking and Cuthbert varieties, in spite of their susceptibility to virus infection, continue to be widely planted. Latham and more recently the Chief variety have been produced in greatly increased quantity. In addition to the inspection service for certification many inspections of fruiting plantations have been made on the request of growers.

### B. 62.03. SUSCEPTIBILITY OF RASPBERRY VARIETIES TO MOSAIC AND OTHER DISEASES

*In charge:* G. C. Chamberlain; *Laboratory:* St. Catharines, Ont.

The planting for this project comprised eight varieties set out with certified stock in the fall of 1932. While no mosaic disease has been observed in this planting as yet, there was a moderate infection of *Verticillium* wilt during the past season. The Viking variety proved outstandingly susceptible and considerable loss of fruiting wood was occasioned. The Chief, Newburgh and Cuthbert were also affected but to a much less extent. The remaining varieties, Herbert, Latham, Lloyd George and Brighton, were little affected. The other diseases were of no importance. Only one instance of virus infection (leaf curl) was observed in the Cuthbert variety.

### B. 62.04. STRAWBERRY ROOT-ROT STUDIES

*In charge:* G. H. Berkeley; *Laboratory:* St. Catharines, Ont.

(1) Hildebrand, A. A., Recent observations on strawberry root-rot in the Niagara Peninsula. Can. Jour. of Res. *11:* 18-31. 1934.
(2) Berkeley, G. H. and I. Lauder-Thomson, Root-rots of strawberry in Britain. Jour. Pom. & Hort. Sci. *12:* 222-246. 1934.

During 1931 and 1932, work on this problem was focused around the improvement of technique for inoculating plants in order to obtain results as clear-cut as possible. Isolations from naturally affected roots were continued, and as in the past *Ramularia* sp. proved to be the predominating fungus.

During 1932 a comparison was made between the pathogenicity of *Ramularia* sp. and *Coniothyrium Fuckelii* Sacc., and *Hainesia Lythri* (Desm.) v. Höhn, the organisms associated with black root in Michigan, U.S.A. The comparative tests pointed out that all three fungi were capable of producing a similar type of root-rot.

During the summer of 1933 and 1934 the investigations at St. Catharines resolved themselves for the most part into two general lines of procedure (1) critical microscopic examination of, and (2) isolations from a large number of naturally infected roots. Isolations have yielded many different organisms among which are representatives of the genera of fungi which have been shown by numerous workers elsewhere to be associated with a pathological condition of the roots of strawberry, e.g., *Pythium, Coniothyrium, Hainesia, Fusarium, Ramularia (Cylindrocarpon), Cylindrocladium,* and the endotrophic mycorrhizal fungus of the *Rhizoctonia* type familiar in orchids. Infection experiments involving these and other fungi have shown that while some of the organisms exhibit weak parasitic capabilities, none of them to date has proved to be an aggressive parasite.

Microscopic examination has revealed the almost universal occurrence of two of the so-called " endotrophic mycorrhizal fungi," one, of the characteristic phycomycetoid type, producing arbuscules and vesicles, the other, of the *Rhizoctonia* type referred to above. At certain periods during the growing season, *Olpidiaster,* some members of the *Plasmodiophoraceae,* and *Pythium* have been noted also in diseased roots.

Nematodes have been encountered in association with diseased roots in number and frequency sufficient to suggest a possible causal relationship to strawberry root-rot.

During 1933 and 1934 the opportunity was presented at East Malling, Kent, England, of studying root-rot of strawberries as it occurred there, and this study demonstrated that at least five fungi were capable of producing typical root-rot.

During the past four years, therefore, the St. Catharines laboratory has definitely demonstrated that a specific trouble known as root-rot is present throughout the strawberry growing districts of Ontario, and that several different fungi bear an important causal relationship to the disease.

### B. 62.05. SUSPECTED MOSAIC DISEASE OF STRAWBERRY

*In charge:* G. H. Berkeley; *Laboratory:* St. Catharines, Ont.

To date no satisfactory results have been obtained with our study of this trouble. All attempts to transmit the disease by juice transfer and insect vectors, have so far failed. Plakidas[1] who tried bridge grafting in an endeavour to transmit this disease also records negative results. In the Annual Report of the Dominion Botanist[2] the possibility was suggested that this disease may be genetic in origin. Recently Guba[3] has published a paper in which he says: "The disease is unquestionably of genetic origin and undoubtedly the result of a recessive genetic factor, the expression of which is influenced by the environment." His hypothesis is that sexually propagated stock, self-fertilized rather than cross-fertilized, has contributed to the source of the trouble. Accordingly new varieties and seedlings containing the factor for chlorosis would always be liable to chlorotic outbreak under suitable conditions. In this connection it is interesting to note that so far this "chlorosis" is definitely a trouble of "new varieties" and "seedlings."

### B. 62.07. SPRAYING EXPERIMENTS TO CONTROL SPUR BLIGHT OF RASPBERRIES

*In charge:* L. W. Koch; *Laboratory:* St. Catharines, Ont.

This project was a continuation of previous investigations on this disease.[1] In a comparison of spray materials Bordeaux mixture proved superior to other materials used. During the years 1931 to 1933 inclusive, two applications of Bordeaux 3.6.40 resulted in an average control of 90·3 per cent accompanied with only 1·4 per cent leaf injury.

### B. 62.10. CROWN GALL OF RASPBERRIES

*In charge:* G. C. Chamberlain; *Laboratory:* St. Catharines, Ont.

This project was started in the fall of 1933 to ascertain the effect of planting canes heavily affected with crown gall on the vigour and productiveness of the resulting plantation.

Heavy gall infection on planting stock was not reflected in greater loss of plants or in weakened vigour in the new growth when such factors as number of new canes, branches, suckers and greatest height of cane were considered. New crown gall infection was found at the crown of 22 per cent of the new canes produced in the plot set out with canes 100 per cent affected. Six per cent of the new canes in the plot set with healthy canes showed gall infection

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[1]Plakidas, A. G., The "June yellows" of strawberries. Phytopathology *22:* 22. 1932.
[2]Report of the Dominion Botanist, page 125, 1930.
[3]Guba, E. F., "Suspected mosaic" of the strawberry. Phytopathology *23:* 6. 1933.
[1]Koch, L. W., Spur blight of raspberries in Ontario caused by *Didymella applanata.* Phytopathology *21:* 247-287. 1931.

at the crowns. Direct damage to the cane results in severe cases of infection from the breaking over of the cane at the galls although generally the presence of crown gall is not reflected in any noticeable manner.

## Other Fruit Disease Investigation: Project Group No. 63.00

### B. 63.01. SPRAY SERVICE IN BRITISH COLUMBIA

*In charge:* G. E. Woolliams; *Laboratory:* Summerland, B.C.

In 1933 and 1934 an experimental block was sprayed only when climatic conditions intimated that an infection of scab had occurred. Sprays were applied within thirty-six hours after the infection. It was found that in both years only one severe infection occurred and this was effectively controlled with only one spray application. In 1933 the control obtained was 2·7 per cent scabby fruit with 43·8 per cent on the check, and in 1934, 2·9 per cent scabby fruit with 51·3 per cent on the check.

## MYCOLOGICAL STUDIES: PROJECT GROUP No. 70.00

### B. 70.05. MAINTENANCE OF NATIONAL MYCOLOGICAL HERBARIUM

*In charge:* I. L. Conners; *Central Laboratory:* Ottawa.

The mycological collections have been rearranged and transferred to steel herbarium cases. The exsiccati, which contain over 10,000 specimens, have been separated from the main collection, arranged as they were issued, and indexed. The working herbarium consists of the collections of the late Dr. John Macoun, with additions made by members of the Division and correspondents. Two thousand four hundred specimens were added to the herbarium in the past 4 years and some duplicate material is available for exchange. The Reliquiae Farlowianae, which contains 600 numbers and over 700 specimens, was obtained in 1934 from the Farlow Herbarium of Harvard University on an exchange basis.

### B. 70.06. REFERENCE COLLECTION OF PURE CULTURES OF PATHOGENIC FUNGI

#### (*a*) *Wood-destroying Fungi.*

*In charge:* Irene Mounce and Ruth Macrae; *Central Laboratory:* Ottawa.

Mounce, Irene. Microscopic characters of sporophores produced in culture as an aid in identifying wood-destroying fungi. Trans. Roy. Soc. Canada *26:* 177-181. 1932.

During the years 1931-34 cultures of ninety-eight other species have been added to the collection of pure cultures kept at Ottawa, making 191 species in all. There are, as well, series of monosporous isolations of 38 species. During that period 207 cultures were received from other workers and 267 sent in answer to requests.

#### (b) *Sclerotium-Producing Fungi*

*In charge:* F. L. Drayton; *Central Laboratory:* Ottawa.

This collection has been greatly increased during the four years under review, as a result of the sexuality studies that are being undertaken in the *Sclerotinieae* and the related forms in the Fungi Imperfecti. The 167 cultures maintained in this collection do not include an equivalent number of species, for in many instances isolates of a single species have been collected from as many localities as possible in order to obtain sexual compatibles.

### B. 70.10. DETERMINATION OF THE OCCURRENCE OF BIOLOGIC FORMS OF PLASMODIOPHORA

*In charge:* D. J. MacLeod; *Laboratory:* Fredericton, N. B.

One hundred and eight species of *Cruciferae* (including a number of varieties of turnip, kale, cabbage and cauliflower) were tested on soils heavily infested with the club root organism from 7 different sources in the Maritime Provinces. There were significant variations in club root infection among the several species and varieties tested on identical soils and also marked differences in infection among the several species and varieties on soils from different sources.

### B. 70.13. SEXUALITY AND CULTURAL STUDIES OF WOOD-DESTROYING FUNGI

*In charge:* Irene Mounce; *Central Laboratory:* Ottawa.

Monosporous mycelia have been isolated from thirty-six species of wood-inhabiting fungi, and pairings made. In addition to those previously reported the following are heterothallic and bisexual: *Polyporus adustus* (Willd.) Fr., *P. betulinus* (Bull.) Fr., *Trametes heteromorpha* (Fr.) Bres. and *T. variiformis* Peck; while *Fomes fraxinophilus* (Peck) Sacc., *Panus stypticus* (Bull.) Fr., *Pholiota aeruginosa* Peck, *Polyporus cinnabarinus* (Jacq.) Fr., *P. fumosus* (Pers.) Fr., *P. pubescens* (Schum.) Fr., *P. volvatus* Peck, and *P. versicolor* (L.) Fr. are heterothallic and quadrisexual. By pairing monosporous mycelia of the non-luminous European form of *Panus stypticus* with those from the luminous American form it has been shown that these two forms are interfertile.

### B. 70.16. CLASSIFICATION OF FUSARIUM SPECIES ASSOCIATED WITH FIELD CROP DISEASES

*In charge:* W. L. Gordon; *Laboratory:* Winnipeg, Man.

W. L. Gordon. Species of *Fusarium* isolated from field crops in Manitoba. (Accepted for publication, Proceedings World's Grain Exhibition and Conference, Regina, Vol. II.)

This project was commenced in 1932. As the collections of field material made in 1934 have not been completely worked over, only the results for 1932 and 1933 will be entered in this report. Approximately 1,800 isolations of *Fusarium* spp. were made during 1932 and 1933 by Dr. J. E. Machacek from diseased roots and bases of wheat, oats, barley and rye. A taxonomic study of these isolates has shown that 21 species, varieties, and forms of *Fusarium* representing 7 Sections of the genus, were present. *F. herbarum* (Cda) Fr. v. *avenaceum* (Fr.) Wr., *F. Equiseti* (Cda) Sacc. *f. 1* Wr., *F. oxysporum* Schl. v. *aurantiacum* (Lk.) Wr., and *F. culmorum* (W. G. Smith) Sacc. were most frequently isolated, accounting for approximately 90 per cent of the total number of isolations.

### B. 70.18. THE GROWTH OF RHIZOCTONIA SOLANI AND FUSARIUM SP. IN RELATION TO TEMPERATURE, ACID, ALKALI, AND OTHER FACTORS

*In charge:* W. Newton; *Laboratory:* Saanichton, B.C.

Newton, W. The Physiology of *Rhizoctonia*. I The thermal death point of vegetative cultures. Sci. Agric. *12:* 178-182. 1931.

The lethal temperature period for vegetative cultures of *Rhizoctonia Solani* Kühn, was one hour at 50°C. The lethal temperature of potato tubers was between 45° and 50°C., but at 45°C. the tubers were severely injured. Sclerotia germinated that were attached to tubers immersed for 1 hour at 55°C.

The growth temperature graph for *R. Solani* reaches zero at 6° and 32°C., exhibiting an optimum at 25°C. Tube cultures transferred from 8°C. to 25°C. did not attain a constant growth rate until the fourth day.

Newton, W., and N. Mayers. The Physiology of *Rhizoctonia Solani* Kühn. III. The susceptibility of different plants as determined by seedling infection. Sci. Agric. (accepted for publication).

As judged by the growth of seedlings on infested soil, wheat, oats, red clover, crimson clover, and Mammoth White Dutch clover, appear to be immune or highly resistant. Alfalfa, sunflower, and rye grass are quite resistant, while peas, beans, vetch, buckwheat and timothy are moderately or highly susceptible to *Rhizoctonia Solani* Kühn.

Turnips and carrots are markedly stunted when grown on infested soil but exhibit no lesions or other symptoms of infection.

The growing of seedlings on nutrient agar inoculated with *Rhizoctonia* is not a satisfactory method of determining their relative resistance to the fungus, e.g. clovers and sunflower show maximum susceptibility when grown on agar but are highly resistant when grown on infested soil.

Newton, W., and N. Mayers. The Physiology of *Rhizoctonia Solani* Kühn. IV. The effect of a toxic substance produced by *Rhizoctonia Solani* when grown in liquid culture, on the growth of wheat, carrots and turnips. Sci. Agric. (accepted for publication).

Heat sterilized filtrates of old liquid cultures of *Rhizoctonia Solani* Kühn, were markedly toxic towards seedlings of carrots and turnips compared with wheat. Hot water extracts of washed, dried and ground mycelia were likewise toxic towards turnips but at the concentrations employed in these experiments no evidence of toxicity towards wheat was obtained. This evidence suggests that a heat stable toxin is secreted by *R. Solani* during growth and that it is also present within the mycelia. This toxin may serve to evaluate the relative immunity of plant species and varieties against this fungus for previous studies showed that carrots and turnips were markedly stunted when planted on soils that were artificially infested with the living fungus. Under the same conditions the living fungus had little effect upon wheat.

### B. 70.19. CLASSIFICATION OF HELMINTHOSPORIUM SPECIES ASSOCIATED WITH FIELD CROP DISEASES IN CANADA

*In charge:* J. E. Machacek; *Laboratory:* Winnipeg, Man.

The distribution of *Helminthosporium* species in Canada has not yet been completely studied. It is known, however, that many of these species occur on field crops, particularly on cereals. The purpose of this study is to make a complete systematic study of *Helminthosporium* species which occur in Canada and to devise a working key for their classification. Thus far the species which have been identified include *H. sativum* P., K., and B.; *H. teres* Sacc.; *H. gramineum* Rabenh.; *H. geniculatum* Tracy et Earle; *H. tetramera* McKinney; *H. Avenae* Eidam; *H. Bromi* Died.; and *H. Tritici-repentis* Died. Several other species have also been isolated but their identity has not yet been determined.

### B. 70.20. A CYTOLOGICAL STUDY OF THE SEXUAL MECHANISM OF SCLEROTINIA GLADIOLI (MASSEY) DRAYTON

*In charge:* F. L. Drayton; *Central Laboratory:* Ottawa

Drayton, F. L. The sexual function of the microconidia in certain Discomycetes. Mycologia 24: 345-348. 1932.

Without any experimental detail, the announcement is made that the structures well known in some Discomycetes, termed microconidia, are functional spermatia. In the fungus *Sclerotium Gladioli* Massey, the development of apothecia was induced by placing the microconidia of one thallus on receptive structures of another thallus. The apothecia are typical of those found in the genus *Sclerotinia.*

The term "spermatization" is suggested for the process of bringing spermatia into contact with the receptive structures.

Each thallus bears both receptive bodies and microconidia, but they are self-sterile. Apothecia are formed only when microconidia from certain isolates are applied to the receptive bodies of certain other isolates. Vegetative pairing of compatible isolates does not result in the development of apothecia.

Drayton, F. L. The sexual mechanism of *Sclerotinia Gladioli*. Mycologia *26:* 46-72. 1934.

Monomycelial cultures develop both receptive bodies and microconidia. Ten isolates derived from various localities and sucepts were crossed in all possible ways and the development or lack of development of apothecia in the various crosses was tabulated. This demonstrated that the isolates used could be divided into two groups on the basis of compatibility and these exhibit reciprocal intra-group sterility, reciprocal inter-group fertility, and individual self-sterility.

Single ascospore cultures were made, the receptive bodies from these were back-crossed separately with microconidia from each of the parent isolates, and this showed clearly a segregation of the compatibility factor, apparently in the ratio of 1:1.

Receptive bodies were fertilized by microconidia developed on ascopores discharged on the receptive bodies. A filtered suspension of microconidia in which the latter were removed did not effect fertilization. Apothecia did not develop as a result of hyphal fusions, even between compatible isolates.

The technique is described for the development of microconidia, receptive bodies, and apothecia, and for the spermatization of the cultures.

Some preliminary cytological notes are given, including details of the changes which take place in the coiled ascogonial hyphae of the receptive bodies, when the latter are spermatized with compatible microconidia.

The phenomenon exhibited by this sexual mechanism is not regarded as one of heterothallism, as Blakeslee defined this term, for there is no segregation of the sexes in separate thalli, but rather a homothallic condition in which each thallus is self-sterile and fertility exhibited only between certain compatible thalli.

*Additional Cytological Work*

The cytological phase of the work summarized in the previous paragraphs was not completed. The extreme minuteness of the nuclei and the fact that few mitotic figures were encountered in the sections, made it impossible to obtain the entire nuclear history of this sexual mechanism.

It was thought that these difficulties were the result of an unsuitable technique in killing and embedding the specimens, and that the material was removed too infrequently. The whole investigation was repeated, using a modified technique and 173 batches of material were embedded in paraffin, and 50 blocks have been cut and stained.

These slides have not been examined critically, but the indications are that the nuclei are as small as those in the first series. Some additional information will be obtained, but it is hoped that some other species will be found which will lend itself better to this study and will be of assistance in the interpretation of the nuclear phenomena in *S. Gladioli.*

B. 70.21. A STUDY OF THE SEXUAL MECHANISM OF CERTAIN SPECIES OF THE SCLEROTINIEAE

*In charge:* F. L. Drayton; *Central Laboratory:* Ottawa

(*a*) *Development of Apothecia*

The microconidia of *Sclerotinia Gladioli* function as spermatia, and the fact that microconidia of the same type are of general occurrence in other species of *Sclerotinia* and in species of the form-genera *Botrytis* and *Sclerotium*, has opened up a huge field of investigation in this large group of fungi.

A number of representative species have been chosen for a continuation of these studies. So far, the most extensive work has been done with *Botrytis Tulipae* (Lib.) Lind and *Botrytis convoluta* Whet. & Dray. A collection of monomycelial isolates has been made from material collected in as many localities as possible. Based on the technique used in the *S. Gladioli* studies, every effort is being directed to the development of apothecia in these species by varying conditions during vegetative development and by subjecting the mature thallus to a number of different environmental conditions, combined with cross-spermatizations.

Encouraging results have been obtained with *B. convoluta.* Following cross-spermatization, apothecial fundaments were obtained in two cultures, but in the absence of equipment at that time to provide light in a low temperature chamber, mature apothecia were not obtained.

### *(b) Development of Microconidia*

In all of these experiments, it has been necessary to evolve a technique for each species studied, whereby a supply of microconidia is available for the cross-spermatizations.

In the case of *S. Gladioli* this was obtained by growing the isolates on a mixture of matrimony vine stems and potato dextrose agar. In *B. Tulipae,* three week old cultures on potato dextrose agar are cut up into squares and these pieces are transferrable to dishes of sterilized wheat brought to a definite degree of alkalinity by the addition of sodium hydroxide. The microconidia develop on the squares of inoculum. In *B. convoluta,* squares of inoculum, similar to those of *B. Tulipae* are placed on fresh dishes of potato dextrose agar, and in addition when certain isolates are paired, microconidia develop along the line of junction of the two thalli.

### *(c) The Structure of the Sclerotia of Sclerotinia sclerotiorum*

Receptive bodies, comparable to those found in *S. Gladioli* have not been seen in this species, and an effort has been made to locate the position of the ascogonium. Good hand sections of the sclerotia were cut prior to and after the appearance of apothecial fundaments. Careful staining has revealed the presence of coiled ascogonial systems just beneath the rind of the sclerotia. This differentiated tissue can later be traced into the apothecial fundaments. It is believed that the earliest stages in the development of these fundaments constitute the receptive condition, with spermatization and fertilization occurring at that time.

### *(d) The effect of the Hydrogen-ion Concentration of Culture Media*

(F. L. Drayton and A. J. Hicks)

*Botrytis Tulipae* grown in potato—2 per cent dextrose agar corrected to a pH range varying from 2·1 to 8·0, showed the best growth and development of sclerotia at 4·4 to 4·6. In a similar series using sterilized wheat planted with paired inocula of *B. Tulipae* and *Sclerotium perniciosum* van S. & Sim. Thom., the acid side definitely favoured the former species, while the latter occupied most of the space on the plates at the alkaline end of the series. This definitely disproves the possibility of these two fungi being identical, as has been suggested. *Botrytis convoluta* resembles *B. Tulipae* in that its optimum growth is on the acid side, but the former is more tolerant of extremes of acid and alkali.

*(e) Antagonism between Isolates of the Same Species*

(F. L. Drayton and A. J. Hicks)

During the investigations on *S. Gladioli* it was found that when sexually compatible isolates were paired in a Petri dish culture of potato dextrose agar, a dark brown line developed between the thalli. Pairings of sexually incompatible isolates, however, grew together without any line of demarcation.

The six isolates of *Botrytis convoluta* were paired in every possible way, and two antagonistic groups were indicated, consisting of three isolates in each group. The development of apothecial fundaments was obtained as a result of intergroup spermatizations. These results seemed to indicate that this antagonistic action could be used as a criterion of sexual compatability. Unfortunately, however, when 56 isolates of *Botrytis Tulipae* were paired with two definitely antagonistic isolates the result was not so convincing, for out of 110 plates of paired cultures, all except 8 showed antagonism. The evidences of antagonism are even more striking here, for at the line of junction of the thalli, a band up to one-half an inch in width was left in which no sclerotia or only a few extremely small ones developed, and within this "no man's land" a brown line of disorganized hyphae was frequently evident. It is of passing interest to note that when antagonistic isolates were paired on such media as wheat, corn meal, sliced tulip bulbs, etc., interaction was not recognizable.

It is impossible at this time to explain this prevalence of antagonism between isolates of *B. Tulipae,* but it is hoped that, if it is ultimately possible to develop the sexual stage, an explanation of this phenomenon may be forthcoming.

## POTATO DISEASE INVESTIGATION

### Tuber Investigation Project Group No. 80.00

B. 80.83. INVESTIGATING THE CAUSE OF STORAGE LOSSES OF POTATOES IN PRINCE EDWARD ISLAND

*In charge:* R. R. Hurst; *Laboratory:* Charlottetown, P.E.I.

*Physical Nature*

1. Light versus darkness.

Potatoes were stored from February 27 to May 16 as follows:—

(*a*) In daylight at 60° Fahrenheit.
(*b*) In diffused illumination at 40° Fahrenheit.
(*c*) In darkness at 40° Fahrenheit.

At a temperature of 60° Fahr. the average daily relative humidity was 86 per cent. At 40 Fahr. the average daily relative humidity was 80 per cent. Tubers stored in the manner indicated above were examined critically and cut into 1½-ounce sets for observations on vigour of plants and yield, with the following results:—

STORAGE LOSSES OF POTATOES
(Physical Nature)

| — | Storage factors | | |
|---|---|---|---|
| | 60° Fahr. (daylight) | 40° Fahr. (diffused light) | 40° Fahr. (darkness) |
| Condition of sprouts—Appearance | Strong, no spindling | Strong, no spindling | Strong, no spindling |
| Length | 3 inches | 1½ inches | 1 inch |
| Percentage stand | 100 | 100 | 100 |
| Vigour | Good | Good | Good |
| Yield in bushels per acre* | 241·5 | 265·3 | 249·6 |

* Average of 3 replications of 40 plants each.

AIR SUPPLY IN RELATION TO STORAGE LOSSES

| Treatment number | Percentage rotted tubers | Percentage sound tubers | Condition of sprouts | | Texture of tubers |
|---|---|---|---|---|---|
| | | | Strong | Weak | |
| | | | % | % | |
| A | 0·7 | 99·3 | 98 | 2 | Moderately firm. |
| B | 3·0 | 97·0 | 95 | 5 | Soft. |
| C | 0·1 | 99·9 | 99 | 1 | Moderately firm. |
| D | 3·5 | 96·5 | 93 | 7 | Soft. |
| E | 0·0 | 100·0 | 100 | 0 | Firm. |
| F | 0·0 | 100·0 | 100 | 0 | Firm. |

*Organic Nature*

1. Importance of rot producing organisms.

Considerable attention was devoted towards identifying the organisms associated with rotted tubers in storage. This phase of the investigations was carried on in our laboratory storage basement and in one commercial storage house.

THE OCCURRENCE OF ROT IN STORED POTATOES

| Organisms | Variety | Per cent rotted tubers | |
|---|---|---|---|
| | | Laboratory storage | Commercial storage |
| *Phytophthora infestans* (Mont.) de Bary | Green Mountain | 0·50 | 0·50 |
| | Irish Cobbler | 0·25 | 0·65 |
| *Fusarium oxysporum* Schlecht | Green Mountain | 0·10 | 0·25 |
| | Irish Cobbler | 0·25 | 0·50 |
| *Bacillus phytophthorus* (Frank) Appel | Green Mountain | 0·11 | 0·0 |
| | Irish Cobbler | 0·10 | 0·25 |
| *Fusarium* sp | Green Mountain | 0·10 | 0·50 |
| | Irish Cobbler | 0·30 | 0·75 |
| *Alternaria Solani* (Ell. and Mart.) Jones and Grout | Green Mountain | 0·25 | 0·0 |
| | Irish Cobbler | 0·10 | 0·0 |

## B. 80.06. TESTING EFFECT OF NEW CHEMICAL SUBSTANCES ON THE CONTROL OF POTATO TUBER DISEASES

*In charge:* D. J. MacLeod; *Laboratory:* Fredericton, N.B.

MacLeod, D. J., and J. L. Howatt. Soil treatment in the control of certain soil-borne diseases of potatoes. Amer. Pot. Jour. 9: 60-61. 1934.

Tests conducted over a period of six years revealed that seed treatment with standard disinfectants failed to control *Rhizocontia Solani* Kühn. and *Actinomyces scabies* (Thaxt.) Güssow, satisfactorily on heavily infested soils.

Trials conducted over a similar period showed that mercuric and mercurous chlorides at the rate of 10 to 15 pounds per acre effected satisfactory control of *R. Solani and A. scabies* on heavily infested soils with an acid reaction. These compounds failed to control *R. Solani* and *A. scabies* satisfactorily on soils with a relatively high iron content, and were less effective on soils where potatoes were grown continuously for more than one year. Preliminary trials revealed that soils with a positive oxidation-reduction potential favoured the efficacy of the compounds.

*Rhizobium leguminosarum* Frank and *Clostridium butyricum* Prazmowski were not affected by the concentrations of the compounds used.

Mercuric and mercurous chlorides at the rate of 10 to 15 pounds per acre had no apparent deleterious effect on wheat, oats, barley, clover and timothy.

Potatoes grown on soils treated with mercuric and mercurous chlorides appeared to be more susceptible to *Phytophthora infestans* (Mont.) de Bary.

B. 80.10. A STUDY OF THE RELATIVE VALUE OF THE PRESENT FORMALIN, CORROSIVE SUBLIMATE AND OTHER TREATMENTS AGAINST COMMON SCAB AND RHIZOCTONIA

*In charge:* G. B. Sanford; *Laboratory:* Edmonton, Alta.

Hot formaldehyde, cold formaldehyde, mercuric chloride or Bayer No. 649, used as soak treatments, produced no perceptible effect in reducing common scab on the resulting crop in field culture. In sterilized soil of optimum moisture content *Actinomyces scabies* grew vigorously even when almost in contact with cores of potatoes treated with hot formaldehyde, cold formaldehyde, mercuric chloride or Bayer No. 649 solutions and with those coated with sulphur, Semesan Bel or Bayer No. 649 dusts. The planting of untreated scabby sets did not increase the amount of scab on the resulting crop. When sets were coated with a virulent culture of *A. scabies* only a slight amount of scab appeared on the new crop and then only on a few of the tubers which grew close against the old inoculated set. It is concluded that the methods now recommended for disinfecting seed potatoes to reduce common scab on the resulting crop are of no practical value under ordinary field conditions.

Sanford, G. B., and J. W. Marritt. The toxicity of formaldehyde and mercuric chloride solutions on various sizes of sclerotia of *Rhizoctonia Solani*. Phytopath, *23:* 271-280. 1933.

In the standard cold formaldehyde solution, strength 1-240, 2 per cent of the sclerotia of small size, 19 per cent of medium size, and 56 per cent of the large size were viable after being immersed for 2 hours. It required 390 minutes to kill all the medium sclerotia and 480 minutes for the large ones. Stronger solutions were increasingly effective for all sizes. The lethal period for the small, medium, and large sizes in strength 1-120 was 90, 180, and 270 minutes, respectively. The cold mercuric chloride solution, strength 1-834, was more efficient than any of the cold formaldehyde solutions used. The lethal period for the small, medium, and large sizes was about 30, 130, and 150 minutes, respectively, depending upon the texture. The acidulated mercuric chloride solution, strength 1-500 plus 1 per cent by volume of hydrochloric acid, killed all the small sclerotia in 3 minutes and the medium size in 5 minutes. Eight per cent of the large size were still visible after 5 minutes and 2 per cent after 13 minutes. Treatment in strength 1-834 killed the small sclerotia, but a rather high percentage of the medium and large sizes grew. Evidence from plating treated sclerotia showed that where small or medium sclerotia are concerned, the solution of either acidulated or non-acidulated mercuric chloride was effective up to the fifth successive treatment, and, for practical purposes, probably up to the eighth by extending the time.

B. 80.11. DATE OF DIGGING POTATOES IN RELATION TO DEGREE OF INFECTION WITH RHIZOCTONIA

*In charge:* R. R. Hurst; *Laboratory:* Charlottetown, P.E.I.

The data gathered in 1932 and 1934 coincided in a large measure with the results obtained from similar experiments conducted during the three previous years, and from these findings it may be inferred that the practice of early digging reduced the amount of rhizoctonia infection very materially as indicated by the number of sclerotia on the tubers when dug. Results for the year 1932 were particularly significant, for on September first Irish Cobblers were entirely free from sclerotia while traces only appeared on tubers of the Green Mountain

variety. Subsequent diggings demonstrated that infection became increasingly heavy as the season advanced, reaching its maximum on the sixth digging date (October 6).

The first two diggings (September 1 and 8) resulted in comparatively low yields, which, due to the earliness of the season, were in accordance with expectations. The highest yields with greatest freedom from rhizoctonia came from the third and fourth diggings; a noteworthy feature because of the apparent tendency towards increased development of sclerotia on tubers harvested on these dates. In other words, it would seem that from the standpoint of rhizoctonia control and considering the yield obtained, potatoes may be dug with profit on or about September 15. The findings indicate further that as the season advances past this date greater difficulty is experienced in the production of disease-free potatoes, a matter of great importance to the producer of Certified Seed Potatoes.

## Virus Diseases of Potato: Project Group No. 81.00

### B. 81.02. THE IDENTITY, TRANSMISSION, VARIATION AND CONTROL OF VIRUS DISEASES

*In charge:* D. J. MacLeod; *Laboratory:* Fredericton, N.B.

An examination of tubers affected with leafroll (Green Mountain) indicated that phloem necrosis is a current year symptom of this disease.

Investigations with plant filters showed that *Petunia major* carried the whole complex of rugose mosaic and Bliss Triumph mosaic. *Petunia hybrida* Vilm., *Lycopersicon esculentum* Mill., *Solanum nigrum* L. and *Nicandra physalodes* (L.) Pers. are susceptible to the whole complex of Quanjer's crinkle (Green Mountain). *Datura Stramonium* L. is susceptible to only one component of this disease.

The thermal death point of aucuba mosaic (Irish Daisy) was found to be 60° and the dilution tolerance 1-150.

A mosaic attacking *Rosa* spp. was transmitted to *Nicotiana Tabacum* L.

A survey of aphides conducted co-operatively with the Dominion Entomological Laboratory at Fredericton in 198 potato fields revealed that *Macrosiphum solanifolii* Ashm. occurred abundantly, *Aphis abbreviata* Patch, to a lesser extent and *Myzus persicae* Sulz. and *Myzus pseudosolani* Theob. in insignificant numbers.

### B. 81.08. THE RATE OF SPREAD OF VIRUS DISEASES

*In charge:* C. Perrault; *Laboratory:* Ste-Anne, P.Q.

Plots planted with seed of the third and fourth generation show a larger annual increase of mosaic than plots of the first and second generation.

Application of nicotine sulphate does not seem to exert any control on the spread of mosaic in the field.

The original rate of infection of 1 to 5 per cent does not seem to influence, under our conditions, the rate of spread of mosaic in the plots.

Certain potato plants, neighbouring mosaic hills for the last four years, have not contracted the disease while others more distant, strangely show decided mosaic symptoms from the very first year of growth.

### MISCELLANEOUS VIRUS DISEASES OF POTATOES

*Spindle Tuber and Giant Hill*

R. R. Hurst, Charlottetown, P.E.I.

The spindle tuber disease of potatoes is an important problem in Prince Edward Island although very gratifying advances have been made towards its suppression through the effective operation of the Seed Certification Service.

*Spread of Spindle Tuber by Seed-Piece Contact*

Field tests conducted in the year 1931 gave strong indications that spindle tuber could be spread by means of seed-piece contact. In 1932, 1933 and 1934 experiments were continued in the greenhouse and contamination was made positive by rubbing the cut surface of healthy sets against the cut surface of sets from tubers known to be infected with spindle tuber. Results indicated that spindle tuber was spread through set contact and that this agency no doubt accounted in a very great measure for dissemination of the disease. In consequence, therefore, field tests have been resumed in 1933 and 1934 and again the results demonstrated the effectiveness of contaminated sets in spreading spindle tuber. One hundred freshly cut sets from spindle tuber potatoes were marked indelibly for identification purposes and shaken up thoroughly in a basket with 560 healthy sets also freshly cut. At intervals of one-half hour 56 of the unmarked sets were removed and planted immediately. The sets used for inoculation purposes were planted immediately after the fifth removal. Irish Cobblers were thus treated, sets only from the same variety being used for inoculations.

Tests on the role of the cutting knife in spreading spindle tuber were as follows:—

SPREAD OF SPINDLE TUBER BY CUTTING KNIFE

(Greenhouse Tests)

| — | Number of healthy plants | Number of spindle tuber plants | Percentage number of plants infected | Number of spindle tuber hills |
|---|---|---|---|---|
| | | | % | |
| Using 100 sets inoculated | 66 | 34 | 34 | 34 |
| Using 50 sets not inoculated (checks) | 50 | 0 | 0 | 0 |

SPREAD OF SPINDLE TUBER BY CUTTING KNIFE

(Field Experiments)

| — | Number of healthy plants | Number of spindle tuber plants | Percentage number of plants infected | Number of spindle tuber hills |
|---|---|---|---|---|
| | | | % | |
| Using 300 sets inoculated | 252 | 48 | 19·0 | 48 |
| Using 150 sets not inoculated (checks) | 150 | 0 | 0·0 | 0 |

In the set contact tests all of the inoculum sets from spindle tuber potatoes produced spindle tuber plants. Furthermore, all of the plants from uninoculated sets were healthy, whilst in the set contact tests infections ranged from 1·8 per cent to 11·1 per cent, there being no indication of spindle tuber in the plants produced from the sets removed at the 1½ hour and 4 hour intervals. In reference to the experiments on the possible role of the cutting knife in transmitting spindle tuber the 34 per cent and 19 per cent infections obtained in the greenhouse and in the field respectively, would indicate further that the suppression of spindle tuber is very largely contingent upon the ability of the farmer to detect spindle tuber potatoes and remove them from his seed supply.

To date there is conclusive evidence pointing to the picker points of potato planters as agents causing the spread of spindle tuber.

Giant hill of potatoes has been reported from a number of sections throughout the province, although, because of its rare occurrence, percentage amounts have not been determined. In appearance affected plants have unusually large tops with the youngest leaves showing a tendency to roll inwards from the midrib. Such plants retain their vitality for some time after the surrounding plants are dead. The tubers are always few in number, usually rough and oversized and very frequently wasp-waisted.

Sanford, G. B. A malady of the potato in Alberta similar to psyllid yellows. Sci. Agric. *15:* 46-48. 1934.

There is in Alberta a malady of the potato which appears to resemble psyllid yellows, recently described by Richards and Blood, and said by them to be destructive in Utah, U.S.A., and present in certain neighbouring states. They found the malady to be associated with the feeding on the vines of nymphs (only) of *Paratrioza cockerelli* Sulc. As to its seriousness, they state: "Psyllid yellows, in its effect upon the plant, must be ranked among the most destructive of known potato diseases." When the plant is attacked during early stages of tuber formation no crop results, and early death of the plant frequently ensues. They also state: "The symptomology of psyllid yellows varies greatly with the number of insects feeding, the length of feeding period, and the intensity and duration of light exposure during the time of feeding," and further: "Psyllid yellows is systemic and affects the form and physiology of the entire plant." Each year from 1919 to 1922, inclusive, in 1924, and from 1927 to 1933, a disease similar to the foregoing description has appeared in central Alberta, and a severe and typical outbreak involving over 100 acres occurred at Medicine Hat in 1932. Tubers from affected plants were found by experiment not to transmit the malady.

## Foliage Diseases (Blights, etc.); Project Group No. 82.00

### B. 82.01. RESISTANCE STUDIES OF IRISH COBBLER AND GREEN MOUNTAIN STRAINS FOR LATE BLIGHT AND VIRUS DISEASES

*In charge:* R. R. Hurst; *Laboratory:* Charlottetown, P.E.I.

#### (*a*) *Late Blight Resistance*

A number of varieties, strains and seedlings have been collected showing qualities of blight resistance.

In the field tests one section was sprayed regularly with Bordeaux mixture while another duplicate section was left unsprayed except for the necessary applications of arsenicals against insects. The season was especially favourable for blight to which the plants exhibited most striking degrees of tolerance. The crop was harvested two weeks after the tops were destroyed by frost and the disease counts were made two weeks later.

Comparing the results from the sprayed and unsprayed plots it was found that several seedlings were unaffected by blight while others showed varying degrees of resistance. It is the unconfirmed belief that resistance in most cases should refer rather to the plants than to the tubers, although our labora-

tory tests have demonstrated that the tubers of certain seedlings have power to resist blight infection as follows:—

COMPARATIVE DEVELOPMENT OF THE LATE BLIGHT FUNGUS ON UNCOOKED STERILE TISSUE FROM SEEDLING TUBERS

| — | Seedling number | Degree of resistance |
|---|---|---|
| Foliage highly resistant | 3 | Susceptible |
| | 20 | Moderately resistant |
| | 42 | Highly resistant |
| Foliage resistant | 26 | Susceptible |
| | 30 | Susceptible |
| Foliage fairly resistant | 14 | Highly resistant |
| | 22 | Susceptible |
| | 33 | Moderately resistant |
| | 66 | Susceptible |

All of the blight resisting seedlings and varieties mature late in the season. Some are prolific, high in starch content, of good cooking qualities, agreeably flavoured and of good type. Seedling Number 66 is considered very promising.

*(b) Seed Potato Strains*

For some years past the Charlottetown Laboratory has attempted with some success to retrieve and maintain the original strains of the potato varieties which have been introduced since the inception of the Certified Seed industry in Prince Edward Island. Not only is it highly desirable to maintain the identity of these much favoured strains but also to ensure a constant available supply of disease-free stock, a matter of recognized difficulty even on the most carefully supervised potato farms. Most of the original varietal strains are now held at the Laboratory. Each winter they are eye-indexed and the disease-free material thus obtained is subsequently planted in field tests from which are gathered the facts pertaining to disease freedom, vigour, type, and yielding capacities.

### B. 82.02. CONTROL OF EARLY AND LATE BLIGHT

*In charge:* D. J. MacLeod; *Laboratory:* Fredericton, N.B.

In 1932 Burgundy mixture was superior to Bordeaux mixture and in 1933 the latter was superior to the former in the control of late blight. In 1932 and 1933 Bouisol was superior to Burgundy and Bordeaux mixtures. Bordeaux and Burgundy mixtures combined with Sulphoturk were superior to these fungicides alone or combined with ammonium linoleate and potassium abietate. All the fungicides tested in 1931, 1932 and 1933 failed to control early blight satisfactorily. There was a significant increase where Bouisol was applied. Slight decreases in yield occurred where the potassium abietate and ammonium linoleate were used.

### B. 82.03. THE VALUE OF BORDEAUX MIXTURE IN CONTROLLING LATE BLIGHT AND ITS EFFECTS UPON YIELD

*In charge:* C. Perrault; *Laboratory:* Ste-Anne, P.Q.

So far, results demonstrate that potato plots sprayed with Bordeaux yielded slightly more than unsprayed plots. Similarly, plots that received six sprayings yielded more heavily than those that received four sprayings only. In blight free years and when dry weather prevails in July, early sprayings, although discontinued at the end of July, seem to be more beneficial than late sprayings.

B. 82.04. LATE BLIGHT EPIDEMIOLOGY

*In charge:* R. R. Hurst; *Laboratory:* Charlottetown, P.E.I.

*Depth of Soil Covering in Relation to Late Blight Tuber Rot*

Very slight traces of blight were found affecting the plant tops in the plot which received the regular spray of Bordeaux mixture. By comparison of the results from the sprayed and unsprayed plots it was clear that the lighter soil coverings are conducive to tuber infection although this was materially reduced by Bordeaux mixture. While it is customary in farming practice to provide the growing potato tubers with a liberal covering of soil, nevertheless, it has been observed that disregard of this essential has led to considerable losses from blight. During the month of October, 1932, a survey was conducted to investigate this point and out of thirty-two fields in which examinations were performed an average of five per cent of the plants produced tubers showing through the ground, all of which had contracted blight.

Meteorological records show that during August and the first week of September, the possible infection period in the province, temperature and precipitation were higher during the late blight epidemic year of 1932 than in 1931, 1933, and 1934.

The strong winds from north, more frequent during the last two years than in 1932, seem to be an important factor in the late appearance of the disease and its spread in the lower St. Lawrence district.

## Other Potato Studies; Project Group No. 84.00

B. 84.01. DOMINION SEED POTATO CERTIFICATION SERVICE

*In charge:* John Tucker; *Central Laboratory:* Ottawa.

The following is a concise report on the work of the Seed Potato Certification Service for the four years ending December 31, 1934.

SUMMARY OF FIELD INSPECTIONS, 1931-1934

| Year | Number of applicants | Number of fields entered | Number of fields passed | Per cent passed | Number of acres entered | Number of acres passed | Per cent passed |
|---|---|---|---|---|---|---|---|
| | | | | % | | | % |
| 1931 | 7,796 | 11,309 | 9,133 | 80·7 | 38,424 | 32,592 | 84·8 |
| 1932 | 6,455 | 8,931 | 6,411 | 71·8 | 27,827 | 20,691 | 74·4 |
| 1933 | 5,297 | 8,019 | 6,088 | 75·9 | 24,358 | 18,602 | 76·4 |
| 1934 | 7,166 | 9,411 | 6,827 | 72·5 | 28,810 | 21,322 | 74·0 |

PRODUCTION AND SHIPMENTS, CERTIFIED SEED POTATOES

1931—Production approx. 6,200,000 bushels
Shipments approx. 2,250,000 bushels
1932—Production approx. 3,700,000 bushels
Shipments approx. 1,000,000 bushels
1933—Production approx. 3,200,000 bushels
Shipments approx. 1,200,000 bushels
1934—Production approx. 4,295,000 bushels
Shipments approx. 1,150,000 bushels

Approximately one-half of the total seed crop produced is ultimately sold for seed purposes, the rest is partly retained by growers for their own seed purposes and partly disposed of as table stock, the off-type and slightly damaged and defective material going as table stock. The shipments shown above refer to stock which has actually been shipped under official tags and does not include seed sold bin-run for local use, direct, and for which no tags were requisitioned.

The reduction in the acreage entered for inspection in 1932 and 1933 was largely due to economic conditions. The 1931 crop produced was largely in excess of the trade requirements and consequently the usual premium for seed over table stock was not obtainable, and large quantities of seed had to be disposed of at approximately table stock prices. The continued low prices obtainable for potatoes in 1932 resulted in a further decline in the seed potato acreage planted in 1933. The demand improved sharply for seed potatoes from the 1933 crop and there was barely sufficient seed available to meet the demands of the trade. This condition resulted in an increased demand for field inspections in 1934.

During the period under review every economy possible, without sacrificing efficiency, was practised. In 1933 and 1934, no applications for inspection on fields of less than one acre were accepted, except in the case of members of organized clubs engaged in potato improvement work and where necessary transportation was provided the inspector to visit the plots. No applications were accepted from outlying districts unless the acreage entered from such districts was sufficiently large to warrant the cost of sending an inspector into the district. This procedure enabled the service to be continued with a reduced staff, and a shorter period of service for the temporary inspectors employed, resulting in a substantial saving, but it is evident that no further reduction in cost is possible without serious risk of disorganizing this service.

The acres passed, by varieties, for the period 1931-34, were as follows:—

| Year | Green Mountain | Irish Cobbler | Rural New Yorker | Bliss Triumph | Other Varieties |
|---|---|---|---|---|---|
| 1931 | 15,008 | 13,167 | 1,499 | 1,779 | 1,139 |
| 1932 | 8,710 | 8,334 | 1,201 | 1,399 | 847 |
| 1933 | 6,761 | 8,891 | 1,278 | 785 | 887 |
| 1934 | 5,870 | 12,396 | 1,123 | 1,064 | 869 |

The particulars covering the percentage of the fields entered that were rejected for various reasons, are given in the following table:—

FIELD REJECTIONS 1931-34

PERCENTAGE OF THE FIELDS ENTERED

| Year | Mosaic | Black leg | Leaf roll | Foreign varieties | Adjacent to diseased | Poor culture, insects, etc. | Miscellaneous | Total |
|---|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % | % |
| 1931 | 7·7 | 1·5 | 0·7 | 2·5 | 2·0 | 0·7 | 4·2 | 19·3 |
| 1932 | 16·1 | 2·1 | 1·3 | 2·6 | 2·7 | 0·3 | 3·1 | 28·2 |
| 1933 | 13·4 | 0·9 | 1·4 | 2·4 | 2·9 | 0·3 | 2·8 | 24·1 |
| 1934 | 12·6 | 1·4 | 1·9 | 3·2 | 4·4 | 0·7 | 3·3 | 27·5 |

In addition to the actual inspection work, which includes two field inspections on the growing crop, the tuber inspections in the storages and final shipping inspections, the preparation of official reports on each lot inspected, the issuance of approximately one million stamped and dated official tags annually, and the issuance of several thousand Health and Special Seed Certificates (required by some foreign countries), there were other seasonal activities undertaken by the inspectors, as follows: The usual demonstration plots were planted

in every province each season for the study of potato diseases and for the identification of varieties, strain tests and seed treatment tests; field demonstrations at the regular field day and organized potato club tours to illustrate the value of using disease-free seed; inspection of several hundred plots planted to certified seed by junior farmers in various competitions, thereby establishing practical co-operation with the provincial agricultural authorities in every province in this regard; assisting at special organized potato meetings, etc.; the judging of potatoes at fall fairs and exhibitions; the preparation and setting up of exhibits; tuber index work at some experimental and selected farms, etc.

Lists of growers having seed for sale are prepared and distributed to those known to be in the market for certified seed, and a considerable portion of the crop is disposed of by this method of bringing the producer and the consumer together. Copies of field reports are issued, on request, to responsible persons wishing to know the field readings of any particular seed potato crop in which they may be interested, as prospective purchasers. These additional services appear to be very much appreciated by the trade, and are in increasing demand.

### B. 84·02. THE ISOLATION IN TUBER LINES OF DISEASE-FREE AND HIGH-YIELDING POTATOES

*In charge:* W. K. McCulloch; *Laboratory:* Kentville, N.S.

The aim of this project was to test the control of virus diseases by means available to the farmer, and to make available for distribution small lots of high-grade foundation stock.

It has not been found possible, under conditions at Kentville, to hold any particular tuber line free from virus diseases for long.

Aphid infestation was very severe during the period under review and all varieties were infected. Bliss Triumph and Green Mountain suffered most severely. Irish Cobbler and Early Rose, which matured before aphid infestation was at its height, escaped with a lighter infection.

Various trials looking to the control of virus diseases resulted as follows: (1) The addition of nicotine sulphate to the Bordeaux spray did not improve matters. (2) As a site for foundation-stock plots North Mountain proved much superior to Kentville, and of much economic importance. (3) Cutting off the tops of plants during the growing season gave complete control of virus in the case of Irish Cobbler and Early Rose and partial control in the case of Green Mountain. In the case of the latter the unexpected growth of shoots on the stubs provided a further opportunity for aphids. (4) Many varieties were tried, both old and new, without any marked resistance to virus diseases being noted.

Pursuit of the second aim of this project met with considerable success. From time to time small lots of Bliss Triumph, Irish Cobbler, Early Rose, Green Mountain and Dakota Red were sent out.

Bliss Triumph has a notable record in this regard. Small lots from the Kentville tuber lines were multiplied in Pictou and Cumberland counties, then purchased by Kings county growers and transferred to North Mountain. In 1932, five years from the time the seed was first sent out, a crop of about 50,000 bushels of Extra No. 1 Certified Seed was grown and exported. Owing to the vagaries of the potato trade only enough seed was retained to plant 40 acres in 1933, and about 80 acres in 1934.

### B. 84·07. CUT SEEDS VERSUS WHOLE SEED IN B.C.

*In charge:* Walter Jones; *Laboratory:* Saanichton, B.C.

Jones, Walter. Soft rot of potatoes caused by *Pythium ultimum* Trow. Sci. Agric. *15:* 402-410. 1935.

The fungus, *Pythium ultimum* Trow., has been found to cause a soft rot of potato tubers before harvest, in storage, and in cut sets after planting in the spring.

The following conditions for the growth of the fungus have been established: optimum temperature, 25-31° C.; max. temp. 40° C.; min. temp., 4° C.; opt. pH, 6-8; max. pH, 9; min. pH, 3-4.

When freshly cut sets were planted in soil inoculated with this fungus complete disintegration of the sets occurred in the fifteen potato varieties under investigation within four days. Uninjured tubers were not affected.

Treating cut sets with mercuric chloride solutions and pastes and with sulphur dusts did not check infection. Infection of cut sets increased when allowed to dry out for 48 hours before planting, but conspicuously decreased when suberized by maintaining them in an atmosphere of high humidity for the same length of time. Infection was less when freshly cut sets were planted in a moderately dry compared with a moist soil.

### B. 84·10. THE CAUSE OF MISSES IN POTATO FIELDS

*In charge:* R. R. Hurst; *Laboratory:* Charlottetown, P.E.I.

From investigations conducted in the years 1931 and 1932 factors contributing to poor stands were determined as follows:—

1. Seconds were used as seed.
2. Seed-pieces were constantly found with no eyes.
3. Fertilizer injury to seed-pieces.
4. Inefficient working of mechanical planters.
5. Improper care of cut sets.
6. Backward weather conditions after seeding.
7. The use of small seed tubers.
8. Failure to disinfect seed tubers.
9. Unfavourable location of eyes in seed-pieces.
10. Sprout infection.
11. Late blight infected seed-pieces.

In 1933 the laboratory was called upon to investigate a number of cases of poor stands, most of which were attributed to a combination of the above listed agencies. Of unusual interest was one very striking instance of a poor stand being due to the combined action of rhizoctonia and potash, the latter being formed following the burning of hardwood tree stumps on the reclaimed land given over to the crop. Inasmuch as the field was planted with seed treated by the bichloride method it is believed that the rhizoctonia fungus was part of the native flora of the soil. The virulence of this fungus was such that countless numbers of the young sprouts were destroyed, giving rise in many cases to the growth of seed-piece tubers which in turn became infected. Actual counts in this particular field set the amount of misses at 75 per cent, 50 per cent of which were due to rhizoctonia injury, while 25 per cent were caused by the caustic affect of the potash in the land. So active was the potash, in fact, that seed-pieces, stolons, sprouts and many tiny tubers were destroyed. Even moderately large tubers exhibited typical evidence of potash injury.

### B. 84·12. TESTING NEWLY DEVELOPED STRAINS AND VARIETIES OF POTATOES FOR RESISTANCE TO COMMON POTATO DISEASES

*In charge:* D. J. MacLeod; *Laboratory:* Fredericton, N.B.

Tests conducted over a period of five years showed that the Paisley Forty-fold variety was slightly resistant to *Phytophthora infestans* (Mont.) de Bary, and is a late maturing type resembling that grown in Europe under the name of President.

Tests over a similar period showed that the Katahdin variety developed by the United States Department of Agriculture was resistant to mild mosaic but quite susceptible to leaf roll.

Twenty-five thousand seedlings developed by the Fredericton Experimental Station were tested for resistance to mild mosaic. Three thousand two hundred and twenty-two of these showed no symptoms of the disease.

### B. 84.14. THE USE FOR SEED OF POTATOES PREVIOUSLY EXPOSED TO FREEZING TEMPERATURES

*In charge:* R. R. Hurst; *Laboratory:* Charlottetown, P.E.I.

Hurst, R. R., and H. L. McLaren. Some observations on the sprouting habits of potato tubers exposed to low temperatures. Am. Pot. Jour. *11:* 123-127. 1934.

1. From a series of tests designed to study the reaction of potato tubers subjected to low temperatures it was clearly evident that sprouting tendencies were influenced very largely by the duration of the exposure.

2. At an air temperature of 24° F. tubers exposed for 60 minutes produced sprouts of slightly greater vigour and size than did the unexposed check tubers. Sprouting capacity, however, was affected adversely by exposures at lower temperatures.

3. Definite relationships were indicated with respect to length of sprouts and duration of exposure. In general it would appear that the longer exposures were detrimental, especially at the lower temperatures, thus, exposure at 11° F. for 25 minutes arrested sprout growth and caused necrosis and exterior spotting.

*Investigations 1934*

1. Sprouting tendencies were influenced by the intensity of the exposures. There was no evidence in the sprouting habits to show that potatoes are injured if exposed for 120 minutes at temperatures from 21° to 30° F.

Injury due to exposures at low temperatures are represented by a marked reduction in the length of sprouts.

2. Interior injury to potatoes subjected to low temperatures coincided appreciably with retarded sprouting.

3. In the present tests tuber temperatures before exposures varied from 45° to 55° and after exposures from 22° to 35° F. Tuber temperatures were comparatively high at the termination of exposures so severe as to cause the destruction of the tubers. On six occasions only, the tuber temperature dropped below 30° F. Strong air currents during certain exposure periods may have been responsible in a large measure for the final lower tuber temperatures. In spite of potential hardships on account of exposures at low temperatures the detrimental effect was not so serious as one might anticipate.

4. The greater tuber temperature depressions coincided with the most severe tuber injuries.

5. Air temperatures of 18 degrees and lower were detrimental with respect to stand, and especially so following exposures of 20 minutes and longer, a feature more noticeable at temperatures ranging from one degree to five degrees. Temperatures from 16 degres to 20 degrees with exposures up to 30 minutes exerted a detrimental effect upon the stand. Lower exposures up to one hour coincided with excellent stands. Tubers exposed at 21° to 31° gave indications of having lost nothing in vitality even after exposures of two hours.

In general the stand of potatoes does not appear to be impaired if the seed tubers have been exposed from 5 minutes to 2 hours at 21° to 31° F., inclusive.

## VEGETABLE DISEASE INVESTIGATIONS

### Tomato Diseases: Project Group No. 90.00

#### B. 90.03. TOMATO STREAK RESEARCH

*In charge:* G. H. Berkeley; *Laboratory:* St. Catharines, Ont.

Research work under this project during 1931 and 1932 was centred mainly around the possibility of seed transmission. Considerable success was obtained and two papers were published in Scientific Agriculture, the first in November, 1932, (1) and the second in March, 1933 (2). The results recorded in these papers demonstrate that both streak and mosaic may be seed-borne, though it would appear that this does not always occur, since many negative results were obtained during the course of the experiments. On the other hand as high as 66·6 per cent mosaic and a similar per cent streak have been obtained by inoculations with embryos from seed of mosaic and streak plants. During 1933 a special opportunity presented itself of co-operating with the Rothamsted and Cheshunt Experimental Stations in England in a study of Canadian tomato mosaic and tomato streak, in comparison with similar diseases as found in England. The results of this study have been published (3). The most important fact brought out of this study is that streak in Ontario is for the most part due to a single virus, not a mixture of viruses.

#### B. 90.06. THE INFLUENCE OF ENVIRONMENT ON TOMATO DISEASES

*In charge:* Wm. Newton; *Laboratory:* Saanichton, B.C.

Bosher, J. E. and W. Newton. Host preference of the root-knot nematode. Plant Disease Reporter *17:* 18-19. March 1, 1933.

Lobelia (*L. erinus* var. *gracilis*) only was found infested with a non-specialized form of root-knot nematode (*Caconema radicicola*) in an intimate plant association with the geraniums, *P. hortorum* and *P. peltatum, Chrysanthemum frutescens* and *Nepeta hederacea.*

Bosher, J. E. An outdoors infestation of root-knot nematode in British Columbia. Plant Disease Reporter *17:* 105-106, July 15, 1933.

The root-knot nematode, *C. radicicola,* caused considerable damage to an outdoor field of lettuce near Victoria, B.C., in 1933, and the infestation could not be traced to greenhouse source. Although root knot has been classified only as a parasite of greenhouse crops in Canada, this infestation appears to have survived for several years out of doors.

### Other Vegetable Diseases: Project Group No. 91.00

#### B. 91.01. THE CONTROL OF LATE BLIGHT OF CELERY

*In charge:* J. K. Richardson; *Laboratory:* St. Catharines, Ont.

Each summer since 1931 field experiments have been conducted in an endeavour to determine the most satisfactory fungicide to use for controlling late blight of celery. The following fungicides, with and without spreaders, have been tested: Burgundy mixture, Bordeaux mixture, copper-lime dust, a colloidal copper compound, Kolofog, Koloform, lime sulphur and sulphur-lime dust.

(1) Berkeley, G. H., and G. O. Madden. Transmission of streak and mosaic diseases of tomato through seed, I. Sci. Agric. *13:* 194-197. 1932.
(2) Berkeley, G. H., and G. O. Madden. Transmission of streak and mosaic diseases of tomato through seed, II. Sci. Agric. *13:* 455-457. 1933.
(3) Ainsworth, G.C., G. H. Berkeley, and J. A. Caldwell, comparison of English and Canadian tomato virus diseases. Annals of Applied Biology *21:* 566-580. 1934.

Although weather conditions have varied considerably the disease has always been prevalent in the control plots and the various compounds have shown a wide variation in their disease-controlling ability. Burgundy mixture, Bordeaux mixture and copper-lime dust have all given good commercial control of the disease, with their efficiency in the order mentioned. The addition of a spreader appears to increase the efficiency of Bordeaux mixture. The sulphur compounds proved useless as fungicides for controlling this disease.

### B. 91.02. FUSARIUM BULB-ROT OF ONIONS

*In charge:* G. E. Woolliams; *Laboratory:* Summerland, B.C.

The results obtained were in conformity with the earlier findings indicating that this organism is largely confined to the species *Allium Cepa*, and that among the best horticultural varieties of this species there are none which show a very high resistance except the Bermuda varieties.

On a seven-acre block, by following a crop rotation of two years in onions, one year in corn and three years in alfalfa, the amount of infection has been reduced from approximately 40 per cent to 1 per cent. The acreage production rose from 6 tons per acre in 1927 to 15 tons in 1932 and 16½ tons in 1933.

### B. 91.03. EGGPLANT WILT

*In charge:* J. K. Richardson; *Laboratory:* St. Catharines, Ont.

A paper on this subject was published in 1933. The disease is a typical wilt and may involve the whole or part of the plant. It is caused by the fungus *Verticillium Dahliae* Kleb., which produces a vascular discoloration of affected tissues. The pathogen will grow between 8°C. and 34°C. and within the range of pH 2·3 to 9. The application of mercuric chloride to the soil retards the progress of the disease.

Since the publication of this paper numerous additional control experiments have been conducted and from the results obtained there is promise that the proper application of cyanamid in the soil may reduce the amount of disease to a considerable extent. Each year attempts have been made to select strains of plants in the field which exhibit resistance to the disease, but to date only negative results have been obtained.

### B. 91.06. CELERY BLACK HEART

*In charge:* J. K. Richardson; *Laboratory:* St. Catharines, Ont.

Celery diseases of this type have been most generally reported as due to physiological conditions, but bacteria and insects have also been held responsible for the trouble.

In the Niagara Peninsula the physiological disease causes the greatest damage. It develops mostly in the early planted celery just before the crop is mature and appears to be due to an unfavourable moisture and temperature relationship between the host and its environment. Succulent, vigorously-growing plants are more susceptible to the disease than those exhibiting a slower, harder type of growth. Under favourable conditions plants frequently outgrow the disease after the first appearance of the symptoms. Bacterial soft rot has been observed to a small extent, but the damage is largely secondary, the infection either completing the decay initiated by black heart or causing a rot following insect injury.

The disease has been artificially produced by subjecting plants to conditions of abnormal temperature and humidity, but little information has been gleaned from soil moisture and fertilizer tests.

(1) Richardson, J. K., Eggplant wilt. Sci. Agric. *14:* 120-130. 1933.

### B. 91.07. CONTROL OF NECK ROT OF ONIONS

*In charge:* G. E. Woolliams; *Laboratory:* Summerland, B.C.

By use of slatted crates in comparison with the regular standard sacks, the losses from neck rot in 1930-31-32 were reduced as follows: 32·0 per cent to 4·2 per cent; 68·7 per cent to 3·8 per cent; and 50·3 per cent to 27·5 per cent. An attempt to control the disease by exposing bulbs to fungicidal gases have not as yet shown much beneficial effect. The gases used were vaporized sulphur, hydrogen sulphide, sulphur dioxide, ammonium hydroxide, ammonium carbonate, ammonium sulphide, carbon tetrachloride, ethylene chloride, sulphurous acid, hydrochloric acid, methyl alcohol, furfural, cresylic acid, acetyl chloride, methyl acetate, toluene, acetaldehyde and ethylene chlorohydrin.

### B. 91.08. ALTERNARIA DRY ROT OF EGGPLANT

*In charge:* J. K. Richardson; *Laboratory:* St. Catharines, Ont.

In September, 1933, eggplant fruits were noticed which exhibited rather large lesions differing from anything hitherto observed. They were from one-half to one and one-half inches across, considerably depressed and covered to within one-quarter of an inch of their margins with an olivaceous black spore mass of *Alternaria* sp. The remaining outer ring was considerably darker than the surrounding healthy purple tissues. Cross sections of the lesions showed a dry rot extending into the tissues for a distance up to three-quarters of an inch. The affected tissues were leathery in consistency and varied in colour from amber to almost black, the darker shades predominating. Successful artificial inoculations have been made both in the field and under greenhouse conditions.

### B. 91.09. STEWART'S DISEASE OF SWEET CORN

*In charge:* G. H. Berkeley; *Laboratory:* St. Catharines, Ont. (In co-operation with Ontario Department of Agriculture and Department of Bacteriology, Ontario Agricultural College, Guelph.)

This bacterial disease of corn was encountered for the first time in Ontario in 1932. A survey covering the counties in Southwestern Ontario and those bordering Lake Ontario revealed that the disease was general and severe in Essex, Kent and Norfolk counties where many plantings showed infection ranging from 5 to almost 100 per cent. In the other counties the disease was unimportant, a few scattered cases only being found in Elgin, Huron, Lambton, Brant, York, Middlesex, Halton, Wentworth and Lincoln counties.

The disease proved to be most severe on the early planted varieties of sweet corn. It was also found in plantings of field corn but to a much smaller extent and one instance of the disease was noted in a planting of pop corn. In most cases investigated the disease could be traced to infected seed imported from the U.S.A., and undoubtedly the disease was introduced into Ontario in this way. From data collected from the survey it was concluded that the disease had been in Ontario for at least two years.

In 1933 a limited survey[1] of those districts where the disease was epidemic in 1932 showed that while the disease could be readily found, the severity was much less than in 1932. Only one instance in Kent county was noted where the disease was a serious factor with an infection of 60 per cent. In the majority of cases the percentage of infection was small. It is a matter of interest to note that a number of growers who suffered heavy losses in 1932 had abandoned the planting of sweet corn in 1933.

The losses caused by this disease were heavy. It is thought, however, that it is not likely to become one of annual occurrence in severe form but is

[1]Made by G. C. Chamberlain.

more likely to occur in epidemic form, only spasmodically when certain climatic conditions are favourable. Selection of seed for freedom from disease, obtaining seed from disease-free sources, or the use of resistant varieties are the main measures that may be used in the control of Stewart's disease. A few trials of supposedly resistant seed of hybrid sweet corn were carried on in 1933. Of these, Golden Cross Bantam and No. 1413 showed good resistance but were from ten days to two weeks later in season than the commonly grown varieties, which, from the growers' standpoint, is a distinct disadvantage.

### B. 91.10. TIPBURN OF LETTUCE

*In charge:* G. E. Woolliams; *Laboratory:* Summerland, B.C.

The influence of the following factors on the production of tipburn have been studied: shade, various colours of the spectrum, Hotkaps, and various chemicals applied as fertilizers and as sprays. A test has also been made of a new variety of lettuce known as hybrid T.B.R., developed by the Colorado Experiment Station. The results obtained to date indicate that shading, as produced by a cloth screen, has a slight benefit in reducing the amount of disease, while the use of Hotkaps increases the disease. The Hybrid T.B.R. appears to be slightly resistant. The influence of various light rays and of different chemicals has not yet been sufficiently investigated to warrant the drawing of any conclusions.

## MISCELLANEA

## Project Group No. 100.00

### B. 100.01. SURVEY OF THE PLANT DISEASES OCCURRING IN CANADA

*In charge:* I. L. Connors; *Central Laboratory:* Ottawa.

Observations on the occurrence of plant diseases in Canada have been summarized in the following mimeographed reports:—

Conners, I. L., and Eardley, E. A., Annual Report on the Prevalence of Plant Diseases in the Dominion of Canada 10(1930): i-v, 1-102. 1931.

Conners, I. L., Annual Report of the Canadian Plant Disease Survey 11(1931): i-ii, 1-130. 1932.

Conners, I. L., Annual Report of the Canadian Plant Disease Survey 12(1932): i-ii, 1-112. 1933.

Conners, I. L., Annual Report of the Canadian Plant Disease Survey 13(1933): i-ix, 1-128. 1934.

The report for 1934 is now in preparation.

Bunt, or stinking smut of wheat has greatly decreased in prevalence since 1930, in Western Canada, although it was more prevalent in 1934 than in 1933. Bacterial wilt or Stewart's Disease (*Pseudomonas Stewartii*) caused severe damage to sweet corn in south-western Ontario upon its first appearance in Canada in 1932. Stem-end hard rot (*Phomopsis tuberivora*), a new disease of potato, was found on Vancouver island and in the Fraser River valley, B.C. Spotted wilt, a serious virus disease of tomato in Australia and England, has been reported from Saskatchewan and Ontario.

#### *Root-Rot Survey in Saskatchewan*

In 1931 a total of 385 fields was surveyed: wheat 293, oats 49, barley 24, rye 14, and flax 5. Take-all was prevalent in districts where moisture was plentiful. Pre-maturity blight was found in 12 per cent of the wheat fields examined; a trace was found in oats. Browning root-rot was not widespread. Common root-rot was prevalent with some severe cases in the older wheat fields.

In 1932 a total of 418 fields were surveyed, 298 of wheat, 27 of barley, 77 of oats, 8 of rye, and 8 of flax. Take-all was found in 54 wheat fields with injury varying from a trace to moderate. There were only a few cases of pre-maturity blight. Browning root-rot was observed in 31 wheat fields with injury varying from a trace to about 20 per cent. Common root-rot injury varied from slight to moderate and was found in the majority of the wheat, oats, barley and rye crops examined.

In 1933, the number of fields examined amounted to 176, 137 of wheat, 31 of oats, 6 of barley and 2 fields of rye. Take-all was slight this season. Browning root-rot appeared in epidemic form in the Saskatoon and adjacent districts. Affected crops were retarded and later the situation was aggravated by drought. Injury from the disease in many cases was severe. Common root-rot was prevalent and severe cases were reported for 67 of the wheat fields examined. It was frequently observed that plants suffering from drought bore conspicuous common root-rot lesions.

In 1934 the fields surveyed consisted of 270 of wheat, 72 of oats, 22 of barley and 9 fields of rye making a total of 373 fields. A slight amount of take-all root-rot was found in 16 wheat fields. One field near St. Gregor had about 2 per cent of the plants killed. Pre-maturity blight was found in a few fields of wheat, oats, and barley, being slight in every case. Browning root-rot was confined to limited areas appearing in epidemic form in wheat fields around Watson and Lac Vert. Moderate attacks were reported from Lanigan, Davidson, and Indian Head. Common root-rot was prevalent. It was reported as occurring in 251 wheat fields, being severe in 7, moderate in 91 and slight in the remainder. Infections appeared to be most severe in areas badly affected by drought.

### B. 100.02. DETERMINATION OF DISEASES OF INTERCEPTED PLANT IMPORTATIONS

*In charge:* A. J. Hicks; *Central Laboratory:* Ottawa.

During the four-year period a total of 3,699 shipments of plants and plant products was intercepted by the inspectors of the Division of Foreign Pests Suppression because of the presence of disease. Samples from each of these shipments were submitted to the Division of Botany for identification of disease, disposal of the shipment being dependent upon the pathologist's findings.

### B. 100.08. ROOT-ROT OF GINSENG

*In charge:* A. A. Hildebrand; *Laboratory:* St. Catharines.

Hildebrand, A. A., Root-rot of ginseng in Ontario caused by members of the genus *Ramularia*. Accepted for publication by The Canadian Journal of Research.

Two destructive diseases of the roots of ginseng *Panax quinquefolium* L., have assumed economic importance in Ontario. The more destructive of the two diseases, commonly known as the disappearing-rot, is characterized by the fact that affected roots may in a relatively short time either completely disappear in the soil or leave as evidence of their presence only a peridermal shell enclosing fragments of vascular tissue. The disease is caused by at least three representatives of the genus *Ramularia*, one of which has been identified as *R. panacicola* Zins., and the other two being new to science, are described as new species for which are proposed the binomials *R. Mors-Panacis* and *R. robusta*. They appear to persist in the soil indefinitely either saprophytically or in a dormant condition.

The cause of the other serious but less destructive disease known as the rust has not been definitely established but the evidence suggests that it is probably also caused by representatives of the genus *Ramularia*.

In regard to control, rotation and rigid sanitation are the only measures suggested, resistant varieties not having been encountered.

In the present work a large number of additional representatives of the genus have been isolated from similar lesions on various other hosts. Cross-inoculations indicate variations in pathogenicity among the isolants and specificity in host relationships.

### B. 100.13. TESTING EFFICIENCY OF STANDARD SPRAY MATERIALS

*In charge:* Wm. Newton; *Laboratory:* Saanichton, B.C.

Newton, W., and H. I. Edwards. Chemical compounds lethal to yeasts and bacteria. Sci. Agric. *12:* 564-573. 1932.

Using a yeast as the test organism, the lethal concentrations of a number of chemicals were determined. These values are recorded together with a list of compounds that are not lethal at relatively high concentrations. Similar values were obtained when *Bacterium Juglandis,* an important plant pathogen, was used in place of the yeast as the test organism.

The exceptionally high phenol coefficient of potassium permanganate has been suggested as the probable reason why the fungicidal efficiency of sulphur dust can be greatly increased by the inclusion of a small proportion of permanganate dust.

Newton, W., and J. E. Bosher. The Tomato Root Knot Disease. Sci. Agric. *13:* 594-595. 1933.

A 1 per cent formalin solution (a 0·4 per cent formaldehyde solution) effectively controlled the root-knot nematode and appeared to stimulate the growth of the seedlings. Lower concentrations, 0·5 per cent and 0·25 per cent were not effective in preventing infection. Calculated from the experiments, one gallon of commercial formalin (100 gallons of solution) will effectively sterilize 50 cubic feet of soil.

Other compounds lowered the incidence of infection but did not effectively prevent infection.

### B. 100.14. HOP DISEASE RESEARCH

*In charge:* Walter Jones; *Laboratory:* Saanichton, B.C.

Jones, W. A new technique for obtaining oospores of the hop downy mildew by inoculating cotyledons. Science (N.S.), *75:* 108. 1932.

By inoculating cotyledons and primary leaves of hop seedlings, kept under humid conditions, with conidial suspensions of downy mildew (*Pseudoperonospora humuli*), abundant oospores were produced in the tissue. Conidia were also produced. Oospores and conidia for experimental use in the laboratory during the winter months may be obtained by this method.

Jones, W. Downy mildew infection of hop and nettle seedlings in British Columbia. Jour. Inst. of Brew. *38:* 194-196. 1932.

Oospores of the downy mildew of the hops are produced in abundance in the cotyledons and primary leaves of infected hop seedlings.

The approximate incubation period for the production of oospores is six days.

Oospores of hop downy mildew were produced in abundance in the cotyledons of infected seedlings of the common nettle of British Columbia, *Urtica Lyallii* Wats., under laboratory conditions.

Slight infection of a nettle plant about eight inches high was obtained in the laboratory when grown under maximum humidity conditions. A few conidia and numerous oospores were found in the diseased tissue.

Infection of nettle seedlings has not been observed in the field, but laboratory results indicate that infection of the cotyledons with the production of oospores is very probable under field conditions in the hop growing section of British Columbia.

The destruction of hop seedlings on and around the crowns during the spring months, by clean cultivation is considered a necessary control measure.

Since infection of nettle plants may take place in the field, it may also be necessary to destroy nettle plants in the neighborhood of hop yards.

Jones, W. The downy mildew of the hop in British Columbia. Jour. Inst. of Brew. *39:* 126-127. 1933.

Evidence has been secured that infection of hop seedlings outdoors takes place at or below soil levels. Cotyledons are the first to show infection, and the evidence suggests that the infection occurs through oospores germinating in the soil or on the fall cone bracts. Infected seedlings appear above soil level before the growth of crown shoots commences. Destruction of hop seedlings during these early stages is considered an important control measure, since abundant conidia can be produced in them that will infect the crown shoots.

Dusting the crown with Bordeaux dust (16 pounds anhydrous copper sulphate and 100 pounds calcium hydrate) after pruning in spring induced a significant reduction in the number of diseased spikes. Approximately 1 ounce per hill was used or about 50 pounds per acre. The approximate cost of materials and application is $1.25 per acre.

Hoerner, G. R. and Walter Jones. Crown treatments for hop downy mildew control. Phytopath. Zeitschrift. *6:* 619-626. 1933.

The results obtained in British Columbia and Oregon indicate that dusting the crowns in early spring with different compounds checks the development of basal spikes. The copper-containing dusts are considered the most effective and it is suggested that a dust mixture of not less than 1 part of monohydrated copper sulphate to 6 parts of hydrated lime be applied to the exposed crowns after pruning in the spring. An application of approximately 1 ounce per hill is recommended.

The results of dusting in the fall and also before flooding in the spring indicate that some of the material applied is leached away, making the treatment less effective.

If further field experiments support these conclusions, the cost of downy mildew control on the Pacific coast of America should be materially reduced.

### B. 100.15. FERMENTATION STUDIES

*In charge:* Wm. Newton; *Laboratory:* Saanichton, B.C.

Newton, W. and H. I. Edwards. Titration curves of fruit and vegetable juices and culture media. Sci. Agric. *11:* 542-545. 1931

Titration curves of fruit and vegetable juices and culture media indicate their possible significance in fermentation and plant disease studies. For example, the total acid of loganberry juice decreases progressively with the maturation of the fruit but this is not accompanied by a progressive increase of the initial pH values. Fermentation by a wine yeast brings about qualitative as well as quantitative changes in loganberry must.

A distinct difference occurs in the shape of the titration curve of juice from potato tubers infected with witches broom compared with the juice from healthy tubers and those infected with mosaic.

The shapes of the titration curves of apple and pear juice are more similar than that of the plum, and those of three distinct grape varieties reveal marked differences in total acid.

Newton, W. and H. I. Edwards. The influence of alcohol upon the effectiveness of wine preservatives. Can. Chem. and Metallurgy, March, 1932.

A study of two yeasts isolated from loganberry juice shows that the wild yeast type is more sensitive to potassium bisulphite and sodium salicylate than the wine yeast type. The suggestion is advanced that the beneficial effect upon the subsequent fermentation obtained by sulphurizing the must of wines may be due to the selective influence of the preservative upon the flora of the must.

The lethal efficiencies of both preservatives towards both yeasts increases with the alcohol content.

Potassium bisulphite as a lethal agent is more effective than sodium salicylate. On the other hand, the salicylate is more effective than the sulphite in preventing the multiplication of the yeast cells, unless a loss of $SO_2$ is assumed.

Newton, W. and F. L. Munro. The determination of alcohol and extract in wine, by means of the density and refractive index. Can. Chem. and Metallurgy, *17:* No. 6, 1933.

On theoretical considerations a rapid method of analysis of wines for alcohol and extract content has been developed, leading to the formula

$$X = 962{\cdot}5\ r - 352{\cdot}2\ s$$
$$Y = 281{\cdot}6\ r + 140{\cdot}8\ s$$

where $X = \%$ alcohol by volume
$Y = \%$ extract by weight
$r = n - 1{\cdot}3330$
and $s = D - 1$.

This formula has been verified experimentally on a number of wines of varying alcohol and extract content, and has been found to be correct within an average difference of 0·4 per cent for alcohol and 0:7 per cent for extract content.

### B. 100.16. PREVALENCE OF VIRUS DISEASES IN PRINCE EDWARD ISLAND

*In charge:* R. R. Hurst; *Laboratory:* Charlottetown, P.E.I.

In addition to the virus diseases reported previously marked chlorosis was found commonly in 1931 in three hosts as follows: Larkspur (*Delphinium* sp.) Cockscomb (*Celosia cristata* L.) Oxeye daisy (*Chrysanthemum Leucanthemum* L.). Because of the destructive nature of the virus disease of dahlias gardeners have been obliged frequently to replace many favourite varieties. Affected plants are decidedly undersized, the leaves become yellowish-green early in the growing season, and any flowers that may form are small and poorly shaped.

Yellows.—The virus disease known as "aster yellows" has been troublesome for many years in Prince Edward Island and particularly destructive to china aster, (*Callistephus chinensis* Nees) a plant held in great favour by commercial and amateur gardeners. Affected plants are stunted, yellowish, generally spindling, and lacking in vigour as further indicated by the entire absence of flowers in cases of early infection and the development of greenish-yellow one-sided blooms following late infections.

The native host known as Fall dandelion (*Leontodon autumnalis* L.) is particularly subject to yellows. It is suspected that the disease winters in this plant and serves as the source of primary infection of such ornamentals as dahlia and aster. Experiments are being conducted to investigate this point.

A complete list of the plants in the province showing symptoms of virus disease is as follows:—

| Cultivated hosts | Wild hosts | Ornamentals |
|---|---|---|
| Potato—Leaf roll | Plantago major L. | Marigold |
| Rugose Mosaic | Chrysanthemum Leucanthemum L. | Sweet Pea |
| Mild Mosaic | Leontodon autumnalis L. | Petunia |
| Aucuba Mosaic | Rubus sp. | Nicotiana |
| Streak | Rumex obtusifolius L. | Delphinium |
| Giant Hill | Spergula arvensis L. | Aster |
| Spindle Tuber | Echinocystis lobata (Michx.) T. et G. | Marguerite |
| Calico | Sonchus arvensis L. | Dahlia |
| Tomato | | Pyrethrum |
| Beet | | Gaillardia (perennial) |
| Parsnip | | Coreopsis |
| Celery | | Sunflower |
| Spinach | | Calendula |
| Lettuce | | Calliopsis |
| Sugar beet | | Dimorphotheca |
| Cucumber | | Nemesia |
| Strawberry | | Ursinia |
| Garden Pea | | Venidium |
| Bean | | Shasta Daisy |
| Corn | | Helichrysum |
| Alfalfa | | |
| Red Clover | | |
| Tobacco | | |
| Wheat | | |
| Rhubarb | | |
| Buckwheat | | |
| Turnip | | |
| White Clover | | |
| Egg Plant | | |
| Pumpkin | | |
| Squash | | |
| Lettuce | | |

## B. 100.17. SOIL TREATMENT

*In charge:* D. J. MacLeod; *Laboratory:* Fredericton, N.B.

MacLeod, D. J., and J. L. Howatt. Magnesium deficiency in potatoes. (Accepted for publication, Proceedings of the Canadian Phytopathological Society, 1934.)

Mercuric and mercurous chlorides applied in dry form directly in the drill at the rate of 10 to 15 pounds per acre effected control of club root of turnips, cabbage and cauliflower on heavily infested soils ranging from pH 5·0 to 6·5 and low in iron.

A serious breakdown of potatoes was discovered in commercial fields in 1933. The disorder was corrected by supplementing the fertilizer (4-6-10) with dolomitic lime, keiserite, magnesium sulphate and magnesium carbonate at rates equivalent to 20 pounds of magnesium oxide per acre. A survey of soils from 300 commercial potato fields revealed many instances of magnesium deficiency.

Plants grown on magnesium deficient soils appeared more susceptible to *Alternaria Solani* (E. & M.) Jones and Grout. A *Botrytis* sp. was found attacking the leaves of potato plants suffering from magnesium deficiency. A serious outbreak of *Helminthosporium teres* Sacc. on barley, a severe attack of *Rhizoctonia Solani* Kuhn. on potato, a destructive breakdown in sugar beets and mangels and a debilitated condition in oats and corn occurred on soils deficient in magnesium.

### B. 100.18. DISEASE OF ZOSTERA MARINA L. (EELGRASS)

*In charge:* Irene Mounce; *Central Laboratory:* Ottawa. (In co-operation with the Biological Board of Canada.)

Mounce, Irene, and W. W. Diehl. A new *Ophiobolus* on eelgrass. Can. Jour. Res. *11:* 242-246. 1934.

*Ophiobolus halimus* Diehl and Mounce n. sp. is reported on *Zostera marina* L. from St. Andrews, N.B. It was collected on rhizomes and fertile shoots, and developed in leaves kept in sea water in the laboratory. The fungus is described and illustrated and it is compared with related species.

Perithecia developed freely in the laboratory on leaves of *Zostera* collected in September, October, and December, 1933, and occasionally on those collected in April, June, and July, 1934. By the end of July mature perithecia were found on a few rhizomes at Birch Cove, N.B., and in great numbers on the browned decaying parts of fruiting stalks at Tidal Cove, N.B. They developed, too, on leaves from Trois Pistoles, Temiscouata Co. and from Kecarpoui, Saguenay Co., Quebec.

### B. 100.20. TOBACCO DISEASE INVESTIGATIONS

*In charge:* G. H. Berkeley; *Laboratory: St. Catharines, Ont.*

In 1933 a limited survey of the tobacco-growing areas of Ontario and Quebec was carried out to determine the diseases of importance to tobacco in these districts. Resulting from this survey studies have been commenced on mosaic disease of tobacco which was found to be prevalent in Ontario, and black-root-rot disease which the survey indicated was of major importance in Quebec.

During the season of 1934 the survey conducted related only to the steaming in preparation of the plant beds. The temperatures obtained during steaming were recorded and it was found that adequate sterilizing temperatures were obtained by the inverted pan method of steaming which is the common practice, where a pressure of 80 to 115 pounds is used for 20 minutes provided the soil is of a light type and neither wet nor dry. Where the soil is too wet the temperature obtained is scarcely sufficient to give a sterilizing effect. Under dry soil conditions a high temperature may be obtained but the rise is more gradual and the drop in temperature after the steam is shut off more rapid than where the soil is moist.

The field work was confined to experiments at the Delhi Tobacco Substation, principally to determine the effect of mosaic infection on the yield and quality of flue-cured tobacco. Where the plants were inoculated at transplanting time there was a reduction in yield of 55·6 per cent and 78·9 per cent in the grade index or average value per pound when compared to healthy plants. Where the plants were inoculated one month after planting there was no decrease in yield but a reduction in value of 58·1 per cent.

In an experiment to obtain the amount of spread of mosaic due to cultural practices a number of plants were inoculated two weeks after planting. The increase in mosaic ranged from 44 per cent to 67 per cent after two months.

The ease of inoculating plants with mosaic was demonstrated by contaminating the hands of the operators before planting. One hundred and four plants out of one hundred and thirty-seven planted by operators after contaminating their hands were mosaic in two weeks after planting.

Research work to date on the tobacco viruses suggests that more than one virus is commonly to be found in tobacco fields; that the mosaic virus is not killed during flue-curing and that therefore sanitation in relation to the flue-cured crop is just as important as with the air-cured crop. The mosaic virus has been recovered from pipe tobacco and from most brands of manufactured

cigarettes, suggesting the possibility that the use of tobacco during seeding, weeding, and transplanting may be partially responsible for the rapid spread of this disease.

*Tobacco Root-rot Investigations*

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Root-rots of tobacco are a serious factor in Quebec where chiefly Burley and cigar leaf varieties are grown. *Thielaviopsis basicola* (Berk.) Ferr. is responsible for much of the damage. In addition to this fungus, however, fungi belonging to the twelve genera, namely, *Pythium, Rhizoctonia, Fusarium, Coniothyrium, Phoma, Hormodendrum, Pestalozzia, Penicillium, Mucor, Alternaria, Trichoderma,* and *Cephalosporium* have been isolated from diseased roots. Microscopic examinations of diseased roots have also shown that a phycomycetous "mycorrhizal" organism (probably similar to the organism observed by other investigators in the roots of strawberry and other plants) producing intercellular mycelium, vesicles and arbuscules, as well as a species of *Asterocystis,* are consistently associated with lesions on which *T. basicola* is fruiting. Preliminary pathogenicity experiments in the greenhouse have indicated to date pathogenicity on the part of four distinct strains of *Rhizoctonia* and two strains of *Pythium* as well as *T. basicola.* Soil disinfection experiments as well as experiments in biologic control have been initiated.