DOMINION OF CANADA

DEPARTMENT OF AGRICULTURE

DOMINION EXPERIMENTAL FARMS

DIVISION OF BOTANY

REPORT OF THE DOMINION BOTANIST

H. T. GÜSSOW

FOR THE YEAR 1930

The seed potato inspection service of the Division of Botany provides an opportunity to farmers to secure information on disease control, and on the most desirable varieties and types to select for seed purposes.

Printed by Authority of the Hon. Robert Weir, Minister of Agriculture,
Ottawa, 1931

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Report of the Dominion Botanist for the year 1930

INTRODUCTION

The arrangement of the subject-matter of the Annual Report prepared by myself and the members of my staff, which has been followed during the past few years, viz., by definite sections comprehensive of subjects related to each other, has met with universal approval. The former arrangement according to work done at the central and the ten branch laboratories from the Atlantic to the Pacific, frequently caused the material on the investigations of the same problems to appear disjointedly throughout the report, which was inconvenient and costly, as it necessitated the distribution of the entire report to people only interested in a certain section. This has now been overcome, but not without a certain sacrifice, which was unavoidable, of the identity of each individual laboratory. This I have sought to overcome by incorporating in the table of contents the items for which each laboratory has been responsible. It is hoped that in this way an idea will be conveyed of the diversity of the problems subject to research at the individual laboratories.

The separate sections are: (1) General and Economic Botany; Diseases of Ornamentals; Mycology; and Miscellanea. (2) Forest Pathology and related subjects. (3) Diseases of Cereals and Grasses. (4) Diseases of Fruits and Vegetables. (5) Diseases of Potatoes and Field Crops, and Potato Certification.

During the year the Dominion Botanist was an official delegate at the International Horticultural Congress in London and the International Botanical Congress at Cambridge. Official visits were also paid to all the branch pathological laboratories.

Among the outstanding features reflecting credit upon the research work of the division may be mentioned the work of Dr. J. H. Craigie, Senior Plant Pathologist in charge of the Dominion Rust Research Laboratory, Winnipeg, on "An Experimental Investigation of Sex in the Rust Fungi", which memoir was awarded the "Eriksson's Prize" for Cereal Rust Investigation, 1930. Incidentally the same excellent and outstanding piece of research formed the subject of a thesis in partial fulfilment of the requirements for the degree of Doctor of Philosophy at the University of Manitoba.

The work at each of the laboratories is progressing most satisfactorily and it is a pleasure to acknowledge the loyal support given me in our work by each one of my colleagues and associates. The present report is documentary evidence of the nature and merit of the research work carried on by this division.

H. T. GÜSSOW,
Dominion Botanist.

SECTION I

GENERAL AND ECONOMIC BOTANY; DISEASES OF ORNAMENTALS; MYCOLOGY; AND MISCELLANEA

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GENERAL ECONOMIC BOTANY

Report on General Botany for 1930

J. Adams (Ottawa)

Much time was devoted as in previous years to routine work and general correspondence. This related to (1) Economic plants, such as chicory, yellow mustard, elderberry, etc.; (2) Medicinal plants, such as chamomile, ginseng, peppermint, Seneca snakeroot, etc.; (3) Food plants of muskrats and wild ducks, including eel grass, wild celery, wild rice, etc.; (4) Miscellaneous groups, such as extraction of Canada balsam, Uses of sumac, oil of *chenopodium*, etc.; (5) Inquiries of a physiological nature, such as the germination of seeds of *Doronicum* and *Eremurus*, the propagation of spores of ferns, injuries to plants as the result of fumigation, etc. There were also the usual inquiries for suitable literature on botany and on the wild flowers of Canada.

The annual Exchange List of Seeds collected in the year 1929 comprising the names of 1,482 species and varieties was distributed to 114 botanical gardens and other institutions.

During the year 2,831 packets of seeds were received from foreign botanical gardens as well as 61 specimens of shrubs with roots from the Morton Arboretum at Lisle, Illinois, U.S.A. In exchange 5,911 packets of seeds were sent out to various persons in Canada and Botanical Gardens in other countries ranging from Uruguay to New Zealand, Japan, Egypt, and Finland. Among the largest consignments dispatched were 281 packets to Hohenheim, Germany; 278 packets to Graz, Austria; and 241 packets to Belgrade, Jugoslavia.

Several cuttings of various species were also sent out, as well as a consignment of roots of Swamp Milkweed (*Asclepias incarnata*), dispatched to a firm in England interested in its possibilities as a fibre plant. It is worthy of note that experiments were made with this same species at Dundas, Ont., in the year 1860 with promising results.

Further additions to the collection of foreign seeds were made during the year.

A list of all the trees and shrubs growing in the Arboretum in the year 1930 has been compiled.

Two more sections of the "Bibliography of Canadian Plant Geography," covering the period 1911-1925 inclusive, were published as Part 2 of the Transactions of the Royal Canadian Institute, volume xvii, 1930.

Orchard Pollination Investigations

(B. 10.05)

H. Groh (Ottawa)

The assistance given this project was a continuation of surveys commenced in 1928, in sixteen Kings county, N.S., orchards. It extended over a period of four weeks then, has now covered an additional two weeks, and is to be still further extended. The purpose is, first, to learn what weeds and other wild plants are prevalent in and around Cornwallis valley orchards, and second, to record the flowering period of each species. In recent years since orchard dusting has become a common practice, the hive bee population has been almost wiped out by poisoning, in spite of precautions to avoid dusting during apple blossom time. The poison dusts drift to weeds which are in flower, the bees visiting them are destroyed, and pollination of the orchards is by that much interfered with. Elimination of such weeds as wild radish and dandelion might often therefore, make the difference between a good or poor set of fruit, when for any reason, other factors are adverse. The data collected will appear in the report of the committee on this work, when the project is completed.

Surveys for Eastern Pasture Improvement Committee

(B. 10.06)

H. Groh (Ottawa)

Altogether 265 fields and plots were given surveys in 1930. In addition 21 of these at Ottawa and Lennoxville were examined at a second date, and a number of quadrat surveys besides, brings the total up to about 300. At Fredericton this was the third annual inspection, and at the other five stations either the second or first. Surveys have been in different months each year, giving together a composite initial record of conditions, with which future data can be compared. By another year some changes already becoming apparent can be more safely evaluated.

Reference may be made here to the striking dissimilarity between the pasture stands at these six places. While most of the plants are found in all pastures, the importance of each species, whether as useful plant or weed, varies widely. Various species also, which rank well up at one Station, may be almost or entirely absent at others. Orange hawkweed, for instance, is a dominant weed at Lennoxville, but scarcely to be seen at Ste. Anne de la Pocatière, where its place is taken by an equal abundance of mouse-ear hawkweed. Among the grasses brown top is relatively more important in the Maritime Provinces stands, and the blue grasses elsewhere, especially at Ottawa. White clover is fairly prominent generally, but less so at Ste. Anne, at least while the plots are new, and most at Fredericton where the experiments average the longest duration.

So far as they have gone the surveys in general reveal increased luxuriance resulting from the fertilizer applications; a thickening up of white clover stands, a result in part at least, of regulated grazing, or frequent close clipping in the case of plots; and a decrease of moss, in some series already, to practically none, apparently as a direct result of denser vegetation and closer occupation of the ground by white clover and other useful pasturage. No pronounced change in total weed content is evident, but individual species have begun to show, in some cases decrease, in others increase.

Redwater Disease of Cattle

(B. 10·07)

H. Groh (Ottawa)

Late in the summer a botanical survey of the lower Fraser valley in British Columbia was commenced, and is to be continued, in an effort to determine whether there is ground for the suspicion under which various plants have been held, as possible causes of the locally prevalent redwater disease (haematuria) of cattle. This baffling trouble has been the subject of federal and provincial investigation from different angles, for some years.

Surveys were made at nearly 40 points throughout the 70 miles from Agassiz to the coast. These were on upland and lowland farms and areas, representing both affected and clean neighbourhoods, and many conditions of farm practice. Tabulation of the records will not be fully carried out until after those from a spring survey have been added.

At the present stage of the study, bracken, a fern of extraordinary abundance and luxuriance in the valley and on Vancouver island, has shown more consistent association with the occurrence of the disease than any other plant. It is on all the bench-lands, and at lower altitudes may also occur plentifully, but not on the true delta lands, or so-called prairies or meadows of alluvial nature. Remarkably sharp boundaries are apparent between them, the only encroachment of bracken upon the latter being along road or railway embankments, on the earth thrown from ditches, or on other disturbed soil. All that is known of the incidence of the disease by local investigators, whose hearty co-operation is gladly acknowledged, points to the same boundaries holding good for it pretty generally. Bracken has long been suspected, and feeding experiments have been carried out as a part of earlier research, but without any positive result in the case of cattle. It has been well proved to be the cause of staggers of horses. Up to the present no conclusion has been reached as to whether it may be a cause of this trouble of cattle, or whether the striking association found, indicates merely some soil, water, or other condition conducive to both.

Agricultural Botany and Weed Investigation

H. Groh (Ottawa)

Correspondence, as usual, consumed a good deal of time, that in connection with weeds and identification of plants reaching its peak during the summer months when outside work is also pressing. Every effort is made to give enquirers promptly the best information that is available, while at the same time striving to advance the investigations upon which so largely, the value of such information depends.

Publications issued during the year that embodied results of studies carried on were: Circular No. 74, Horsetail, a Horse Poisoning Weed; Circular No. 75, Poison Ivy; and Pamphlet No. 117, Grande Prairie Weeds. Press articles were also prepared, and meetings were addressed on various occasions.

Owing to an increased amount of time claimed by co-operative investigations for which the Division provides botanical surveys and analyses, rather a limited program of work on weed control could be carried through. This was confined mostly to further tests of the chlorate herbicides, and a few trials of a torch weed burner, both of which lines of effort still remain uncompleted, and need not be reported on here, except to remark that the encouraging results with chlorates on the shallow rooting perennials, as reported last year, are further borne out.

The work and travel involved in the surveys just referred to were turned to good account in the furtherance of the Dominion weed survey. With the important exception of the greater part of the Prairie Provinces, the farming belt of Canada has been fairly well covered since 1923 with the initial surveys necessary for such an appraisal of the weed flora as has never been possible before. Methods of utilizing the mass of records collected have been developed to a point where it is possible, with a reasonable expenditure of time, to chart for each of hundreds of the worst weeds, the special plague centres, as well as the frontiers, of their infestations. In addition, scores of weeds of more recent introduction have been located; and their progress, until spread is prevented by summary local action, will be kept under observation.

The most interesting discovery of the year is no doubt that of the Old World weed, Butterbur-*Petasites vulgaris,* Hill. which was observed in small patches at three separate points in the lower Fraser valley, B.C. So far as known, it had not been found in Canadian territory before. Right at our doors in Ottawa, too, a well established patch of Hoary Cress, *Lepidium Draba* L., is apparently the first occurrence known in this part of Ontario, and one of few east of the prairies.

Methods of putting the weed surveys to practical use in local weed situations have received some consideration. On occasions particular warning of a new pest has been passed on to those concerned, with advice as to what should be done, but only rarely has it been found subsequently that any action has followed. Local weed campaign proposals have been given help, and in that direction probably lies more hope of real progress. Branch Experimental Stations, agricultural representatives, and others in a position to encourage individual initiative, or to set up local organization for weed offensives, can be assisted in choosing methods adapted to the particular situation, taking into account not only the principal weed, but those associated with it, the soil, prevailing farm practices, etc. Procedure against couch grass, for instance, would not be the same in arable as in grassland farming; against perennial sow thistle might be much modified according as wild oats or other annual weeds were, or were not also troublesome; against wild oats or Russian thistle would depend on soil and locality; and against any weed would be conditioned on the prospects of actual extermination, or merely control in greater or less measure. For all such problems the weed survey is engaged in finding the appropriate application of the now fairly well understood general principles of weed warfare. It can also register and give publicity to any appreciable rise or wane of weed "populations," such as spread, or check of spread and increase, or even wane, as has actually occurred in a few instances, like that of chess in Ontario agriculture, within the generation just past. It is expected that the survey will eventually develop means of making publicity an efficient weapon against weeds, and a stimulus to those campaigning against them. In certain directions, too, quarantine regulations, based on survey information will become feasible. The time must come, and better soon than late, when present haphazard and often wasted effort will be brought under more comprehensive and wise direction. Half-hearted measures frequently do no more than transplant and give a fresh lease of life to weeds; and similarly, misdirected effort discredits perfectly satisfactory methods, or at the very least throws away time and money.

Survey Lists of Prevalence

(B. 11·02)

H. Groh (Ottawa)

Following the practice of other years of listing the more prevalent weeds of some region recently surveyed, two areas at the opposite extremes of Canada are herewith similarly treated—Cape Breton and Vancouver island. Over 100 miles of route were covered in the former and fully 150 miles in the latter, with somewhat more time, and securing in consequence longer lists. Under the term weed are included, with noxious species, any native plants aggressive enough to compete with plants of cultivation, and any introduced or crop plants maintaining themselves in the wild state, as well as any poisonous or injurious plants. Prevalence is indicated by frequency of appearance and position in the survey lists, the lists being well distributed over the route. Prevalence, it should be pointed out, is only one factor indicating the importance of a weed. The tables (1 and 2) immediately following will be found to contain both like and unlike elements among the predominant species of these widely separated parts of Canada; both weeds of pretty general occurrence in the Dominion, and others perhaps nowhere else nearly so prominent.

TABLE 1.—CAPE BRETON WEEDS IN ORDER OF OBSERVED PREVALENCE, JULY, 1930

Ox-eye Daisy—*Chrysanthemum Leucanthemum* L.
Pearly Everlasting—*Anaphalis margaritacea* (L.) B. & H.
Canada Thistle—*Cirsium arvense* (L.) Scop.
Tall Buttercup—*Ranunculus acris* L.
Red Clover—*Trifolium pratense* L.
White Clover—*Trifolium repens* L.
Field Horsetail—*Equisetum arvense* L.
Timothy—*Phleum pratense* L.
Bracken—*Pteris aquilina* L.
Fall Dandelion—*Leontodon autumnalis* L.
Sheep Sorrel—*Rumex Acetosella* L.
Sheep Laurel—*Kalmia augustifolia* L.
Blue Flag—*Iris versicolor* L.
Tufted Vetch—*Vicia Cracca* L.
Curled Dock—*Rumex crispus* L.
Alsike Clover—*Trifolium hybridum* L.
Yarrow—*Achillea Millefolium* L.
Sensitive Fern—*Onoclea sensibilis* L.
Couch Grass—*Agropyron repens* (L.) Beauv.
Caraway—*Carum Carvi* L.
Common Dandelion—*Taraxacum officinale* Weber
Fireweed—*Epilobium angustifolium* L.
Evening Primrose—*Oenothera* sp.
Brown Top—*Agrostis tenuis* Sibth.
Common Plantain—*Plantago major* L.
and others to a total of 165.

TABLE 2.—VANCOUVER ISLAND WEEDS IN ORDER OF OBSERVED PREVALENCE, OCTOBER, 1930

Bracken—*Pteris aquilina* L. var.
Common Dandelion—*Taraxacum officinale* Weber
Bull Thistle—*Cirsium lanceolatum* (L.) Hill
Cat's ear—*Hypochaeris radicata* L.
Ribgrass—*Plantago lanceolata* L.
Wild Barley—*Hordeum jubatum* L.
Red Clover—*Trifolium pratense* L.
Knotgrass—*Polygonum aviculare* L.
Hedge mustard—*Sisymbrium officinale* (L.) Scop. var.
Orchard Grass—*Dactylis glomerata* L.
Snowberry—*Symphoricarpos* sp.
Timothy—*Phleum pratense* L.
Kentucky Blue Grass—*Poa pratensis* L.
Burdock—*Arctium minus* Bernh.
White Clover—*Trifolium repens* L.
Common Plantain—*Plantago major* L.
Sheep Sorrel—*Rumex Acetosella* L.
Broom—*Cytisus scoparius* (L.) Link.
Canada Thistle—*Cirsium arvense* (L.) Scop.
Yorkshire Fog—*Holcus lanatus* L.
Common Annual Sow Thistle—*Sonchus oleraceus* L.
Curled Dock—*Rumex crispus* L.
Pineappleweed—*Matricaria suaveolens* (Pursh) Buchenau
Shepherd's Purse—*Capsella Bursa-pastoris* (L.) Medic.
Spiny Annual Sow Thistle—*Sonchus asper* (L.) Hill
and others to a total of 200.

DISEASES OF ORNAMENTALS

Botrytis Disease, "Fire" of Tulips

(B. 40·03)

W. Newton and Staff (Saanichton, B.C.)

The 1930 survey of all the commercial tulip plantings of Vancouver island and the Lower Fraser valley showed that Tulip Fire, *Botrytis Tulipae* (Lib.) Lind, was general in all districts. The survey data reveal that approximately 50 per cent of all tulips were infected, but for the most part the lesions consisted of foliage spots due to conidiospore infection. The autumn inspection proved that the fungus had reached the bulbs in a relatively small proportion of cases. Later, laboratory studies substantiated these findings. The relation of soil colour, acidity and drainage is shown in the following table:—

TABLE 3

—	Colour			Acidity			
	Light	Medium	Dark	5.-5.5	5.5-6	6.-6.5	6.5-7
Per cent plants infected.....	50	60	80	100	65	60	50

	Drainage		
	Poor	Fair	Good
Per cent plants infected...	100	40	60

The data reveal that the light coloured soils are on the average superior for the production of tulip plants free from "fire". Also, neutral soils are more favourable than acid. With respect to drainage, it is evident that poorly drained soils are unsatisfactory but on the light gravelly soils where the drainage is most perfect, the percentage of diseased plants tends to be greater than on soils reasonably well drained. This condition is probably due to excess drying of the plants during periods of their growth.

Similar data were obtained for unclassified bacterial and fungous diseases of narcissus, but no significant correlation was obtained between the percentage of plants infected and soil colour or acidity. With narcissi, good drainage appeared the most important factor in the production of disease free plants, for a percentage of infected plants decreased as the drainage conditions improved.

FACTORS INFLUENCING THE PRODUCTION OF CONIDIA IN BOTRYTIS TULIPAE

On barley meal, corn meal and nitrate synthetic agars, good crops of mycelia were produced but no conidia. On the other hand, tulip bulb extract agar, tulip pulp, and potato discs produced abundant crops of both mycelia and conidia, but 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 the production of mycelium by increasing or decreasing the hydrogen ion concentration, became favourable to the production of conidia. At the optima 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, 90 per cent to 100 per cent, but at 20° C., lower humidities, around 73 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.

DISCUSSION

It has been found that certain vegetable media are more favourable for the production of conidia than others, but in general when the composition, pH, or temperature are unfavourable for mycelial growth, conidia production is stimulated. Under field conditions it is probable that temperature is the most important of the factors that stimulate conidia production. This investigation suggests the advisability of applying protective sprays to the tulip foliage in the early spring particularly during periods of cold weather.

Influence of Disinfectants on Bulb Diseases

(B. 40·05)

W. Newton and Staff (Saanichton, B.C.)

Tulip bulbs were planted after treatment with various dips at various concentrations in pots filled with soils artificially infected with the sclerotia of *Botrytis Tulipae*. The experiments have already proven that mercuric chloride is superior to formaldehyde, due to the greater residual effect of the former.

Gladiolus Diseases

(B. 40·01)

A. J. Hicks (Ottawa)

In the Report of the Dominion Botanist for 1927, page 27, fig. 5, is shown an illustration of a gladiolus corm infected with a *Botrytis* sp. This type of infection has been much in evidence in recent importations of gladioli and appears to be of a serious nature. Corms infected with this fungus have been kept in storage and after two months or so have become mummified.

Lesions are very typical. They are usually round and fairly deep and regularly sunken. The lesion is straw coloured in the centre, the colour deepening to brown at the outside. An unusual feature is the appearance of the surface of the lesion. This resembles a dried, tightly stretched skin with, in most cases, a hole or crack showing where the diseased tissue has shrunk away from the suberized wall usually separating the diseased and healthy tissue. Black sclerotia of from 1 mm. to 4 mm. diameter are often found on the surface of these lesions. The causal organism has been isolated in pure culture and is being studied at the present time.

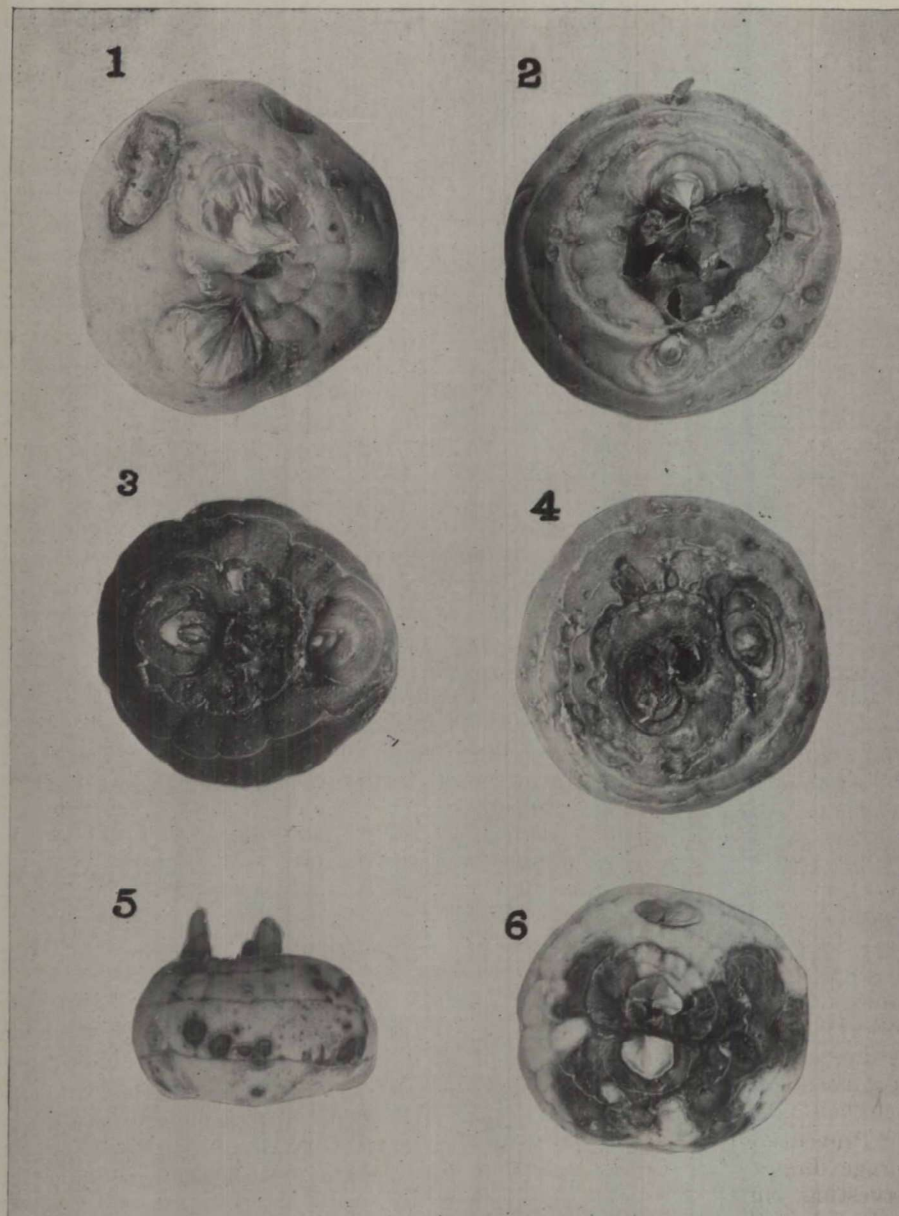

PLATE 1.—Gladiolus corms affected with a decay caused by a *Botrytis* sp.

Figures 1-6. Six types of lesions on gladioli caused by a *Botrytis* sp. Note sclerotia on surface of lesions in figures 1 and 6, and also cracking of surface of lesions in figures 1 and 2. As will be seen, infection is confined to the top of the corm in practically every case. (Photos by A. J. Hicks)

Tuber Rot in Dahlias

(B. 40·07)

D. J. MacLeod (Fredericton, N.B.)

In the report of this laboratory for 1929 appears a description of a disease of bacterial origin which produces a destructive rot in dahlia tubers while in storage.

Findings in connection with experiments conducted in 1930 reveal that the causative organism of the disease gains entrance to the interior of the tuber largely through cracks and abrasions due to mechanical injuries and that infection takes place in the tuber, especially during the first two or three weeks in storage. During this period the tuber is active physiologically, giving off much moisture which accumulates on the surface of the same, creating an excellent condition for the growth of rot-producing organisms.

Studies on the effect of ventilation on the occurrence of the disease show that prevention of the rot is dependent to a considerable extent upon the rapid evaporation of the moisture collecting on the surface of the tuber during the sweating period in storage.

Temperature also influences the development of the disease. At 20° C., infected tubers may be decomposed in five to ten days. When the temperature ranges from 4° C. to 7° C., the disease progresses rather slowly requiring many weeks to complete decomposition of roots so affected. Below 4° C., the causal organism of the disease appears to be quite inactive.

Treatment with Semesan and mercuric chloride effected partial control of the disease, particularly when the tubers were thoroughly washed before treatment. The Semesan was applied in both dust and instantaneous dip form at the rate of 4 ounces per bushel in case of the former and 2 ounces in 1 gallon of water for the latter. The mercuric chloride was used at the rate of 1 ounce of chemical in 10 gallons of cold water for one-half hour. Formaldehyde and sulphur were quite ineffective in controlling the disease.

Storing the tubers after they were treated with disinfectants in various substances to prevent excessive drying was also tested. Ordinary soil, sand, and wood sawdust proved to be the best materials for maintaining the proper amount of humidity. Paper, sphagnum moss, and excelsior proved unsatisfactory for this purpose. Storing untreated and unwashed dahlia roots in the several substances mentioned above failed to give the desired results in most cases.

Leaving a long portion of the stem attached to the roots and storing the roots upside down was also tested but the results obtained failed to confirm the values attributed to these practices by certain growers. Unmatured tubers and those injured by frosting were found to be most susceptible to the disease. While the disease usually develops in storage it is not confined to the harvested crop for it has been found previous to digging time, particularly in heavy moist soils and when harvesting was delayed.

Prevention of this disease is inseparably connected with the control of storage diseases in general, requiring special attention in connection with the harvesting, curing, and storing of the tubers. The following recommendations are based on the results obtained:—

(1) Tubers should be well matured when harvested.
(2) Harvesting of tubers should be performed during warm dry weather.
(3) Excessive frosting and injury to the tubers before and after they are dug should be avoided.
(4) Tubers should be cured for one to two weeks in a well ventilated room with a temperature of 18° C. to 24° C.

(5) Following the curing period the tubers should be thoroughly washed, treated with Semesan or mercuric chloride and packed in ordinary clean soil, sand, or wood sawdust, and maintained at a temperature ranging from 1° C. to 3° C.

(6) The humidity should be held between 40 and 65. It may be necessary to add a small amount of water from time to time to the packing to maintain the proper humidity.

(7) Tubers manifesting any evidence of disease should be discarded immediately they are found.

Aster Wilt and Aster Yellows Investigations in Disease Resistance

(B. 41·04)

D. J. MacLeod (Fredericton, N.B.)

Aster wilt and aster yellows are two diseases causing some concern among flower growers in many localities. Aster wilt is caused by a fungus (*Fusarium conglutinans Woll.* var. *Callistephi* Beach) and aster yellows is attributed to a virus. The former is soil borne while the latter is transmitted by the agency of a leafhopper (*Cicadula sexnotata* Fall.)

Aster wilt is characterized by a progressive yellowing and dropping of the leaves beginning at the base of the plant and continuing upward until the entire plant is involved. A dark brown discoloration is usually visible in the invaded tissues of the vascular system. Severely affected plants usually die in the course of ten to twenty days.

Aster yellows manifests itself primarily on the leaves of the plant as a clearing or transparency of the veinlets, which ultimately changes to a slight yellowing. Infected leaves are malformed and the entire plant is dwarfed. An interesting feature of the disease is the release of a large number of buds, resulting in the development of numerous secondary shoots in the axils of the leaves. A striking symptom also is the abnormal development of the flowers. Instead of the natural type of inflorescence, dwarfed flowers are formed, portions of which show the natural colour of the variety and the remaining part a greenish yellow or white colour. Frequently no flowers are produced. Diseased plants usually produce little or no seed.

The causative organism of aster wilt was not found attacking any other plants, but aster yellows was observed in several hosts as follows: *Helianthus, Calendula, Tragopogon, Taraxacum, Lactuca, Rudbeckia, Zinnia, Dahlia, Coreopsis, Erigeron, Tagetes, Gaillardia, Lavatera, Dimorphotheca, Helichrysum, Ageratum, Leontodon, Plantago, Spergula, Chrysanthemum, Apium* and *Antirrhinum.*

Owing to the fact that aster wilt is soil borne and aster yellows is transmitted by an insect, ordinary methods of plant protection cannot be readily applied for the prevention of these diseases. The most feasible method for controlling these diseases appears to be the development of resistant varieties. To this end, a project conducted co-operatively with the Dominion Experimental Station was initiated in 1929. In 1930, seventy-seven strains of asters were tested on soil heavily infested with *Fusarium conglutinans* var. *Callistephi.* Five strains obtained from Prof. L. R. Jones of the University of Wisconsin proved to be completely resistant to wilt on the soil used. The other strains showed from 7 to 100 per cent infection. Red strains appear to be more resistant than white, pink and purple types. This suggests some association of resistance with the red pigment. Seed has been selected from the most resistant plants in each strain for future improvement. Fifty-five strains of commercial varieties were selected for resistance to aster yellows in 1929. Three of these strains appeared slightly resistant in 1930 while the remainder showed practically 100 per cent infection. Asters kept under cheese-cloth-covered cages which excluded leaf hoppers remained free from the disease during the entire season.

The Fungus *Plenodomus Meliloti*, causing a Root Rot of Hollyhocks

H. T. Robertson (Edmonton, Alta.)

A fungus, apparently the same as *P. Meliloti* Dearn. & Sanford was isolated from lesioned roots of hollyhocks, *Althaea rosea*, Calgary, 1929, and tested for its pathogenicity on roots of sweet clover and hollyhocks during the winter of 1929-30. Severe root rot occurred on inoculated sweet clover and hollyhock plants, and pycnidia were produced. The conclusion is that *P. Meliloti* is pathogenic to hollyhocks under winter conditions.

Suspected Mosaic Disease in Sweet Peas in British Columbia

(B. 41·03)

W. Newton and Staff (Saanichton, B.C.)

Systematic field surveys were made of commercial sweet pea plantations of Vancouver island and the Lower Fraser valley again during the summer of 1930, but no positive evidence was found of the presence of sweet pea mosaic. The method employed was to tag suspicious plants and seed therefrom was tested in the greenhouse. Samples of juice from chlorotic plants were transferred to normal plants with negative results. There again appeared to be a tendency for sandy soils to induce a chlorotic condition in sweet pea plants during periods of dry weather, particularly when heavy applications of mineral fertilizers were applied.

Infectious Chlorosis of Roses

(B. 42·02)

W. Newton and Staff (Saanichton, B.C.)

The symptoms of infectious chlorosis or rose mosaic did not appear in the field until the plants were well developed. Under greenhouse conditions they became apparent much earlier, and the characteristics upon Manetti were distinct from those upon Ulrich Brunner and Mrs. J. Laing.

No disease symptoms were induced in Thornless Multiflora and Canina stock roses through living unions with diseased Manetti, but La France bud shoots became infected through living unions with Multiflora, if the latter were borne upon diseased Manetti root stocks.

Diseased cuttings remained infected after a one hour immersion in hot water at 45° C., and after a fifteen minute immersion in a one per cent potassium permanganate solution.

Mature Multiflora plants remained dormant when cut back except as scions upon Manetti, and Multiflora as root stocks induced a dormant condition in Manetti scions.

The selection of healthy pure lines for propagation purposes should be based upon more than a single season's observations owing to the seasonal masking of the symptoms; and for test purposes, advantage should be taken of greenhouse conditions where masking is less likely to occur. The advantage of isolation is problematical owing to the present lack of evidence upon insect transmission.

Verticillium Wilt of Roses

(B. 42·01)

G. O. Madden (St. Catharines, Ont.)

The defoliation of a large number of roses at a local nursery in the year **1928** was the first indication of this disease in Ontario. This disease has since been observed attacking climbing and bush roses in various parts of the Niagara peninsula. The damage done to roses may consist of a severe defóliation and killing back of the main branches and laterals, or it may only cause the leaves on a few stems to wilt and drop off (fig. 1).

FIG. 1.—Manetti rose plant showing defoliation caused by *Verticillium* sp.

The progress of the disease is readily seen in inoculated plants. The first indication of the trouble is noticed at the base of the stems, where the leaves begin to turn yellow. This discolouration is followed in turn by wilting and finally the leaves of affected branches fall to the ground. A few leaves, however, usually remain adhering to the tips of the most vigorous stems until the following spring. The defoliated stems are usually a sure indication of the presence of the organism in the tissues.

CAUSE

Isolations from stems and roots of many wilted plants gave almost invariably cultures of a *Verticillium* sp. That this was the fungus responsible for the trouble was proved by a series of artificial inoculations made in root or stem, which ultimately produced the same symptoms as found in the field under natural conditions. Re-isolations from inoculated plants revealed the same *Verticillium* sp. as used for inoculation. The species has not been identified, but since it produces sclerotia it belongs to the *V. Dahliae* group and is most likely a strain of *Verticillium ovatum* Berkeley & Jackson.

MYCOLOGICAL STUDIES

The Growth of *Rhizoctonia Solani* in relation to Temperature, Acid, Alkali, and Other Factors

(B. 70·18)

W. Newton and Staff (Saanichton, B.C.)

THE THERMAL DEATH POINT OF VEGETATIVE CULTURES

The lethal temperature period for vegetable cultures of *Rhizoctonia Solani* Kühn was one hour at 50° C. Shorter periods at the same temperature caused a lag in the growth rate when the cultures were transferred to an incubator at 25° C. The lethal temperatures of vegetative cultures of *R. Crocorum* (Pers.) DC. were slightly lower than those of *R. Solani*.

Potato tubers immersed for one hour at 45° C., were severely injured, at 50° C., were killed, and at 55° C. sclerotia germinated that were removed from the immersed tubers.

THE GROWTH RATE AS INFLUENCED BY TEMPERATURE

Many of the experimental errors in the determination of growth rates in relation to temperature may be overcome by growing filamentous fungi in long tubes, about half full of nutrient agar in a radial direction.

The growth temperature graph for *Rhizoctonia Solani* Kühn reaches zero at 6° C. and 32° C., and an optimum growth rate at 25° C. The shape of the graph indicates that the temperature coefficient progressively increases as the temperature decreases.

When tube cultures were transferred from 8° C. to 25° C., a constant growth rate was not obtained until the fourth day.

Determination of the Occurrence of Biologic Forms of *Plasmodiophora Brassicae*

(B. 70·10)

D. J. MacLeod (Fredericton, N.B.)

The problem of developing resistant varieties is complicated by the fact that physiological host specialization occurs among the parasitic fungi. The phenomenon is almost of universal occurrence.

Evidence from experiments conducted from time to time suggest the possibility of biologic forms of *Plasmodiophora Brassicae* Woron. This assumption is based to some extent on the fact that certain crucifers definitely known to be highly resistant to club root in certain localities are quite susceptible to the disease when grown in other places. Accordingly, some preliminary work was performed in 1929 and 1930, with the view to determining the existence of specialized strains of the organism of club root. The following method was adopted. Club root material from various crucifers was collected before the diseased parts began to disintegrate. Sections of infected tissue were removed aseptically from the best nodules, then macerated with equal precautions and placed in 100 cc. Erlenmeyer flasks containing a sterile decoction of turnip intended to keep the organism alive for a period of time. Isolations were made in this manner from several varieties and strains of different crucifers including both cultivated and wild species. The material thus collected was used as inoculum to test varieties and strains of crucifers for resistance to club root. The tests were conducted in small pots in the greenhouse. Inoculum from 50 different sources was tested on thirty strains of turnips and twenty wild and cultivated crucifers. The seeds in each case were sterilized in bichloride of mercury (1-1000) and sterile soil was used throughout.

The results obtained to date fail to establish the existence of biologic forms of *Plasmodiophora Brassicae*. There was, however, evidence of partially resistant lines within certain families of crucifers.

Determination of the Occurrence of Biologic Forms of *Sphaerotheca Humuli*

(B. 70·09)

W. Newton and Staff (Saanichton, B.C.)

Systematic surveys of the commercial hop yards of Sardis, Sumas, and Agassiz, B.C., revealed that there was no injury through the fungus, *Sphaerotheca Humuli* (DC.) Burr. during the 1930 season.

Mushroom Studies

(B. 70·01)

W. S. Odell (Ottawa)

During the Mushroom season from early spring till the frosts of autumn, special attention has been given to collecting mushrooms as additions to our herbarium; and particularly in obtaining perfect specimens where possible, for photographic purposes. It is our aim to eventually acquire a complete set of photographs of the fleshy fungi found in the vicinity of Ottawa, to be used in a second edition of "Mushrooms and Toadstools".* As many of the favourite collecting grounds for mushroom hunting, adjacent to the city have been drained, cleared of trees, or become cultivated, conditions favourable for growth have been entirely altered, necessitating excursions further and further afield. A new collecting district was discovered last season up the Gatineau river. Occasional photographs had been taken of mushrooms, but only during the past two or three seasons have we been able to do this more systematically. During the past season these have been arranged in a cabinet, and a complete card index made. The cabinet to date contains negative and print of 77 genera and 216 species.

During the Central Canada Exhibition held at Ottawa last season, a fine exhibit of mushrooms was arranged for, different members of the staff assisting in imparting information to the public concerning it. The department also put on an exhibit of mushrooms at the Canadian National Exhibition at Toronto, and judging from the interest taken in it by the general public, the effort was worth while. A much keener interest is taken in this subject in Western Ontario than in this district. It may be mentioned here that during that exhibition orders were received for 131 copies of "Mushrooms and Toadstools," later to be filled through the Department of the King's Printer, Ottawa. We are pleased to infer that the information given to the public concerning our exhibits has stimulated the desire of many to grow Mushrooms for their own

* Güssow and Odell, Mushrooms and Toadstools, 128 plates, 274 pages, publ. Dept. Agric., Ottawa. (Price, $1.00).

use. Numbers of inquiries from all over Canada are received, asking for information concerning failures in this enterprise. It is not such a simple venture in which to make an easy addition to one's income, as the public imagines, since failures far outnumber successes.

MISCELLANEA

Hop Disease Research

(B. 100·14)

Walter Jones (Saanichton, B.C.)

SEEDLING INFECTION

The large number of infected seedlings found in the hop yards in the early spring suggested that oospore infection of downy mildew (*Pseudoperonospora Humuli* (Miyabe & Tak.) Wilson was responsible. Diseased cones planted in flats in the greenhouse did not produce infected seedlings, hence no experimental evidence has been obtained so far that oospores were responsible for the general infection of seedlings in the field.

THE TOXICITY VALUE OF DUSTS

Bordeaux dust as used in the hop yards is prepared by mixing powdered anhydrous copper sulphate 16 pounds, with calcium hydrate 100 pounds. This dust was compared with Sulphur and Zinfandalite, a commercial dust. The copper sulphate proved to be much superior to the commercial dust but the latter was superior to the sulphur as indicated by the rate of zoospore disintegrations affected by the dusts.

ADHESIVE EFFICIENCY OF SULPHUR DUST

In an experiment to determine the comparative merits of dusts in the control of downy mildew of the hop, it was found that sulphur did not adhere well to the foliage. The addition of calcium hydrate or talc to sulphur reduced its adhesive properties, the addition of powdered resin to sulphur and talc had no significant effect. The best coverage and highest adhesive value was obtained with a mixture of sulphur, talc, and resin in the ratio of $8:1:1\frac{3}{4}$.

TREATMENT OF CROWNS AGAINST HOP MILDEW INFECTION

Crown treatment with different compounds checked the development of basal spikes, and Bordeaux dust is considered the best material for such treatment.

Injury of young shoots was general where mercuric chloride at different concentrations was used for treatment.

Factors influencing the Spread of Downy Mildew of Hops

(B. 100·10)

W. Newton and Staff (Saanichton, B.C.)

VARIETAL SUSCEPTIBILITY

The large hop acreage in varieties susceptible to downy mildew is an important factor in the situation in British Columbia. Although only 967 acres were grown in 1930, a marked reduction in acreage, over half consisted of susceptible varieties, e.g., Early Clusters, 496 acres; Late Clusters, 136 acres. The remainder consisted of English varieties that were practically immune, unless trained very late. These were Fuggles, 267 acres; Kents, 41 acres; and Goldings, 17 acres.

PRECIPITATION

The first "spikes" were found late in March. During April, a period of high precipitation, the spread of downy mildew was very rapid. During this period the relative humidities near the ground were distinctly higher than a few feet above the ground. This is the probable explanation why early training again proved to be such an important control measure. Early training and early spraying proved to be two very important factors in the control of downy mildew in British Columbia. Throughout the season it was found necessary to keep all foliage off the ground. Conidia were invariably present on leaves touching the ground when those higher up were free or only slightly infected.

TEMPERATURE AND HUMIDITY

During June, July and August the disease spread very slowly, although relative humidities above 90 per cent that are favourable for the germination of the spores, were reached almost daily between the hours 2 and 9 a.m. The slow spread may be accounted for by the inverse relation between temperature and humidity. The temperature rarely was above 50°C, when the humidity was above 90 per cent. Since approximately 68°C, is the optimum for the germination of the spores, the low temperatures, while the humidities are high, may account for the slow spread. It is doubtful whether it is economical to spray during these months. A protective cone spray is essential, however, owing to the probabilities of humid weather during cone development. The spread of the disease during the season was spasmodic and was most rapid when the relative humidities were above 90 per cent and the temperatures approached 68°C.

Ginseng Root-Rot[1]

(B. 100·08)

A. A. Hildebrand (St. Catharines, Ont.)

The growing of ginseng, though restricted to scattered and relatively limited areas in Ontario, has in recent years become of considerable economic importance. In the district of Waterford, Ontario, where the industry has become more concentrated than in any other part of the province, approximately twenty growers, whose gardens total 45-50 acres and range in extent from one-half to eighteen acres, are now engaged in its production. A yield of two thousand pounds per acre is considered a good crop and is by no means uncommon. The total net yield of dried root in the Waterford district at the close of the 1929 season was about forty-five thousand pounds. With the price of ginseng lower than it has been for years, due to the continued unsettled political condition of China to which country it is exported, the value of the 1929 crop approximated $370,000. Under normal conditions, the price per pound averages about $12.50.

It is reported by the older growers that during the earlier years of the industry in Ontario, ginseng was singularly free from disease. However, following the importation of a large quantity of seed from New York state about nine years ago, two apparently different and destructive rots affecting the roots and the portion of the stems between the crown of the root and the ground level, made their appearance. These rots known locally as "rust" and "disappearing rot," from the manner in which they affect the roots, have spread until scarcely a garden in the district has escaped. In certain cases gardens have had to be abandoned altogether after amounts as high as $1,500 per acre

[1] This project is being carried on in co-operation with the Botany Department, University of Toronto.

have been expended on them for seed, labour, and material. For the past two summers more serious attention has been given to these rots which are threatening to curtail the production of ginseng.

Early in the summer of 1929 the ginseng gardens were visited and specimens of both rusted and rotted roots were obtained. Macerations and free-hand sections of affected roots, examined microscopically, revealed the presence of bacteria, nematodes, and an abundance of fungous spores and mycelium. An examination of the diseased tissue of rusted roots in the same way showed the presence of only small amounts of mycelium as compared with rotted roots. From these first specimens and from others obtained on subsequent occasions almost one thousand cultures have been made on nutritive media. The following genera of fungi have been isolated; *Ramularia, Fusarium, Rhizoctonia, Rhizopus, Penicillium, Verticillium, Alternaria,* and *Pythium.* Nematodes were found frequently with the above-mentioned fungi, as were bacteria almost invariably when non-acidified media were used. *Ramularia* has been found most consistently in association with typically rotted roots and species of *Fusarium* were second in frequency of occurrence.

There has been found more or less constantly associated with rusted roots, a fungus though not definitely determined, thought to belong either to the genus *Ramularia* or to the closely related genus, *Septocylindrium.* This fungus has never been found in association with rotted roots nor has the *Ramularia* obtained from rotted roots ever been isolated from rusted roots. Besides the fungus referred to above, species of *Fusarium* and other soil-inhabiting and saprophytic fungi have been isolated from rusted roots, as was the case in the isolations from rotted roots.

INOCULATION EXPERIMENTS

During the past two summers four series of inoculation experiments have been undertaken to test the pathogenicity of the organisms isolated from both rusted and rotted roots. In three instances the experiments were carried out under normal field conditions at Waterford, this having been made possible by the generous co-operation of the Messrs. Hellyer and Clyde Renner. A fourth series of inoculations was carried out in the experimental plots at St. Catharines during the summer of 1930, using roots which had been transplanted in the autumn of 1929. Monosporous cultures of the different organisms were used as inoculum.

The results of the inoculation experiments indicate that the *Ramularia* isolated from rotted roots may be the causal organism of "the disappearing rot." A series of inoculation experiments using the same organism but carried out under conditions of more rigid control is being undertaken to compare with the results obtained in the field. Species of *Fusarium* were found to be more or less parasitic on ginseng roots but the lesions they produced were not typical of those found on naturally infected roots.

In a series of inoculations carried out in the fall of 1929, using as the source of inoculum, the *Ramularia* or *Septocylindrium* which had been isolated from rusted roots, positive results seemed to have been obtained, for, in the spring of 1930, eleven of a total of fifteen roots involved, appeared to be typically rusted roots. When re-isolations were made, however, only in one instance could the organism be recovered. Using the same organism, further inoculations were made during the summer of 1930 but without definitely positive results. There is the possibility that the conditions of temperature, of moisture, or both, which prevail either during the late fall or winter or early spring, may be more favourable for the development of this fungus than those which obtained during the past summer.

CONTROL EXPERIMENTS

The opinion is quite generally held by the growers in the Waterford district that the root-rotting organisms were introduced either in or on the seed imported from New York state nine years ago. Since that time practically all seed has been subjected to treatment before planting. Of the numerous treatments that have been tried, the most successful, and the one which is most generally in vogue throughout the district at the present time, involves a presoaking in formaldehyde. In the fall of 1929, seed-treatment experiments were carried out. About three thousand seeds were treated with some of the more commonly used chemicals and fungicides including semesan, uspulun, copper sulphate and solutions of formaldehyde of different strengths. The results on the whole, especially in consideration of the amount of time and labour involved were disappointing in that only relatively few of the seeds, treated and untreated, germinated. On a basis of percentage of germination and the general vigour of the seedlings, the best results were obtained from the seed which had been treated with formaldehyde.

Control experiments involving soil sterilization have been undertaken this fall, at St. Catharines, on artificially infested soil and at Waterford, on naturally infested soil, with the hope of finding a means of checking the spread of the disease when it appears in isolated spots throughout the gardens. When such spots appear in two, three, or four-year-old beds, it means that, if the disease is not effectively checked at once it will spread radially outward from the point of infection until by the fifth or sixth year, when the roots are ready to be dug, large areas will have become involved.

The Value of Casein Spreader in Powdery Mildew Control

(B. 142)

W. Newton and Staff (Saanichton, B.C.)

The comparative tests conducted during the summer of 1930, again showed that casein was inferior to the potassium resin soap spreaders in the control of powdery mildew of roses and other ornamentals and downy mildew of hops. A considerable variation was found in the comparative merits of different commercial brands of both casein and glue spreaders for Bordeaux and although the casein spreaders tested this year were slightly superior to the glue spreaders, there appeared to be no significant differences in their relative merits as distinct classes.

Two seasons' experiments in field and laboratory have proven that casein spreaders are inferior to potassium resin spreaders.

A New Sulphur Resin Spray[1]

(B. 100.12)

W. Newton and Staff (Saanichton, B.C.)

A complex potassium resin sulphide powder was synthesized that proved to be a more effective fungicide for tulips and other ornamentals than any known standard spray. This spray material has been well received by the growers of ornamentals. It is prepared by mixing powdered potassium hydroxide (KOH) 7 pounds, resin 4 pounds, and sulphur 4 pounds, and adding less than 1 pound of water, while the mix is constantly stirred. As a control for downy mildew of the hops, this spray material proved to be unsuitable, owing to foliage injury. A modified form containing the same ingredients but in the following proportions, KOH 7 pounds, resin 8 pounds, sulphur 4 pounds, gave

([1] Scient. Agric. Vol. IX, September 1930) satisfactory results in the control of hop mildew, and has since been adopted as a spray for ornamentals with delicate foliage. At spray strength, 15 pounds to 100 gallons, the fungicidal properties were equal to the original material and no significant spray injury has been found. As a greenhouse spray the value of this material cannot be questioned.

Another modified type is now being manufactured by commercial interests, as a dormant spray to take the place of lime sulphur. The ingredients are the same as the original type synthesized, except that the excess alkali which we found to be the cause of the foliage injury, is neutralized by the addition of fish oil.

We have definitely established that the injury to the foliage of hops and other plants through the use of the original potassium resin sulphide spray material is due to the excess alkali. This excess can be removed, without lowering the desirable physical properties of the original spray material, by doubling the proportion of resin, or by adding one part fish oil to every four parts sulphur before any water is added, or heat is applied to fuse the ingredients.

Testing Efficiency of Standard Spray Materials

(B. 100.13)

W. Newton and Staff (Saanichton, B.C.)

A number of sprays were applied to the leaves of tulip plants and their relative efficiencies evaluated by the number of lesions that developed when discs cut from agar cultures of *Botrytis Tulipae* were stuck to the dry sprayed surfaces.

Definite evidence has not been obtained that this technique is a satisfactory method of evaluating the comparative protective efficiency of sprays.

The Influence of Spreaders Upon the Efficiency of Bordeaux Spray

(B. 100.09)

W. Newton and Staff (Saanichton, B.C.)

A field study of the efficiency of spreader for Bordeaux again showed that without a spreader the Bordeaux coverage on the under side of the leaves was far from satisfactory with all types of spray machinery and spray nozzles. The following table summarizes the field observations. The coverage values are recorded as figures which represent an approximation of the per cent of leaf surface covered by the spray.

TABLE 4.—THE INFLUENCE OF SPREADER ADDED TO A BORDEAUX SPRAY APPLIED TO HOPS

Spreader	Amount added to 100 gallons Bordeaux Dry weight in gr.	Added to agitated Bordeaux as a	Coverage
			%
None	....	....	50
Casein	10 ounces	Thin paste	65
Glue (pearl brand)	2 ounces	Thin paste	60
Whale oil soap	3 pounds	Thin paste (dissolved in 2 gals. water)	80
Potassium resin soap	2·5 pounds	Thin paste (prepared by heating together 20 pounds resin, 10 pounds KOH, 3 gals. water)	85
Whale oil soap and resin	4 pounds	Thin paste (prepared by heating 3 pounds soap in 2 gallons water)	85
Needham spreader	5 pounds	Thin paste (prepared by heating together 2·5 pounds fish oil, 10 pounds resin, 10 pounds whale oil soap, 2 pounds, NaOH, 6 gallons water)	92

The investigations revealed that the spreaders containing resin were superior to all others. The potassium resin soap as prepared by heating together 20 pounds resin, 10 pounds potassium hydroxide, and 3 gallons water proved unsuitable due to the excess alkali which caused injury to the hop plants. When the resin content was doubled, resin 40 pounds, potassium hydroxide 10 pounds, water 3 gallons, the injury became much less significant. Owing to the efficiency and popularity of the Needham spreader, a laboratory study was made with the view of simplifying the method of manufacture. These studies resulted in the development of a spreader superior to the Needham spreader and much more simple to manufacture. It is prepared by heating together resin 40 pounds, KOH 10 pounds, and fish oil 10 pounds. This mix dissolves and when cool the solid mass can be readily pulverized and sold as a staple dry spreader. The powder is dissolved in warm water and added to the spray as a thin paste in quantities ranging from 1 to 5 pounds of the dry powder per 100 gallons of Bordeaux.

Fermentation Studies of Loganberry Wine

(B. 100·15)

W. Newton and Staff (Saanichton, B.C.)

NUTRIENT DEFICIENCIES IN LOGANBERRY "MUST"

An investigation upon the cause of "secondary fermentation" in loganberry wine showed that it was due, at least in part, to a deficiency in the "must" of ammonium and phosphate salts. The results suggest that the addition of primary ammonium phosphate in the proportions of $\frac{1}{2}$ pound to 100 gallons loganberry "must" may offset the losses through secondary fermentation. Both ammonium and phosphate salts added separately, accelerated the fermentation rate but the maximum acceleration was obtained when a salt or salts containing both ammonia and phosphate were added.

Two optimum concentrations of primary ammonia phosphate were found with respect to the fermentation rate.

TITRATION CURVES

Titration curves of fruit juices indicate their possible significance in fermentation studies. E.g., 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.

The shape of the titration curves of apple and pear juice are more similar than that of plum, and those of three distinct grape varieties revealed marked differences in total acid.

Examination of Plant Importations

(B. 100·02)

A. J. Hicks (Ottawa)

In 1930 shipments intercepted at the ports of entry numbered 1,264, of which 896 were dealt with by the Division of Botany. These latter shipments contained 3,174 varieties, samples of each of which were submitted for examination. Computing on the basis of an average of 7 individual specimens per sample; this constitutes approximately 22,218 specimens which have been critically examined during the year. Of the 3,174 varieties intercepted, 469 were refused entry, or either sorted and re-inspected, returned to the respective shippers or destroyed.

Contrary to usual procedure the Dutch growers exported large quantities of gladioli in the fall of 1930 for the coming year's crop, instead of exporting in the spring. Following a wet summer in Holland some of the material was heavily infected with diseases. Usually, however, the diseased lesions on the corms were in the pinhead stage, that is, had not developed sufficiently to present a chance of establishing the identity of a causal organism. Another drawback to the shipping of gladioli at this time of the year is damage due to freezing. Numbers of shipments were found to be badly frozen on arrival in November and December.

Dominion Plant Disease Survey

(B. 100·01)

I. L. Conners (Ottawa)

The plant disease survey of the Dominion of Canada was begun in 1920, the compilation of which was undertaken by the Division of Botany at the request of the plant pathologists in Canada. Annual reports on the prevalence of plant diseases in this Dominion have been published in mimeograph form for the years 1920 to 1926, except for 1924 when a summary covering the years 1920 to 1924 was published as a bulletin. Very few data for the 1929 survey were received until the spring of 1930. Not until the fall of the year was the compilation of the individual records begun and the annual report for 1929 will not be ready for distribution till January, 1931.

As the usefulness of an annual report on the prevalence of plant diseases in Canada is increased by its timely appearance, it was decided that the survey year for 1930 should end on October 31 and the observations should be submitted to the Central Laboratory at Ottawa by November 15. All data for the 1930 report were received within one month of the date set. Compilation was begun at once and it will be possible to issue the plant disease survey report for the current year by March 31, 1931.

A few of the more interesting observations may be briefly reviewed here:—

Stem rust (*Puccinia graminis* Pers.) was destructive throughout Manitoba except in the southwestern corner, where the crops suffered from drought. The loss from rust was as follows: common wheat, 5-10 per cent; oats, 5 per cent; barley, less than 5 per cent; durum wheat, none. Some loss also occurred in eastern Saskatchewan, but in western Saskatchewan and Alberta the crops were not affected by rust.

Barley leaf rust (*Puccinia anomala* Rostr.) has been observed previously in Manitoba, but it has never been so prevalent before. A very light infection occurred throughout the province and in many fields every plant was infected.

The rôle of the buckthorn in initiating epidemics of leaf rust (*Puccinia coronata* Corda) of oats was clearly shown from observations made in Carleton county, Ontario. Two mature hedges were found bordering the front yard of a farmhouse. These bushes were about 8 feet high although they were kept well trimmed. The owner said that the bushes were about fifty years old. This was the only cultivated hedge located in the immediate vicinity, but numerous escaped bushes were found within a radius varying from a half to one and one-half miles from the hedges. The escaped bushes were all located along the fence rows. The bushes were of all ages and heights, varying from young plants 2 feet high to mature ones 8 to 10 feet in height. In several instances the buckthorns were growing intermixed with chokecherry and plum, forming almost continuous hedges. The older bushes were actively reproducing themselves except the two hedges, which in recent years have been kept trimmed to prevent the setting of seed.

Leaf rust was heavy on the oats around the edges of the field, where buckthorns were growing. Near the buckthorns the crop was often lodged and infected 100 per cent with rust. On the upright plants infection was somewhat less, 60 to 100 per cent of the leaf surface being rusted. The rust became gradually lighter from the edge toward the centre of the field until at 75 yards from the edge only 25 per cent of the plants were rusted, the affected plants showing a trace to 5 per cent infection. From this point the infection remained the same over the rest of the field. In fields near by, but where buckthorns were not growing along the edges, infection often fell to a trace on not over 25 per cent of the plants. Several other fields, which were several miles away from this general area, were examined the same day. Sometimes no leaf rust was observed and generally less than one per cent of the plants were infected with traces of rust.

Damage caused by leaf rust was not great except close to the buckthorns and might be considered of little importance, but it should be noted that the present season was unfavourable for the development of rust and under conditions ideal for rust development the yield would be seriously reduced. Farmers are well advised to remove all buckthorns in order to produce a satisfactory return from oats.

Losses from wheat bunt (*Tilletia Caries* (DC.) Tul. and *T. foetens* (Berk.) Trel.) are still on the increase in the prairie provinces, especially in Hard Red Spring wheat. The percentage of cars graded "smutty" by the Western Grain Inspection Division from August 1 to October 31, 1930, was as follows:—

Hard Red Spring	1·7 per cent
Alberta Red Winter	5·5 "
Durum	16·6 "
All wheat	2·8 "

An outbreak of stem smut of rye (*Urocystis occulta* (Wallr.) Rabh.) occurred this year in Saskatchewan. The infection centred about Balcarres, Lemberg and Neudorf, although smut was found also at Mortlach and Fairlight. Infection varied from a trace to 11 per cent in the individual fields. As far as known, this smut has been observed in Saskatchewan only once previously, when a trace was found several years ago. A trace of stem smut was also collected this year at Carman, Man.

Of the foot and root rot diseases of wheat and other cereals, take-all (*Ophiobolus graminis* Sacc.) was more abundant or more easily recognized than in 1929, especially in Alberta. However, foot and root rots caused by *Helminthosporium sativum* P.K. & B. and *Fusarium* spp. appear to be more important in the aggregate as they occur more frequently than other rots.

Club root (*Plasmodiophora Brassicae* Woron.) is not usually severe on cauliflower in this country, but in a field in Lincoln county, Ontario, 15 to 20 per cent of the plants were severely diseased.

In addition to the plant disease survey work it has been possible to devote some time to work of a more mycological nature. An excellent start has been made on a bibliographical index to the fungi of Canada and some collecting has been done, many of the collections being valuable additions to the Mycological Herbarium of the division.

SECTION II

FOREST PATHOLOGY AND RELATED SUBJECTS

27559—3½

FORESTRY

Survey of Province of Quebec

In recent years there has been a very noticeable stimulation of interest in tree diseases, on the part of the general public, and especially among those who are most directly concerned with forest industries. As a result of this tendency there has been an increase in the number of requests received by the Division of Botany, for information regarding the importance of these diseases, their causes, and means of combating them. In order to keep pace with this increased demand, we have this year enlarged our staff by the addition of a forest pathologist for work in the province of Quebec. A forest pathological survey of this province has been commenced, and with the coming field season, a definite program of study of the more important tree diseases that have not already been dealt with, will be adopted. The work will be carried on in closest co-operation with the forest services of the province of Quebec and the Dominion as well as private owners. These services having become duly impressed with the destructive nature of many diseases affecting the trees of the forest, are most anxious to be assisted by specialists along this line of research.

The services of one member of the forest pathological staff (Mr. A. W. McCallum) were loaned during the year to the National Council for Scientific and Industrial Research to conduct inquiries into the damage done to tree vegetation by smelter fumes and gases at Trail, B.C.

The Cytospora Disease of Russian Poplar

(B. 50.02)

G. B. Sanford (Edmonton, Alta.)

In the spring of 1930 many groves of Russian poplars in central and southern Alberta were seriously injured, decimated or destroyed. *Cytospora chryso-*

FIG. 2.—Characteristic pycnidia of *Cytospora chrysosperma* on twigs of Russian poplar.

sperma was constantly and usually abundantly associated with the injury, the pycnidia of which were plainly visible, as shown in fig. 2.

The severest injury occurred in central and southern Alberta, from Lethbridge and McLeod, north to Calgary, and eastward. The injury directly north of Calgary to Edmonton was definitely less, but in the general Drumheller area severe damage occurred. The cause has not been determined. However, the general opinion among farmers was that the hot dry winds of 1929 in southern Alberta were responsible, and there was some meteorological evidence to support this opinion. Long (Journ. Agric. Res. 13: 331, 1918) has shown that an attack of poplar canker may follow dry seasons which weaken the trees. Indications are that this canker is not serious on healthy or uninjured trees. It was found that *Cytospora* canker was prevalent and severe in a central Alberta nursery which annually distributes a large number of Russian poplars.

Willow Disease Investigations—Maritime Provinces

(B. 50.01)

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

Since presenting a preliminary report[1] on this subject, detailed life history studies of the fungi associated have been carried out and effective control measures established. A full account of this work will be published at a later date.

A study of the associated fungi revealed two organisms capable of causing serious injury to the willows. The first of these, *Fusicladium saliciperdum* (Allesch & Tub.) Tub., a member of the Fungi Imperfecti, is known to cause the scab disease of willows in Europe. This disease appears on the young leaves in early spring. It invades the leaf blade and passes down the petiole causing a canker on the twig. It also kills back the tips of the young growing shoots. The organism produces its spores on the dead leaves, tips of twigs and cankers. These spread the disease through the summer and fall. The organism overwinters as dormant mycelium in the cankers and dead twig tips. The first spring spores mature about the time the catkins open on *Salix vitellina.* Rains are necessary for spreading the spores and maintaining favourable conditions for their germination.

The second organism, *Physalospora Miyabeana* Fukushi, was first reported from Japan and has since been described in England as causing a serious canker on basket willows. This is an ascomycete with a *Gloeosporium* as the imperfect stage. In pure culture it also produces spores on aerial mycelium. This fungus initiates a blight on the leaves somewhat later in the spring than the *Fusicladium.* An especially favourable location of infection is the adventitious growth that appears after the foliage attacked by the latter has been killed. The ascospores of *Physalospora* do not mature in the spring until a week or ten days after the first spores of *Fusicladium.* It is conceivable that the *Gloeosporium* stage might be a factor in primary spread under certain conditions as it commonly appears on twigs placed in moist chambers. However, it has not been observed in nature in the early spring.

The *Physalospora* attacks the leaves, spreads through the petioles and causes cankers in a manner comparable to *Fusicladium.* The *Gloeosporium* stage, however, rarely appears on the blighted leaves and only under very humid conditions. However, this stage sporulates abundantly on the cankers and blighted twigs and is quickly followed by the perithecia so that throughout the summer both ascospores and conidia play a part in the spread of the disease.

[1] Harrison, K. A. Willow Blight. Report of Dom. Bot. for the year 1928: 34-36, 1929.

The blights caused by these two organisms can be identified only after the spores have developed. During humid conditions in the field it is easy to distinguish between the olive brown velvety masses of the spores of *Fusicladium* and the small pink masses and black perithecia of the *Physalospora*. Care must be taken not to confuse the latter fungus with a saprophytic *Fusarium* which frequently forms pink spore masses on the blighted twigs.

A study of the life histories of the two fungi reveals one point in common that is important in outlining control measures. Both fungi overwinter on the blighted twigs and from these initiate the first infections in the spring.

The most effective control measures have begun by pruning the trees while dormant to remove all the limbs that have died or are seriously infected and as many of the diseased twigs as practical. The food reserves of a diseased tree are materially reduced. Therefore the removal of a portion of the weaker branches aids in the forcing of adventitious growth and lessens the amount of spraying. Pruning greatly reduces the early spring infection and if Bordeaux sprays are applied just after the leaf buds have broken there is no difficulty in keeping the disease suppressed. Almost perfect control was obtained with five sprays spaced at two week intervals. They proved so effective that it was not necessary to spray the following year though trees left as checks were 70 per cent defoliated. The Bordeaux was a 3-9-40 mixture using 9 pounds of hydrated lime. It was applied by means of power sprayer that gave 300 pounds pressure. A solid stream spray gun was used to reach the higher branches. More recent experiments have shown that three sprays starting when the leaves are about the size of a mouse's ear are sufficient to keep the disease under control. Careful pruning and the removal of all parts of the tree that are too high also simplifies the spraying operations when a high powered sprayer and a solid stream spray gun are not available.

If planting willows the following should be considered: *Salix alba* L. var. *vitellina* (L) Koch. is the common willow of the Maritime Provinces and is very susceptible to the two diseases. This is also true for the horticultural form, the Golden Willow. There are several willows, however, that are not readily attacked. *Salix babylonica* L., one of the weeping willows, has proved very resistant and *Salix pentandra* L. (Bay-leaved willow) is also highly resistant. The latter is not a large tree but grows luxuriantly under local conditions with dense shiny foliage and seems to be a desirable type for replacements or new plantings.

Cultural Studies of Wood-Destroying Fungi

(B. 70·13)

Irene Mounce (Ottawa)

STOCK CULTURES OF WOOD-DESTROYING FUNGI

In the annual report for 1926 a list was given of the species of wood-destroying and wood-inhabiting fungi represented in the collection of stock cultures at Ottawa. At present there are some ninety-two species which, as a rule, are represented by two or three cultures from different sources. In the case of forms which are being studied more particularly there may be anywhere from ten or twenty to one hundred different cultures.

Many of the cultures have been made from specimens collected in the vicinity of Ottawa or in the Temagami Forest Reserve, Ontario, but we are very much indebted to the following workers for contributions of specimens, cultures, or both: Dr. S. R. Bose, Calcutta; Mr. K. St. G. Cartwright, Prince's Risborough; Dr. J. H. Faull, and Mr. Grant Darker, Harvard University; Prof. H. M. Fitzpatrick, Cornell University; Dr. C. W. Fritz, Ottawa; Prof.

Takewo Hemmi, Kyoto; Prof. Iwao Hino, Miyazaki; Prof. J. Liese, Eberswalde; Mr. J. L. Lowe, University of Michigan; Dr. L. O. Overholts, Pennsylvania State College, and Dr. J. Westerdijk, Baarn.

A list of the species represented in the collection is appended. The asterisk (*) indicates that monosporous mycelia of this species have been isolated—in some cases from several different cultures. First a series of all possible pairings of monosporous mycelia from each source is made, then, if the species proves to be heterothallic, monosporous mycelia from one source are paired with monosporous mycelia from each of the other sources.

Armillaria mellea
Chlorosplenium aeruginosum
Claudopus nidulans
**Collybia velutipes*
Coniophora cerebella
Coprinus atramentarius
Coprinus micaceus
Daedalea confragosa
Daedalea quercina
Daedalea unicolor
Echinodontium tinctorium
Endothia parasitica
Favolus canadensis
Fistulina hepatica
**Fomes annosus*
Fomes applanatus
Fomes conchatus
Fomes fomentarius
**Fomes fraxinophilus*
Fomes igniarius
Fomes igniarius var. laevigatus
Fomes officinalis
**Fomes pinicola*
Fomes rimosus
Fomes robustus
Fomes roseus
**Fomes ulmarius*
Ganoderma oregonense
Hexagonia discopoda
Hydnum chrysocomum
Hydnum caput-ursi
**Lentinus lepideus*
Lentinus tigrinus
Lenzites betulina
**Lenzites saepiaria*
Merulius domesticus
Nectria cinnabarina
Panus stypticus
Pholiota adiposa
Pholiota albocrenulata
Pholiota destruens
Pholiota lucifera
Pleurotus ostreatus
Pleurotus sapidus
Pleurotus serotinus
Pleurotus subpalmatus
Pleurotus ulmarius
**Polyporus abietinus*
**Polyporus adustus*
**Polyporus anceps*
Polyporus balsameus
Polyporus Berkeleyi
**Polyporus betulinus*
**Polyporus borealis*
**Polyporus brumalis*
Polyporus chioneus
**Polyporus cinnabarinus*
Polyporus circinatus
Polyporus conchifer
Polyporus elegans
Polyporus frondosus
Polyporus fumosus
Polyporus galactinus
**Polyporus hirsutus*
Polyporus lucidus
**Polyporus pargamenus*
**Polyporus pubescens*
Polyporus radiatus
**Polyporus resinosus*
Polyporus Schweinitzii
Polyporus squamosus
Polyporus sulphureus
**Polyporus Tuckahoe*
Polyporus vaporarius
**Polyporus versicolor*
Poria incrassata
Poria obducens
Poria punctata
Poria prunicola
Poria subacida
Poria vaporaria
Schizophyllum commune
Stereum purpureum
Stereum sanguinolentum
**Trametes subrosea*
Trametes Pini
**Trametes protracta*
**Trametes serialis*
**Trametes suaveolens*
Xylaria polymorpha

Collection of Wood-Destroying Fungi

(B. 52·02)

Irene Mounce (Ottawa)

During the year all the specimens of wood-destroying fungi and of wood rots have been arranged, labelled, and indexed, so that they are readily available.

Wherever possible glycerine jelly mounts have been made of the spores from herbarium specimens and of the mycelium obtained from tissue cultures, and stained preparations have been made of the wood rots. These slides are filed in a cabinet and indexed under the name and number of the specimen from which they were obtained.

SECTION III

INVESTIGATIONS OF THE DISEASES OF CEREALS AND GRASSES

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Epidemiology of Cereal Rusts

(B. 20·02)

B. Peturson (Winnipeg, Man.)

(A) STATIONARY SLIDE EXPOSURES

Stationary slide exposures were made at five stations in Manitoba, two in Saskatchewan and one in Alberta.

No definite spore showers of *Puccinia graminis* Pers. occurred during June. However, a few isolated urediniospores were found on the slides exposed in Manitoba from June 6 on. This indicates that a light sprinkling of spores was gradually being brought in from the south. The number of spores caught on the slides exposed in Manitoba during this month was much lower than for the same month in 1927 or 1929.

On July 1, the first spores were caught on slides exposed at Saskatoon and Indian Head. It was not until July 29, that spores were detected on the slides exposed at Edmonton.

The first definite spore shower occurred on July 14; it extended over all of Manitoba and into eastern Saskatchewan. On July 23, just nine days after the occurrence of the first spore shower, the spore counts at all the stations east of Saskatoon increased from several spores to several hundred spores per square inch of slide exposed and, by the 26th of the month, counts of several thousand spores per square inch were quite common. During the remainder of the season the number of spores deposited on the slides was much greater than for the corresponding period in any previous year. Most of the spores caught during this period were undoubtedly of local origin.

A significant fact gleaned in connection with this year's slide exposures is the demonstration of the possibility of a severe rust epidemic developing under favourable environmental conditions with only a relatively low concentration of spores present in the air during the early part of the season.

(B) SLIDE EXPOSURES BY AEROPLANE

Slides were exposed from June 24 to July 31, by patrols of the Royal Canadian Air Force Substation at Lac du Bonnet, Man. Exposures were made also in the vicinity of McDonald, Man., by Flying Officer C. Cox, pilot in charge of the plane used for sulphur dusting. At McDonald exposures were made during July and the first two weeks of August; on each flight one exposure was made at each of the following altitudes: 1,000, 5,000, 10,000 and 14,000 feet.

A relatively small number of spores was caught on the slides exposed at Lac du Bonnet, during June, and the first two weeks of July. A considerable increase in spore count occurred on July 14, and on July 23 a still greater increase occurred. The slides exposed by aeroplane did not intercept as many spores as those exposed in spore traps. The results, however, were comparable. In both instances only a very few spores were caught during the early part of the season, and noticeable increases in spore counts in both cases occurred on the same dates.

Eight series of exposures were made at McDonald, six of which were made in August during the height of the rust epidemic. The average number of spores caught per square inch of slide exposed at the various altitudes was as follows: 10,050 at 1,000 feet, 1,180 at 5,000 feet, 28 at 10,000 feet and 11 at 14,000 feet.

These exposures demonstrate that rust spores in considerable numbers ascend to an altitude of at least 14,000 feet, and that the concentration of inoculum is greatest near the ground and diminishes with increasing altitude.

(C) FIELD STUDIES

This year, heavy stem rust infections occurred throughout Manitoba except in the southwestern corner which came within the area of low precipitation. Rust conditions very similar to those which existed in Manitoba prevailed throughout all of the eastern third of Saskatchewan. In the central portion of Saskatchewan only a very light sprinkling of rust was present, and it was not of sufficient severity to cause any appreciable damage; very slight traces of stem rust occurred in the western third of this province. In Alberta stem rust was even less prevalent than in western Saskatchewan.

Weather conditions in Manitoba and eastern Saskatchewan during the whole of June and the first three weeks of July were very favourable for rust development. Frequent rains and heavy dews during this period ensured spore germination, and high temperatures favoured rapid rust development. From July 23 to the end of the growing season, practically no rain fell, and high temperatures hastened the ripening of cereal crops probably by a week or more.

Stem rust was first observed in Manitoba on June 26, in Saskatchewan on July 11, and in Alberta on August 10. By July 20, stem rust had become quite prevalent in Manitoba and eastern Saskatchewan and a severe rust epidemic appeared imminent. From then on rust development was checked by the dry weather. The severity of infection on common wheats in the heavily rusted areas ranged from 20 to 80 per cent with infections averaging about 60 per cent. Durum wheat even within the heavily rusted area was only slightly rusted.

Barley was quite heavily rusted throughout Manitoba and eastern Saskatchewan.

Stem rust of oats was very prevalent in the Red River valley, severity of infection ranging from 30 to 70 per cent. This rust was much less severe in western Manitoba and eastern Saskatchewan, and mere traces were present in western Saskatchewan and Alberta.

Leaf rust of wheat (*Puccinia triticina* Erikss.) covered practically the same area as stem rust but was not quite so severe. Evidences of overwintering of leaf rust were found in Alberta.

Crown rust of oats (*Puccinia coronata* Corda), although present in all localities in eastern Saskatchewan and Manitoba, was not nearly so abundant as the rusts already discussed. The heaviest infections occurred in the Red River valley, where the severity of infection averaged 5 per cent. This rust was not found in Alberta.

A light sprinkling of dwarf leaf rust of barley (*Puccinia anomala* Rostr.) occurred throughout Manitoba. It was found in eastern Saskatchewan, but was not reported from western Saskatchewan or from Alberta.

Yellow stripe rust of wheat (*Puccinia glumarum* (Schm.) Erikss. & Henn.) could be found in Alberta from the international boundary to Edmonton. This rust was not observed in the other two prairie provinces.

Leaf rust of rye (*Puccinia dispersa* Erikss.) occurred quite frequently in Manitoba, but was not common enough to cause any damage. It was scarce in Saskatchewan and exceedingly rare in Alberta.

RUST DAMAGE

Stem rust caused no damage in Alberta or in the western half of Saskatchewan. In the latter province the damage was confined almost entirely to the area east of a line drawn from Weyburn through Indian Head and Melville to Canora. In Manitoba rust losses occurred in all districts except those in the extreme southwestern corner of the province. The rust losses this year, although considerable in eastern Saskatchewan and Manitoba, were certainly much lighter for the whole of Western Canada than in 1927; for in that year rust took its toll from all of the three western provinces, whereas, this year the epidemic was confined to a comparatively small portion of the wheat growing area.

The carrying out of the studies on epidemiology was made possible by the generous co-operation of the officers and pilots of the Royal Canadian Air Force, who made all the aeroplane slide exposures. Thanks are also due to Dr. G. B. Sanford of the Dominion Laboratory of Plant Pathology at Edmonton, Alta., and to Dr. P. M. Simmonds and Mr. J. B. Sallans of the Dominion Laboratory of Plant Pathology at Saskatoon, Sask., who took care of stationary slide exposures and made field observations in Alberta and Saskatchewan respectively.

The Seasonal Distribution of Physiologic Forms of *Puccinia graminis* var. *Tritici* in Canada

(B. 20.13)

Margaret Newton, T. Johnson and A. M. Brown (Winnipeg, Man.)

The present report summarizes the results of the eleventh year of research in Canada on the seasonal distribution of physiologic forms of *Puccinia graminis* Pers. var. *Tritici* Erikss. & Henn. from cereals and grasses.

Collections of wheat stem rust were made on cereals and grasses in the three western provinces—Manitoba, Saskatchewan and Alberta—from 1919 to 1924, but it was not until 1926 that a systematic search for physiologic forms was begun in all the provinces of the Dominion. As a consequence of this endeavour, in the east, rust was collected on the barberry as well as on cereals and grasses. The number of collections made annually was also greatly increased and many new forms were discovered. Most of the new forms originated in Eastern Canada from aeciospores or from urediniospores collected in areas where barberries were commonly grown. In 1927, Craigie demonstrated that *Puccinia graminis* var. *Tritici* was heterothallic and furnished a technique by which the possibility of hybridization between species and physiologic forms might be experimentally investigated. By means of that technique, the present authors and others have shown that physiologic forms do hybridize freely on the barberry with the production of new forms. As a result of these researches it has been necessary to take into account the source of origin of the different physiologic forms and to study separately: (1) the forms arising from barberries, and (2) those arising from cereals and grasses. The present report deals only with the latter study. It will be noticed that table 5 does not agree with earlier published tables as it has been revised to include only physiologic forms isolated from cereals and grasses.

Although thirty-nine physiologic forms have been isolated during the period 1919 to 1929, different physiologic forms predominate in different years. From table 5 it will be seen that from 1919 to 1921, form 17 was the predominating one and form 21 occurred only rarely. From 1922 to 1929, the reverse was true, form 21 becoming one of the most prevalent forms while very few collections of form 17 were made. In the same way form 1 appeared for a season or two, and then disappeared for a series of years; or again, form 3 appeared so consistently year after year as to be looked upon as a permanent form, and then, without any apparent cause, it disappeared. In 1925, form 36 suddenly became the predominating form, comprising over sixty-four per cent of all collections made that year in Canada. It has continued to be the most common form although, from year to year, it has continued to grow less in quantity. In 1929 it formed but twenty-two per cent of all the collections.

The distribution by provinces of the physiologic forms of wheat stem rust from cereals and grasses in 1929 is shown in table 6. Of the three hundred and six collections of wheat stem rust made, two hundred and forty came from the three western provinces—Manitoba, Saskatchewan and Alberta.

TABLE 5.—PHYSIOLOGIC FORMS OF *Puccinia graminis* var. *Tritici* FROM CEREALS AND GRASSES IN CANADA FROM 1919 TO 1928 WITH A RECORD OF THE NUMBER OF TIMES EACH FORM WAS COLLECTED ANNUALLY

Form	Number of times form was collected										
	Year										
	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929
1	2	1	...	...	...	...	...	...	...	2	11
2	...	...	...	...	1	...	...	...	...	...	...
3	...	4	3	10	10	16	...	...	...	...	...
9	4	6	2	3	...	...	...	1	4	...	...
11	2	5	2	3	5	9	...	...	...	5	2
12	...	2	...	...	...	5	...	...	...	...	...
14	...	...	...	...	...	...	...	2	16	2	5
15	1	...	...	...	...	...	...	2	8	21	1
16	...	...	...	...	...	...	...	...	2	...	...
17	9	31	27	16	10	1	...	1	15	6	13
18	4	7	3	2	...	...	...	...	...	...	...
19	1	...	...	...	...	...	...	1	1	6	4
21	4	...	4	24	...	1	44	84	133	103	26
23	...	...	...	...	...	...	...	...	...	4	...
24	1	...	1	...	...	...	...	...	...	...	...
29	...	17	1	...	...	...	13	28	4	11	15
30	...	1	...	...	...	...	1	7	7	...	...
32	...	4	1	...	...	...	3	12	4	...	10
33	...	...	...	...	...	...	...	...	...	...	1
34	...	...	...	1	3	7	1	4	10	15	4
35	...	...	...	...	...	...	...	1	...	...	...
36	...	...	...	2	...	...	113	211	204	154	69
38	...	...	...	...	...	...	...	18	26	32	65
39	...	...	...	...	...	...	...	...	...	...	1
40	...	...	...	...	...	...	...	...	...	1	...
48	...	...	...	...	...	...	...	2	...	...	2
49	...	...	...	...	...	...	...	3	8	14	68
50	...	...	...	...	...	...	...	...	4	...	6
52	...	...	...	...	...	...	...	1	3	6	...
53	...	...	...	...	...	...	...	...	1	...	...
63	...	...	...	...	...	...	...	...	...	1	...
64	...	...	...	...	...	...	...	...	...	1	...
74	...	...	...	...	...	...	...	...	...	1	...
75	...	...	...	...	...	...	...	...	...	1	...
77	...	...	...	...	...	...	...	...	...	1	...
78	...	...	...	...	...	...	...	...	...	4	...
83	...	...	...	...	...	...	...	...	...	...	1
84	...	...	...	...	...	...	...	...	...	...	1
97	...	...	...	...	...	...	...	...	...	...	1
Total number of forms	9	10	9	8	5	6	6	16	17	21	20
Total number of collections made in year	28	78	44	61	29	39	175	378	450	391	306

TABLE 6.—DISTRIBUTION BY PROVINCES OF THE PHYSIOLOGIC FORMS OF *Puccinia graminis* var. *Tritici* IN CANADA IN 1929

Province	Physiologic forms																				Total
	1	11	14	15	17	19	21	29	32	33	34	36	38	39	48	49	50	83	84	97	
Alberta	3	...	...	...	1	...	1	1	1	...	...	11	1	...	...	5	...	...	...	...	24
Saskatchewan	6	2	1	...	4	1	10	6	2	...	1	32	21	...	...	38	4	...	...	...	128
Manitoba	1	...	3	...	4	...	8	6	2	...	2	22	14	1	1	22	1	...	...	1	88
Ontario	1	...	1	1	1	1	3	...	3	1	1	1	8	...	1	1	...	1	1	...	26
Quebec	...	...	...	...	1	...	1	...	...	...	...	...	11	...	...	...	1	...	...	...	14
Nova Scotia	...	...	...	...	...	2	2	1	...	...	...	1	4	...	...	2	...	...	...	...	12
New Brunswick	...	...	...	...	1	...	...	1	...	...	...	1	3	...	...	...	...	...	...	...	6
Prince Edward Island	...	...	...	...	1	...	1	...	2	...	...	1	3	...	...	...	...	...	...	...	8
Total	11	2	5	1	13	4	26	15	10	1	4	69	65	1	2	68	6	1	1	1	306

The Testing of Hybrids and New Wheat Varieties for Rust Resistance

(B. 20.14)

Margaret Newton, T. Johnson and A. M. Brown (Winnipeg, Man.)

In 1926 the writers undertook to test the rust resistance of a number of wheat varieties and crosses to some of the physiologic forms of wheat stem rust present in Canada. In Scient. Agr. *7:* 161-168. 1927, they reported the reactions of twenty-three common wheat varieties and crosses and six durum wheat varieties to seven physiologic forms of *Puccinia graminis* var. *Tritici.* Later, this work was extended to include a number of other varieties and crosses. The rust reactions of thirty-three of these to twenty-two physiologic forms, including the seven forms above-mentioned, were published in Scient. Agr. *9:* 656-661. 1929. It should be pointed out that these reactions were the reactions of seedlings only.

As field observations had shown that many wheat varieties are more resistant in the after-heading stage than in the seedling stage, a study was made by Dr. C. H. Goulden and two of the above authors of the reactions of fourteen wheat varieties at two stages of maturity to sixteen physiologic forms of stem rust. The results obtained appeared in Scient. Agr. *11:* 9-25. 1930.

The Constancy of Physiologic Forms

(B. 20·07)

Margaret Newton, T. Johnson and A. M. Brown (Winnipeg, Man.)

(A) GENETIC STUDIES OF PHYSIOLOGIC FORMS OF PUCCINIA GRAMINIS VAR. TRITICI

The genetic studies of physiologic forms of *Puccinia graminis* var. *Tritici* were undertaken with the immediate object of discovering: (1) to what extent such forms could change in pathogenicity when they were allowed to complete their life cycle by passing from their graminaceous hosts to their alternate host, the common barberry, and from the barberry back to their graminaceous hosts; and (2) whether or not new physiologic forms could be produced by crossing two known physiologic forms.

An attempt was made to answer the first of these questions by studying, individually, the breeding behaviour of eight physiologic forms. This study involved the production of teliospores of each form, the germination of the teliospores and the infection of the barberry by their sporidia, the selfing of each form (i.e., the intermixing of the nectar of the haploid pustules), and the identification of the physiologic forms obtained from the aecia. Of the eight forms studied, seven were heterozygous for pathogenicity, that is, each form broke up into two or more physiologic forms after passing through the barberry; one form only was homozygous. The heterozygous physiologic forms, namely, forms 17, 21, 36, 49, 50, and 53, each produced in its progeny several different physiologic forms, the smallest number (4) being produced by form 36 and the largest (18) being produced by form 53. Only one form, physiologic form 9, was found to be homozygous. The progeny of this form was in all cases physiologic form 9.

A large number of crosses between physiologic forms were made by intermixing the nectar of haploid pustules produced by two forms. In the majority of the crosses the hybrid forms differed in pathogenicity from both parent forms, frequently being somewhat intermediate in pathogenic characters. Some of these hybrids were identified as previously described physiologic forms, others as new or hitherto undescribed forms. A number of crosses between forms 17 and 49 may serve as examples. From these crosses the following forms originated: form 30 and form 52 (previously described); form 87 and form 93 (new forms). All these forms differed markedly from both parent forms.

In certain other crosses it was found, however, that the first-generation hybrids were identical with one or other of the parent forms. Thus in a cross between form 9 and form 15, all the hybrids were identical in pathogenicity with the form 9 parent and were consequently described as form 9. Similarly in a cross between form 9 and form 52 the hybrids were identical with form 9. Evidently in these crosses the pathogenicity of form 9 was dominant over that of forms 15 and 52.

Certain of these hybrids were studied in the second generation in an attempt to determine whether or not the inheritance of pathogenicity was governed by Mendelian laws. To obtain the second-generation hybrids it is necessary to produce teliospores of the first-generation hybrid cultures, germinate the teliospores and infect the barberry by their sporidia, and " self " the form by intermixing the pycnial nectar of the pustules, and, finally, to identify the physiologic forms obtained from the aecia. In this manner second-generation hybrids were obtained from two of the crosses.

One of these crosses, form 9 x form 36, produced first-generation hybrids which were identified as form 17. This hybrid form was selfed and 126 second-generation cultures were studied for pathogenicity on the twelve wheat differential varieties. The second-generation cultures were identified as one or another of seven physiologic forms, namely, 1, 11, 15, 17, 36, 57, and 85. Only one of the parental forms, namely, form 36, appeared again in the second generation. The number of classes in the second-generation (each form being considered as a class), and the distribution of the cultures in these classes, have suggested the possibility that three pairs of Mendelian factors determine the inheritance of pathogenicity in this cross, but the approximation to a tri-hybrid ratio is not close enough to allow the establishment of a three-factor basis. The smallness of the hybrid population accounts, perhaps, for the lack of agreement with any known genetic ratio.

The other cross from which second-generation hybrids were obtained, form 9 x form 15, produced first-generation hybrids identified as form 9. This hybrid form 9, on selfing produced second-generation hybrids which were identified as one or another of four forms, namely, forms 9, 85, 57, and 15. Both the parental forms, 9 and 15, thus appeared in the second-generation in addition to two other forms. As only 25 second-generation cultures were studied, it is impossible to place the inheritance of pathogenicity on a factorial basis, although it appears likely that the inheritance is Mendelian in character.

CYTOPLASMIC INHERITANCE

In several of the crosses there was evidence of the presence of a type of inheritance which could not be explained on a Mendelian basis. Ordinarily, when a cross between two physiologic forms is made in both directions, the hybrids which arise from the two sides of the cross are identical. This is what would be expected if the inheritance is of a Mendelian character. In crosses between some physiologic forms it was found, however, that the hybrids produced by a cross and its reciprocal cross were not identical in pathogenic characters. For example, in a cross between form 14 and form 36, it was discovered that the hybrids arising from the form 14 side of the cross were identical with form 14, while the hybrids arising from the opposite side of the cross were different in pathogenicity and were identified as form 88, a new physiologic form. These two forms, while very similar, are easily distinguishable by their reaction-types on the variety Marquis. Now the parent-forms differ widely in their reactions on Marquis; form 14 produces a (1) type of reaction, while form 36 produces a (4) type of reaction. The hybrids produced from the form 14 side of the cross are in all respects identical with form 14, including the characteristic (1) type of reaction on Marquis. The hybrids produced from the form 36 side of the cross are identical with form 14 in all respects, except their reaction on Marquis which is designated as (X), and resembles the reaction of the form 36 parent on Marquis more than that of the form 14 parent. Apparently such results cannot be explained on Mendelian basis alone. If it is assumed, however, that the cytoplasm of the maternal pustule—the one to which the pycniospores of the other parental pustule are applied—also contributes to the inheritance of pathogenicity, a plausible explanation can be reached. To specify, the pycniospores of a haploid pustule of form 36 were transferred to a haploid pustule of form 14, the maternal pustule. It would then be expected that as the nuclei of the pycniospores of the form 36 pustule and the nuclei of the haploid hyphae of the form 14 pustule contribute equally to the inheritance of the hybrid, the additional inheritance from the cytoplasm of the form 14 pustule would cause the hybrid developed in it to resemble in pathogenicity the form 14 parent more than the form 36 parent. For the same reason, when pycniospores of the form 14 pustules were transferred to the form 36 pustule it would be expected that the hybrid developed in the latter pustule would resemble the form 36 parent in pathogenicity more than the other parent. Apparently, the most plausible explanation of the resemblance of these two hybrid forms to what may, perhaps, be called their "maternal" parents is to be found in maternal cytoplasmic inheritance.

THE INHERITANCE OF UREDINIOSPORE COLOUR

The occurrence of physiologic forms of abnormal colour provided an opportunity for the study of the inheritance of spore colour. Three forms of abnormal urediniospore colour were available for this study. One of these, form 9, was characterized by uredinia of orange colour. The other two, forms 36 and 52, possessed uredinia of greyish-brown colour. It was thought that crosses between these forms might yield some interesting information concerning the inheritance of urediniospore colour.

Four crosses were made between form 9 (orange) and form 36 (greyish-brown). The majority of the progeny of these crosses was normal (red) in urediniospore colour. In fact, out of the 73 cultures studied, 67 were red, while 3 were greyish-brown and 3 contained a mixture of red and orange uredinia. The greyish-brown progeny is undoubtedly the result of an accidental selfing of the greyish-brown parent form. It is more difficult to account for the presence of orange rust among the first-generation hybrids. At present it seems most plausible to ascribe the origin of the orange rust to mutation.

One of the red first-generation hybrids was selfed in order to study the inheritance of urediniospore colour in the second generation. One hundred and thirty-five second-generation cultures were studied. Of these, 59 were red, 47 orange, 22 greyish-brown, and 7 white. The occurrence of four distinct colour groups suggests that the inheritance of colour has a Mendelian basis and suggests also the possibility that two pairs of factors are involved. The frequency distribution in these classes does not, however, conform with the dihybrid ratio, and consequently it is not possible to establish definitely a two factor basis.

(*b*) STUDIES IN HYBRIDIZATION BETWEEN VARIETIES OF PUCCINIA GRAMINIS

Hybridization between Puccinia graminis var. Tritici and Puccinia graminis var. Secalis

Crosses between forms 30 and 95 of *Puccinia graminis* var. *Tritici* and a field culture of *Puccinia graminis* Pers. var. *Secalis* Erikss. & Henn. have resulted in the production of four hybrid rust forms, three of which have not hitherto been described. These hybrids, although distinguishable, resemble one another rather closely in pathogenic characters. They are much less virulent on wheat varieties than other known physiologic forms of the *Tritici* variety, and are likewise less virulent on rye varieties than forms of the *Secalis* variety. If these hybrids are characteristic of all hybrids between the *Secalis* and *Tritici* varieties of *Puccinia graminis*, it is probable that such hybridization is not important as a source of virulent strains of wheat stem rust or rye stem rust.

The Germination of Wheat Stem Rust Teliospores

(B. 20.23)

T. Johnson (Winnipeg, Man.)

The production and germination of teliospores of physiologic forms of wheat stem rust is essential in any study of hybridization among such forms. The work here described was undertaken with the object of germinating greenhouse-formed teliospores of certain physiologic forms as soon as possible after their formation so that these forms could be used in hybridization studies. Previous experience with teliospores formed in the greenhouse had shown that such spores were erratic in germination; but germination had, however, been secured by overwintering them out-of-doors. This procedure had the drawback that it necessitated waiting for about six months from the time of formation of the teliospores until their germination. It was desirable, in order to expedite the work on hybridization, to shorten their usual period of dormancy. Several previous efforts to accomplish this object had failed. Various chemical treatments, designed to increase the permeability of the spore-wall to water and oxygen, had failed to induce germination. It was then decided to simulate the environmental conditions to which naturally-formed teliospores are exposed as closely as this could be done in the laboratory. The method decided upon involved freezing the teliospores for a short period; thawing them and spraying them with cold tap water for a few days; and subsequently wetting and drying them alternately. This method proved unexpectedly successful.

As it was thought possible that conditions which prevailed during the formation of the teliospores might affect their germinability, it was decided to form the spores under different environmental conditions. Consequently teliospores of each physiologic form were produced at two different temperatures: some at a temperature of 55°—60° F.; others at a temperature of 70°—75° F. Soon after the formation of the spores they were frozen in water for periods of two to seven days in a Frigidaire running at a temperature of about —5° C. They were then thawed out and placed under a spray of tap water (at a temperature of 5°—10° C.) for seven days. After this they were tested for germination. None of the spores ever germinated at this stage. The same spores were then dried in the laboratory (at a low humidity) for two days, soaked over-night in water, and tested for germination. They commonly began to germinate after the first period of drying. This procedure of alternate wetting and drying (wet two days, dry two days) was continued, in some cases, for as long as the spores would germinate.

By this method teliospores of seventeen physiologic forms were germinated during the winter of 1929-30. The teliospores of these forms were produced in the greenhouse during the months of December, January and February, and were induced to germinate from late in January until the end of March.

Two significant facts have emerged from this study. First, that the dormancy period in teliospores does not necessarily coincide with the winter season, but can be shortened greatly by appropriate methods. Second, that the temperature prevailing during the formation of the teliospores has a considerable effect on their germinability.

The first of these facts raises the question: What is the shortest possible dormancy period of teliospores formed in the greenhouse? Efforts were made to decide this point. The shortest period between the completion of teliospore formation and the germination of the spores was twenty days. Spores frequently germinated between thirty and forty days after formation. The shortest period from the inoculation of wheat plants with urediniospores to the germination of the teliospores formed on them was fifty-five days.

The effect of the temperature during the formation of the teliospores on their germinability was quite marked. The spores formed at a comparatively low temperature, 55°—60°F., germinated more abundantly and more consistently than those formed at a higher temperature, 70°—75°F.

Experiments were also carried out to determine the duration of germination in certain telia. Groups of telia were alternately wetted and dried from the time the spores began to germinate until germination ceased. Germination began on January 24, 1930, and continued until April 1. This represents a period of sixty-eight days of which actual germination took place in thirty-one days. The spores were subjected to twenty periods of alternate wetting and drying before germination finally ceased. There are evidently marked physiological differences in spores in the same sori, for some of the spores germinated after each period of drying and wetting while others did not. The last spores to germinate passed unaffected through the first nineteen periods of alternate drying and wetting but germinated after the twentieth period.

It is natural to ask the question: "What part of the stimulation to germination is due to the freezing and what part is due to the process of alternate wetting and drying?" Certain experiments were performed in an attempt to decide this issue. Teliospores germinated after being frozen and then kept constantly moist. They also germinated when alternately wetted and dried without being frozen. But in both cases germination was poorer and more erratic than when the two processes were combined, i.e., when freezing was followed by alternate wetting and drying. Apparently, then, both freezing and alternate wetting and drying are operative in shortening the dormancy period of teliospores.

Studies of the Effects of Environmental Factors on the Uredinial Development of Cereal Rusts

(B. 20·21)

(A) PUCCINIA GRAMINIS VAR. AVENAE

W. L. Gordon (Winnipeg, Man.)

It had frequently been noted, particularly during the summer months, that the reaction of Joanette Strain to certain physiologic forms of *Puccinia graminis* Pers. var *Avenae* Erikss. & Henn. fluctuated beyond the normal limits. This was considered to be due partly to the high temperature prevailing in the greenhouses during the summer months. The installation of temperature control apparatus in two of the greenhouse sections made possible the study of the effect of temperature on rust reactions.

The effect of temperature on the reactions of the differential hosts to physiologic forms of *Puccinia graminis* var. *Avaeae* was studied in the following manner. Cultures derived from single spores of each of the eight physiologic forms were used as inoculum. The differential hosts, White Russian, Richland, Joanette Strain, and Victory, were inoculated in the seedling stage to each of the eight physiologic forms and incubated at the following mean temperatures: 57·4°F., 64·8°F., 71·9°F., and 75·4°F.

There was no significant difference in the reactions of White Russian, Richland, and Victory, to any of the physiologic forms at these temperatures. Joanette Strain gave a similar type of rust reaction to physiologic forms 2, 6, 7, and

8 at all four temperatures. However, the reaction of this variety to physiologic forms 1, 3, 4 and 5 was decidedly affected by temperature. At the lowest temperature, Joanette Strain was highly resistant to forms 1, 3, 4 and 5, but completely susceptible to these at the highest temperature. At 71·9°F., and 64·8° F., it was moderately susceptible.

The effect of a change in temperature at various stages of the incubation period on the reaction of Joanette Strain to physiologic forms 1, 3, 4, and 5, was also studied. Seedlings of Joanette Strain were inoculated and, after the regular period in the incubation chambers, were divided into two lots. One lot was placed at a temperature of 76·8°F., and the other at 60·8°F. After one day, and on each succeeding day for seven days, one pot was transferred from the low to the high temperature, and one from the high to the low temperature. The longer the period Joanette Strain was kept at a temperature of 60·8°F., before it was transferred to a temperature of 76·8°F., the greater was the resistance it showed. Conversely, the longer the period the host was kept at 76·8°F., before it was transferred to a temperature of 60·8°F., the greater was its susceptibility.

These results explain the observed fluctuations in the reactions of Joanette Strain to physiologic forms 1, 3, 4 and 5. The temperature variations which occur under ordinary greenhouse conditions had undoubtedly affected the reaction of this host.

(B) PUCCINIA CORONATA VAR. AVENAE

(B. 20·21)

B. Peturson (Winnipeg, Man.)

In the process of identifying physiologic forms of *Puccinia coronata* Cda. var. *Avenae* Erikss., it was observed that the reactions of some of the cultures varied from time to time on some of the differential hosts. It was quite evident that the relationship of host and fungus was being influenced by environmental conditions.

Since physiologic forms of this rust are identified on the basis of their parasitic behaviour on certain oat varieties, it is important to know whether or not the variations in environmental factors encountered under ordinary greenhouse conditions influence the rust reactions of the differential hosts to such an extent that the identification of a physiologic form is affected. Temperature is undoubtedly one of the most important factors influencing rust development. As this factor varies greatly under greenhouse conditions from season to season and even from day to day, experiments were conducted to ascertain to what extent temperature influences rust reactions of differential host varieties to physiologic forms of crown rust of oats.

The effect of temperature on the development of physiologic forms 1, 3, 4, and 7, of crown rust of oats on six differential host varieties of oats was studied. Cultures of each of these forms were incubated at the three following temperatures, 57°, 70°, and 77° F.

The rate of rust development on the plants inoculated with these forms and kept at 57° F., was retarded by about two days, as compared with the rate of development on those kept at 77° F. The type of rust reaction produced by forms 1 and 3 was not influenced by temperature. One variety, Red Rustproof, was susceptible to form 4 at 70° and 77° F., but resistant to it at 57° F. Form 7 developed heavily on all the differential varieties at 77° F., but at 57° F., it failed to produce spores on Green Mountain, White Tartar and Green Russian.

These results emphasize the importance of maintaining a uniform greenhouse temperature while the identification of physiologic forms of crown rust of oats is in progress. Unless a uniform temperature is maintained, some of the physiologic forms of this rust will show considerable variation in rust reaction on several of the differential varieties.

(C) PUCCINIA GRAMINIS VAR. TRITICI

(B. 20·21)

T. Johnson (Winnipeg, Man.)

It has been recognized for some time that environmental conditions, such as temperature, light, air humidity, and carbon-dioxide concentration of the air, play an important rôle in the development of cereal rusts on their grass hosts. The extent to which each of these factors of the environment can affect rust development has, however, not yet been thoroughly investigated. In order to allocate to each of these factors its proper share in the total effect of the environment, it is necessary to exercise rigid control over each factor. As temperature control was available the work here reported deals more particularly with the part which temperature plays in rust development.

Certain physiologic forms of *Puccinia graminis var. Tritici* lend themselves exceptionally well to a study of this kind. These forms produce on certain wheat varieties the so-called "X-reaction". Previous experience had shown that this reaction varied considerably at different seasons of the year and it was presumed that climatic conditions were the cause of this variation.

THE EFFECT OF TEMPERATURE ON RUST DEVELOPMENT

The behaviour of several physiologic forms characterized by producing the X-reaction on certain wheat varieties was studied at two different temperatures: 55°—60° F., and 70°—75° F. The behaviour of these forms on hosts which normally exhibited the X-reaction was markedly different at the two temperatures. Fig. 3 which shows the reactions of Mindum seedling leaves to

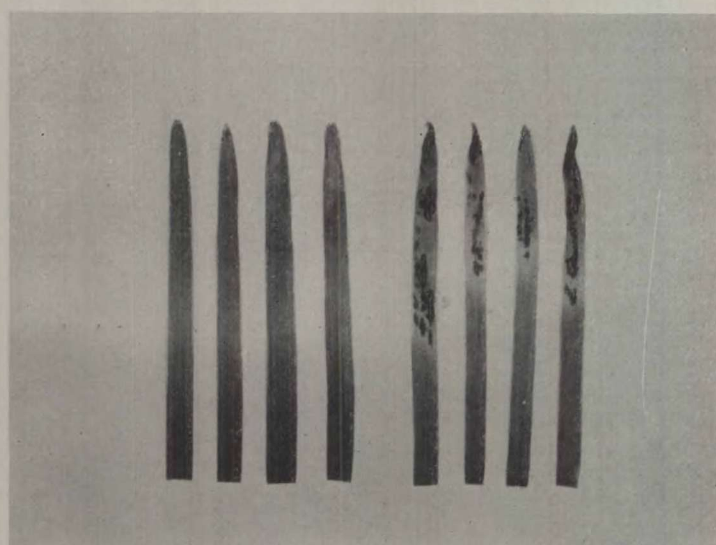

FIG. 3.—Reactions of Mindum seedlings to physiologic form 29. Left: Leaves of plants kept at a mean temperature of 58·0°F. Right: Leaves of plants kept at a mean temperature of 73·1°F.

physiologic form 29 at mean temperatures of 58° F., and 73° F., illustrates the effect of temperature on rust development. The X-reaction did not appear at either of these temperatures; at the lower temperature the Mindum seedlings were highly resistant; at the higher temperature they were quite susceptible. This behaviour is typical of those forms which at ordinary greenhouse temperatures (about 65° F.) produce the X-reaction, but is manifested only on wheat varieties which normally exhibit the X-reaction when infected by these forms. On varieties which are normally resistant or normally susceptible these physiologic forms do not vary appreciably in pathogenicity at these temperature ranges. Forms which do not produce the X-reaction at ordinary greenhouse temperatures are not appreciably influenced by temperature in their rust reactions.

THE EFFECT OF LIGHT ON RUST DEVELOPMENT

As no accurate control of light intensity was available it was attempted to determine by indirect methods the effect of light intensity on rust development, with particular reference to X-forms. In the greenhouses in which the experiments were carried on, daylight is at a minimum in both duration and intensity in the months of December and January, but increases gradually as spring approaches. By studying the reactions of the X-forms at gradually increasing light intensities, but at the same temperatures (55°-60° F, and 70°-75° F.) which were used during December and January, it was possible to determine how far increased light intensity affected rust reaction. Experiments carried out from February 15 to March 31, showed that the rust reactions of the X-forms became gradually more vigorous with the increase in light intensity. Forms which, during December and January, produced reactions of (0); and (1) types at 55° F. to 60° F., produced a light X-type on the same wheat varieties and at the same temperature in the month of March. Apparently, increased light intensity is capable of producing the same effect on the development of the X-forms as increased temperature.

THE EFFECT OF CARBON DIOXIDE CONCENTRATION OF THE AIR ON RUST DEVELOPMENT

The effects of several different carbon dioxide concentrations of the air on the development of the X-reaction were determined. The following concentrations were used: 0·03, 0·15, 0·75, 1·50, 3·00 and 4·50 per cent of carbon dioxide by volume. No increase in rust development was noted at any of these concentrations, but, on the contrary, a decrease was observed at concentrations of 1·50 per cent and above. The pustules at these higher concentrations were minute, and hypersensitive flecks were abundant on the leaves.

CONCLUSION

The above-mentioned facts concerning the effect of environmental factors on rust development are of considerable significance in any studies of physiologic forms of wheat stem rust. This is particularly so in the identification of physiologic forms. It is evidently of the greatest importance to avoid excessively high or excessively low temperatures in greenhouses where physiologic forms are being identified. A form characterized by the X-reaction is liable to have the appearance of one form at one temperature and that of another form at a different temperature. It is also desirable to control other factors in the environment, particularly light, which seems to produce much the same effect on rust reaction as temperature.

It is difficult to say how far these environmental factors can increase or decrease the virulence of physiologic forms in a natural rust epidemic. It seems probable, however, that they operate in much the same manner in the field as in the greenhouse. If so, it is highly probable that certain wheat varieties are more or less resistant to certain physiologic forms under some weather conditions and susceptible under others.

A Study of Yellow Stripe Rust *(Puccinia glumarum)* in Western Canada

(B. 20.19)

Margaret Newton, T. Johnson and A. M. Brown (Winnipeg, Man.)

For three years many difficulties have been encountered in culturing yellow stripe rust, *Puccinia glumarum* (Schm.) Erikss. & Henn., in the greenhouse during the summer months. Each year, as the summer advanced and the temperatures became higher, it became increasingly difficult to maintain the rust in culture, and eventually, the cultures which we had at the beginning of the year were lost.

During this time a study was made of the temperatures that favoured or inhibited spore germination. It was found that the optimum temperature for germination was about 50° F., the minimum just above freezing point and the maximum about 68° F. These temperatures were considerably lower than the corresponding temperatures for the germination of other cereal rusts.

Since low temperatures seemed to favour the optimum development of *Puccinia glumarum,* a study was undertaken of the effect of temperature on the host reactions to this rust. This work is still in progress but the results have shown that temperature influences very definitely the reactions of wheat varieties to *Puccinia glumarum.* At 70° F., varieties such as Chul, Mindum and Kanred become highly resistant, they fleck heavily but develop no rust pustules; at 64° F., on the other hand, they are highly susceptible and develop abundant pustules.

As has been stated in previous reports, the distribution of stripe rust has been restricted almost exclusively to the provinces of British Columbia and Alberta. The present work seems to show that the high temperatures which have prevailed in Manitoba and Saskatchewan during the summer months have been one of the chief factors in preventing the eastward spread of this rust.

Investigations of the Dwarf Leaf Rust of Barley *(Puccinia anomala)*

(B. 20.17)

A. M. Brown (Winnipeg, Man.)

In 1929, two collections of *Puccinia anomala* Rostr. were made; one in Manitoba, and one at Vineland, Ont. When cultured, both collections were identical in their reactions on the differential hosts, but were different from the three physiologic forms described in the previous report. They have been designated, therefore, as physiologic form 4. Form 3 has been collected only at Victoria, B.C. Forms 1 and 2 were prevalent in Manitoba and Saskatchewan in the years 1927-28.

The differential hosts used in the previous year's work were found to be unsatisfactory and the addition of the varieties Flynn, Stavropol and Chile, was deemed advisable, Horsford and Moroccan being discarded. An analysis of the reactions of four physiologic forms of *P. anomala,* on their differential hosts is given in table 7.

Table 7.—Reactions of Barley Varieties to Four Physiologic Forms of *Puccinia anomala*

Physiologic form	Gold	Flynn	Californian Feed	Stavropol	Chile	Odessa
1	1+	3	3	1+	1+	3
2	3	3−	3	1+	1+	3
3	3	2+	2+	2	1+	3
4	2−	1+	3	X−	1+	3

The addition of an X-type of reaction, which serves to distinguish form 4 from form 3, is included in this year's study. This type of reaction is in many respects similar to the X-type of reaction in *Puccinia graminis* var. *Tritici.* It is not, however, so clearly defined.

One hundred and fifteen varieties of barley secured from the Department of Agronomy, of the Manitoba Agricultural College, were tested to four physiologic forms of *Puccinia anomala.* Of these, M.A.C. 321, Featherstone, M.A.C. 248, Keystone, Alberta Beardless, Colsess and Mensury Ottawa 60, showed complete resistance to all four physiologic forms; M.A.C. 406, Nepal, M.A.C. 32, Swedish Gold, M.A.C. 524, Danish Island, and O.A.C. 21, showed resistance to three forms; and Sacramento, Mariout and Californian Baird were resistant to two forms. Archer Gartons, C.D. 535, Argyle and Latvia 2-rowed were resistant to only one form.

Physiologic Specialization in *Puccinia coronata* var. *Avenae*

(B. 20.16)

B. Peturson (Winnipeg, Man.)

During the summer of 1929 one hundred and three collections of crown rust were obtained from various localities throughout Canada. These collections were identified in the greenhouse in the fall of 1929 and the winter of 1930. Seven distinct physiologic forms were isolated from these collections.

Before any very definite statement regarding the prevalence of physiologic forms can be made many more collections must be examined. However, the collections determined to date, indicate that some of the forms are apparently of common occurrence while others are quite rare. The number of times each form was isolated in 1928 and 1929 is given in table 8.

TABLE 8.—NUMBER OF ISOLATIONS OF EACH PHYSIOLOGIC FORM OF *Puccinia coronata* var. *Avenae* IN 1928 AND 1929

Form	Number of Isolations		Form	Number of Isolations	
	1928	1929		1928	1929
1	10	38	7	0	0
2	0	0	8	1	3
3	0	0	9	0	0
4	8	10	10	2	3
5	0	0	11	6	15
6	1	2	12	9	32

Table 8 indicates that forms 1, 4, 11, and 12 are of fairly common occurrence. Of all the forms identified to date, form 1 is the most virulent. This form, as well as being the most virulent, is the most common, comprising 27·1 per cent of the 1928 collections and 36 per cent of those identified in 1929.

As regards distribution of these forms it is clear that some at least are by no means localized. Form 1 was collected from Saskatchewan to Prince Edward Island, and forms 4, 11, and 12, which are also frequently met with, were collected in widely separated localities.

Varietal Resistance of Oats to Crown Rust

(B. 20·04)

B. Peturson (Winnipeg, Man.)

A knowledge of the resistance of existing oat varieties to physiologic forms of crown rust is basic to any attempt to produce varieties resistant to this disease. It is particularly desirable to know how varieties react in the field, since this knowledge helps the plant breeder to determine which varieties are likely to be most suitable as parent material. Accordingly, a large number of oat varieties were subjected to artificial epidemics of crown rust under field conditions, in an endeavour to discover some varieties partially or wholly resistant to crown rust. These tests were conducted in 1927, 1928, and 1930, and included one hundred and eleven American oat varieties and seventy-seven European varieties belonging to six of the eight species of oats. The inoculum used included physiologic forms 1 and 8 in 1927, 1, 4, and 8 in 1928, and 1, 3, 4, 6, and 11 in 1930.

Several varieties showed considerable resistance to crown rust under field conditions in certain years, even when crown rust was abundant. No variety, however, which has been tested for more than one year has proved to be resistant in all trials. In view of what is known regarding physiologic specialization, it is not surprising that a variety should be highly resistant one year and completely susceptible the next. The fact that a variety may be resistant to one form and susceptible to another explains this seeming anomaly. Thus far no variety tested has been found suitable as parent material for the production of varieties resistant to all physiologic forms of crown rust of oats. An attempt will be made to obtain more oat varieties in the hope of securing one which is resistant to all physiologic forms of crown rust of oats.

Physiologic Specialization in *Puccinia graminis* var. *Avenae*

(B. 20·06)

W. L. Gordon (Winnipeg, Man.)

The survey for stem rust in Western Canada was carried on during 1929 in the usual manner. Oat stem rust was first collected in Manitoba on July 17. Later in the season, it became more or less widespread throughout the province, but did little, if any, damage to the crop. In Saskatchewan and Alberta it was also of little importance. Although no rust survey was carried on in Eastern Canada, the rust nurseries, when marked about the end of August, did not reveal more than a moderate amount of rust.

During the year, 135 collections of oat stem rust were cultured in the greenhouse, and the physiologic forms were isolated and identified. The number of collections obtained from each province is shown in table 9.

Table 9.—Number of Collections of *Puccinia graminis* var. *Avenae* from each Province Cultured During 1929

British Columbia	0	Quebec	5
Alberta	5	New Brunswick	4
Saskatchewan	29	Nova Scotia	4
Manitoba	79	Prince Edward Island	0
Ontario	9		

All the cultures, with the exception of seven which came from the barberry, were obtained from uredinia on *Avena* spp., collected in the field. Five of them arose from barberries artifically inoculated at Winnipeg, Man. with telial material which had been collected in the field plots of the laboratory during the summer of 1928, and which had been kept outside during the following winter. The other two cultures came from barberries naturally infected at Guelph, Ont. Forms 2, 3, 7, and 8 were isolated from the barberry cultures from Winnipeg, and forms 1 and 3 from the Guelph cultures.

As usual, physiologic forms 2 and 5 were the most prevalent and the most widely distributed. They composed approximately 82 per cent of the total isolations. The number of isolations of form 1 was slightly less than the average number of isolations of this form for the years 1925-1928. There was a considerable increase in the number of isolations of physiologic form 3. Form 3, in the past, has been isolated only infrequently from collections in Canada.

Forms 4 and 6 were isolated but once during 1929. Form 7 composed approximately 4·5 per cent of the total isolations. This physiologic form was not found in Canada until 1928.

In addition to the physiologic forms already mentioned, all of which have been collected previously in Canada, another form was isolated in Canada this year for the first time. It is physiologic form 8, previously known to occur only in Australia. This form was isolated twice. One isolation was made from a collection of uredinia on Monarch Strain at Nappan, N.S. (table 10); the other, from aecia on a barberry that was artificially inoculated in the greenhouse at Winnipeg, Man. Although form 8 is not so virulent as form 6, it is more virulent than the commonly-occurring forms 1, 2, and 5. At the present time all the known physiologic forms of *Puccinia graminis* var. *Avenae* have been isolated from collections made in Canada.

Richland, Heigira Strain, and Monarch Strain are susceptible to three forms; White Russian to four forms; Joanette Strain and Strain 703 to five forms; and Victory is susceptible to all the physiologic forms. Richland, Heigira Strain, Monarch Strain, and White Russian are resistant to the physiologic forms most frequently isolated in Canada.

TABLE 10.—DATA CONCERNING VIRULENT PHYSIOLOGIC FORMS COLLECTED IN CANADA DURING 1929

Rust survey No.	Place of collection	Form	Host
Saskatchewan—			
121	Bienfait	3	*A. sativa.*
Manitoba—			
2	Winnipeg	8	Barberry.
3	"	7	"
4	"	3	"
5	"	7	"
52	"	3 & 6	White Russian.
69	"	3	"
133	"	7	Heigira Strain.
120	Laurier	3	*A. sativa.*
127	Ericksdale	7	"
Ontario—			
7	Guelph	3	Barberry.
63	Beamsville	7	*A. sativa.*
96	Ottawa	7	Victory.
97	"	4	Joanette Strain.
Quebec—			
82	Ste. Anne de la Pocatière	7	Victory.
Nova Scotia—			
89	Nappan	8	Monarch Strain.

A list of the collections from which the more virulent forms were isolated in 1929, is given in table 10. It is hoped that these forms may not become prevalent in Canada as the varieties now used in breeding for rust resistance, although resistant to the commonly-occurring forms 1, 2, and 5, are more susceptible to forms 3, 4, 6, 7, and 8.

The assistance given by the members of the Dominion Laboratories of Plant Pathology in sending in collections of oat stem rust is gratefully acknowledged.

Salt Treatment for the Control of Rust

(B. 383)

F. J. Greaney (Winnipeg, Man.)

In 1929, an investigation was commenced to test the value of applying to the soil, common salt (NaCl) in various quantities and at different times, for the control of wheat stem rust (*Puccinia graminis* Pers. var. *Tritici*, Erikss. & Henn.). Due to the light epidemic of rust in 1929, the test was not satisfactory. The results of the experiment showed, however, that in no case was the yield significantly influenced by the application of salt. The investigation was continued in 1930.

A large block of late-sown Marquis wheat was used for the test at Winnipeg in 1930. This block was divided into twenty-five 1/200th acre plots which were separated by pathways two feet wide. Applications of salt were made by hand to the surface of the soil. The first treatments were made on June 16 when the plants were 4 to 6 inches tall, and in one series of plots, a second application was made two weeks later.

In order to study the effect on yield of applying salt in various rates and at different frequencies, the twenty-five 1/200th acre plots were arranged in a 5 by 5 Latin Square in which four different treatments were used, the fifth being the check which was left untreated. The experiment was so arranged that the yield data could be analyzed statistically and the significance of the yield results determined. The various treatments, together with the results, showing the effect of salt applicatians on the amount of rust infection and on the yield, are given in table 11.

Table 11.—Results of Treating Plots of Marquis Wheat with common salt in order to determine its effectiveness in controlling stem rust, at Winnipeg, in 1930.

Treatment symbol	Amount of salt per application, per acre	Date applications were made	Mean results of five plots arranged in a Latin Square				
			Per cent stem rust severity		Weight per bushel	Grade	Yield per acre
			Range	Average			
	lb.				lb.		bush.
A	4,000	June 16	90–100	96	38	Feed	3·4
B	2,000	" 16	80–100	95	37	"	3·2
C	1,000	" 16	85-100	95	38	"	3·9
D	2,000	" 16, 30	90–100	97	37	"	3·6
E	Check (untreated)	No salt	85–100	95	37	"	3·5

In 1930, all the wheat plots were very heavily attacked by stem rust. The low yields per acre and the poor grades obtained from treated and untreated plots alike, indicate clearly the destructiveness of the disease at Winnipeg. However, from a study of the data in table 11, it is evident that the amount of stem rust infection was not influenced by any of the salt treatments. It was observed again, that the treated plots of Marquis wheat ripened two to three days earlier than the untreated ones.

From the results obtained in 1929 and 1930 it is evident that rust cannot be controlled by applying salt to the soil; the amount of stem rust infection was not reduced and the yield was not influenced by any of the salt treatments. Moreover, it would appear that the early ripening effect of the salt treatment is not of sufficient importance to reduce the amount of rust infection. From the results obtained from this investigation it would seem that there is nothing to recommend the practice of applying common salt to the soil for the control of rust as has been claimed.

Sulphur Dusting for the Prevention of Cereal Rusts

(B.20·12)

F. J. Greaney (Winnipeg, Man.)

The field experiments carried out in 1930 form a part of an extended series undertaken during the past six years to determine the effectiveness and agricultural value of sulphur dusting for the control of cereal rusts. Three types of field experiments were continued in 1930: (1) Winnipeg small plot studies. (2) Ground dusting trials. (3) Aeroplane dusting experiments.

WINNIPEG SMALL PLOT EXPERIMENTS

Blocks of Marquis wheat and Victory oats of from 25 to 144 plots each were used to study some of the factors influencing the effectiveness of sulphur dusting for the control of rust. The Latin Square system of plot replication was used throughout these trials and the size of each plot was 1/400th acre. The plots were rectangular in shape (4 by 28 inches) and separated by pathways and a buffer plot six feet in width, to serve as a protection against dust drift. The sulphur was applied with ordinary hand dusting machines which were properly regulated. Except where otherwise mentioned, Kolodust was used.

Experiments were designed to determine the effect of various rates and frequencies of dust application, the influence of time of dusting, the most efficient dust fungicides, the effectiveness of different methods of application, and the comparative efficiency of before and after rain dust applications.

TABLE 12.—RESULTS OF DUSTING WHEAT WITH SULPHUR. EFFECT OF THE RATE AND FREQUENCY OF SULPHUR DUST APPLICATION ON STEM RUST INFECTION, YIELD AND GRADE OF MARQUIS WHEAT, AT WINNIPEG, IN 1930

Treatment symbol	Amount of dust per acre	Interval between dustings in days	Date dusted		Total number of dustings	Mean results of 12 plots arranged in 12 x 12 Latin Square				
			July	August		Per cent stem rust severity		Weight per bushel	Yield per acre	Canadian Grade
						Range	Average			
	lb.							lb.	bush.	
A	15	21	14	4	2	80–95	87·9	41·7	7·5	Feed
B	15	14	14, 28	11	3	70–90	80·8	42·7	8·2	Feed
C	15	7	14, 21, 28	4, 11	5	45–70	60·0	50·4	14·2	4
D	15	4	14, 18, 22, 26, 30	3, 7, 11, 15	9	15–35	22·9	56·2	19·9	1°
E	15	2	14, 16, 18 20, 22, 24, 26, 28, 30	1, 3, 5, 7, 9, 11, 13	16	15–35	28·7	58·6	25·9	1°
F	30	14	14, 28	11	3	65–90	77·1	43·3	9·8	Feed
G	30	7	14, 21, 28	4, 11	5	25–55	42·9	53·5	18·1	3°
H	30	4	14, 18, 22, 26, 30	3, 7, 11, 15	9	tr-15	7·9	60·3	27·8	1 Hard
I	45	14	14, 28	11	3	60–85	74·2	45·9	10·7	6
J	45	7	14, 21, 28	4, 11	5	25–45	32·1	55·5	21·7	1°
K	45	4	14, 18, 22 26, 30	3, 7, 11, 15	9	tr–10	5·4	60·8	30·4	1 Hard
L	0	check	No dust	No dust	0	90–100	95·0	39·9	6·1	Feed

In order to insure a sufficient amount of rust in the various experimental plots artificial epidemics of leaf and stem rusts of wheat and oats were induced. Although an epidemic of stem rust of wheat occurred at Winnipeg, leaf rust was not particularly abundant and, owing to the unusually dry weather in July, the amount of leaf rust infection was difficult to estimate. Leaf and stem rust of oats were prevalent in the experimental plots and caused a great deal of injury to the late stand of grain.

The results of the rate and frequency sulphur dusting tests for the control of leaf and stem rusts of wheat, are summarized in table 12. As in previous years the most satisfactory rust control was achieved by the heaviest applications at the greatest frequencies. In 1930, nine 45-pound per acre biweekly dustings made from July 14 to August 11 increased the yield 24·3 bushels per acre and improved the grade from "Feed Wheat" to No. 1 Northern. The increase in yield due to dusting was almost 400 per cent. Weekly applications of 15, 30 and 45 pounds of sulphur gave effective and profitable rust control. In every case the gain in yield and grade more than covered the cost of the treatment. The results show distinctly that in severe rust epidemic years, relatively small amounts of a suitable sulphur dust, properly applied, will effectively and profitably control stem rust of wheat.

Stem and leaf rusts of oats were effectively controlled even in the presence of severe epidemics. Again, the best control was achieved by the heaviest applications at the greatest frequencies, i.e., by 45 pounds per acre applied twice a week during the period, July 16 to August 23. The average yield of 10 dusted plots was 74·8 bushels of No. 1 Feed Oats per acre; whereas the average of the undusted rusted check plots was 29·5 bushels of No. 2 Feed Oats. In 1930, dusting increased the yield of oats 153 per cent.

In studying the comparative fungicidal efficiency of nine different dusts it was found that finely-divided sulphur dusts such as: Kolodust, Electric Dust, Koppers Dust and Koppers Lime Dust, were the most efficient fungicides. Coarse sulphurs (a large percentage of the particles not passing a 300-mesh sieve) gave poor results in these field tests. Oxidized sulphur dusts were not as efficient fungicides as the ordinary finely divided dusting sulphurs.

The results of some other experiments emphasized the importance of protecting the plants early in the season and demonstrated clearly the increased protection afforded by sulphur when the whole plant was thoroughly dusted.

GROUND DUSTING TRIALS

Field dusting trials with horse-drawn and self-propelled power dusters were continued in 1930. Trials were conducted on the farms of Mr. F. Froebe and Mr. W. McCutcheon at Homewood, Man.; on large plots on the Dominion Experimental Farms at Morden and Brandon; and on the College Farm, Winnipeg. Appreciation is expressed to Mr. Froebe and Mr. McCutcheon, and to the officials at Morden and Brandon, for their generous co-operation in carrying out these field tests. Acknowledgment is also made to the Niagara Sprayer and Chemical Company, Middleport, New York, U.S.A., for the loan of four dusting machines, and to the Cockshutt Plow Company, Winnipeg, Man., for the use of the "Shunk" duster.

On the Froebe farm thirty acres of summer-fallow Marquis wheat was dusted with a horse-drawn Niagara "Aero" duster. An area comprising 30 acres was left untreated as a check. The Niagara self-propelled power duster was used on the farm of Mr. McCutcheon to treat ten acres, while twenty acres was used as a check. In both practical farm tests, Kolodust was applied at the rate of 30 pounds per acre at five-day intervals from July 16 to August 1.

The weather during July was unusually dry and this served to check the rust epidemic and mature the grain uniformly and early. The results, however, were very satisfactory, for in both trials effective and practical control was obtained. In the Froebe field four 30-pound dustings increased the yield 16 bushels per acre and improved the grade from No. 3 to No. 1 Northern. Since the full cost of the treatment would not be more than $5 per acre, the gain in yield and grade gave a very good margin of profit.

In the McCutcheon trial a yield increase of 6·2 bushels per acre and an improvement in quality from No. 2 to No. 1 Northern resulted from dusting.

The effectiveness as well as the agricultural value of the dust treatment for the control of stem rust of wheat was thoroughly demonstrated in these practical farm tests.

The results of the 1930 co-operative field experiments to devise an efficient and practical wheat dusting schedule, are summarized in table 13.

TABLE 13.—RESULTS OF DUSTING LARGE PLOTS OF MARQUIS WHEAT WITH SULPHUR BY MEANS OF HORSE-DRAWN DUSTING MACHINES AT MORDEN, BRANDON AND WINNIPEG, IN 1930

Station	Amount of Kolodust per acre	Interval between dustings in days	Date dusted		Total number of dustings	Mean results of two one-half acre plots				
			July	August		Per cent severity of rust		Weight per bushel	Yield per acre	Canadian Grade
						Leaf	Stem			
	lb.							lb.	bush.	
Morden	60	10	11, 21, 31	11	4	35	45	51·5	22·6	4
	40	7	11, 18, 25	1, 8, 15	6	25	35	55·0	25·7	3°
	20	7	11, 18, 25	1, 8, 15	6	45	60	52·0	21·4	4
	20	3-4	11, 14, 18, 21, 25, 28	1, 4, 8, 11, 15	11	15	25	55·5	28·3	2°
	Check....	....	No dust..	No dust..	0	55	85	44·0	10·2	Feed
Brandon	60	10	14, 24	2, 12	4	35	30	59·0	31·2	2°
	40	7	14, 21, 28	4, 11	6	20	15	60·0	33·9	1°
	20	7	14, 21, 28	4, 11	6	30	25	61·5	34·7	1°
	20	3-4	14, 18, 21, 25, 28	1, 4, 8, 11	10	15	10	62·5	39·2	2°
	Check....	....	No dust..	No dust..	0	60	85	52·0	21·2	5
Winnipeg	60	10	18, 28	7, 17	4	65	50	52·0	7·4	5
	40	7	18, 25	1, 8, 15, 22	6	60	40	49·0	7·6	6
	20	7	18, 25	1, 8, 15, 22	6	80	45	44·5	4·7	Feed
	20	3-4	18, 21, 25	1, 4, 8, 11, 15, 18, 22	10	40	30	53·0	7·8	5
	Check....	....	No dust..	No dust..	0	95	55	40·5	3·2	Feed

In general, the 1930 results confirm the findings of 1929. At Brandon, Morden and Winnipeg, the bi-weekly 20-pound per acre treatments gave the most satisfactory rust control. The results at Brandon and Morden were conclusive and indicated clearly the practical possibilities of bi-weekly and weekly dustings. At Morden, six weekly 40-pound dustings increased the yield 15·5 bushels per acre. Similar results were achieved by weekly applications at Brandon. The Winnipeg tests were not conclusive. The wheat was sown very late and an exceedingly severe rust epidemic occurred. The yield differences were not significant. In general, the results emphasized the effectiveness and possibilities of the treatment for the practical control of rust.

AEROPLANE DUSTING EXPERIMENTS

Aeroplane dusting experiments were carried out in Manitoba in 1927 and 1928. (See Report of Dominion Botanist, 1927, 1928.) The results of these tests were encouraging and indicated the possibilities as well as the limitations of aeroplane dusting for the control of rust. The experiments were continued in 1930. The Canadian Civil Air Service provided the dusting plane and equipment, with a pilot and mechanics. The Department of Agriculture provided the dust, and planned and supervised the experiments.

The Keystone Puffer (fig. 4), a specially designed dusting plane, was used. The machine was piloted by Pilot Officer P. Cox, of the Royal Canadian Air Force, Winnipeg Air Station. The pilot's skill in low flying, and in handling and manipulating the machine under very difficult air conditions contributed greatly to the success of the experiments. The staff of the Dominion Rust

Research Laboratory greatly appreciated the interest and co-operation of Squadron Leader N. R. Anderson, Officer Commanding, Winnipeg Air Station in carrying out these tests.

The object of the experiments was to develop an efficient technique for dusting large areas of wheat, and to determine the practical utility of the aeroplane for controlling rust over large acreages. The experiments were designed to study the effectiveness of different frequencies and rates of dust application,

FIG. 4.—The "Keystone Puffer" used in aeroplane dusting experiments for the control of rust. Loading the plane with sulphur dust. The hopper is directly in front of the cockpit. Hopper capacity 600 pounds.

FIG. 5.—Dusting plane in operation, showing behaviour of the dust after being discharged from the hopper. The machine is flying at an altitude of from 10 to 15 feet.

as well as timeliness of application. In 1930, eight fields of summer-fallow Marquis wheat, comprising 714 acres located near the town of Macdonald, in the Portage Plains District of Manitoba, were chosen for the experiments. A part of each field was left untreated as a check. Each check plot was separated from the treated area by a buffer strip at least 150 feet in width which served as protection against dust drift. In 1930, an area comprising 428 acres was dusted by aeroplane, while 286 acres remained undusted and was used for control areas (checks).

TABLE 14.—RESULTS OF AEROPLANE DUSTING EXPERIMENTS AT MACDONALD, MANITOBA, IN 1930. EFFECT OF DUSTING MARQUIS WHEAT WITH SULPHUR ON THE PER CENT SEVERITY OF RUST, AND ON THE YIELD AND GRADE

Field	Treatment	Size of field	Amount of dust per acre	Date dusted		Total number of dustings	Per cent severity of rust		Yield and quality results			
				July	August		Leaf	Stem	Weight per bushel	Yield per acre	Grade	Gain per acre
		acres	lb.						lb.	bush.		bush.
Elgert......	Dusted.....	30	40	17, 23, 29	4	4	10	15	61	24·3	1 N	2·2
	Check......	16	0	....	....	0	30	45	61	22·1	1 N	
Walker.....	Dusted.....	66	25	19, 25, 30	6	4	30	30	61	28·6	1 N	
	Check......	30	0	....	....	0	35	65	60	28·8	1 N	−0·2
Brown......	Dusted.....	48	40	25	1, 7	3	35	15	60	28·8	1 N	4·7
	Check......	50	0	....	....	0	35	50	57	24·1	2 N	
Ferguson....	Dusted.....	51	30	19, 25, 31	6	4	30	35	59	28·6	1 N	6·2
	Check......	50	0	....	....	0	40	70	59	22·4	1 N	
Sturgeon....	Dusted.....	33	25	19, 25, 31	6	4	25	30	60	25·4	1 N	2·4
	Check......	50	0	....	....	0	40	70	57	23·0	1 N	
McMaster...	Dusted.....	40	25	18, 23, 29	4	4	35	15	59	28·6	1 N	4·0
	Check......	40	0	....	....	0	40	65	58	24·6	1 N	
James......	Dusted.....	40	25	18, 23, 29	4	4	35	10	61	28·8	1 N	7·0
	Check......	30	0	....	....	0	35	60	57	21·8	2 N	
Ferris.......	Dusted.....	60	20	18, 25, 31	....	3	20	35	61	30·8	1 N	3·7
	Dusted.....	60	20	18, 21, 25, 29	1	5	10	10	63	37·2	1 N	10·1
	Check......	40	0	....	....	0	25	55	59	27·1	1 N	

The aeroplane dusting schedules, together with the results showing the effect of the different treatments on the severity of leaf and stem rust, and on the yield and grade, are given in table 14. A photograph of the dusting plane in operation is shown in fig. 5.

An extended period of dry weather in July checked the development of rust and ripened the grain uniformly and rapidly. Under these conditions the wheat crop in the Macdonald district matured early and, to a large extent, escaped the effects of a heavy stem rust infestation. In all fields moderate to heavy stem rust infections occurred. In most of the cases, however, yields were not significantly influenced by the disease. Moreover, the quality of the grain was not affected, for, in 1930, the wheat from practically every field in the district graded No. 1 Northern.

As is shown in table 14 the amounts of stem rust in the experimental fields, were markedly reduced by dusting. Leaf rust was not satisfactorily controlled by any of the treatments. In the Ferris field five 20-pound applications of sulphur dust reduced the amount of stem rust infection from 55 to 10 per cent and increased the yield 10·1 bushels per acre. The quality of the grain was not influenced by dusting. It is well to point out that in most of the fields the gain in yield and grade would not cover the cost of aeroplane dusting.

Aeroplane sulphur dusting is a practical and effective means of protecting large areas of cereal crops against rust. The technique of aeroplane dusting for the control of rust has been developed. At the present time, however, this method cannot be profitably applied in checking small outbreaks of rust and preventing their spread over large areas. There are certain natural factors always operating to reduce the effectiveness of the treatment. Moreover, economic factors will determine whether or not aeroplane dusting for the control of rust can be made a profitable farm practise. The method is suited only to large continuous areas of crop. Regardless of the immediate results which have been obtained in controlling rust epidemics by this method, the efforts spent in the experiments have been well repaid in the practical development of aeroplane dusting for general use against destructive outbreaks of plant disease.

Stripe Rust in Alberta

(B. 20·18)

G. B. Sanford and W. C. Broadfoot (Edmonton, Alta.)

A field of fall sown wheat near Claresholm, which was very heavily rusted with *Puccinia glumarum* in 1929, was examined for stripe rust during April, 1930. Most of the fall foliage had died during the winter. The dead leaves which bore rust lesions were brought to the laboratory and the spores tested for viability. About 2 per cent of the spores germinated. On another part of the field, where the snow had remained during the winter, the foliage was still green and bore normal stripe rust lesions, the spores of which were found to be viable. No evidence of the spread of the rust to the new foliage was detected then or later during the summer. It appeared that the over-wintered stripe rust had disappeared with the withering of the lower leaves.

Several cases of over-wintering of leaf rust of wheat, *P. triticina*, were observed on the green plants in this field, during April and May. Both primary and secondary infections were noticed on nearby plants, which indicated that the over-wintered rust had spread. Later, during June and July, it appeared that all traces of this rust had disappeared completely from the field. Apparently a similar fate frequently overtakes cases of *P. glumarum* which may over-winter under Alberta conditions. On the other hand, it would also appear that at least some of the stripe rust which develops each season has its origin from cases of over-wintered rust on *Hordeum jubatum* L., the foliage of which has been protected by snow from winter-killing. This theory is supported by the finding in early June of an occasional plant of *H. jubatum*, the lower leaves of which were heavily rusted and the newer ones less so.

As in previous years, stripe rust made its general appearance during the middle of July, and first occurred in southern Alberta. By October stripe rust was to be found more or less generally distributed, according to location, from the southern boundary of Alberta to about fifty miles north of Edmonton and as far east as Brooks, Hanna and Vermilion, principally on *H. jubatum*. In the South, several fields of wheat, probably Kitchener and Bobs, were heavily rusted, but apparently not much damaged.

Stripe rust was collected on *H. jubatum* at two places in the Upper Columbia valley in British Columbia (north of Cranbrook and near Invermere). This is the first case reported of this rust in this part of the mountain area of British Columbia.

Uniform stripe rust nurseries, in which varieties of wheat and barley were planted, were strategically located in Alberta. Marquis 7, Chagot, Bunyip, E. Baart, Prelude, OAC 21 barley, were more or less heavily rusted. Marquis 10B and Garnet were not rusted, while Reward and White Barbless barley only slightly.

It is hoped to publish shortly a more detailed report on stripe rust in Alberta.

SELECTION OF TIMOTHY RESISTANT TO *Puccinia graminis* Pers. var. *Phlei-pratensis* (ERIKSS. & HENN.) STAKM. & PIEM.

(B. 20·01)

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

This project, which was begun in 1926 and first reported on in 1928,[1] was undertaken for the purpose of obtaining strains of timothy resistant to rust, possessing as well, acceptable qualities for a hay and forage crop. The possibilities in this connection have been pointed out by Hayes and Stakman.[2] The chief difficulty, however, has been the uncertainty as to whether or not this form of rust is a fixed species or composed of strains known as biologic forms. This phase was dealt with in a highly capable manner by Barker and Hayes[3] who found no definite evidence of biologic specialization. These authors suggested, however, that more experiments should be made and they stated as well that the production of varieties of timothy, which will be resistant to stem rust in different regions, may be accomplished rather easily, inasmuch as resistance appears to be a dominant factor.

Results at Charlottetown support this last statement, as instanced by the behaviour of three strains of timothy which for three years have exhibited a marked degree of resistance. These strains, Ottawa 3A, Ottawa 12, and Gloria, have the appearance of desirable hay crop plants. By consulting the results given in table 15 it will be seen that encouraging resistance was shown in a number of instances, while in others susceptibility was marked.

In the case of the more susceptible strains infection was sufficiently heavy to cause injury to the heads. Undoubtedly, this circumstance has been largely responsible for the failure of heavily infected plants to set seed; a belief having further support from the fact that the more resistant strains show a stronger tendency to produce seed.

TABLE 15.—RESISTANCE OF TIMOTHY SELECTIONS TO RUST, 1930

Strain	Degree infection	Susceptibility
No. 1. Ottawa	Moderate	Resistance trace.
No. 2 Ottawa	Trace	Resistance trace.
No. 3. Ottawa	Heavy	Susceptibility marked.
No. 3A. Ottawa	0	Immune
No. 4. Ottawa	Heavy	Susceptibility marked.
No. 5. Ottawa	Moderate	Resistance trace.
No. 6. Ottawa	Trace	Resistance marked.
No. 7. Ottawa	Heavy	Susceptibility marked.
No. 8. Ottawa	Trace	Resistance trace.
No. 9. Ottawa	Trace	Resistance marked.
No. 10. Ottawa	Trace	Resistance marked.
No. 11. Ottawa	Moderate	Susceptibility marked.
No. 12. Ottawa	Heavy	Susceptibility marked.
No. 13. Ottawa	0	Immune.
No. 17. Ohio	Trace	Susceptibility marked.
No. 18. Ottawa	Heavy	Susceptibility marked.
No. 21. Ottawa	Heavy	Susceptibility marked.
No. 17. Ohio	Moderate	Susceptibility marked.
No. 18. Gloria	0	Resistance marked.
No. 19. Huron	Heavy	Susceptibility marked.
No. 20. Ohio	Moderate	Susceptibility marked.
No. 28. Ohio	Heavy	Susceptibility marked.

[1] Division of Botany Report for 1928.

[2] Hayes, H. K. and Stakman, E. C. Rust resistance in timothy. Jour. Amer. Soc. Agron. 11:67-70. 1919.

[3] Barker, H. D. and Hayes, H. K. Rust resistance in timothy. Phytopath. 14:364-370. 1924. Literature cited p. 370-371.

In addition to the selections represented in table 15, a number of native timothy selections have been collected because of their apparent qualities of resistance to rust. Several clonal lines have been acquired also from Kentville, N.S. These latter are serving as differential hosts in the biologic specialization studies in connection with timothy rust; while the former are under further observation for qualities of rust resistance and usefulness for hay. Special attention is being paid to dry matter determinations.

RESEARCHES ON SMUT DISEASES

The Control of Bunt of Wheat by Seed Treatment

(B. 21·01)

W. F. Hanna and W. Popp (Winnipeg, Man.)

THE PREVALENCE OF BUNT OF WHEAT IN WESTERN CANADA

During the past year further information has been collected on the prevalence and distribution of bunt of wheat in Western Canada. With the generous co-operation of Mr. J. D. Fraser, Chief Grain Inspector of the Western Division, and members of his staff, it has been possible to make an analysis of the records of smutty wheat for the period 1919-1929, and to examine numerous samples of smutty wheat collected from different places in Western Canada to determine the species involved. Several interesting and important facts have emerged from the enquiry. Foremost among them is the heavy monetary loss which is incurred yearly by Western grain growers through bunt of wheat.

Bunt is increasing rapidly in both the hard red spring and durum varieties. In 1927, 1,012,094 bushels of wheat graded smutty; in 1928, 2,876,239 bushels; and in 1929, 4,042,239 bushels. The inspection results to date indicate that losses from bunt of wheat in the 1930 crop will be quite as high if not higher than in 1929. Bunt is particularly prevalent in the durum varieties. In 1929, 16·5 per cent of the durum wheat inspected graded smutty, as compared with 1·07 per cent of the hard red spring wheat.

Bunt has been responsible for relatively heavier losses in Manitoba than in the other western provinces. In 1928, 0·62 per cent of the wheat crop of Western Canada graded smutty, whereas the percentage for Manitoba grown wheat was 4·04. Of the 2,132 cars of smutty wheat shipped from points in Western Canada in that year, 1,201 cars, or 56 per cent of the total, originated from points in Manitoba. It is apparent, therefore, that bunt is a much more serious problem in Manitoba than in the other western provinces.

It has been found by examining microscopically a large number of commercial samples of smutty wheat that the durums are almost invariably contaminated by the rough-spored species, *Tilletia Tritici* (Bjerk.) Wint. The majority of the hard red spring samples were found to be contaminated by the smooth-spored species, *T. laevis* Kühn.

Several causes may be contributing to the increasing prevalence of bunt—the growing of susceptible wheats, especially certain durum varieties; the natural selection of more virulent strains of the bunt fungi; and the neglect of farmers to treat properly all seed wheat. Many farmers consider it unnecessary to treat grain unless it is known to be contaminated with bunt. It is probable that this attitude is chiefly responsible for the present situation.

BUNT CONTROL EXPERIMENTS

In 1930, seed treatment experiments on the control of bunt of wheat were conducted at the Agricultural College, Winnipeg, and at the Dominion Experimental Farm, Brandon, where the superintendent kindly set aside space for plots, and arranged for assistance in seeding them.

The varieties Kota and Mindum were used in the experiments, and the seed was inoculated with spores of *Tilletia Tritici,* previously prepared by passing them through a 200-mesh sieve, at two rates—1 part of spores to 200 parts of seed; and 1 part to 1,000 parts of seed by weight. The spores were collected in 1929 on Mindum wheat growing in the smut plots at Brandon. The fungicides tested included, in addition to several standard products such as formalin and copper carbonate, a number of newer preparations supplied by Ansbacher Siegel Corporation, New York.

The formalin sprinkle treatment was applied by sprinkling the seed, at the rate of three-quarters of a gallon per bushel, with formalin solution (1-320) and covering it for 4 hours. The formalin used in this treatment was manufactured by the Standard Chemical Co., Montreal, P.Q. The dusts listed below were applied by shaking the inoculated seed in a stoppered Erlenmeyer flask with the proper weight of dust.

1. Deloro copper carbonate, containing 20 per cent copper (Deloro Chemical Co., Deloro, Ont.).
2. Mococo copper carbonate, containing 54 per cent copper (Mountain Copper Co., San Francisco, Cal.).
3. Cupro-Jabonite, a copper carbonate containing 20 per cent copper (Geo. C. Gordon Chemical Co., Kansas City, Mo.).
4. Monohydrated copper sulphate (Nichols Copper Co., New York).
5. Vitrioline, containing 17 per cent copper (Usines Schloesing Frères & Cie, Marseilles, France).
6. Ceresan, containing 1·6 per cent ethyl mercury chloride (Bayer-Semesan Co., New York).
7. Preparations manufactured by the Ansbacher Siegel Corp., New York: (1) Copper carbonate, (2) Sanoseed Grain Dust, (3) Sanoseed (*a*) 1·3 per cent mercury, (4) Sanoseed (*b*) 0·65 per cent mercury, (5) Bordeaux (*a*) 12·5 per cent copper, (6) Bordeaux (*b*) 12·5 per cent copper, (7) Oxo Bordeaux 12·5 per cent copper, (8) Colloidal calomel, (9) Colloidal yellow oxide of mercury.

Each lot of treated seed was sown in quadruplicate rod rows. The rows at Winnipeg were sown April 26; those at Brandon April 23 and 24. Some treatments with Cupro-Jabonite, added to the Winnipeg experiments at the request of the Geo. C. Gordon Chemical Co. of Kansas City, Mo., were sown May 20.

With one exception, the percentages of bunt were arrived at by making two counts of 100 heads each at different places in each of the four rows, and taking the average of the eight counts. The seed treated with Cupro-Jabonite was seeded in duplicate rows only and, therefore, the percentages of bunt were based on a count of only 400 heads.

A relatively high percentage of bunt developed in all the untreated rows sown in April at both Winnipeg and Brandon, the infection being particularly good at Winnipeg where the mean percentage of bunt in the rows of untreated Mindum (spore load 1-200) was 64·8. On May 20, when the Cupro-Jabonite rows were sown at Winnipeg, the soil temperature had increased and the percentage of bunt in these rows is correspondingly reduced.

In the rows at Winnipeg inoculated with spores at the rate of 1-200, where the highest percentages of bunt were secured in the untreated rows, the formalin sprinkle treatment gave better control than any of the dusts applied at the rate of 2 ounces per bushel. With the lighter spore load of 1-1000, however, the copper carbonates, copper sulphate dust, Ceresan and Vitrioline, proved to be more effective than formalin. At Brandon the formalin treatment, copper carbonate, copper sulphate dust and Ceresan, gave much the same degree of control.

Reactions of Wheat Varieties to Bunt

(B. 21·09)

W. F. Hanna and W. Popp (Winnipeg, Man.)

A number of wheat varieties were tested in 1930 for their resistance to two collections of *Tilletia Tritici* and one of *T. laevis*. Collection A, of *T. Tritici*, was made in 1929 from Mindum wheat growing in the smut plots at Brandon; collection B, of *T. Tritici*, was made in 1928 from a field of durum wheat near Treherne, Man.; the spores of *T. laevis* were collected in 1928 from Kota wheat growing in the smut plots at Brandon.

Before inoculation, the seed was treated with formalin, washed, and then dried. The spores were cleaned by sifting through a 200-mesh sieve. They were applied to the seed at the rate of 1 part of spores to 200 parts of seed, by weight. The inoculated seed of each variety was sown April 28 in a single rod row at Winnipeg. The percentage of bunt was estimated by making two counts of 100 heads in different parts of each row.

Mindum, which is commonly grown in southwestern Manitoba, appeared to be quite susceptible, especially to the two collections of *T. Tritici.* Vernal Emmer, Garnet and Marquillo proved to be highly resistant to all collections. Marquis was moderately susceptible to *T. laevis* but highly resistant to both collections of *T. Tritici;* whereas, Khapli was resistant to *T. laevis,* but susceptible to one collection of *T. Tritici.*

Control of Loose Smuts of Wheat and Barley by Seed Treatment

(B. 21·07)

W. F. Hanna and W. Popp (Winnipeg, Man.)

Loose smut (*Ustilago Tritici* (Pers.) Jens.) appears to be increasing among certain varieties of wheat in Western Canada. In 1930, counts of loose smut were made in fifteen fields of Reward in different districts of Manitoba, and the average infection was estimated to be 2·2 per cent. In one of these fields 7·6 per cent of the heads were affected by loose smut. As requests for information on methods of treating wheat for loose smut were being received frequently, it was considered advisable to test the standard methods of treatment and, if possible, to devise new and simpler methods. Up to the present the effectiveness of the hot water treatment has been tested, particular attention being given to its action on the germination of the treated grain. Some preliminary trials have been made also with other methods of treatment.

Germination tests of the hot water treated wheat were made with Reward seed supplied by the Superintendent of the Dominion Experimental Station, Morden, Man. This wheat was grown in 1929, and was machine threshed. The kernels were plump, fairly uniform and of good general appearance. Lots of 100 seed, apparently free of injury were counted out and placed in small cheesecloth bags. This seed was soaked in tap water at room temperature for 4 hours, dipped for one minute in water at 120°F., and then immersed for ten minutes in the treating bath. Temperatures ranging from 125°F. to 135°F. were employed. Eight lots of 100 seeds were treated at each temperature.

Four lots of the seed treated at each temperature were dried in the laboratory until the kernels appeared to be of normal moisture content; the other four lots were spread out on a table for about an hour to allow the surface moisture to evaporate. Two lots of the dried and two lots of the moist seed were then dusted with Deloro copper carbonate, and placed to germinate in pots of soil in the greenhouse. The remaining four lots of dried and moist seed were similarly placed to germinate in pots of soil, but without any dust treatment. The copper carbonate dust was applied to the treated seed to determine the maximum degree of germination. Other seed treated at 129°F. was germinated in steam sterilized soil. Two of these lots were dusted with copper carbonate while the grain was still swollen, and then seeded; the other two lots were seeded without the preliminary dusting.

Counts of the number of seedlings produced by each lot of treated grain were made fourteen days from the date of seeding. The mean germination percentages of the different lots of seed have been summarized in table 16.

TABLE 16.—EFFECT OF THE HOT WATER TREATMENT ON THE GERMINATION OF REWARD WHEAT

Treatment	Per cent emergence			
	Seed dried		Seed undried	
	Without copper carbonate	With copper carbonate	Without copper carbonate	With copper carbonate
(Unsterilized soil)				
Untreated	88	90	....	....
4 hrs. presoak	94	95	95	94
4 hrs. presoak; 1 min. 120°F.; 10 min. 125°F	94	93	93	97
" " " " 126°F	88	94	91	97
" " " " 127°F	92	93	91	93
" " " " 128°F	82	88	85	95
" " " " 129°F	76	79	73	91
" " " " 130°F	67	79	59	92
" " " " 131°F	59	62	63	80
" " " " 132°F	45	53	34	68
" " " " 133°F	35	49	34	67
" " " " 134°F	21	24	21	46
" " " " 135°F	10	18	11	30
(Sterilized soil)				
4 hrs. presoak; 1 min. 120°F.; 10 min. 129°F	....	....	92	93

The results show that, when Reward wheat is immersed for ten minutes in water at 129°F., few if any of the seeds are actually killed. About 15 per cent of the treated seed has its power of germination impaired, but by protecting these seeds against soil organisms at the time of germination, a normal stand of seedlings can be obtained. Serious seed injury appears to begin at temperatures above 130°F.

The following treatments were included in the experiment on the control of loose smut of wheat. (1) Four hours presoak followed by a dip of ten minutes in water, at temperatures ranging from 125°F. to 135°F.; (2) 1 hour 50 minutes soak in water at 118·5°F.; (3) 1 hour 35 minutes soak in water at 120°F.; (4) 4 hour presoak followed by soaks of 2 and 4 hours in 0·3 per cent Semesan solution at 113°F.; (6) soaks for various times in cold water; (7) soaks for various times at room temperature in solutions of the following: Semesan, sulphuric acid, sulphurous acid, sodium hydroxide, potassium iodide, sodium chloride, ethyl alcohol and acetone; (8) treatments with dry heat.

The Reward wheat used in testing the effectiveness of various methods of loose smut control was kindly furnished by Mr. Wm. Pierce, Superintendent of the Provincial Experimental Farm, Birtle, Man. Duplicate 30 gm. lots of seed, each containing about 800 seeds, were weighed out for each treatment. After treatment, each lot of seed was sown in a 15-foot row in the field and, when the plants had headed out, counts were made of the number of smutted heads in each pair of rows. Duplicate lots of 100 kernels each were likewise subjected to the treatments with dry heat and the various chemicals, and were afterwards tested for germination in soil in the greenhouse. The smut counts recorded in the field were then corrected to allow for any reduction in the number of smutted heads due solely to reduction in germination. In making this correction the untreated rows were adopted as the standard.

All of the hot water treatments gave perfect control of loose smut. The soaks in 0·3 per cent Semesan solution at room temperature, had no apparent effect on the smut mycelium, and the control obtained by the 2-hour soak at 113°F., in this solution was evidently due only to the action of the hot water. The results with the hot air treatments were not promising. The counts in rows treated with 5 per cent potassium iodide suggest that this chemical may have some selective effect on the smut mycelium; tests with it will be continued.

The results with the hot water treatments indicate that this method when properly applied will eliminate loose smut of wheat. However, when half bushel bags of grain are treated at 129°F., perfect control is not always secured. Preliminary experiments indicate that the grain in the centre of the bag remains at a temperature considerably below 129°F., during a part of the 10 minute period, even though the surrounding water is kept at the proper temperature. Some inexpensive and suitable apparatus for treating grain with hot water would be welcomed.

The Control of Covered Smut of Barley by Seed Treatment

(B. 21·02)

W. F. Hanna and W. Popp (Winnipeg, Man.)

Experiments were conducted at Winnipeg to determine the effectiveness of a number of preparations in controlling covered smut of barley. The variety O.A.C. 21 was used in the experiments. The seed was dusted with spores of *Ustilago Hordei* (Pers.) Kellerm. & Swingle (rate of inoculation, 1 part of spores to 200 parts of seed, by weight) collected at Ebor, Man., and, after treatment with the fungicides, was sown in rod rows in the field. Four rows were sown to each lot of treated seed. The date of seeding was May 22. No smut developed in any of the treated or untreated rows.

Reactions of Barley Varieties to Covered Smut

(B. 21·10)

W. F. Hanna and W. Popp (Winnipeg, Man.)

Nine varieties of barley which have been grown in Western Canada were tested at Winnipeg for resistance to *Ustilago Hordei*. The seed was dusted with spores of the 1929 collection from Ebor, Man., at the rate of 1 part of spores to 200 parts of seed, by weight. On May 21, the inoculated seed of each variety was sown in duplicate rod-rows.

Towards the end of the summer, two counts of 100 heads each were made in each row and the number of smutted heads was recorded. Hannchen, Trebi and Canadian Thorpe were the only varieties which evidenced susceptibility to this collection of smut. No heads of smut appeared in the rows of O.A.C. 21, its behaviour here being the same as in the seed treatment experiment.

Control of Loose and Covered Smut of Oats by Seed Treatment

(B. 21·05)

W. F. Hanna and W. Popp (Winnipeg, Man.)

The co-operative experiment begun by Mr. I. L. Conners in 1929 was continued this year. The inoculation of the seed and the application of the treatments, with the exception of those with formalin, was carried out at the Dominion Rust Research Laboratory, Winnipeg. Whenever possible, the seed sent out to each co-operating station was inoculated with a strain of smut collected at or near that station. At Brandon, however, the four strains of loose smut and the three strains of covered smut used at one or more of the other stations were tested again separately. Thus, it was possible to compare the behaviour of a particular collection of smut at two widely separated points. The co-operating stations and the collections of smut used at each are listed below.

Station	Loose Smut Strain	Covered Smut Strain
Charlottetown	Winnipeg	Winnipeg.
Kentville	Kentville	Kentville.
Fredericton	Fredericton	Fredericton.
Ste. Anne de la Pocatière	Ste. Anne de la Pocatière	Winnipeg.
Ottawa	Winnipeg	Winnipeg.
Brandon	All Strains	All Strains.
Indian Head	Winnipeg	Winnipeg.
Saskatoon	"	"
Edmonton	"	"
Winnipeg	"	"

Longfellow oats was used in all of the tests. Before being dusted with spores, the seed was dipped in formalin solution (1-320) for ten minutes, drained, and covered for four hours. It was then washed in three changes of water, and dried. The dried seed was inoculated with spores at the rate of 1 part of spores to 1,000 parts of seed by weight. The spores had been prepared previously by sifting them through a 200-mesh sieve. The inoculated seed was sprinkled with water and spread out to dry slowly for forty-eight hours, after which it was stored in a cool place until the time of treatment.

The seed treatments employed, and the rates and methods of applying them were the same as those used in the 1929 experiments. The formalin "sprinkle" (1-320) and the formalin "spray" (1-64) treatments were carried out at the co-operating stations immediately before the oats were sown. A small quantity of commercial formalin and uniform instructions for applying the two treatments were sent to the co-operating stations from the Winnipeg laboratory.

Each lot of treated seed was sown in quadruplicate rod rows. When the plants had headed out, two counts of 100 heads each were made in each row. The average number of smutty heads in the eight counts was then taken as the percentage of smut for the treatment.

Germisan, DuPont No. 12 and Semesan, applied according to the methods used in these experiments, failed to give satisfactory control of either loose or covered smut. Ceresan, an ethyl mercury chloride dust manufactured by the Bayer-Semesan Co., gave uniformly good control of both smuts. The formalin "sprinkle", formalin "spray", and Smuttox, a formalin-containing dust manufactured by the Grasselli Co., were about equally effective in controlling smut. The indifferent control secured with the formalin solution treatments may perhaps be attributed to the too rapid evaporation of the gas from the small lots of treated grain.

The Determination of Varietal Susceptibility of Oats to Loose and Covered Smut

(B. 21·03)

W. F. Hanna and W. Popp (Winnipeg, Man.)

Experiments were conducted at Winnipeg to determine the reactions of several species and varieties of oats to collections of loose and covered smut. Before inoculation, the seed was treated with formalin, washed with several changes of water and dried. Six collections of *Ustilago Avenae* (Pers.) Jens., and eight of *U. levis* (Kellerm. & Swingle) Magn. were used.

The spores of the different collections were cleaned by sifting them through a 200-mesh sieve. The seed was inoculated with spores at the rate of 1 part of spores to 500 parts of seed, by weight. There was not sufficient seed of some varieties to make tests with all of the spore collections.

The seed inoculated with each collection of smut was sown in single rod rows on May 20 and 21. When the plants had headed out, two lots of 100 heads were examined in each row, and a record was kept of the number of smutted heads in each lot.

The results of one year's test in single rod rows do not justify the drawing of conclusions as to the pathogenicity of the individual smut collections. However, there are certain evident differences in the general behaviour of the varieties of oats. *Avena barbata, A. brevis, A. sterilis, A. strigosa,* and the varieties Markton and Black Mesdag of *A. sativa,* were immune from or highly resistant to nearly all of the collections of both smuts. *A. nuda, A fatua* and the variety Abundance of *A. sativa* were all quite susceptible.

Factors influencing Infection with Smuts

(B. 21·06)

W. F. Hanna and W. Popp (Winnipeg, Man.)

A few experiments were made to compare three methods of inoculating Longfellow oats with loose and covered smut. Before inoculation, the seed was treated with formalin, washed with water and dried. The spores of both species of smuts used in the experiments were collected at Winnipeg; they were cleaned by passing them through a 200-mesh sieve.

The rate at which the spores were applied to the seed was the same for all three methods of inoculation, *i.e.,* 1 part of spores to 500 parts of seed, by weight. The following methods of inoculation were compared: (1) *Dry spore inoculation.* The seed was dusted with dry spores. (2) *Gage*[1] *method.* The seed was dusted with spores, sprinkled with water, and spread out to dry slowly for 48 hours, after which it was stored in a cool place until seeding time. (3) *Germinated seed.* The dry seed was dusted with spores and sown in pots of sand. The pots were maintained at a temperature of about 20° C., until the seedlings were 4 inches in length.

The seed inoculated by the first two methods was sown in duplicate rod-rows in the field May 21. The germinated seed was transplanted in the field in two rod rows May 26. When the plants had headed out, the degree of infection was estimated by examining two groups of 100 heads in each row, and recording the number of smutty heads in each group.

None of the methods of inoculation produced a high degree of infection, but the best results were secured with the Gage method. The seed germinated in sand gave unexpectedly poor results. No special precautions were taken to regulate the moisture content of the sand in the pots, and this may have been responsible for the poor infections following this method of inoculation.

Physiology and Sexuality of *Ustilago Avenae* and *U. levis*

(B. 21.11)

W. F. Hanna and W. Popp (Winnipeg, Man.)

An experimental study has been made of the genetic relationship between the two species of oat smuts. Spores of the loose and covered smuts have been germinated singly in hanging drops, and their sporidia removed one by one and cultured separately on artificial media.

Young oat seedlings were inoculated with the following cultures or combinations of cultures: (1) Monosporidial cultures of *U. Avenae* used singly and in pairs. (2) Monosporidial cultures of *U. levis* used singly and in pairs.

[1] Cornell University Agr. Exp. Sta. Memoir 109, 1927.

(3) Pairs of cultures, each one made by mixing together a monosporidial culture of *U. Avenae* with one of *U. levis*.

The seedlings were grown to maturity in the greenhouse, and observations were made as to the appearance of the smutted heads, and the kind of spores borne in them. The results of the inoculations are of considerable interest and may be summarized briefly as follows:—

(1) Plants inoculated with a single monosporidial culture of *U. Avenae* or *U. levis,* did not produce smutted heads.

(2) Plants inoculated with two monosporidial cultures of opposite sex produced smutted heads. If the two cultures were of *U. Avenae* the infected heads were " loose " in appearance and their spores echinulate; if of *U. levis* the heads were " covered " in appearance and their spores smooth; if one of the cultures was of *U. Avenae* and the other of *U. levis* the infected heads were somewhat variable in appearance, but upon close examination they proved to be of the " loose " type, and their spores were echinulate.

(3) The sporidia of *U. Avenae,* like those of *U. levis* are of two kinds, (+) and (—); the sporidia of one species mate without difficulty with sexually opposite sporidia of the other species.

These results indicate that *U. Avenae* and *U. levis* are genetically distinct with respect to the characters by which they are differentiated, but the ease with which crosses can be made between them suggests that they are closely related species.

Cereal Smut Survey

G. B. Sanford (Edmonton, Alta.)

From the 1930 field survey in August and September it was found that, as in previous years, the loose and covered smuts of oats were quite prevalent and too often very severe. Of the one hundred and fifty-five fields of oats examined for smut, 18·7 per cent contained more or less smut (mostly covered smut). Of the seventy-two fields of barley, 31·9 per cent had covered smut and 8·3 per cent had loose smut. Of the four hundred and sixteen wheat fields inspected for smut 1·2 per cent had bunt. It may be added that the results of the field survey did not reveal the prevalence of bunt indicated by elevator grading. Apparently loose smut of wheat was extremely rare, the highest infection in any field found was 0·05 per cent of the total plants. Loose smut of Reward wheat appears to have decreased almost to a minimum and evidence suggests that this variety may not be more susceptible than other wheat varieties under average field conditions.

A questionnaire regarding treatment against smuts was sent to five hundred and fifty farmers, selected at random, in the vicinity of the experimental stations at Edmonton, Lacombe, Olds, Claresholm, Lethbridge, Vermilion and Beaverlodge. The questionnaire, enclosed in a stamped addressed return envelope, asked whether they used formaldehyde or copper carbonate treatment and the method employed with each, also whether smut resulted in oats, wheat or barley. Approximately 36 per cent of the farmers in each locality answered the questionnaire. Of these 76 per cent used formaldehyde for wheat, oats and barley, while 5 per cent used copper carbonate, using a shovel to mix the dust. Of those using formaldehyde, 8 per cent reported smut in wheat, 12 per cent smut in oats, and 19 per cent smut in barley. The most striking and possibly the most valuable information obtained from this questionnaire was that most of those using formaldehyde were following the directions which are generally recommended. On the other hand, the fact that about two-thirds of the farmers did not answer the questionnaire may be because they were not treating their grain and were not anxious to admit it. Whatever the cause, indications are not lacking that much extension work is needed among the farmers on the subject of seed treatment for the control of smut.

RESEARCHES ON ROOT ROT DISEASES

Root Rot Survey for Manitoba

(B. 22·07)

F. J. Greaney and J. E. Machacek (Winnipeg, Man.)

Field surveys of the cereal growing districts of Manitoba were made during the spring, summer, and autumn months. During the spring the damage was slight but with the progress of summer the damage increased until in autumn the amount of injury proved to be considerable. Root- and foot-rot injury was most noticeable in wheat, 58 fields showing medium to heavy infection, 50 fields slight to medium infection, while in 38 of the wheat fields examined, no infection was found. On barley the prevalence of foot-rots was almost as great as in the case of wheat. On oats and rye some foot-rots were found, but only in small quantities. Traces of Take-all of wheat (*Ophiobolus graminis* Sacc.), were found in seven fields. No evidence of the "Browning" disease of wheat was found in any field examined.

Foot-rots, therefore, caused considerable damage to wheat and barley during the current year. A rough estimate of the average amount of infection in all the fields examined was about fifteen per cent, although in some isolated spots the percentage of infection was much higher. Specimens were collected from many fields for the purpose of isolating from them the root-rotting fungi. Approximately fourteen hundred isolations were made, of which the greatest number were *Fusaria*. The number of isolations of *Fusarium* was more than twice the total number of all the other fungi isolated. *Helminthosporium* was not so common, being only about one-tenth as prevalent as *Fusarium*. The genera of the fungi isolated from diseased cereal plant bases, together with the number of isolations of each, were as follows: *Fusarium* (989), *Helminthosporium* (216), *Alternaria* (30), *Mucor* (36), *Rhizopus* (51), *Penicillium* (9), *Cephalosporium* (2), *Acrostalagmus* (2), *Phoma* (2), *Pythium* (5), *Rhizoctonia* (4), *Sporotrichum* (4), unidentified (45). In certain of the genera mentioned above a number of different species or strains were observed. These are tabulated as follows: *Fusarium* (14), *Helminthosporium* (4), *Alternaria* (2), *Mucor* (4) *Rhizoctonia* (2). Only one species of each of the other genera was observed.

In making the isolations the diseased plant bases were separated into the following parts—crown, sub-crown, and roots—and plated out separately on nutrient agar. From the isolations made in this way it was found that there was some difference in the preference of a fungus for a certain plant part. *Fusarium* appeared to be most common in the sub-crown, while *Helminthosporium* preferred the crown and sub-crown with the infection spreading up the first internode. In regard to the preference of these two groups of fungi for different crops it was found that *Fusarium* appeared most often in wheat and oats, while *Helminthosporium* was found most frequently in barley and wheat. The other fungi were found to be irregularly scattered in the plant bases.

While making the isolations it was observed that association of different fungi occurred in the same plant part. These associations were variable, often consisting of the association of two species or strains of the same genus. As many as five different species of fungi were isolated from the same plant part. The following associations were most commonly observed. *Fusarium* and *Fusarium; Helminthosporium* and *Helminthosporium; Fusarium* and *Helminthosporium; Mucor* and *Helminthosporium; Fusarium* and *Mucor; Fusarium, Helminthosporium* and *Rhizopus; Fusarium, Helminthosporium* and *Alternaria; Penicillium, Fusarium, Helminthosporium;* and *Fusarium* and *Penicillium*. The association of two or three species of fungi was common.

A Study of the Annual Fungous Flora of the Basal Parts of the Wheat Plant

(B. 22.06)

P. M. Simmonds (Saskatoon, Sask.)

This project is an attempt to determine, (1) the number and kinds of fungi isolated from wheat crowns and roots, and (2) if there are seasonal or regional differences. The general procedure was the same as last season. Isolations were made from Marquis and Kubanka wheats grown at Morden and Winnipeg in Manitoba, Indian Head, Saskatoon, and Swift Current in Saskatchewan and Edmonton in Alberta. Rather complete records for the Saskatoon isolations are presented below, followed by a summary of the results for all stations.

In the first two tables the fungi considered are *Helminthosporium sativum, Fusaria, Alternaria* and *Rhizoctonia*, whereas the summary tables only *H. sativum* and *Fusarium* isolations are listed.

Isolations were made from samples collected at three periods, viz., seedling, heading and stubble. Fifty pieces from the crowns and fifty root pieces were plated for each sample and for each variety.

The records obtained for the Saskatoon samples are given in tables 17 and 18.

TABLE 17.—RESULTS IN PERCENTAGE OF ISOLATIONS FROM MARQUIS WHEAT GROWN AT SASKATOON IN 1930

Date	Stage	Crown					Root				
		Total fungi	Hel.	Fus.	Alt.	Rhiz.	Total fungi	Hel.	Fus.	Alt.	Rhiz.
June 16	Seedling	74	20	40	0	2	104	0	82	2	0
July 21	Heading	116	22	46	4	0	112	2	62	0	0
Sept. 3	Stubble	124	48	54	0	0	106	0	56	0	0

TABLE 18.—RESULTS IN PERCENTAGE OF ISOLATIONS FROM KUBANKA WHEAT GROWN AT SASKATOON IN 1930

Date	Stage	Crown					Root				
		Total fungi	Hel.	Fus.	Alt.	Rhiz.	Total fungi	Hel.	Fus.	Alt.	Rhiz.
June 16	Seedling	86	8	66	0	0	96	2	70	0	0
July 21	Heading	100	42	26	0	4	90	0	38	0	0
Sept. 3	Stubble	120	64	52	0	0	88	2	48	2	0

For the crown material the total fungi isolated increased as the season advanced. There appears to have been a larger number of *H. sativum* isolations made from the older samples. This is true for almost all stations. There is not the same consistency in the case of *Fusarium* isolations, which frequently appear in great numbers from the seedling material.

The records for the root isolations show approximately the same total fungi for each sample. Usually the root pieces show a large number of *Fusarium* and rarely more than a few *H. sativum* colonies.

Rhizoctonia is occasionally isolated from crown pieces and *Alternaria* colonies appear from either crown or root tissues.

A comparison of the total *H. sativum* and *Fusarium* isolations recorded for all stations can be seen in tables 19 and 20.

TABLE 19.—TOTAL PERCENTAGE OF *Helminthosporium* AND *Fusaria* ISOLATED FROM MARQUIS WHEAT GROWN AT VARIOUS STATIONS

Stations	Crown		Root	
	Helminthosporium	*Fusarium*	*Helminthosporium*	*Fusarium*
Morden	56·6	10·6	8·6	24·0
Winnipeg	35·3	38·6	20·0	30·0
Indian Head	44·0	30·0	12·6	36·0
Saskatoon	30·0	46·6	0·6	66·0
Swift Current	33·3	42·0	0·6	57·3
Edmonton	21·3	66·6	0·0	40·6

TABLE 20.—TOTAL PERCENTAGE OF *Helminthosporium* AND *Fusaria* ISOLATED FROM KUBANKA WHEAT GROWN AT THE VARIOUS STATIONS

Stations	Crown		Root	
	Helminthosporium	*Fusarium*	*Helminthosporium*	*Fusarium*
Morden	32·6	12·0	9·3	33·3
Winnipeg	21·3	52·6	11·3	44·0
Indian Head	63·3	35·3	20·6	40·0
Saskatoon	38·0	48·0	1·3	52·0
Swift Current	25·3	47·3	4·0	58·6
Edmonton	21·3	69·3	8·6	65·3

With rare exceptions all stations show a rather high percentage of *H. sativum* isolations from the crown pieces. Indian Head samples show the largest amount while Edmonton specimens gave the least. On the other hand the Edmonton samples are highest for the number of *Fusaria* obtained from the crowns. The figures for *Fusarium* isolations are more interesting when the various types are recorded separately, such complete records, however, cannot be given here. The various types were found in all samples but there was some evidence of certain ones being more common to particular regions. Very little can be said in this connection until all possible factors are considered.

Generally speaking very few *H. sativum* colonies arose from root pieces, although there were some marked exceptions. It appears from a preliminary analysis that the same *Fusaria* are isolated from the roots as from the crowns.

Study of Take-all *(Ophiobolus graminis)* of Wheat

(B. 22.02)

R. C. Russell (Saskatoon, Sask.)

LABORATORY AND GREENHOUSE STUDIES

Previous experiments, which we have conducted in the greenhouse, have failed to show any marked difference in the susceptibility of different varieties of wheat to *Ophiobolus graminis* Sacc. This year an intensive study was made of the reaction of four varieties of wheat to *O. graminis*. Seed of Garnet, Marquis, Mindum and Reward wheat was secured from three different places in Saskatchewan. The usual method of inoculation was employed. Seedlings were grown for five week periods in one-gallon crocks in the greenhouse and observations made. Under the conditions of the experiment all four varieties were quite susceptible and there was very little difference in their degrees of susceptibility.

Some study was made of the effects which different degrees of soil moisture have upon the severity of the disease. Marquis wheat seedlings were grown in one-gallon crocks and the experiments were harvested at the end of about five weeks from the time the seed was sown. The crocks were divided into four groups and the soil was kept approximately at the following degrees of saturation: 30, 45, 60 and 75 per cent. The experiment was repeated three times and in each case the disease rate decreased with each increase in moisture. The averages of the disease rates obtained in the three tests were as follows: 30 per cent saturation 85; 45 per cent saturation 66; 60 per cent saturation 59; and 75 per cent saturation, 51. The results show that under the conditions of the experiment infected seedlings are better able to survive in the more moist soils.

The question of differences in virulence of different isolations of *O. graminis,* was investigated further. On the basis of the results obtained the isolations are divided into the following classes:—

Class I—Very virulent, No. 2 and No. 6.

Class II—Moderately virulent, No. 1, No. 4 and No. 11.

Class IIa—Moderately virulent, largely on account of pre-emergence blight, No. 10.

Class III—Weakly pathogenic No. 3 and No. 31.

Thus, with the exception of No. 10, the isolations previously tested in the winter of 1927-28 gave practically the same results this year. Apparently however No. 10 had undergone a change in virulence. The new isolation, No. 6, proved to be virulent. It is quite evident that different isolations vary markedly in virulence, fig. 6.

During the course of our greenhouse experiments it was noticed that there was a marked tendency for moderately diseased seedlings to develop their

FIG. 6.—Relative virulence of different isolations of *Ophiobolus graminis*. Numbering from left to right, the wheat seedlings in the first, second and third bunches were produced in crocks inoculated with isolations number 6, 1 and 11 respectively. The fourth bunch was produced in a check crock.

secondary roots more quickly than did the seedlings in the check crocks. Presumably this reaction resulted from the partial destruction of their primary roots, fig. 7.

FIG. 7.—On the left are three healthy wheat seedlings, on the right are three seedlings of the same age, attacked by *O. graminis*. Moderately diseased seedlings have a marked tendency to develop their secondary roots more quickly than do healthy seedlings.

ROD-ROW EXPERIMENTS

Many of the phases of the take-all problem which we have studied in the greenhouse were also tested out in rod rows under field conditions. The effects on the disease of several different seed treatments, of fertilizers, of depth of seeding and of date of seeding were investigated. Three different isolations of the causal organism were compared as to virulence and the relative susceptibility of our common cereals was again tested. In each of the above cases there was a control and an artificially inoculated row replicated three times, and duplicate experiments were run at Saskatoon and St. Gregor. Besides the foregoing, a number of fertilizer tests were run on naturally infected soil at St. Gregor and Carmel.

Notes taken shortly after the seedlings emerged showed that the artificial inoculations caused very little pre-emergence blight. Later on, however, the inoculated rows were noticeably delayed. When the wheat was nearly mature the heads of each row were cut off and weighed as they were harvested. The yields of the inoculated rows averaged only about 45 per cent of those of the corresponding controls.

The seed treatments did not give promising results. Rows sown 4 inches deep suffered more than rows sown 2 inches deep. In the date of seeding tests the earliest sown wheat was the most severely damaged. In the case of the artificially inoculated rows, the fertilizers did not appear to have much effect in controlling the disease. In the case of the naturally infected rows, however, the fertilizers (superphosphate and ammonium phosphate) gave somewhat promising results. As a control for take-all the use of these fertilizers needs further investigation.

FIELD SURVEY

Following the dry season of 1929 we had another comparatively dry season over the province as a whole and, as was to be expected, Take-all was relatively scarce this year. It appears that when the top soil is very dry the fungus may attack the wheat roots at a depth of several inches and produce considerable damage without appearing on the plant above the seed level. The only way to diagnose the disease with certainty in such cases is to examine the root system for discoloured roots bearing *Ophiobolus* mycelium. In certain districts where the rainfall was more plentiful the commonly known symptoms of the disease were well developed.

A Co-operative Crop Sequence Study for the Control of Take-all Disease of Wheat and for the Testing of Varietal Resistance of Wheat under Field Conditions

(B. 22·08)

R. C. Russell (Saskatoon, Sask.)

The drilled plots at St. Gregor and Melfort were sown to wheat this year and data were obtained which throw some light on the influence of crop rotation on yields in fields infested with Take-all. These plots were sown to wheat in 1927 and 1928 and artificially inoculated in both years with *Ophiobolus graminis*. In 1929 there were three plots each of summer-fallow, wheat, barley and oats. This year all of the plots were again sown to wheat. No artificial inoculum has been added since 1928. From each drilled plot three ten-foot sections of rows were selected systematically. These were dug up, the heads were cut off and weighed and the roots were examined microscopically for *Ophiobolus* mycelium and lesions. The following table shows the results obtained:—

TABLE 21.—Showing the yields in grams of wheat heads from samples taken from duplicate experiments running at St. Gregor and Melfort. The percentages shown are computed by taking the average yield following oats as 100 per cent.

Sample	Summer-fallow 1929	Wheat 1929	Barley 1929	Oats 1929	Summer-fallow 1929	Wheat 1929	Barley 1929	Oats 1929
1	125	58	48	51	140	30	56	70
2	97	40	40	64	146	50	48	83
3	55	40	35	55	130	93	124	145
4	120	56	72	80	192	60	59	65
5	130	40	41	85	179	69	62	70
6	110	19	37	57	183	62	85	178
7	145	45	75	96	150	38	74	61
8	93	41	40	90	82	57	53	75
9	100	54	42	48	130	75	64	117
Average	108	41	47	69	148	59	69	96
Per cent	157	59	68	100	154	61	73	100

The investigation of varietal susceptibility in wheat was confined this year to a rod row test of the same four varieties which were tested intensively in the greenhouse—namely, Garnet, Marquis, Mindum and Reward. Four check rows and four artificially inoculated rows of each variety were grown at both Saskatoon and St. Gregor. The results from these tests were not uniform but all four varieties suffered heavily, the inoculated rows producing, on the average, yields which amounted to from 21 per cent to 49 per cent of that of their controls.

A Study of the Root Rot Problem of Wheat and Barley caused by *Helminthosporium sativum* in Saskatchewan

(22·06)

B. J. Sallans (Saskatoon, Sask.)

Helminthosporium sativum P. K. & B. was of very common occurrence on wheat in Saskatchewan again this year. It appears that the excessive drought with accompanying higher soil temperatures favoured the development of the disease caused by this fungus, though the extent of the actual damage due to the disease was difficult to distinguish from that caused primarily by the lack of sufficient moisture. Of 286 wheat fields visited in Southern Saskatchewan about one half had basal lesionings on a few up to 20 per cent of the plants. The other half of the fields showed lesioning on from 20 per cent up to 100 per cent of the plants. Representative isolations from several of these fields demonstrated *H. sativum* to be the fungus most consistently present, often to the extent of 75 to 100 per cent.

METHODS OF INOCULATION

During the year the question of methods of inoculation with *H. sativum* has been investigated. This type of work is of great importance to further investigation of the disease. The study of the actual damage to infected plants, the testing of varieties for resistance, breeding for resistance, and the study of the relative pathogenicity of physiological strains of the fungus all require that reliable methods of inoculation suitable to each test be developed.

The methods employed include (1), the use of inoculum grown on sterilized oat hull mash in flasks under aseptic conditions. This may be placed with the seed, or above or below the seed at the time of planting; (2) the use of conidia produced on potato dextrose agar in petri dishes, suspended in previously distilled, sterilized water. Suspensions were used on mature threshed seed before sowing and on immature kernels as they developed in the spikelets; and (3) the use of discoloured seed from natural sources, i.e. not artificially inoculated.

Results from a series of experiments, both in the greenhouse and in the field, on the age of oat hull inoculum indicated that the most virulent attacks could be induced by the use of inoculum one or two weeks old, while that three weeks or more was progressively weaker. Germination tests on conidia from cultures of varying age showed the highest germination counts in inoculum over one hundred days old, while the younger inoculum (one and two weeks) gave no germination of conidia whatever in a period of forty-eight hours. This fact indicates that the vigorously growing mycelium of the young cultures accounts for their greater pathogenicity.

It was found in the use of conidial suspensions on mature wheat seed that drying had the effect of increasing distinctly the severity of infection. In these tests seed was treated with a conidial suspension. Some were sown while still wet while the remainder was placed in a desiccator for three days, then stored in air tight containers. Portions of the seed were sown one, three, ten, twenty-four, fifty-two, eighty and one hundred and nine days after treatment. The amount of disease increased sharply to a maximum at ten days after treatment after which it dropped gradually throughout the remainder of the test.

Inoculation of seed while still immature in the spikelets is a method which appears to have much to recommend it. The reports of the Dominion Botanist for 1928, pages 93-95 and for 1929 give the results of work of this nature carried on in the greenhouse by Mr. G. A. Scott. His object was to study the pathogenicity of the fungus on the heads and immature grains of wheat. Some of the seed has since been used in comparison with other methods of inoculation of wheat (see next paragraph). During the past summer a similar method was employed. Since spraying of suspensions on the heads in the field was unlikely to be successful due to the very dry weather, sheaves were cut at various stages of maturity from the soft dough to the hard dough. Both Marquis and Kubanka were used. These were sprayed variously with suspensions of conidia of *H. sativum* and of *Alternaria* sp. while check sheaves were sprayed with water. They were then wrapped in paper to prevent rapid drying and allowed to ripen in the laboratory. No definite discolouration of the seed was produced by any of the treatments. A preliminary test of the grain from these sheaves was made by planting three hundred seeds of each of the nine treatments of both Marquis and Kubanka in sterile sand in the greenhouse. The results, taken at the end of ten days, show that 60 to 86 per cent of the kernels from the sheaves inoculated with *H. sativum* were infected by that fungus sufficiently to cause non-emergence, seedling blight or varying degrees of coleoptile lesioning. Table 22 gives a summary of the results as disease ratings according to the following modification of McKinney's formula (Jour. Agr. Res. 26:5, p. 199).

$$\frac{\text{Sum of numerical ratings} \times 100}{\text{Number of seed sown} \times 4} = \text{Disease rating},$$

where the numerical ratings are 4, 3, 2 and 1 for non-emergence, seedling blight, and severe and slight coleoptile lesions respectively. Isolations proved all the lesioning whether in the checks or inoculated groups to be due to *H. sativum* and none to *Alternaria* sp.

TABLE 22.—Disease ratings of seedlings grown in sterile sand from Marquis and Kubanka cut at various stages of maturity and inoculated in the sheaf

Variety	Date of treatment	Stage of development	Disease ratings on		
			Checks	*Alternaria* sp.	*H. sativum*
Marquis	July 30	Soft dough	4·2	2·3	43·6
	Aug. 9	Firm dough	1·3	2·2	25·4
	Aug. 19	Hard dough	3·2	2·9	21·0
Kubanka	July 30	Milk	3·7	2·6	29·2
	Aug. 9	Soft dough	5·2	4·1	44·3
	Aug. 19	Firm dough	1·5	3·5	38·0

A comparison of several methods of inoculation of wheat with *H. sativum* was made in the field at Indian Head. The following are the methods with the percentage reduction in stand due to non-emergence and seedling blight when the respective checks are taken as 100 per cent.

	Per cent
(a) Oat hull inoculum placed on the seed	59·0
(b) Spore suspension dried on seed in a dessicator for 4 days	30·6
(c) Spore suspension applied to seed and sown wet	7·9
(d) Seed from head innoculations made in the greenhouse, distinctly discoloured and shrunken	83·8
(e) Plump, non-discoloured seed from the same lot as (d)	43·8
(f) Seed discoloured by unknown agents under field conditions	3·8

MOISTURE AND TEMPERATURE STUDIES

Under this heading may be grouped experiments in the greenhouse where an attempt was made to control moisture and temperature and a date of seeding test made in the field, where temperature can not be controlled but varies with the advance of the spring season.

In greenhouse tests use was made of the temperature tanks which were regulated to 12°, 18°, 24°, and 30° C. respectively. Oat hull inoculum was used with the result that non-germination and non-emergence were so marked at all temperatures and at the various soil moistures that no clear cut differences were apparent. Slight differences in the excessively high disease rates indicated that 18° C. was the most favourable temperature. Variations in the amount of moisture did not produce noticeable differences in a range from 40 to 80 per cent of the moisture holding capacity of the soil.

The date of seeding test was conducted at Indian Head. Seedings were made on May 1, 22 and June 12. While the spring was quite dry except for occasional small showers, the soil moisture was maintained satisfactorily from reserves in the lower soil layers so that differences due to variations in this factor would be small. As the results were very clear cut and consistent only a summary table of the four replications need be included in this report (see table 23).

TABLE 23.—THE EFFECT OF ARTIFICIAL INOCULATION OF WHEAT WITH *H. sativum* AT DIFFERENT DATES OF SEEDING

Date of seeding	Treatment	Emergence	Seedling blight	Yield	Weight per bushel	Per cent reduction in	
						Stand	Yield
				grams	lb.		
May 1	Check	763	0	1,818	56	....	....
	Inoculated	613	21	1,415	52	22·4	22·2
May 22	Check	778	2	445	40	....	....
	Inoculated	428	66	125	35	53·4	71·9
June 12	Check	779	1	147	38	....	....
	Inoculated	105	34	8	....	90·8	94·6

The yields of the checks for May 22 and June 12 are much lower than would normally be expected. A very severe rust infection is responsible for this. The first sown plots escaped serious damage from this cause. The later dates of seeding resulted in much greater amounts of disease due to *H. sativum* than the first date, as indicated by the reductions in stand of plants and in final yield of threshed grain as compared to the respective checks. The average of the mean daily soil temperatures for two-week periods following each date of seeding are as follows: May 1 to May 14, 8·5° C.; May 22 to June 4, 12·6° C., and June 12 to June 24, 18·3° C. Thus there is a direct correlation between the soil temperatures and the amount of damage to the wheat seedlings due to artificial inoculation with *H. sativum.* These results suggest the advisability of early seeding of wheat to escape serious seedling infection by this fungus.

A Study of Seed Troubles in Relation to Root-rot of Cereals

(B. 22·25)

H. W. Mead (Saskatoon, Sask.)

A study of some of the diseases of the seed of barley grown in Saskatchewan was started during the summer of 1929 and it was continued during the following winter. The material for the study consisted of fifteen samples of barley of different varieties collected from twelve widely separated centres of barley production in Saskatchewan.

Government statistics show that the amount of barley being consumed in Saskatchewan, chiefly for food and brewing purposes, has increased greatly since 1925. Also the amount of barley being raised is increasing each year, with a consequent increase in the number and severity of barley diseases. Some authors show that barley may go mouldy on malting floors, due to seed-borne fungi and also that disease infested seed in general is one of the means of carrying over from year to year many of our worst plant diseases.

VISUAL EXAMINATION

A visual examination of 1,000 or less seeds of each sample revealed the presence of several types of abnormal seeds, the abnormalities including discoloration and shrinkage, chief among them being smudge, green, bronze, pink and shrunken. Seeds which were just slightly off colour were classified as slightly discoloured. Considering the total number of barley seeds which were examined from all the samples, the relative occurrence of the different types, expressed as a percentage, was as follows: normal, 86·7; smudge, 0·81; slightly discoloured, 6·2; green, 1·64; pink, 0·065; bronze, 0·24; and shrunken, 4·4. That there was a difference in the weight and vitality of seeds of those different types is shown in the following table:—

TABLE 24.—A COMPARISON OF VARIOUS TYPES OF BARLEY SEEDS

Type	Weight per seed	Emergence	Weak germination	Non-germination
	grams	%	%	%
Normal	0·0487	96	2·8	1·2
Smudge	0·0439	92	2·0	6·0
Slightly discoloured	0·0448	85	5·3	9·7
Green	0·0317	67	31·0	2·0
Pink	0·0413	83	0·0	17·0
Bronze	0·0335	76	4·7	19·3
Shrunken	0·0241	73	16·0	11·0

CENTRIFUGE TESTS

The sediment from washings of 200 seeds from each sample was examined microscopically. Spores of stem rust, leaf rust, *Helminthosporium, Alternaria, Heterosporium, Fusarium, Ustilago nuda, Ustilago Hordei,* and bunt of wheat were found in the washings, along with fragments of dark and light mycelium and some bacteria. Rust spores, and spores of *Heterosporium* and *Ustilago Hordei* occurred most frequently. Spores of *Helminthosporium* and *Fusarium* were found in one-third of the samples, but very few spores were seen in any one examination. Fragments of dark mycelium or conidiophores were common. Spores of *Alternaria* were not found often, but that fungus grew quite abundantly on the agar cultures of the same samples.

PLATINGS

In the plating work acidified potato dextrose agar was used. The seeds were surface sterilized with a 0·2 per cent alcoholic solution of mercuric chloride (2 gms. $HgCl_2$ in 1,000 c.c. of 50 per cent alcohol) for one and one-half minutes, washed in sterile water, and plated on the agar. These cultures were held at 24·5° C. for not less than eight days. The total number of fungi produced by the fifteen samples was about 37 per cent of the total number of seeds plated. Of the fungi which could be determined, *Alternaria, Penicillium, Helminthosporium* and *Fusarium* occurred on 21·5, 3·12, 1·83, and 1·28 per cent respectively, of the kernels. The remainder, 9·19 per cent, consisted of sterile fungi and such contaminants as *Rhizopus*. The *Helminthosporium* colonies consisted of *H. sativum* and a fungus determined tentatively as *H. gramineum*. Three main types of *Fusarium* were found, but none of these were of the *F. culmorum* type.

Abnormal kernels had a lower germination and produced more fungi while growing on the agar than did normal kernels. This is illustrated in the following table:—

Table 25.—Normal and Abnormal Barley Kernels on Agar in Petri Dishes

Type	Number of kernels planted	Germination	Fungi
		%	%
Normal	500	48·0	19·4
Abnormal	500	29·6	49·4

Helminthosporium and *Alternaria*, the latter especially, grew from the kernels of many samples, the washings from which did not contain the conidia of those fungi. It was thought that in such cases, the colonies which developed grew from mycelium on or in the pericarp or hull.

MICROSCOPIC EXAMINATION OF HULL AND PERICARP

By means of a sharp scalpel, thin pieces were stripped from the seed coats of several kernels, and these pieces were stained. A microscopic examination revealed thickened and branched mycelium spread over the surface of several pieces, notably those from that part of the hull which formed the palea of the flower.

SAND TEST

All fifteen samples of barley were grown in coarse sterile sand in a wooden plat on the greenhouse bench. The seed was covered to a depth of one and one-half inches and the sand was kept moist during the ten-day period of growth. When the seedlings were removed, many of them were lesioned on the coleoptiles. Some kernels did not germinate at all; others germinated, producing a seedling which did not appear above the surface of the sand, or if it did appear, it died soon afterwards. The latter condition was described as seedling blight. Using a modified form of McKinney's formula, as mentioned previously in this report and giving the values 4, 3 and 1 to non-emergence, seedling blight and lesioning, a percentage infection rating was calculated for each sample. Five of the samples had an infection rating which exceeded 20 per cent and 5 others exceeded 10 per cent. The highest rating was 30·1 per cent; the lowest 6·1 per cent. An interesting correlation existed between the percentages of abnormality as determined by a visual examination and the percentage infection ratings of the fifteen samples, and it can be expressed best by a graph, figure 8.

The sand test showed that discoloured, shrunken and otherwise abnormal kernels of barley have less vigour and may carry more disease than do normal kernels. The infection ratings for the various types were: normal 13·2 per cent, smudge 26·7 per cent, slightly discoloured 23 per cent, green 22·9 per cent, pink 15·4 per cent, bronze 35·2 per cent, shrunken 28·5 per cent.

The seeds of several of the samples were found to be coated with *Penicillium* when they were taken out of the sand. Most often such seeds had not germinated, but where a seedling was produced, it invariably was stunted.

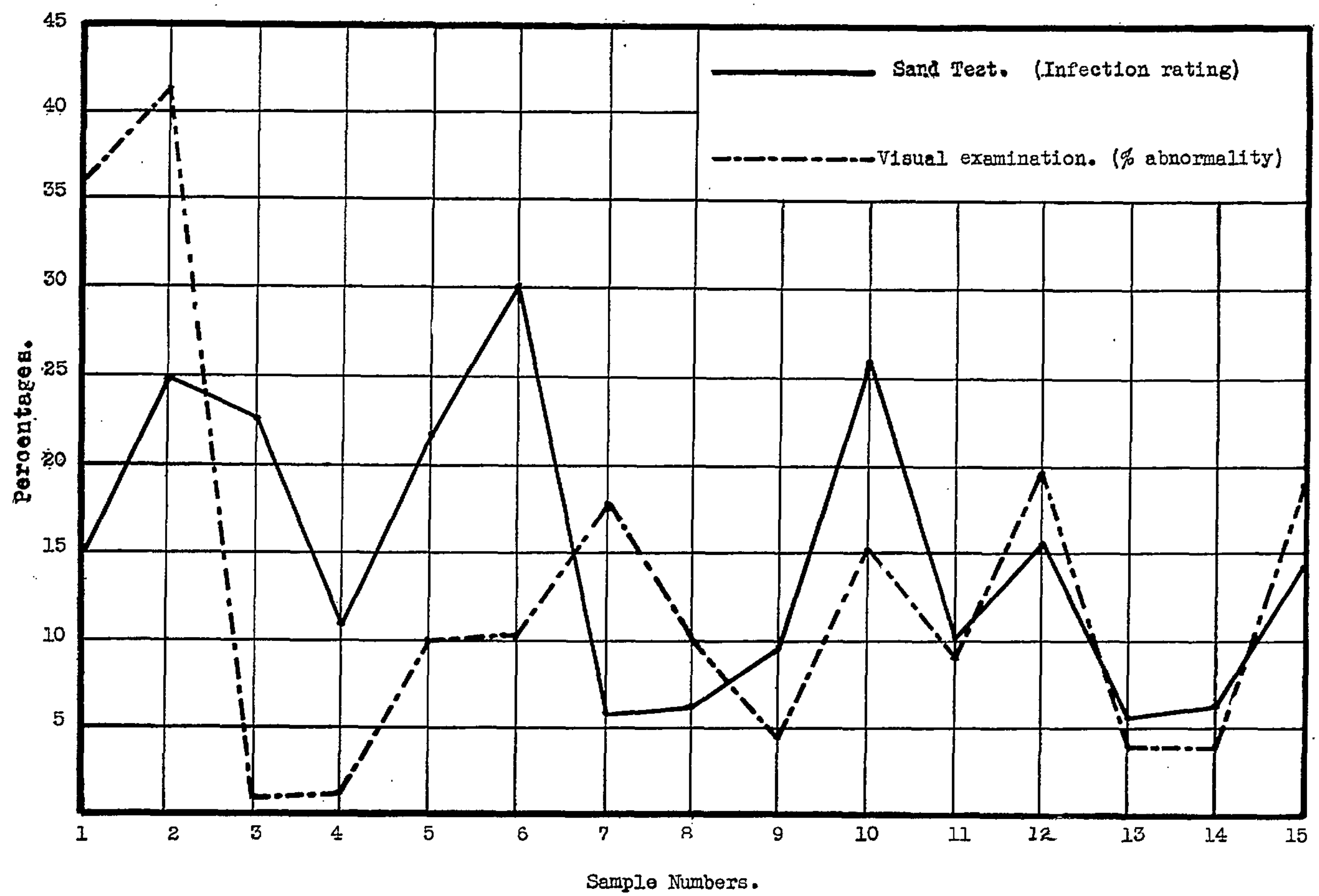

FIG. 8.—A comparison of the results of visual examinations and sand tests of 15 samples of barley.

Helminthosporium sativum was the fungus most commonly isolated from pieces of the lesioned seedlings which had been growing in the sterile sand. It, as well as *Fusarium* and *Alternaria*, was isolated from lesioned seedlings which grew from normal, as well as from each of the types of abnormal kernels.

TUBE CULTURES

Tube cultures of surface-sterilized kernels on nutrient agar showed that discoloured kernels and even normal appearing kernels may carry pathogenic fungi which will lesion the roots and basal parts of the seedlings and which may cause blighting of the seedlings. Blighting apparently caused by bacteria carried on the seed was also observed in one case.

TEMPERATURE TESTS

Tests which would show the effect of temperature on the growth of colonies of two " strains " of each of *Helminthosporium, Fusarium* and *Alternaria* were run. The six temperatures were reasonably constant and considerable difference in the rates of growth was revealed. Very little growth of any of the three fungi occurred at 5° C. The optimum temperature appeared to be 32·5° C. for *H. sativum,* 18° C. for *H. gramineum,* 30° C. for the two " strains " of *Alternaria,* and 24·5° C. for one " strain " of *Fusarium* and 30° C. for the other.

PATHOGENICITY

The pathogenicity of some of the fungi isolated from the barley samples in various ways was tested in the greenhouse against O.A.C. No. 21 barley using soil, seed and tube inoculation methods. For soil inoculation tests the fungi were grown on sterilized oat-hulls for three weeks or a month and the inoculum was placed at seed level in six-inch pots. In other tests, the seed was dipped in a heavy spore suspension and allowed to dry in a desiccator for forty-eight

FIG. 9.—O.A.C. No. 21 barley inoculated with *H. sativum.* Fifty seeds were sown to each pot. Left to right—*Helminthosporium* No. 4, Check and *Helm,* No. 3.

hours before being sown. In both cases the soil was sterile. Heavy infection was obtained in most cases where the pathogen was *H. sativum,* the infection being heavier in the tests where oat hull inoculum was used than in the seed inoculation tests. Comparison was made possible by calculating a percentage infection rating for each strain, using the formula above mentioned and assigning the values 4, 3, 2 and 1 to non-emergence, seedling blight, severe lesioning, and slight lesioning respectively. Pre-emergence killing and lesioning of the coleoptiles and roots were the chief kinds of damage done by *H. sativum.* Figure 9 shows the effect of two "strains" of that fungus when grown on oat hulls and placed in six-inch pots at seed level with 50 kernels of O.A.C. No. 21 barley.

Only two of the various "strains" of *Fusarium* which were used caused any appreciable amount of damage to the barley seedlings. The emergence was good in all but two tests. Some after-emergence blighting occurred and considerable lesioning of the coleoptiles was evident. The fungus was re-isolated from the lesions in practically all cases.

Alternaria was tested in the same manner as were *H. sativum* and *Fusarium* and some lesioning of the coleoptiles and discoloration of the roots occurred in those pots, but the fungus was not recovered from the lesions.

HEAD INOCULATIONS

Attempts were made to produce discoloration of the seeds by inoculating heads of barley in the greenhouse with spore suspensions of various fungi. *H. sativum, Fusarium, Alternaria* and *Gibberella Saubinetii* from a stock culture in the laboratory, were used and the spore suspensions were placed on the heads by spraying, by dipping and by means of a pipette. With the pipette it was possible to place the suspensions between the spikelets and the rachis. The heads were inoculated at a varying number of days after flowering, that stage being taken to be when the anthers belonging to the spikelets on the lower half of the head protruded from the glumes. Heads to be used as checks were treated with sterile water. The plants were held in a moist chamber for forty-eight hours following inoculation.

The heads inoculated with *H. sativum* all contained dark brown seeds, the percentage of discoloration being greatest at eight days after flowering, when 84 per cent of the seeds were discoloured. At that time, the seeds were in the late milk stage of development. The least infection occurred at seventeen days after flowering, when the seeds were in the firm dough stage. *H. sativum* was readily recovered from the discoloured seeds by plating on agar, after proper surface sterilization.

G. Saubinetii caused discoloration of the seeds amounting to 45 per cent at six days and were similar in appearance to those inoculated with *H. sativum.* The *Fusarium* used caused shrinking of the kernels accompanied by a slight darkening. The greatest amount of discoloration produced at any stage was 60 per cent at six days. Heads inoculated with *Alternaria* one day after flowering produced 35 per cent of kernels showing dark grey patches. All three fungi were recovered from surface-sterilized kernels.

A microscopic examination to determine the amount of abnormality, a centrifuge test to determine the surface matter, and a sand test to determine the presence of seed-borne pathogenic fungi, are suggested as a means of giving a fair indication of the disease factor in a sample of grain. The possibility of formulating an index of infection, which would be a summary of several seed tests in addition to those mentioned above, is suggested and is being investigated.

Foot- and Root-rot Survey

(B. 100·01)

Every member of the staff collected data for the plant disease survey and records were forwarded to Mr. I. L. Conners of the Division of Botany for compilation.

A brief summary only of the notes upon foot and root-rot diseases will be mentioned here although a detail synopsis was prepared for our records.

A total of 816 fields were carefully surveyed. This total consisted of wheat, 483; oats, 127; barley, 98; rye, 87 and flax, 21 fields.

Take-all was relatively scarce this year but the dryness of the season tended to mask its symptoms and make it difficult to identify. As nearly as we can estimate it the damage for this type would amount to about 50 per cent of the percentage infected.

Prematurity blight was very scarce and only traces were found in the cases reported. The damage, however, would be nearly equal to the percentage infected as the affected plants produced practically no grain. As this type of root-rot appears late in the season only a small proportion of the total number of fields inspected during the year could be examined for it.

Browning was about as noticeable throughout the province as a whole as it was last year but not nearly as prevalent or destructive as in 1928. The affected plants recovered considerably after the attack in the seedling stage and the average damage was slight.

Helminthosporium-Fusarium root-rot was about as prevalent as last year. The records above were based almost entirely upon the characteristic lesions. It is very difficult to estimate the damage caused by this type.

Two wheat fields showing a slight infestation of nematodes were observed in northern Saskatchewan.

The Degree of Pathogenicity Most Frequently Found in Root-rotting Fungi in Alberta

(B. 22.11)

G. B. Sanford and W. C. Broadfoot (Edmonton, Alta.)

The object of this experiment and the methods employed have been previously reported (see Annual Report of Dominion Botanist, 1929).

About eighty random samples of wheat root-culms affected by root-rot are taken from each field found to be suitably infected. Single spore cultures of *Helminthosporium sativum* and *Fusarium* (culmorum type) are isolated from each of these samples and tested in pot culture and also in the field. The samples are chosen from fields in localities representative of the soil types found in Alberta. In all fields the isolations are made from the third successive crop of wheat. The virulence of each culture is ascertained numerically from the seedling stage and also from the mature plants. It is impossible to make more than a brief summary of the results from one of the two fields from which cultures have been studied. The soil temperature was approximately 16° C.

A brief summary of the results obtained from the isolations from the Camrose field is given in table 26.

TABLE 26.—The number and degree of virulence of *Fusarium culmorum* (W.G.Sm.) Sacc. and *Helminthosporium sativum* P.K. & B. cultures from the Camrose field, tested on Marquis wheat at a soil temperature of approximately 16° C.

(The virulence of these isolations is indicated by the percentage of cultures falling into the various infection rating classes for the seedling and the mature stage respectively.)

Number of cultures	Pathogene	Stage	Infection rating classes in per cent				
			0–2·49	2·5–4·99	5·0–7·49	7·5–9·99	10·0–
64	*Fusarium culmorum*	Seedling	46·8	22·6	21·1	7·1	2·4
11	*Helminthosporium sativum*	"	31·8	18·2	31·8	13·6	4·6
			0–9·9	10–19·9	20–29·9	30–39·9	40–
64	*Fusarium culmorum*	Mature	10·9	32·8	43·8	10·9	1·6
11	*Helminthosporium sativum*	"	54·5	36·4	9·0	0·0	0·0

The results in table 26 agree in general with those obtained to date from the second field (Bittern Lake), viz., that, under the conditions of the test, most of the isolations of *F. culmorum* and *H. sativum* were only weakly pathogenic to the seedling or to the mature plants. *F. culmorum* produced relatively more injury to the mature plants than did *H. sativum*, but the converse was in general the case with regard to the seedlings.

Varietal Tests of Wheat against *Helminthosporium sativum*, *Fusarium culmorum* and *Ophiobolus graminis*

(B. 22.12)

G. B. Sanford and W. C. Broadfoot (Edmonton, Alta.)

About one hundred varieties and strains of wheat were tested in field plots artificially inoculated with cultures each of *H. sativum, O. graminis* and *F. culmorum*. Each variety was systematically replicated four times and suitably checked. The inoculum, consisting of cultures one month old, grown on oat hulls, was sown in the drill (five feet long) with the seed. The disease injury was estimated numerically at harvest.

The results of 1930 did not show significant varietal differences in resistance to *H. sativum* and *F. culmorum* in any of the varieties tested. In fact only a very slight infection was obtained, notwithstanding the liberal amount of inoculum applied. In the case of *O. graminis,* a uniform, though very slight, infection was obtained, the differences not being sufficiently marked from which to make conclusions.

It may be added that satisfactory results have not yet occurred in the field where the artificial inoculum was added to the soil at time of seeding. However, a better method for field testing is being studied.

Co-operative Crop Sequence Study for the Control of Root-rot of Wheat

(B. 22.09)

W. C. Broadfoot (Edmonton, Alta.)

This project is carried on co-operatively with the Dominion Experimental Stations at Morden, Indian Head, Swift Current, Scott and Lethbridge, and the Provincial Schools of Agriculture at Olds and Vermilion.

Just prior to harvest, representative random samples of wheat plants are taken from each plot and notes are taken on the number of fertile culms, the total number of culms, and an infection rating given for each plant. A study is also being made of the frequency and constancy of the occurrence of *Helminthosporium sativum, Fusarium culmorum* and other *Fusaria* from year to year under the same crop sequence, but under dissimilar conditions. The 1928 and 1930 data have been assembled, but from the nature of the project, conclusions cannot yet be drawn.

The Effect of Fertilizers on the Development of Root-rot of Wheat

(Alta.)

(B. 22.16)

W. C. Broadfoot (Edmonton, Alta.)

As in 1929 greenhouse and field tests of the effect of various chemicals and fertilizers on the development of take-all root-rot have been made.

In field tests, chemicals were used at the following rates: potassium (KCl), 250 pounds per acre; superphosphate, 250 pounds per acre; nitrogen ($NaNO_3$), 250 pounds per acre; marl, 3 tons per acre; burnt lime, 1 ton per acre; sulphur, 750 pounds per acre; copper ($CuSO_4$), 250 pounds per acre; iron ($FeSO_4$), 250 pounds per acre. Forty grams per five foot row of artificial inoculum of *Ophiobolus graminis*, grown on oat hull media, was added to the soil at time of seeding. Field tests were carried on at the Dominion Irrigation Station at Brooks, the Lacombe Experimental Station, and the University at Edmonton. During the past two years, it has not yet been possible to detect a marked effect of the inoculum on wheat plants.

The greenhouse tests were carried out in a black loam soil and in river sand. In both cases, the soil moisture was adjusted to 70 per cent of its moisture holding capacity. The soil temperature varied from 16° to 18° C. Although the experiment has not been repeated a sufficient number of times, results to date indicate that nitrogen favours the take-all disease, while phosphorus, copper and iron tend to reduce it. The wheat roots from the plants in the sand cultures which received iron were, in every case, dichotomously branched, whereas in the ordinary soil culture, with iron no dichotomous branching was found.

These experiments are being continued in the field and greenhouse.

Does the Wheat Plant become More Susceptible to the Foot-rotting Fungi with Increasing Age?

(B. 22·21)

W. C. Broadfoot (Edmonton, Alta.)

For this study pathogenic cultures of *Fusarium culmorum, Helminthosporium sativum, Ophiobolus graminis* and *Leptosphaeria herpotrichoides* de Not. were used singly and in combination. The results of a preliminary trial in which Marquis wheat plants, in pot culture, were inoculated at 10-day intervals showed that the wheat plant was more susceptible during the first thirty or forty days than it was later.

In a second and more intensive experiment, pots of Marquis wheat were inoculated at ten-day intervals and also certain pots taken up at these periods to record the progress of the root rot. A fairly complete picture of the progress of the root rots was thus secured. Representative samples of the root parts harvested periodically were also preserved for histological studies. Results were that inoculations up to forty days after planting time were effective, whereas later inoculations were relatively ineffective.

It may be added that Marquis wheat was resown in these pots at the termination of the experiment. Only in a very few pots out of the eight hundred in the experiment were typical take-all symptoms found on the wheat, and then only slight; a fact indicating that *O. graminis* was ineffective or that it had not survived in the soil after one hundred and twenty days.

In another part of this experiment the organisms mentioned were tested out in sterilized soil and in non-sterilized soil, singly and in combination. In practically every case, the infection rating was much higher on plants in the sterilized soil than on those in the non-sterilized soil. A significant fact is that the infection ratings, where *O. graminis* was used alone, were practically always higher than where *O. graminis* was used in combination singly or collectively with *F. culmorum, H. sativum* or *L. herpotrichoides*.

Histological Study of the Root-rots of Wheat during the Post-seedling Stage

(B. 22·17)

H. T. Robertson (Edmonton, Alta.)

The tissue of wheat culms and roots was examined by histological methods to determine if significant histopathological differences existed by which plants affected with Take-all could be distinguished from those affected by *Helminthosporium sativum* and other root rotting fungi. Diseased plants, representing some of the different symptoms to be found in field and greenhouse culture, were examined and characteristic features studied and photographed. This study is not complete.

Among other results obtained it may be said that indications are that *Ophiobolus graminis* causes much more serious injury than *Fusarium culmorum* or *H. sativum* and that apparently it is the only fungus of the three that can penetrate the crown and the endodermis of the roots. When a combination of the three fungi is present in the root, probably the *Ophiobolus* would mask the others if they were present in the tissues. Infection of the crown seems to come invariably from the subcoronal internode and the secondary roots.

The appearance of *F. culmorum, H. sativum* and *O. graminis* in affected root and culm parts of wheat are shown in fig. 10. (A) is a section of a primary

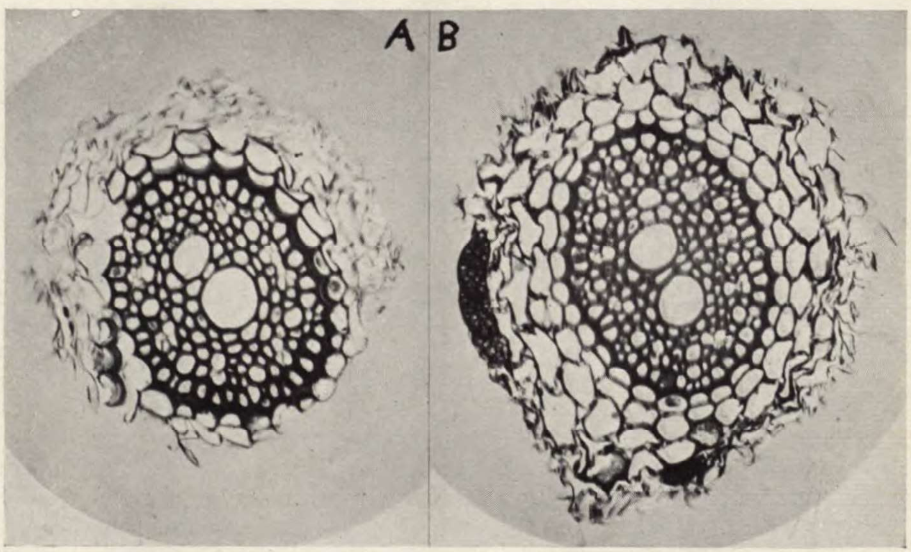

FIG. 10.—Illustrations of root-rot of wheat. (A) *Fusarium culmorum*, primary root. X 190 (see context). (B) *Helminthosporium sativum*, primary root. X 175 (see context).

root, thirty days old, inoculated with *F. culmorum* at seeding time. The cortex is disintegrated but no mycelium is apparent. The stele is intact and the wall of the endodermis is greatly thickened. X 190. (B) is from a primary root, thirty days old, inoculated with *H. sativum* at seeding time. The cortex is mostly disintegrated, but no mycelium is apparent. Peculiar isolated cells in the cortex appear to be completely plugged with mycelium. X 175. In fig. 11

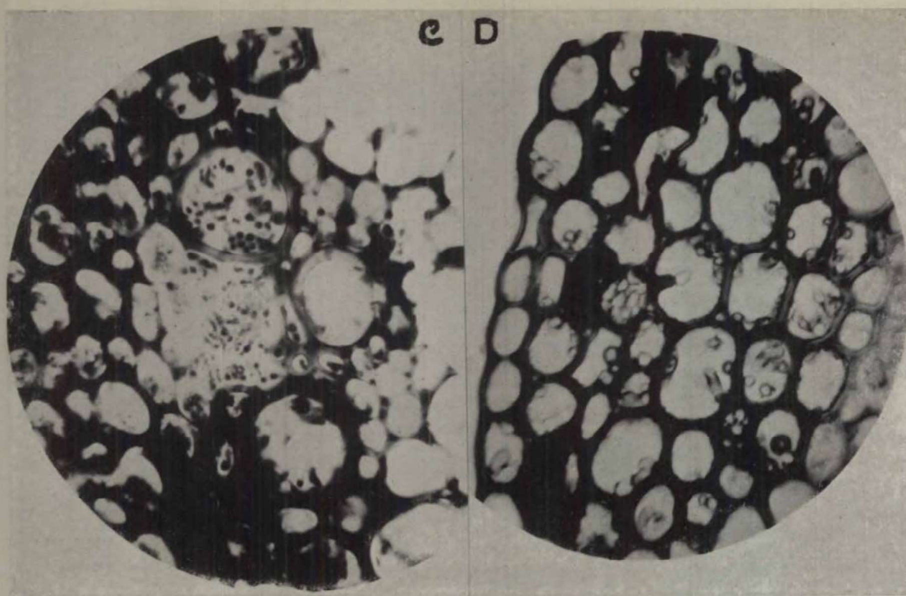

FIG. 11.—Illustrations of root-rot of wheat. (C) *Ophiobolus graminis* in culm tissue just above crown. X 525. (See context). (D) *O. graminis* in tissue just above crown. X 525. (See context).

(C) shows a part of the culm just above the crown. The vessels of a vascular bundle are filled with the mycelium of *O. graminis.* X 525. (D) shows the parenchyma cells of the culm just above the crown filled with coloured matter and mycelium of *O. graminis.* The walls are discoloured. X 525.

The Browning Root-rot Disease in Alberta

H. T. Robertson (Edmonton, Alta.)

The browning root-rot disease was identified in a field of oats and also in a nearby field of wheat near Okotoks, Alberta, in 1930. The crop of oats, which was very severely diseased, followed summerfallow and a crop of wheat which had yielded only seven bushels per acre in 1929. The fields had been under cultivation thirty years. The root tips of the wheat and oats were found to contain oospores of a *Pythium* spp., which Mr. Truscott, of the University of Saskatchewan, corroborated as causing the "browning" disease. Soil from the infected field of oats was brought to the laboratory for test. Wheat, oats, barley and rye were seeded in pots of the unsterilized soil and suitably checked with plants in the same soil sterilized. After sixty days the roots of the wheat, oats, barley and rye in the unsterilized soil contained the characteristic oospores and showed typical symptoms of the browning injury. The wheat was the most severely injured of the four cereals tested. The plants in the sterilized soil were free from oospores and browning symptoms.

The results of greenhouse test are indicated in fig. 12.

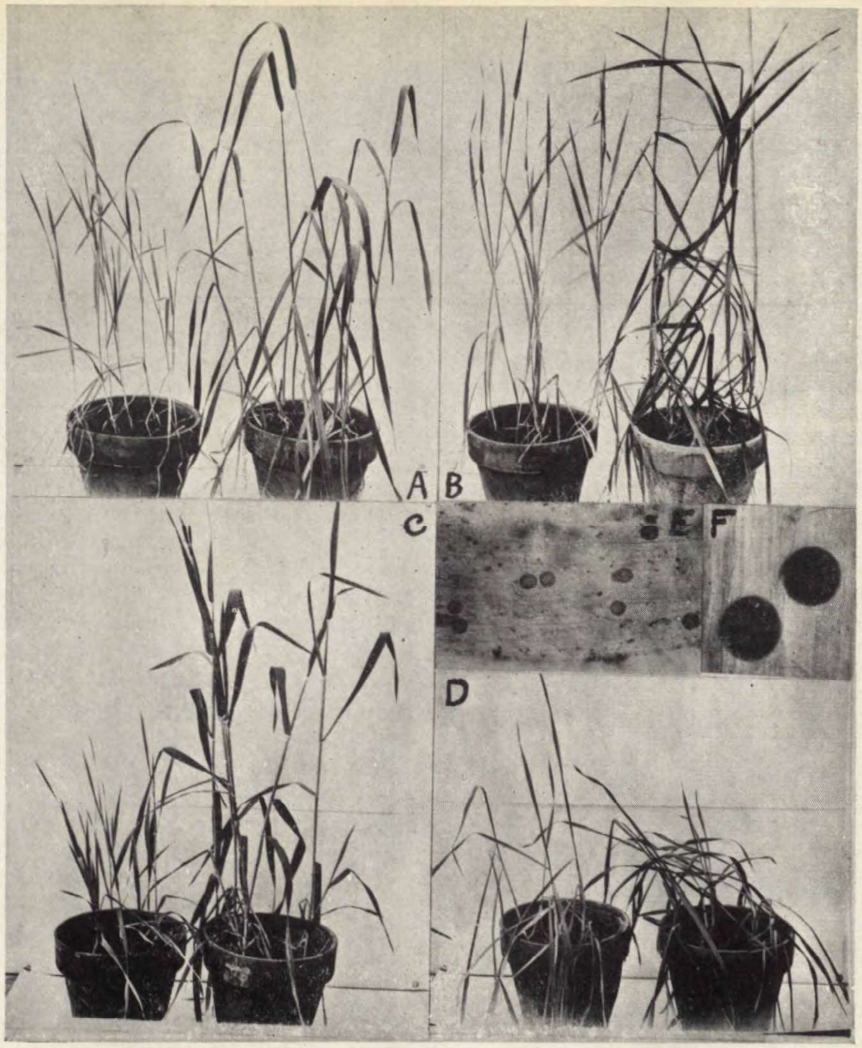

FIG. 12.—The browning root rot of cereals from soil, Okotoks, Alberta. (A), (B), (C) and (D) are wheat, oats, barley and fall rye, respectively. Soil in pots on right sterilized. Pots on the left contain unsterilized soil and plants with browning disease. (E) Oospores of *Pythium* sp. in primary root tissue; (F) same, more highly magnified.

OTHER CEREAL PROJECTS

Studies of Bacterial Diseases of Wheat

(B. 23·01)

F. J. Greaney (Winnipeg, Man.)

SULPHUR DUSTING FOR THE PREVENTION OF A BACTERIAL DISEASE OF WHEAT CALLED BLACK CHAFF

In an experiment designed to study the effectiveness of sulphur in controlling leaf rust (*Puccinia triticina* Erikss.), and some of the minor leaf and stem diseases of wheat, it was found that frequent applications of sulphur dust prevented the development of a bacterial disease of wheat called black chaff (*Pseudomonas translucens* J. J. & R. var. *undulosa* (S. J. & R.) Stev.

PLAN OF EXPERIMENT

For the purpose of the study, a strain of wheat from a cross H-44-24 x Marquis, obtained from the Cereal Division, Dominion Rust Research Laboratory, was used. This strain is of no particular agronomic value but is of interest because of its resistance to stem rust and susceptibility to leaf rust. Thus, by eliminating the effects of stem rust, it was hoped by sulphur dusting experiments to determine the relation between leaf rust and yield.

The wheat was sown on May 25, in forty-eight 18-foot rows, one foot apart, fifteen grams of seed being sown in each row. The rows were arranged as follows: 3 rows of Garnet wheat for border, one row of hybrid wheat dusted with sulphur, 4 rows of Garnet to serve as a buffer against dust drift, 2 rows of hybrid wheat not dusted (checks), 4 rows of Garnet, 2 rows of hybrid wheat dusted with sulphur, 4 rows of Garnet, 2 rows of hybrid wheat not dusted, 4 rows of Garnet, etc. This arrangement extended over two series each containing 12 dusted and 12 undusted rows of hybrid wheat, besides border and buffer rows of Garnet. In this arrangement the adjacent dusted and undusted rows were considered as a pair, and the experimental yield data were subjected to statistical analysis. A completely random arrangement of pairs would have been more desirable from the standpoint of the analysis of the results, but it was necessary to have dusted components of different pairs together, so the randomized plan was impractical.

Dusting was commenced July 11, and thereafter half of the wheat hybrid rows were treated at three-day intervals until August 19 when the wheat was ripening. At each dusting, Kolodust was applied at the rate of 15 pounds per acre with an ordinary hand duster. In previous studies this treatment had given almost complete control of stem and leaf rust.

EXPERIMENTAL RESULTS

Before the grain was harvested, the dusted and undusted rows were examined for leaf and stem rust, and an estimate was made also of the percentage of plants infected with Black Chaff. The rows were then cut and threshed separately, and records were kept of the yields in bushels per acre, weight per bushel, kernel weight and grade.

Very little leaf or stem rust was found on the plants in any of the rows. In the undusted rows a high percentage of the plants were infected with Black Chaff, but in the dusted rows only traces of Black Chaff were found. It was apparent, therefore, that the sulphur dust had largely prevented the development of this disease. The effectiveness of the control obtained is shown in figures 13 and 14. Moreover, the dusted rows outyielded the undusted rows by 5·9 bushels per acre. In the absence of significant amounts of leaf and stem rust it seemed probable that this increase in yield was due to the control of Black Chaff.

This experiment indicated that when favourable conditions for its development occur the organism causing the Black Chaff disease spreads from plant to plant in the field. Insects have been considered to play an important part in the transmission of this disease. It would seem, however, that wind and rain are the most important agents of dissemination.

The results obtained in 1930 are purely of preliminary value and only indicate possibilities of the practical value of sulphur dusting for the control of Black Chaff. Furthermore, since most of the commonly grown varieties of spring wheat appear to be quite resistant to Black Chaff, it is not likely that varieties or strains as susceptible as the one used in this experiment will ever be grown generally. More extensive field experiments are under way to determine the relation between Black Chaff and the yield of susceptible wheat strains.

FIG. 13.—Heads of H-44-24 x Marquis wheat hybrid, showing control of the bacterial black chaff disease by dusting with sulphur. Left: head not dusted, infected with black chaff. Black stripes on glumes and rachis. Right: head dusted, not infected.

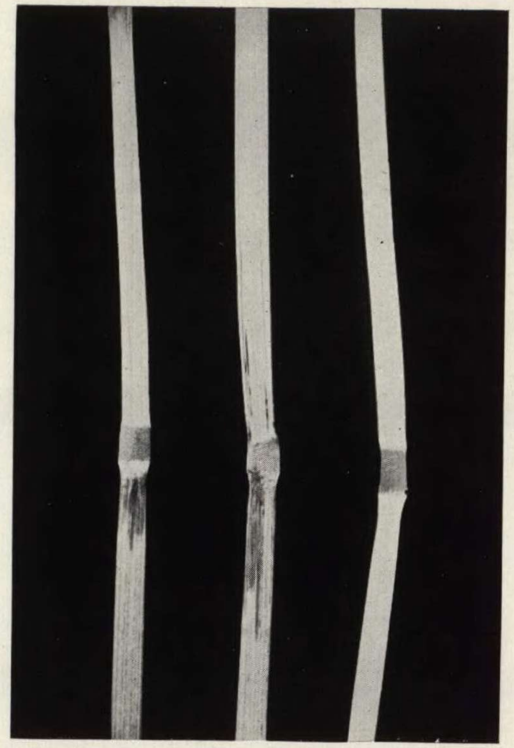

FIG. 14.—Stems of H-44-24 x Marquis wheat hybrid, showing control of the bacterial black chaff disease, by dusting with sulphur. Left: two stems not dusted, infected with black chaff. Black lesions below nodes. Right: stem dusted, not infected.

Maintenance of Fungous Diseases in Field Plots for Experimental Purposes

(B. 23·02)

F. J. Greaney and J. E. Machacek (Winnipeg, Man.)

In 1930, plant disease garden studies were commenced at Winnipeg as one of a series of co-operative projects between the plant breeders of the Cereal Division and the plant pathologists of the Division of Botany. The object of the study was to determine the comparative resistance of standard varieties and promising new productions of wheat, oats and barley to the most common diseases of cereals. In 1930, the disease garden test was confined to a study of the disease reaction caused by root- and foot-rots of cereals. Special field tests were made also to study the comparative resistance of a group of wheat varieties to specific root- and foot-rotting organisms.

The behaviour of forty varieties of wheat, twelve oat varieties, and eleven varieties of barley, to a miscellaneous group of soil fungi was studied. In addition, an attempt was made to determine the comparative resistance of the same group of forty wheat varieties, to specific root-rotting organisms.

In 1930, the arrangement of material in the disease garden, the method of estimating the amount of root- and foot-rot infection, and the statistical analysis of the experimental infection and yield data, were given particular attention. In order to study the conditions under which root- and foot-rotting organisms were acting, close observations were made on plant growth and disease development. An attempt was made also to study some of the factors influencing the development of artificial epidemics of root- and foot-rot diseases.

The disease garden experiment consisted of three randomized blocks of 63 rod rows each. On May 21, one hundred seeds were sown in each rod row, the seeds in each row being spaced two inches apart. The rows were one foot apart. A light covering of inoculum, consisting of spores and mycelium of a number of fungi growing on oat hull media, was placed on top of the seed. The seed and inoculum were covered with about two inches of soil. The disease garden soil was inoculated with fungi belonging to the following genera: *Helminthosporium*, *Fusarium*, *Ophiobolus*, *Mucor*, *Cladosporium*, *Phoma*, *Rhizopus*, *Alternaria*, and *Cephalothecium*. Many of the fungi used were virulent pathogens on wheat and barley; all were originally isolated from diseased parts of cereal plants.

On June 26, when the plants were well above the ground, the surface soil was inoculated with the same group of organisms. The method of inoculation consisted of spreading the oat hull inoculum between the rod rows and thoroughly mixing it with the top layer of soil.

The same group of varieties of wheat, oats and barley, was sown in uninoculated soil and arranged in three randomized blocks of 63 rod rows each. This plot served as a check and was separated from the disease garden plot by a pathway six feet wide. One hundred seeds were spaced in each rod row and sterilized oat hulls were spread over the seed. The seed and oat hulls were covered with about two inches of soil.

In addition to the general disease garden test, three special field plot experiments were made. In each experiment the comparative resistance of the same group of forty wheat varieties to a specific root- and foot-rotting organism was studied. The same system of replication was used in each experiment. Each plot consisted of three randomized blocks of 40 rod rows each. One hundred seeds were placed in each row, the seeds in each row being spaced two inches apart. The soil in one plot was inoculated with a Saskatchewan strain of *Helminthosporium sativum* P.K. & B., which was furnished by the Dominion Laboratory at Saskatoon. In the second plot experiment, *Fusarium graminearum* Schwabe (*Gibberella Saubinetii* (Mont.) Sacc.) was used. The third plot was inoculated with a Manitoba strain of *Helminthosporium sativum*. In greenhouse trials these organisms were distinctly pathogenic on wheat and barley. On June 26, the surface soil of each plot was sprinkled with oat hull inoculum, the method of inoculation being similar to that used in the disease garden test.

At harvest time, leaf and stem rust readings and other disease data were obtained. Ten plants were pulled from each rod row and, when the roots and stem bases of the plants had been washed, the infection data were recorded separately for each row. Thus, in each experiment, thirty plants of each variety were used to determine the percentage of diseased plants and the degree of disease infection. Disease infection ratings were made for each of the following parts of the plant; base of stem, sub-crown, crown and roots. The degree of infection was based on a scale ranging from 0 to 10, a rating of 0 indicating complete absence of disease, and 10 a very severe root- or foot-rot infection. The remainder of each rod row was harvested and threshed separately and the yield determined.

The experimental data were subjected to the analysis of variance test as described by Dr. R. A. Fisher (Statistical Methods for Research Workers, London, 1928). Comparing the effect of these diseases on different varieties, it was found that the differences in amount of infection and yield were not greater than would be expected by the ordinary laws of chance. The results were not significant. The statistical analysis of the experimental data brought out many of the difficulties to be encountered in studying the field reaction of cereal crops to root- and foot-rot diseases.

In 1930, the disease garden studies served a very useful purpose in furnishing information concerning the arrangement of experimental field plots, and the method of recording disease infection results. With the use of more efficient technique, the disease garden test should be a reliable one for eliminating the varieties of wheat, oats and barley which are most susceptible to destructive root- and foot-rot diseases.

SECTION IV

INVESTIGATIONS OF THE DISEASES OF FRUITS AND VEGETABLES

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INVESTIGATIONS OF THE DISEASES OF POME FRUITS

Seasonal Development of the Apple Scab Fungus

(B. 60.01)

NOVA SCOTIA AND NEW BRUNSWICK

J. F. Hockey (Kentville, N.S.)

The scab fungus, *Venturia inaequalis* (Cke.) Wint., was not favoured by abundant moisture during the spring months of 1930. By the end of April only a few scattered collections from orchards in locations favourable for the fungus showed differentiated spores in the asci. A warm rain the end of April forced such as these to maturity but mature spores were very scarce until nearly the middle of May. The trees broke dormancy the latter week of April and first of May. By the middle of May the trees were ready for the pre-pink spray. The first spore discharge was recorded both at Kentville and Middleton on May 16. This was the latest date experienced for several years and was due to the dry condition of the leaves during early May from the comparative scarcity of rainfall. April precipitation was 1·21 inches less than the sixteen year average of 2·81 inches and the May precipitation was 0·89 inch less than the sixteen year average of 2·50 inches for that month. From this it can be seen that the rainfall for April and May, 1930, was only 60 per cent of the average for those months.

The heaviest liberation of ascospores is normally anticipated just before full bloom. This season was again exceptional in that, while a heavy prolonged discharge of ascospores occurred just as bloom was starting, May 27 to June 2, there was a further heavy infection period from ascospores, June 19 to 21. At this latter period the largest single day's discharge of ascospores was recorded at Kentville. The pink spray was applied in the majority of orchards before May 27 and the calyx application between June 10 to 15. The last ejection of ascospores at Kentville was recorded June 25. The season was very favourable for spraying operations and good protection was obtained in many orchards by only two pre-blossom and two post-blossom applications. However, growers who carried out the recommended calendar of three sprays before bloom and two or three after bloom obtained excellent results.

The first conidia on new infections were found June 2 and by June 20 conidia were very abundant on leaf lesions on unsprayed trees. Following this initial development of foliage scab there was little secondary spread for the remainder of the season. Only a few individual growers have reported late scab infection on the fruit and they have explained it as being from tall trees difficult to spray coupled with no application after the end of June when they knew scab was present in the tops of the trees.

OBSERVATIONS IN NEW BRUNSWICK

At Fredericton, N.B., the seasonal development studies were made under the direction of Mr. D. J. MacLeod, Pathologist in charge. Observations on ascospore discharge indicate that the first ejection was observed on May 16 and 17, on which days a total of 0·47 inch of rainfall was recorded. At this time both Fameuse and McIntosh varieties were in the late green tip stage and advancing rapidly to the closed cluster or pre-pink stage of development.

A second period of ascospore discharge of greater intensity than the first occurred May 20 to 22 when the above varieties were well into the pre-pink stage and some showing pink.

There were two additional inadequately heavy periods of ascospore ejection. The first was between May 26 and 31, and the second between June 9 and 16. The latter period shows two peaks of spore intensity on June 10 and June 16—date of final record—respectively. The discharge between May 26 and 31 found the trees in the blossom pink stage rapidly advancing to full bloom which was recorded as June 4. By June 7 the petals were falling and the trees approaching the open calyx stage.

From these observations it can be concluded that two sprays before bloom and two after bloom should have given commercial control of scab at Fredericton in 1930. A spray May 13 to 15 would give adequate protection until the pink stage when a second spray about May 23 to 26 would secure protection during full bloom. If the trees were in the calyx stage by June 7, the calyx spray, provided it was a sulphur fungicide, should have given adequate protection from concurrent and successive ascospore discharges if applied up to June 11. A rainfall on June 8 would interfere with spraying and cause spore ejection but a sulphur spray applied up to June 11 should have prevented infection or development if initial infection had taken place. An additional application of fungicide in ten days' time should have given adequate protection for the remainder of the season, if as reported, the last spore ejection occurred June 16.

Primary leaf infections were found on Fameuse and McIntosh on June 9 and 12, respectively. Fruit infections were first observed on June 25. Under circumstances where leaf and fruit infections appear in amounts of over 10 per cent by the end of June an additional fungicidal application is advisable to prevent further spread, the last of June or early July.

There was a general similarity in the early seasonal development of the scab fungus at Fredericton, N.B., and Kentville, N.S., during 1930. There appears to be a general relationship between mean temperature and rainfall during April and early May and the earliness of ascospore ejection. A similar relationship is evident during May and June to the intensity of spore ejection. The factors governing perithecial development at this time are probably of major importance.

BRITISH COLUMBIA

G. E. Woolliams (Summerland, B.C.)

In the district north of Kelowna, the disease appears annualy in some areas and occasionally in others. That part of the northern section of the valley from Armstrong north to Salmon Arm, is included in what is known as the "Wet Belt." In this area the humidity is higher than farther south and apple scab develops each season. The rest of the Okanagan valley south of Armstrong, is included in the "Dry Belt," where the humidity is low during the period of growth. From Vernon south to Winfield, scab may develop in some years and not in others. Scab has developed at Kelowna only on rare occasions, but south of this district, has never caused damage to fruit.

Several years ago, experiments on apple scab control were conducted by the Horticultural Branch of the Provincial Department of Agriculture. The experiments showed that three or four sprays of lime-sulphur gave efficient control of apple scab in the area lying between Armstrong and Salmon Arm. Since the disease appears from Vernon south as far as Winfield during some years and not others, apple scab sprays are usually applied annually. Tests of the Horticultural Branch have shown that in this area the two or three sprays recommended are not always satisfactory. Occasionally severe scab infection developed after the grower had applied the sprays recommended. The Provincial Department requested the assistance of the laboratory in locating the trouble.

During the past two seasons, therefore, observations have been made on the seasonal development of apple scab during the spring. At different points in the valley, from Winfield north to Salmon Arm, spore traps were placed out in orchards. They were set up during the latter part of April and were examined frequently until the first discharge of spores occurred. We found that this took place in each district at the end of April or the first part of May. At this time the apple trees usually have reached the pre-pink or pink stages of development, depending upon the locations of the orchards. Recommendations by the Provincial Horticultural Branch as to the time at which the first apple scab spray should be applied are now based on the information obtained from these spore discharge traps. The exceptionally early production of spores, as shown by the traps, has necessitated an early application of spray. The results being obtained under these new recommendations are now quite satisfactory.

ONTARIO

G. H. Berkeley (St. Catharines, Ont.)

The data concerning the ascospore discharge for 1930 were recorded as in former years. In the annual report of the Dominion Botanist, Dominion Department of Agriculture, 1929, the records for 1924-29 were outlined in detail and certain correlations of the environmental factors and discharge periods pointed out. The same correlations can be shown for the year 1930. An interesting feature of these records is the fact that the perithecia were practically mature by April 5 and dry conditions in the month of April delayed initial discharge until May 1. Moist chamber tests of the leaves produced discharge April 10.

SPRAYING EXPERIMENT IN THE CONTROL OF APPLE SCAB

G. C. Chamberlain (St. Catharines, Ont.)

This spraying demonstration was continued on young trees not yet of bearing age and the observations were taken on the percentage of foliage showing scab infection. Different materials were used and in one instance the delayed dormant spray was omitted. The unsprayed trees on September 5 showed 53·1 per cent of foliage bearing scab lesions. On lime sulphur sprayed trees as high as 28·8 per cent of the foliage showed scab infection. These trees also showed severe foliage injury from this material, but where iron sulphate was added to the lime sulphur no injury developed. Bordeaux sprayed trees showed greatest freedom from scab with only 5·1 per cent. Where Bordeaux was used for the first two applications followed by Wettex (wettable sulphur and arsenate of lead) the percentage of scab infected leaves was 33·6 per cent. In the block where the delayed dormant application was omitted there was 25 per cent more scabbed foliage than in the block receiving similar treatment with the addition of this application. The delayed dormant proved to be the most important application in preventing heavy primary infection this season.

In the block of apples comprising different varieties the Courtland, McIntosh, Northern Spy and Fameuse proved to be the most susceptible to infection. Duchess showed high susceptibility in 1929 but this year was remarkably free from infection.

Co-operative Investigation of Fungicides of Apple Orchards

(B. 60·12)

J. F. Hockey (Kentville, N.S.)

Kelsall and Hockey[1] in a paper to the Nova Scotia Fruit Growers' Association presented observations on some experiments in apple orchards with several spray mixtures. Considerable work has been done with the aluminium sulphate-lime sulphur and iron sulphate-lime sulphur mixtures. The former spray passed its main experimental stage two years ago and was offered to the growers in the regular calendar. During 1930 the iron sulphate came into commercial use and the 1931 spray calendars include this mixture.

The Nova Scotia Spray Calendars were presented in abbreviated form in the report for this laboratory for 1929 included in the Report of the Dominion Botanist for that year. The iron sulphate mixture can be made according to the aluminium sulphate calendar by substituting 4 pounds iron sulphate for the 3½ pounds of aluminium sulphate to 40 gallons of water and increasing the calcium arsenate to 1½ pounds to 40 gallons up to the fourth spray when the arsenic should be reduced to 3 pounds per 100 gallons.

During 1930 the four spray calendars, Bordeaux mixture, lime sulphur, aluminium sulphate-lime sulphur, and iron sulphate-lime sulphur were compared in several orchards. The results of these tests were presented to the Nova Scotia Fruit Growers' Association in a paper by Kelsall and Hockey in December, 1930, to be published in the 67th annual report of that association. The results of these experiments indicated that,—

1. The four spray calendars are efficient in the control of apple scab.
2. Calcium arsenate is essential to both the aluminium sulphate and iron sulphate-lime sulphur mixtures for fungicidal value.
3. These mixtures reduce the burning from lime sulphur.
4. The iron sulphate mixture is a better carrier of calcium arsenate and larger amounts of the arsenic can be used with safety than with the aluminium sulphate mixture.
5. While the aluminium sulphate mixture is corrosive to the brass parts of a spray machine the iron sulphate mixture is not as no free hydrogen sulphide is generated.
6. The spray residue in the iron sulphate mixture adheres so well that it is inadvisable to use this mixture after July 1.
7. Lead arsenate is not satisfactory with either of these mixtures either in fungicidal value or in preventing injury.
8. Smaller amounts of aluminium sulphate or iron sulphate than those recommended in the spray calendars do not give satisfactory results under Nova Scotia conditions. The formulae should be strictly followed. Spray calendars for the current year may always be obtained on application to this laboratory, but it must be remembered that they are designed for Nova Scotia conditions only.
9. A person using the iron sulphate mixture for the first time is well warned that the spray comes out very black and turns brownish red after drying. On account of its conspicuous colour very thorough spraying can be done. No doubt this influences the good fungicidal results obtained.
10. Neither of the two mixtures cause russetting comparable to that caused by Bordeaux Mixture.
11. Nicotine sulphate is compatible with each of the four spray calendars.

[1] Kelsall, A. and Hockey, J. F.—Experiments with new spray mixtures—66th Ann. Report N.S. Fruit Growers' Assn.: 52-59, Jan. 1930.

Fly Speck and Sooty Blotch and Orchard Spraying

(B. 60·08)

J. F. Hockey (Kentville, N.S.)

In making harvest records on the variety Wellington in an orchard where three standard spray calendars were compared, observations were also made on the amount of fly speck (*Leptothyrium Pomi* (Mont. & Fr.) Sacc.) and sooty blotch (*Gloeodes pomigena* (Schw.) Colby) present. The following results were obtained in a count of 2,000 apples on each plot. Figures are given as percentages.

TABLE 30.—FLY SPECK AND SOOTY BLOTCH CONTROL

Treatment	A.			B.		
	Fly speck	Scab	S. Blotch	Fly speck	Scab	S. Blotch
1. Bordeaux................	0·30	1·46	0·00	0·60	1·70	0·00
2. Lime sulphur............	3·35	0·67	0·15	4·20	0·82	0·25
3. Aluminium sulphate mixture................	1·15	0·45	0·10	....	....	....
Unsprayed..............	80·25	76·47	5·15	....	....	....

All three sprays were effective in commercial control but Bordeaux Mixture gave the best results. It is assumed that the greater adhesiveness of both Bordeaux mixture and aluminium sulphate mixture may account to a large extent for the increased control obtained by these sprays over lime sulphur solution. The table also includes the data on scab control. Scab infections took place mostly between the pink stage and open calyx stage of development of the fruit. Fly speck infection normally takes place about two months later. The proportional control of these two diseases by the sprays mentioned would bear out the assumption that the most adhesive sprays were most effective in preventing late summer infections. The more effective control of scab by sulphur fungicides in 1930 was characteristic of most of the plots in Nova Scotia this past season. In some series of plots this may be credited to the time of application in comparison with ascospore discharge for it has been observed on many occasions that sulphur fungicides applied within three days after a spore ejection period are more effective than Bordeaux mixture applied under similar conditions.

Control of Powdery Mildew of Apples

(B. 60.03)

J. C. Roger (Summerland, B.C.)

The application of lime sulphur for the control of apple powdery mildew, under certain climatic conditions, causes severe fruit burning. In 1929, the Summerland Laboratory carried out a series of experiments in which the addition of iron sulphate to lime sulphur proved effective in reducing the number of marked apples. To determine the value of some of the newer sulphur products, and to ascertain the influence of climatic conditions at the time of application, a new series of tests were planned in 1930.

Using the same orchards, four spray plots and one check plot, were laid out and treated as follows:—

Plot No. 1. Four trees were left unsprayed as checks.

Plot No. 2. Six trees were sprayed with lime sulphur 1:50 on April 25, May 20 and June 18.

Plot No. 3. Four trees were sprayed with lime sulphur 1:50 on April 25, lime sulphur 1:50 and iron sulphate 1:65 on May 20 and June 18.

Plot No. 4. Two trees were sprayed with lime sulphur 1:50 on April 25 and with Cal-mo-sul 13 lbs. :80 on May 20 and June 18.

Plot No. 5. Two trees were sprayed with lime sulphur 1:50 on April 25 and with Flotation Sulphur 1 lb. :10 on May 20 and June 18.

As mildew did not develop on any of the plots and no spray burning occurred, conclusive results were not obtained.

On the days when the last sprays were applied, the maximum temperature in 1929 was 80° F., in 1930, 69° F., the amount of sunshine in 1929 was twelve and one-half hours, in 1930 four hours. As 90° F. is generally considered a safe temperature at which to apply lime sulphur, the continuous intense sunlight in the Okanagan may also be a determining factor in the amount of spray burning which occurs.

Control of Anthracnose of Pear and Apple

(B. 60.14)

J. C. Roger (Summerland, B.C.)

In conjunction with the orchard survey of the Salmon Arm district for perennial canker in the spring of 1930, observations were made to determine the extent and severity of anthracnose. Although the disease is widely distributed in the district, the amount of new infection appears to be decreasing each succeeding year. The most severely infected orchards were found to be located near swamps, creek bottoms, or uncleared bush land, situations having at times an exceptionally humid atmosphere, whereas, orchards more favourably located, and especially those with vigorous growing trees, are practically free from the disease.

During the past three years in Salmon Arm, unusually dry weather has prevailed which has possibly retarded the spread of anthracnose. With the return of more normal weather, however, the wide distribution of infection constitutes a menace to the whole district and necessitates adequate control measures. The sprays, Burgundy followed by Bordeaux, recommended for the control of the disease in the orchards of the Pacific coast, have been tested out in Salmon Arm with unsatisfactory results so far. Accordingly, experiments with new spray materials have been undertaken in an endeavour to determine a more beneficial control. The completed results of these are not yet available.

Perennial Apple Canker Survey in the Okanagan Valley

(B. 60.06)

H. R. McLarty and J. C. Roger (Summerland, B.C.)

A survey to ascertain the distribution and severity of perennial canker (*Gloeosporium perennans* Zeller & Childs) in the Okanagan Valley was commenced in the fall of 1928 and completed during the winter of 1929-30. All orchards from Osoyoos in the south to Salmon Arm in the north were carefully inspected and detailed information concerning each was systematically recorded on cards. The available data are indispensable to the working out and application of control measures.

The prevailing purpose of this survey was to obtain an exact record of the number of infected trees of different varieties and their location in the district. The fruit sections of the Okanagan are naturally divided by untillable land or lakes into thirteen units. To facilitate the compilation of data the territory was separated into these topographical units, numbering from one in the south to thirteen in the north. Each tree was examined and the presence or absence of cankers on the limbs recorded. This was not a difficult task in the dormant season, for in the Okanagan perennial canker is practically the only canker attacking apple trees. The only exception to this occurred in district number thirteen, where anthracnose is somewhat prevalent and also a canker of unknown origin similar in appearance to that caused by the Perennial Canker fungus. All doubtful cankers were identified, however, by a member of the Laboratory staff. The provincial Department of Agriculture co-operated by providing transportation for inspectors and supplying the necessary detailed information on local orchard conditions.

When the infected trees numbered less than ten, a map was drawn on the card to indicate their positions in the orchard. By this means isolated cases can readily be located at any time. Owing to the lightness of infection in the districts 1-7, which were first inspected, cankered trees were not permanently marked. Later, however, it was deemed advisable in the districts 8-11, where the extent of the disease was greater, to paint a white cross on all infected trees. Typical orchards were selected here and there throughout the districts in which the percentage infection of each tree was ascertained. The figures recorded in a severely infected orchard are presented in table No. 27.

The results of the survey disclosed that the disease is more extensive and severe in the northern districts, 8-11. This would seem to indicate that the low winter temperatures occurring there influence and increase the amount of infection. It was also evident that the disease was most severe in those orchards which suffer from frost injury. Throughout all districts, with the exception of number thirteen, woolly aphis were found. The entire absence of the disease in the one district free from woolly aphis infestations, but where cold winters occur, greatly substantiates the contention that perennial canker can only persist when woolly aphis are present.

In table No. 27, in which the details of a severely infected orchard are given, there is shown a great variation in the amounts of infection in the different blocks, which constitute the main orchard. It is of interest to note that although perennial canker has been present in this orchard for at least fifteen years, less than twenty-six per cent of the trees show medium or heavy infection, and over thirty-one per cent have remained entirely free from the disease.

Table 27.—Severity of Infection in a Badly Infected Orchard in District No. 9

Block No.	Clean	Heavy, over 10 cankers	Light, under 10 cankers	Total
Block No. 1—				
Jonathan	32	....	112	144
Nonsuch	8	38	....	46
Salome	195	....	46	241
McIntosh	435	....	35	470
Wagener	262	....	44	306
Spitzenberg	2	11	21	34
Newtown	80	3	82	165
Sundry	5	....	1	6
	1,019	52	341	1,412
Block No. 2—				
McIntosh	191	....	79	270
Rome Beauty	101	111	100	312
	292	111	179	582
Block No. 3—				
Newtown	16	33	95	144
Spitzenberg	6	48	50	104
Delicious	193	17	76	286
King	....	....	2	2
	215	98	223	536

TABLE 27.—SEVERITY OF INFECTION IN A BADLY INFECTED ORCHARD IN DISTRICT NO. 9—*Concluded*

Block No.	Clean	Heavy, under 10 cankers	Light, under 10 cankers	Total
Block No. 4—				
Jonathan	8	56	123	187
Newtown	8	110	18	136
Spitzenberg	....	66	3	69
Delicious	30	27	52	119
King	....	1	1	2
Crabs	384	....	4	388
	430	260	211	901
Block No. 5—				
Jonathan	8	155	597	760
McIntosh	13	....	21	34
Spitzenberg	....	1	....	1
	21	156	618	795
Block No. 6—				
Jonathan	98	162	290	550
Wagener	167	170	300	637
Newtown	1	94	101	196
McIntosh	15	....	52	67
Wealthy	15	....	291	306
Spitzenberg	5	1	....	6
	301	427	1,034	1,762
Block No. 7—				
Jonathan	....	275	110	385
Wagener	....	171	200	371
Newtown	....	249	....	249
Spitzenberg	1	58	....	59
McIntosh	44	4	92	140
Wealthy	....	....	169	169
Winesap	....	....	4	4
Delicious	1	....	....	1
	46	757	575	1,378
Total	2,324	1,861	3,181	7,366

In table No. 28, which presents a list of varieties in order of their susceptibility to the disease in the different districts, the variation of the order in which these occur indicates that climatic and growth conditions have a marked influence on the severity of the disease. However, Spitzenberg, Newtown, Grimes

TABLE 28.—RELATIVE SUSCEPTIBILITY OF VARIETIES IN THE DIFFERENT DISTRICTS

All Districts	District 8	District 9	District 10	District 11	All Other districts
Spitzenberg	Spitzenberg	Spitzenberg	Spitzenberg	Jonathan	Cox Orange
Grimes Golden	Newtown	Newtown	Newtown	Grimes Golden	Spitzenberg
Jonathan	Cox Orange	Wealthy	Jonathan	Spitzenberg	Baldwin
Newtown	Jonathan	Jonathan	Grimes Golden	Newtown	Rome Beauty
Cox Orange	Grimes Golden	Wagener	Wagener	Wagener	Newtown
Wagener	Rome Beauty	Grimes Golden	Rome Beauty	Rome Beauty	Wagener
Rome Beauty	Wagener	Rome Beauty	Stayman Winesap	Cox Orange	Wealthy
Wealthy	Delicious	Delicious	Winter Banana	Winesap	Winesap
Winesap	Winter Banana	Winesap	Cox Orange	Wealthy	Jonathan
Delicious	McIntosh	McIntosh	Winesap	Stayman Winesap	McIntosh
McIntosh	Winesap	Stayman Winesap	Delicious	Delicious	Winter Banana
Stayman Winesap	Stayman Winesap	Winter Banana	McIntosh	McIntosh	Delicious
Winter Banana	Wealthy	Cox Orange	Wealthy	Winter Banana	Stayman Winesap

Golden, Jonathan and Cox Orange are highly susceptible in practically all districts, while Winter Banana, Stayman, Winesap, McIntosh, and Delicious are as consistently resistant.

In the final table, No. 29, is given the number of diseased and healthy trees together with the percentage of infection in each district. It is noted that in nine out of thirteen districts, infection is either absent or less than one-half of one per cent. The total of all trees in the Okanagan showing even slight infection is less than 5 per cent. Furthermore, since the completion of the survey control measures have materially reduced the amount of infection.

TABLE 29.—THE PERCENTAGE OF INFECTION, TOTAL ACREAGE AND TOTAL NUMBER OF TREES IN THE DIFFERENT DISTRICTS THROUGHOUT THE OKANAGAN VALLEY

District number	Total acreage	Total trees	Trees with cankers	Percentage of cankered trees
1	2,050	26,094	0	0·0
2	585	35,862	6	0·0
3	233	14,453	2	0·0
4	2,602	130,203	105	0·0
5	1,810	108,600	239	0·2
6	825	27,711	13	0·0
7	584	27,161	57	0·2
8	6,944	289,074	14,409	5·0
9	1,644	79,028	11,975	15·0
10	1,006	45,829	3,141	6·8
11	3,875	169,440	22,833	13·5
12	603	24,273	40	0·2
13	2,276	110,789	0	0·0
Total of all districts	25,037	1,088,517	52,820	Average 4·9

Control of Perennial Apple Canker in B.C.

(B. 60·07)

H. R. McLarty (Summerland, B.C.)

The work on control of canker spread, by the use of castor oil and other dressings, has been continued. The results obtained were similar to those in previous years, and bear out our contention that to prevent spread in the cankers, aphis must be removed and kept out of the cankers from July to the end of the season.

Die-back, Corky Core and Drought Spot of Apple

(B. 60·05)

H. R. McLarty (Summerland, B.C.)

The experimental work on the several different orchards as reported on last year, has been continued.

Orchard No. 1 (5 acres). Through a gradually weakening supply of irrigation water, it has been impossible to keep the soil moisture adequate. Corky core, and drought spot have been exceptionally severe on this plot.

Orchard No. 2 (15 acres). The development of this orchard under the new irrigation system inaugurated in 1927 has been highly satisfactory. This orchard at the time of being taken over was badly affected with corky core. Since the application of irrigation, the orchard has been commercially immmune. The grower this year harvested some 3,000 boxes of fruit only 50 pounds of which were diseased.

Orchard No. 3 (10 acres). Improvement in this orchard has been highly satisfactory. A large crop of healthy fruit was produced. At the time of being taken over the whole orchard was badly affected with corky core, while a few trees showed such severe die-back that they were marked for removal. This year the orchard was entirely free from corky core and die-back, except for one tree, previously marked for removal, which still showed a few diseased fruits.

Orchard No. 4 (5 acres). Water supply more satisfactory for tree growth has been maintained. The trees have apparently not yet recovered from the results of previous unbalance, and did not come through the winter well. Throughout the summer a decided improvement was apparent and some healthy fruit was harvested.

Orchard No. 5 (15 acres). Irrigation practices in this orchard, though carefully watched, are still inadequate for providing an even moisture to the roots throughout the whole growing season. Since a very high percentage of the roots are within 6 inches of the surface, it has been found almost impossible to maintain the proper conditions by the usual horticultural practices. corky core occurred throughout practically the whole orchard, but not with sufficient severity to prohibit the marketing of the fruit.

Orchard No. 6 (10 acres). In this tract soil moisture conditions were held satisfactorily but the trees have not as yet responded. Several trees died in the spring and the whole orchard was badly affected with corky core and drought spot. The soil moisture conditions are satisfactory for plant growth were evidenced by the magnificent cover crop of sweet clover. It is evident that factors other than proper soil moisture are here responsible for the failure of the trees to recover.

Orchard No. 7 (7 acres). Super moisture in the past has been responsible for the loss of many trees. Corrective measures are being applied to those remaining, while young trees have been planted out in the killed out area. Around these the soil moisture is being carefully watched and the young trees have made satisfactory growth.

Orchard No. 8 (12 acres). Owing to a change of ownership, direct observational and advisory work in this orchard has been discontinued. Since the change in irrigation practices, however, a distinct improvement has been evident.

Orchard No. 9 (10 acres). On this plot it has been almost impossible to apply an even water supply. The trouble has been that super moisture develops the lower layers while the upper layers become severely dried out. The previous improvement in this orchard has not been sustained and several trees were lost this spring. Drought spot and corky core occurred in several sections of the orchard.

Crown-rot in Apple Trees

(B. 60·11)

J. C. Roger (Summerland, B.C.)

An investigation of several typical orchards in each district in the Okanagan revealed that a serious type of crown rot is widely distributed which requires the general adoption of practical remedial measures. Exposing, bridge-grafting and inarching have been practised in the past with little regard to their applicability in particular cases. There has been a lack of definite information on the efficiency of these methods with a consequent loss of many valuable trees. Experiments, which have been undertaken by the Summerland Laboratory, have demonstrated their comparative values in restoring crown-rotted trees to normal.

One of the simplest methods recommended is removing the soil and exposing the crown and upper root system of affected trees to free circulation of air.

Although this practice may often check the advance of the rot by apparently removing some of the contributory factors, it cannot be relied upon to assist further in the tree's recovery. It has been found extremely useful, however, when time or season prevented the carrying out of other forms of relief.

The beneficial results of bridge-grafting in connection with trees girdled by mice, indicated that a similar treatment of crown-rotted trees might also prove successful. The part affected with rot is usually confined to the area at the junction of the root and crown. In the process of bridge-grafting, the rot is first cleaned out well into the healthy bark, the wound disinfected and painted over with a good wood preservative. In the spring a flexible scion is used to make a union from a healthy root to the trunk above the rot area. Experiments have been carried out over a period of years with this method under careful observation, and it was noted that trees did not recover when the rot was severe or long-established. However, trees apparently recovered when treated soon after the initial attack of the rot and before it had become extensive, but in most cases the regained vitality was transitory. Some of the slightly affected trees were completely restored, but under ordinary conditions bridge-grafting was of little value and cannot be generally recommended.

Inarching suggested itself as the natural procedure in cases where the roots have been badly killed back. In the spring, the affected trees were similarly

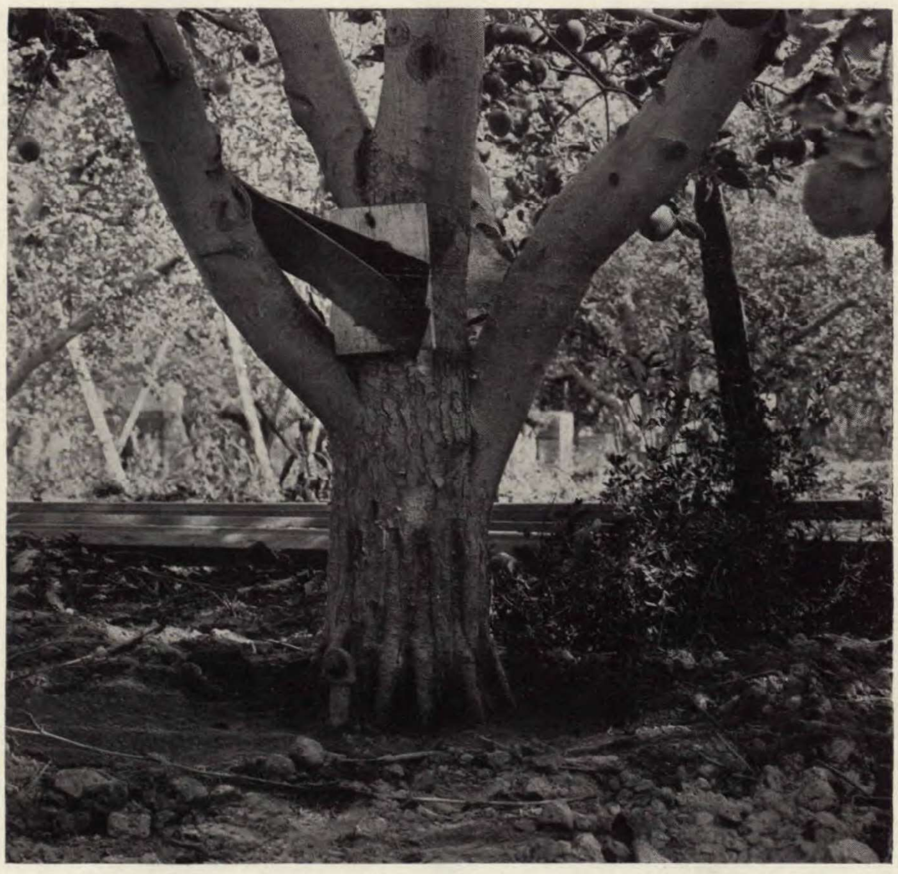

FIG. 15.—Vigourously growing, well placed inarches in their fourth year of growth. Although this tree was completely girdled with crown rot, the prompt application of treatment prevented any serious loss in vitality.

prepared as for bridge-grafting. Instead of using scions, young trees were planted around the tree opposite the rot area in a position which allowed their tops to be carried up close to the crown and trunk. The prepared ends were then inserted in the bark above. This method gave a higher percentage of vigorous quick-growing unions, and a large number of the treated trees fully recovered, while many that were low in vitality showed signs of increased vigour. When the rot was detected in the year of its initial attack, even completely girdled trees were successfully treated (fig. 15). The best results were obtained by using vigorous number one stocks having two-year-old roots. The success of this method depends in a large measure on the degree of vitality in the tree at the time of treatment. Inarching has proved so far to be the most satisfactory of the remedial measures.

Fire Blight Resistant Pear Varieties

(B. 60·02)

H. R. McLarty, G. E. Woolliams (Summerland, B.C.)

This year completes the fifth season during which tests have been made to determine the resistance under local conditions, of supposed immune species and varieties of pears to fire blight.

The stocks used in these tests were obtained from different sources. Those represented by letter and number, as S.P.I. 49489, were those developed by M. B. Waite, of the United States Department of Agriculture. They have been distributed for testing purposes only. The Chinese varieties were obtained from scions sent here direct from the interior districts of China. Scions of other varieties were obtained from trees in different parts of the Okanagan valley that had never been known to be affected with the disease. All the scions were grafted on Pyrus ussuriensis stock which was also used in the tests. The results for this season are tabulated in table 31.

TABLE 31.—RESISTANCE OF PEAR SPECIES AND VARIETIES TO THE FIRE BLIGHT ORGANISM (*Bacillus amylovorus*)

(Inoculations were made on May 12, 1930)

Species or variety	Number of inoculations made	Number of inoculations taking	Remarks
Patten	22	21	All took freely and most of the wood was killed back as far as the *P. ussuriensis* stock, also, 3 of the 5 checks became affected with the disease.
Flemish Beauty	8	8	The fire blight spread from 7 inoculations as far as the *P. ussuriensis* stock. Five of the 7 checks also became affected with Fire Blight.
Seedling pear from Louise Bonne	3	2	Took moderately.
S.P.I. 49489	4	3	Took slightly.
S.P.I. 49490	5	0	No infections.
S.P.I. 49492	7	0	No infections.
S.P.I. 49494	10	9	8 took moderately, 1 took severely; there are also 4 natural infections.
S.P.I. 49495	9	4	2 took slightly; 2 took moderately.
S.P.I. 52461	6	0	No infections.
S.P.I. 52464	10	0	No infections.
Muh Kua Lih	9	9	All took freely; there are 3 free-running natural infections that have run back to the *P. ussuriensis* stock and have killed the grafts.
Ta Huang Lih	2	2	Took very slightly.
Pyrus ussuriensis	17	9	Took moderately.

Fire Blight Investigations in Western Quebec

H. N. Racicot (Ottawa, Ontario)

An epidemic of fire-blight, caused by *Bacillus amylovorus* (Burr.) Trev., occurred in four of the eight apple-growing regions of western Quebec. A study of this disease was undertaken to determine, if possible, the cause of this outbreak, and what immediate measures the growers must take to save severely affected trees.

Many statements were made concerning the cause of the outbreak of fire-blight, among which, that the growers had been applying too much nitrogenous fertilizer. As the Horticultural Division is carrying out fertilizer experiments in a commercial orchard at Abbotsford, careful counts were made in the various plots. There was little twig infection, and the results given in table 32 are for fruit spur infections. There was considerable variation in each plot, and no definite conclusions could be drawn. Yet as one went further away from the Winter Arabka trees, a Russian variety very susceptible to fire-blight, in which there occurred 98 per cent fruit spur infection and which was the probable source of infection for this orchard, the amount of fruit spur infection decreased steadily, as indicated by the figures in table 33. These figures are for one row of ten Fameuse trees, the tree to the extreme left of the table, being next to the Winter Arabka. Therefore it is quite probable that proximity to the source of infection is more important a factor in the development of fire-blight than the fertilizer treatment.

TABLE 32.—PERCENTAGE OF FRUIT SPUR INFECTIONS

Plot	Treatment	Fruit spur infection of individual trees	Average infection
		%	%
	Wealthy:		
1	Check, no fertilizer	25, 29, 23	25
2	Nitrate of soda	26	26
4	Nitrate of soda and superphosphate	27	27
5	Nitrate of soda, superphosphate and muriate of potash	21, 31, 39	30
6	Sulphate of ammonia	50, 59	55
	Fameuse:		
1B	Nitrate of soda	18, 23, 16	19
3B	Nitrate of soda, superphosphate and muriate of potash	13, 25, 28	22
4B	Sulphate of ammonia	25, 37	31
5B	Check, no fertilizer	33, 32, 26	30
4A	Sulphate of ammonia	11, 4	7

TABLE 33.—PERCENTAGE OF FRUIT SPUR INFECTION IN A ROW OF FAMEUSE TREES

37	25	NF (1)	NF	11	4	NF	Tr (2)	Tr	Tr

(1) NF=Not flowering. (2) Tr=Trace (less than 1%).

As many questions remained unanswered after this investigation, it was decided to undertake research work on this disease. A co-operative project between the Divisions of Botany, Chemistry, and Horticulture, and the Entomological Branch, has been prepared and investigations are under way to determine more fully the life-history of the organism, the agencies responsible for its spread, and the methods of control. Cultures of the organism for this work have been obtained so far, from the following sources: Mountain ash, Fameuse, and Wealthy from Abbotsford, McIntosh from Hemmingford, and Mountain ash from Ste. Anne de la Pocatière.

INVESTIGATION OF THE DISEASES OF STONE FRUITS

Peach Canker Investigations

(B. 61·06)

R. S. Willison (St. Catharines, Ont.)

The investigation of cankers on peach trees of the Niagara district has now entered its second year. The problem is directed primarily towards the formulation of effective means of prevention and control, but other phases are also receiving considerable attention. A disease such as this is slow in its development, consequently the earlier results are presented as progress reports.

The third annual survey of our peach orchard, now nearly four years old, has yielded both confirmatory and additional data of considerable interest. Unless otherwise specified, subsequent remarks are based on observations made on this orchard.

ISOLATIONS AND INOCULATIONS

During the past year isolations have been made from cankers of various ages. To minimize the chances of obtaining secondary organisms, samples in most cases were taken well beyond the superficial limits of the lesions. From many young and incipient cankers on old trees, the "brown-rot" organism, *Sclerotinia americana* (Wormald) Norton and Ezekiel, was isolated. On the other hand, species of *Cytospora* were obtained from most cankers of several years standing, as well as from a number of very young ones. In no case has *Sclerotinia* been found in cankers older than two years. In addition, several other unidentified organisms, were procured.

Of the organisms used, during the growing season, for the inoculation of fresh wounds on both newly formed and older wood, *Sclerotinia* has been the only one, up to the present, to produce typical symptoms of the disease. In order to discover whether or not the tree is more susceptible in the dormant condition, to infection by organisms more weakly parasitic than *Sclerotinia,* a second and parallel series of inoculations was made in November. Unfortunately, owing to the slow development of the disease, complete results from either series are not yet available.

DEVELOPMENT OF TREES

Last year the time of discontinuance of cultivation had such a marked effect upon the development of the trees and their maturity at leaf-fall, that it was decided to make the experiment more extensive this year. Accordingly, the orchard was divided into three blocks, two of thirty-five trees each and one of a hundred and seventy. In these, cultivation was stopped on June 17, August 12 and on July 16 respectively. For convenience, these plots will be referred to as plots A, B and C. At the time of cessation of cultivation each block was sown to sweet clover. Prior to the installation of the under-drainage system in the fall of 1929, one part of C was so poorly drained that the trees in it did not thrive so well as those in the rest of the orchard. Also in C there are thirty trees from nursery stock, selected for freedom from blemish.

The graphs (figs. 16-17) were compiled from data collected in the annual surveys of the orchard. The average diameter of each tree, two or three inches from the soil level, was measured to the nearest sixteenth of an inch. The diameters of twenty-five trees in each plot were averaged and these values were used. With the exception of B and six trees in A, the blocks have received the same cultural treatment for two successive years, thus the figures may be considered as representative.

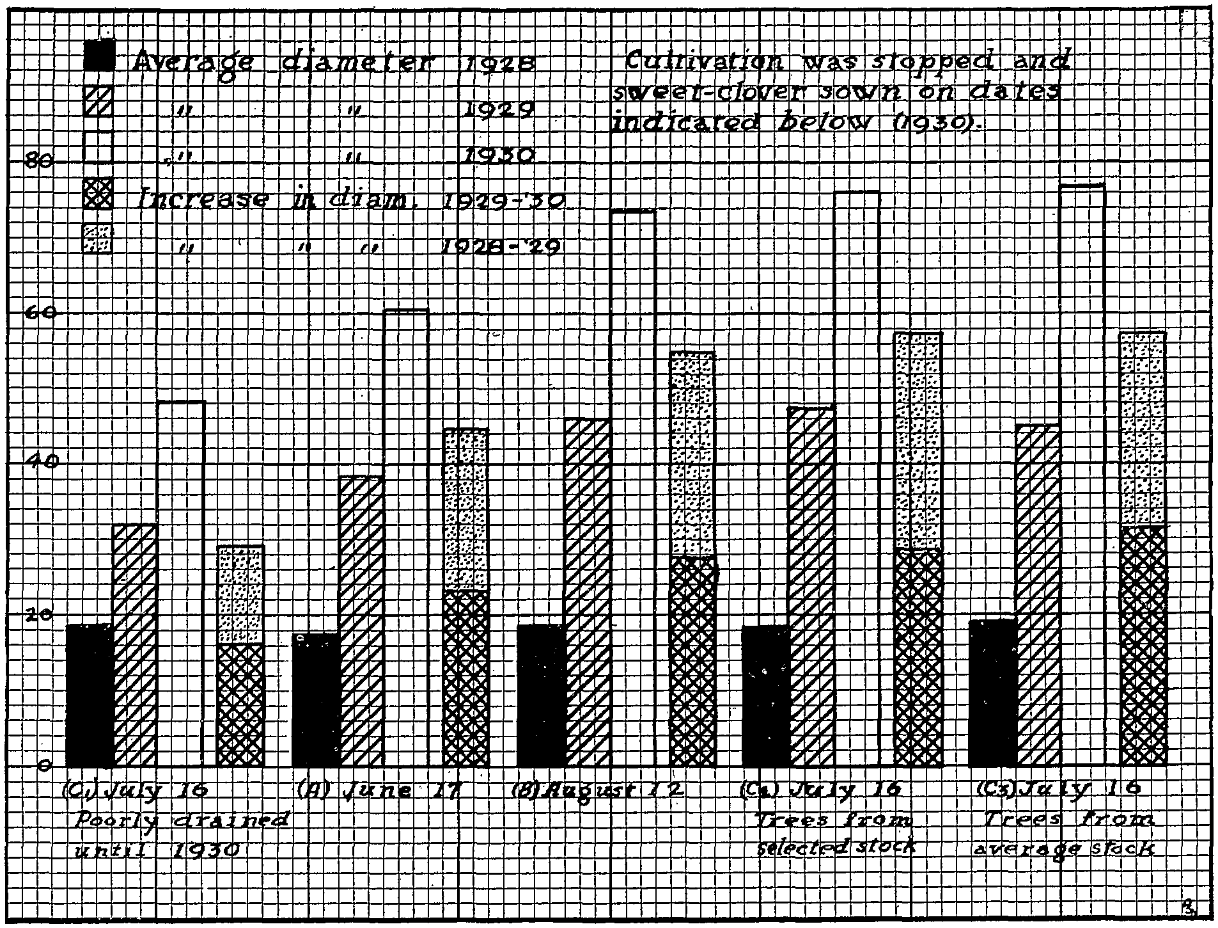

FIG. 16.—Average diameter and average annual increase in thirty-seconds of an inch, of twenty-five trees of the Elberta variety in each of five blocks, A, B, C1, C2, C3, in which cultivation was stopped on June 17th, August 12th and July 16th respectively.

It is obvious that with the cessation of cultivation in June there is a substantial reduction in annual growth. On the other hand, omitting the trees in C that received the set-back last year, it does not seem to make much difference to the increase in trunk diameter whether cultivation is discontinued in July or in August. The reduction of growth in A is also accompanied by signs of early maturity, for, towards the end of August in both 1929 and 1930, the foliage had assumed a light, yellowish green colour, no new growth could be seen, and the terminal buds were well formed. While throughout B and C the older leaves were a deep green and the light green of new leaves was conspicuous. Terminal buds began to appear in C about this time, and in B, two or three weeks later. By the end of September, the fruit buds were somewhat further advanced in A, the abscission layer in the petioles was well developed and the leaves were beginning to fall. In B and C the foliage remained deep green and defoliation did not occur until after the first heavy frost in October. Thus it would appear that the period between the middle of June and the middle of July is the critical time to cease cultivation.

COLLAR INJURY

When it is remembered that the trunks and especially the collars of trees become dormant much later than the branches, the importance of early maturity becomes apparent. The condition of the collar at the beginning of winter ought to be reflected in the amount of injury appearing in that region the following spring. This seems to be the case with regard to the observations for this year. Fig. 17, Graph. A, represents graphically the percentage of trees with collar injuries appearing in the spring of 1930. These are grouped according to the various plots of 1929. It should be noted that the injuries in the June block occurred on trees adjacent to sections where cultivation was continued longer so that an unexpectedly high percentage appears. The trees from selected stock made the most vigorous growth last year (fig. 16) and showed the most injury this spring. The trees in the section with poor drainage made least growth, but appeared last fall to be intermediate in maturity between the trees in the June block and those in the remainder of the July block.

Observations of the injuries were continued during the summer. Six per cent of the injuries resulted in the death of the tree, an equal percentage have become healed, while the majority of the remainder have diminished considerably in size.

WOUNDS AND CANKERS

Where close pruning was practised practically all the wounds were healed before leaf-fall. Most of those remaining unhealed were stubs one-quarter of an inch or more in length. Of these 13·4 per cent became infected and cankers developed around them during the winter. On the other hand, 85 per cent of the wounds present in 1929 and due to other causes, were completely healed and only 5 per cent had developed cankers. These, for the most part, were lateral wounds on trunks and branches. In fig. 17, graph B, the two types of wounds have been grouped together and considered with reference to the various blocks. With the exception of that sown to clover in July, the percentages of cankers developed from wounds in the various plots are of much the same order of magnitude. Therefore canker development would seem to be independent of either maturity or vigour of growth. The value for the exception is undoubtedly fortuitous, owing to the small number of wounds represented. It should therefore be disregarded.

Consideration of fig. 17, graph C, brings to light a feature of great importance. Eighty-two per cent of the cankers which have appeared in the young orchard, are due to careless pruning practices, chiefly neglect of close pruning. To further test this point a number of stubs were purposely left. In August most of these had not begun to be overgrown with callus, in marked contrast to

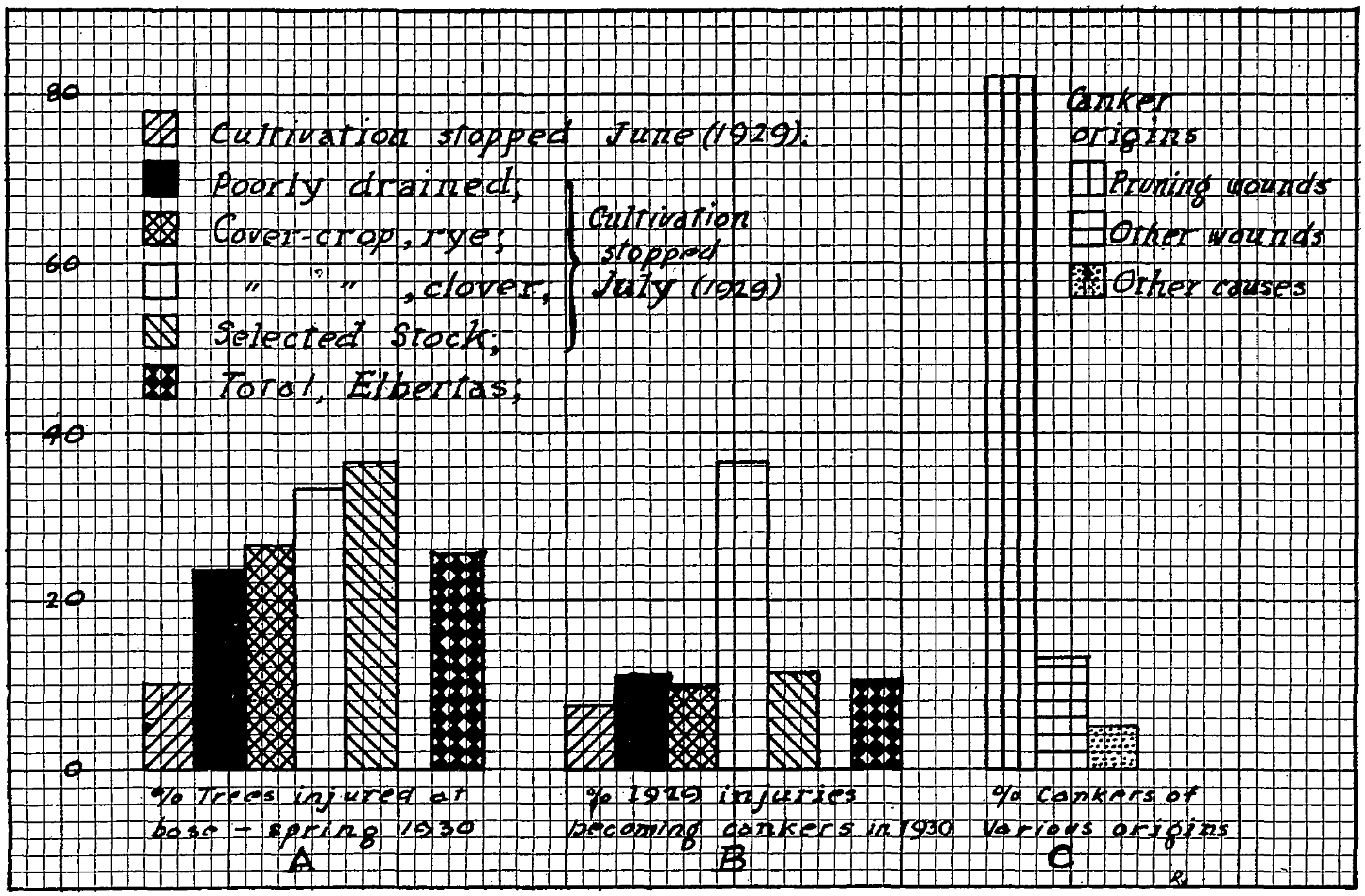

Fig. 17.—Graph A shows percentage of trees injured at base: B, 1930 cankers from 1929 injuries. C, percentage of cankers as to origin.

the wounds due to close pruning, most of which were then almost healed over. It should be remembered, however, that these trees have not yet come into bearing and therefore are not fully exposed to infection from blighted blossoms and "brown-rot" mummies, other important sources of cankers in older orchards.

In view of the fact that such a high percentage of cankers in young orchards originate from pruning-wounds, the importance of the careful culture and pruning of young trees cannot be over-emphasized. The foregoing results indicate that, while such trees usually have a remarkable recuperative ability, nevertheless any wound may serve as the point of origin of a canker. To protect a source of future income, a young orchard ought to receive painstaking treatment from the first. Many of the cankers resulting from pruning of young trees develop at the crotch, are therefore extremely serious, and unfortunately cannot be removed. Pruning is necessary, but it should be done in such a way that the danger of initiating such cankers is reduced to a minimum.

TREATMENT

In addition to the practices already mentioned, disinfection of wounds and spraying are being tested as means of prevention, but, to date, have yielded no conclusive results.

Well-established cankers in old trees have been treated in several ways, with the object of inducing them to heal. Thorough cleaning, with and without the subsequent application of a disinfectant has been tried, but so far, the efficacy of these treatments has not been proven.

Fall Spraying of Peaches to control Leaf Curl *(Taphrina deformans* (Berk.) Tul.)

(B. 61·02)

G. C. Chamberlain (St. Catharines, Ont.)

This project was continued on a somewhat enlarged scale. A number of materials were used and applications were made at favourable opportunities throughout the dormant season (December-April). No leaf curl infection developed in the check block, therefore no results as to the efficiency of the sprays applied could be obtained. The yield from the sprayed blocks was very good, although slightly less than the unsprayed. The blocks sprayed in early winter yielded considerably more than those sprayed in late winter and spring. This difference was due largely to the fact that the latter blocks suffered heavy leaf curl infection the previous season, which resulted in impairment of vigour for the ensuing year. There was no conspicuous difference in the amount of dead wood apparent in the various blocks or in the development of the buds.

Spraying Experiments for the Control of Peach Scab

(B. 61·05)

Spraying experiments were conducted on a commercial scale in a near-by Rochester Peach orchard, a variety which is highly susceptible to infection. The materials used were wettable sulphur, calcium monosulphide and zinc sulphate. Part of the block received one application and another two applications. Two applications of wettable sulphur gave fair commercial control of this disease, the trees yielding 57 per cent more clean fruit than the unsprayed. The other materials gave much poorer results with 18 per cent and 15 per cent more clean fruit respectively than unsprayed trees. Where only one application of material was made little or no control was obtained.

Further experiments conducted in the block of Elberta peaches, with the object of determining the most effective time to spray in the season, were without results due to the absence of scab infection in the orchard. Lime sulphur 1:50 strength was used for one of the applications and it was observed that considerable foliage injury resulted. This injury was in the form of leaf lacerations and shot-holes.

Spraying Sour Cherries for Shot-hole Disease *(Coccomyces hiemalis* Higgins)

(B. 61·04)

In 1930 a similar commercial spraying program to that of 1929 was carried on with the exception that zinc sulphate was substituted for the Bordeaux-aluminum sulphate spray. The season proved unfavourable to shot-hole disease as no infection occurred in either sprayed or unsprayed trees. Contrary to the results obtained in previous years the Bordeaux sprayed trees produced slightly larger cherries than the lime sulphur sprayed trees. However, in the block where the first application of Bordeaux was followed by lime sulphur for the later sprays the fruit compared favourably with the straight lime sulphur block. The largest cherries were harvested from two blocks where the first spray was applied at $\frac{3}{4}$ petal fall rather than the regularly recommended "shucks" time. In this case the trees receiving Bordeaux for the first spray produced slightly smaller cherries than the lime sulphur sprayed trees. This was found to be true in 1929 also and providing equal control of the shot-hole disease is secured, it may be found preferable to apply the first spray at the time of $\frac{3}{4}$ petal fall rather than at shucks time as is now recommended. The zinc sulphate tried this year for the first time did not appear to have any dwarfing effect on the fruit and the foliage was very good.

Spraying Experiment for Blossom Blight

(B. 61·03)

A spraying program was carried out in our Elberta peach orchard and sweet cherry orchard for the prevention of blossom blight. The sprays were applied when the trees were in partial bloom. Although a certain amount of browning of the petals occurred from the application of the sprays, the set of fruit was not affected. A certain amount of foliage injury was noticeable on the foliage of peach trees resulting from the use of the lime sulphur sprays. Blossom blight occurred very sparingly in the check blocks and was not present in the sprayed blocks. The percentage of infection was so slight that conclusions as to the effectiveness of the sprays are not possible.

Peach Scab Investigations

(B. 61.05)

The toxicity of certain fungicides to the conidia of *Cladosporium carpophilum* Thüm., was determined by means of germination tests. The materials tested were zinc sulphate, lime sulphur, calcium monosulphide and wettable sulphur in various strengths. The zinc sulphate and lime sulphur materials showed the greatest toxicity as germination was practically inhibited while with the other materials some conidia (five to eight per cent) attempted a weak germination. Further work along this line, accompanied by inoculation tests, is planned for next year.

Black Knot of Plums and Cherries

(B. 61.01)

L. W. Koch (St. Catharines, Ont.)

Investigations on black knot were continued along the lines begun in 1929. Though no survey of the district was made during the year to ascertain the prevalence of knot, it was quite apparent that it was not as serious as it was last year.

CULTURAL INVESTIGATIONS

Cultures were made from ascospores of *Dibotryon morbosum* (Schw.) Theiss. & Syd., during April and May and from conidia of *Cladosporium* sp. which developed on the surface of young knots in May and June. A number of cultures developed, in about two weeks, pycnidia belonging probably to *Coniothyrium* sp. Isolations from plum and sour cherry knot stromata of various ages almost invariably developed the same pycnidial fructification in about the same length of time. It is hoped to obtain information regarding the significance of this pycnidial form to *Dibotryon morbosum* from the inoculation experiments.

SPORE DISCHARGE

Spore traps were again set out this year to obtain more evidence regarding the abundance and period of spore discharge. The first discharge in 1930 was observed on April 25. This was approximately a month later than in the previous year. Discharges appeared consistently from that date after every rain until June 20 after which no discharge was observed. During the three weeks prior to the last discharge, conidia of a *Coniothyrium* sp. appeared on the slides along with ascospores of *Dibotryon morbosum.* This bore out the results of the previous year. It also emphasized the importance of ascertaining more complete data regarding the *Coniothyrium* sp. which appears so frequently in cultures from knots.

INFECTION EXPERIMENTS

Inoculation experiments were carried out on a large scale during the year. The methods adopted in carrying out these experiments were in the most part similar to those made use of in 1929. Although it is too early to make any statements regarding the results of these experiments it may be mentioned, however, that branches which were inoculated with pycnospores of the *Coniothyrium* sp. in September, 1929, developed marked swellings in the region of the inoculation during 1930. A number of these on sour cherry developed a distinctly knot-like appearance though no spore form matured on them. Re-isolations made from these inoculations eleven months after inoculation developed apparently the same organism as used for the inoculation. A number of the current season inoculations with *Coniothyrium* sp. as well as some inoculations with *Cladosporium* sp. have also developed swellings surrounding the points of inoculation. A marked difference in callus formation has been observed in inoculations with different organisms. Infection experiments will be continued next year.

CONTROL MEASURES

The old Lombard plum orchard was again used for the purpose of carrying out spraying and pruning experiments along lines similar to those reported last year. The results to date clearly point out the advisability of cutting out of all knots, three to four inches below the knot-like swelling and of applying a dormant spray of lime sulphur or Bordeaux oil emulsion.

INVESTIGATIONS OF THE DISEASES OF SMALL FRUITS

Strawberry Root-rot Studies

(B. 62.04)

A. R. Walker (St. Catharines, Ont.)

Strawberry root-rot investigations were continued during 1930 along lines somewhat similar to those followed during the previous year. The two most prominent differences were: (1) the disease was studied over a longer season—commencing in early winter, and (2) methods of inoculating strawberry roots under sterile conditions were used.

ISOLATION OF ORGANISMS FROM DISEASED PLANTS

During a week of mild weather in early winter plants were removed from the field or from cold frames at the University of Western Ontario and were placed in pots in the greenhouse. These plants were allowed to become well established and then isolations were made from those which developed disease symptoms. The isolations were first attempted early in February and were continued at intervals during the winter. In early spring unhealthy plants were removed from the field and used at once for making isolations. This practice was continued throughout the summer. The plants removed early in spring were very little advanced from the winter resting period. Hence it was impossible to know with certainty if they had genuine black-root or were merely going down from winter kill. These early isolations yielded mostly *Fusarium* sp. and several common saprophytes, while *Ramularia* occurred sparingly. Thus in fifty-eight isolations made during winter and early spring 13·8 per cent developed *Ramularia* sp. while 58·6 per cent developed *Fusarium* sp. However, as the season advanced the relative frequency of these two organisms changed. Thus by the middle of June *Ramularia* began to appear with considerable regularity and continued to outnumber the other organisms throughout the remainder of the season. It is interesting to note that this date for the regular appearance of *Ramularia* in isolations corresponds very closely with the time at which the disease has become common in the fields during the past three seasons.

Throughout this period when black-root was prevalent, isolations were made exclusively from two plots at the experimental station at St. Catharines. These patches were of the Wm. Belt and Glen Mary varieties. From forty-six isolations made between June 19 and August 13, 78 per cent gave *Ramularia* sp. while only 35 per cent gave *Fusarium* sp. Some of these isolations yielded fungi which were obviously saprophytic or secondary organisms. It will be noted that the number of organisms isolated exceeded the number of plants used for isolation. This was due to some cultures yielding two or more organisms.

INOCULATED PLANTS OVERWINTERED IN THE FIELD

During August, 1929, several plants were inoculated by placing a quantity of inoculum in incisions near the base of the strawberry crown. Some of these plants of the Glen Mary variety were allowed to overwinter in the field and were observed during the 1930 season.

This experiment involved twenty-four plants inoculated with *Ramularia* sp. and fifteen checks with incisions only. On June 11, which was about the time of the fruit picking, six of these inoculated plants, i.e., 25 per cent, were dead or almost dead while all of the check plants were healthy. By the middle of September a few more plants both inoculated and checks had died. These additional casualties, however, did not appear greater than that suffered by all plants in the field owing to the prolonged hot dry summer.

INOCULATIONS AND RE-ISOLATIONS

An attempt was made to carry out inoculation experiments on the strawberry roots under sterile conditions. Two methods were used to procure plants in sterile soil for this purpose. One method consisted of growing seedlings from sterilized seed in sterilized soil. This method was so slow that it was supplemented by a second one. Runners from potted plants in the greenhouse were trained to set in pots containing sterile soil. The latter method was used for all the plants reported in these inoculation experiments as the seedlings were too small to be of use until almost the end of the season.

Two methods of inoculation were employed. The first method involved making incisions in individual roots and reisolating from these later. The inoculations were made under sterile conditions and the roots were kept as sterile as possible by carefully wrapping them with sterile bandages.

Four weeks later these roots were removed and examined. Twenty roots inoculated with *Ramularia* sp. showed distinct black-root symptoms in every case. Isolations from these yielded *Ramularia* in eighteen cases and sterile cultures in the other two, i.e., 90 per cent gave positive re-isolations and 10 per cent no growth. Twenty roots used as checks with incisions only, produced no typical black-root symptoms. Several of these showed a little darkening of the roots and one showed considerable blackening but with no peeling off of the cortex. Three of these roots yielded *Ramularia* re-isolations, thirteen gave sterile cultures and four more were contaminated with saprophytic soil organisms.

A similar series of inoculations carried on with a couple of strains of *Fusarium* gave distinct blackening of the roots in a few cases but the typical peeling off of the cortex was not evident. Re-isolations from this series yielded *Fusarium* in only 25 per cent of the cases while the remaining cultures produced no growth.

The second method of inoculation consisted of exposing a great part of the root system of the plants to a spore suspension without making any incision. Sterile conditions were again followed throughout. Potted plants were grown in sterile soil and as they were transplanted to larger pots the extensive roots thus exposed were immersed in a spore suspension in the centre of a larger pot of the sterile soil.

Four weeks later the plants were examined. All the root systems which had been placed in a spore suspension of *Ramularia* showed unmistakable black-root symptoms. The root systems inoculated with *Fusarium*, however, showed no distinct black-root symptoms. The plants used for checks were transplanted in the same manner only the roots were immersed in water containing no spores. These check plants showed no symptoms of black-root. Re-isolations were made from all of these plants but an unfortunate accident spoiled the cultures so that no data is available on the organisms obtained.

POTTED PLANTS IN SOIL FROM VARIOUS SOURCES

During the 1928 season soil from various fields was brought into the laboratory and potted. Some of this soil came from fields bearing a crop of strawberries which suffered heavily from root-rot and some of it came from fields producing a virgin crop which showed no evidence of root-rot. This soil was used to produce a crop of plants as indicated in a previous report. The soil was retained in the pots and new runners were trained to set in them early in September. A record of this second crop of plants was kept during 1930.

A similar series of pots was set up late in 1929 with fresh soil brought from growers' fields. Thus we had two series to observe during 1930—one producing a second crop in the pots and one producing a first crop of plants.

The results of these two series are given below as observed on July 19. This date was chosen as it was about ten days after the last of the crop was removed.

It would thus include the plants going down during the cropping period, when diseased plants usually succumb. A later date would include the effects of the very long drought of this season which resulted in the death of many fairly healthy plants. The results are given in the following table and strengthen those obtained last year. Apparently soil bearing diseased roots may be an important factor in carrying the trouble over from year to year.

TABLE 34.—RESULTS FROM POTTED PLANTS

Soil used	Number of plants used	Good or fair on July 19	Poor or dead on July 19	Per cent good or fair
Soil Bearing 2nd Crop in Pots				
Suspected soil lot No. 1	7	4	3	57
Suspected soil lot No. 2	15	4	11	27
Suspected soil lot No. 3	5	2	3	40
Total suspected soil	27	10	17	37
Sterile soil	12	10	2	83
Soil Bearing 1st Crop in Pots				
Suspected soil lot No. 1	10	5	5	50
Suspected soil lot No. 2	15	1	14	7
Suspected soil lot No. 3	10	3	7	30
Total suspected soil	35	9	26	26
Good soil	9	8	1	89
Sterile soil	30	30	0	100

In conclusion it may be stated that the evidence obtained during the past season—especially from inoculating roots under sterile conditions—strongly favours assigning the cause of strawberry root-rot in the Niagara district to the *Ramularia* sp. so frequently isolated.

Suspected Strawberry Mosaic

(B. 62·05)

G. H. Berkeley (St. Catharines, Ont.)

As reported last year, our results so far have been negative in character. That is, after some three years' work in an attempt to artificially produce the disease, we have been unable to do so. All our inoculation tests to date have given negative results. The last series of inoculations was carried out this past summer, and, of course the results of this series are not obtainable until the spring of 1931. Seed was saved from fruit from diseased Van Dyke plants, and this seed gave a percentage of mosaic (?) plants. In other words, the trouble, whatever it is, is carried through the seed.

In many ways, the disease resembles mosaic, while in other ways it does not. For instance, the trouble has not yet been found on any of our old standard varieties, such as William Belt, Glen Mary and Parson's Beauty, but is confined to new varieties, most of which are the result of hybridization. This suggests the possibility of the trouble being genetical in origin. In the field the trouble has been confined to the variety affected, i.e., the disease does not spread in a plantation from variety to variety. This is contrary to the usual mode of spread of mosaic diseases, which is more or less general amongst varieties except where immune or resistant varieties are used. It is hardly to be expected that all of our many standard strawberry varieties would be immune to mosaic because experience so far has shown us that immune varieties are scarce in any species, rather than plentiful. Of course, strawberries may be the exception. Again, the symptoms of this trouble appear with the unfolding of the leaves in the spring but entirely disappear with the hot weather of early summer, to reappear again the following spring. In other words, during July, August and generally through until winter sets in, no symptoms are apparent. True mosaic diseases do not behave in this manner. Although the symptoms are very much like those associated with mosaic disease, nevertheless, there are differences, some of which are mentioned above, which cast some doubt upon this being a true mosaic trouble. The possibility of it being a genetic trouble is not to be overlooked.

Raspberry Diseases in Western Nova Scotia

(B. 62·08)

J. F. Hockey (Kentville, N.S.)

Following the preliminary observations presented in the report of this laboratory for 1929 a more careful examination of diseased leaves and canes was undertaken during 1930. Leaves which had overwintered on the surface of the soil were found bearing large numbers of immature perithecia as well as pycnidia of *Septoria Rubi*. West. The perithecia developed poorly in a moist chamber and it was impossible to obtain a sufficient number for positive identification. The few examined appeared to be very similar to those described by Roark[1] for *Mycosphaerella Rubi* Roark. In some immature perithecia a few paraphyses were found. An effort was made to obtain cultures from the spores in such perithecia but without success. Material containing perithecia was very scarce this spring.

EXPERIMENTS ON CONTROL

In the late summer of 1929 a portion of a diseased patch was caned and freed from weeds. The patch was six or seven years old and had not been making good growth for the past year or so. Half the plots were caned to plant rows about one foot wide and the remaining plots left their natural width, about two feet. After cleaning out the patch a portion was sprayed with 2-6-40 Bordeaux mixture using hydrated lime. The spray was applied on one portion of the patch on July 25 and a later spray was applied on another portion August 20. The first spray showed some beneficial results in protecting the youngest foliage from leaf spotting (*Septoria Rubi*). The later spray had little or no effect as the foliage was showing rather severe leaf spot at the time of application. However, in both cases the sprayed rows retained their foliage later in the season than unsprayed rows which were prematurely defoliated by leaf spot.

In the spring of 1930 plans were made for a series of spray plots with applications commencing soon after foliage commenced growth and at intervals through the season. Owing to other projects demanding attention at the time, the first application was delayed until just before the blossom buds opened. A second application was made immediately after bloom. The first was applied on one half the plots and the second on all plots. Control rows were adjacent on either side the sprayed plots.

During picking time the owner informed us that the patch was to be rogued and the land planted to another crop. Further sprays were therefore considered inadvisable. Final observations on the effect of the two sprays were then made soon after harvest. Unsprayed plants were in very poor condition. The upper four or six leaves on some of the new canes were the only ones free from *Septoria* and the majority of the plants had all foliage spotted. On the latter, defoliation was taking place. The canes were also severely affected with spur blight and many canes girdled.

The rows receiving the first spray alone had much less *Septoria* leaf spot than the controls. There was little evidence of defoliation and the majority of canes had eight to ten leaves free from spot at the top of the new canes. Spur blight was very prevalent and causing some appreciable injury.

The rows which had received two sprays were much better in appearance than any of the treated or untreated rows. Whereas the foliage on the old fruiting canes was practically gone on the other rows, those receiving the two sprays still retained over half of their foliage on such canes. The foliage on new canes was much cleaner and on the average the ten to fifteen leaves uppermost on the canes were free from spotting. It was also noticed that the leaf spotting was less intense than on the other rows. Spur blight was present to a slight extent only and many canes were free from any visible lesions.

DISCUSSION

From the observations made during the two years it is apparent that the patch was not in a vigorous growing condition. Cultural methods were not of the best. The fruiting rows were too wide, frequently over two feet. The soil was heavy in spots and tended to be too wet in the spring, resulting in slow growth of the plants throughout the season.

It is apparent from the observations made that the fungus *Mycosphaerella Rubi* Roark in its conidial stages, *Septoria Rubi*, on the leaves and *Rhabdospora Rubi* Ell. on the canes, caused more injury than any other single pathogene. The *Septoria* leaf spot was particularly severe causing premature defoliation, which resulted in killing back of the canes during the winter.

Other fungi as described in the report of this laboratory for 1929 caused varying amounts of injury to the plants in some years, but are not considered to be of great consequence in the average season. Cultural and control measures which will prevent leaf spot will give adequate protection from these other diseases.

Preventative methods should begin with the caning of the patch as soon after harvest as possible. Weak shoots should be removed and the plant row kept to a narrow path. The old canes should be destroyed immediately to eliminate the source of infections, particularly cane blight.

Commencing in the spring when the first leaves are one-half to one inch in diameter the plants should be thoroughly sprayed with a 2-6-40 Bordeaux mixture, using 2 pounds copper sulphate, 6 pounds hydrated lime and 40 gallons of water. Successive applications at intervals of ten to fourteen days should be made until the fruit begins to size appreciably. Three or four applications before harvest should be sufficient in any season. Bordeaux mixture at the strength used caused no foliage injury.

Raspberry Inspection and Certification

(B. 62·01)

G. H. Berkeley (St. Catharines, Ont.)

Requests for inspection of raspberry plantations this year numbered fifty-one. Of this number, twenty-two growers received certificates for certified stock. A number of these growers have applied for the official certified stock tags. Seven hundred and fifty of these tags have so far been distributed.

Results of raspberry plantation inspections for eastern Quebec were collated at Ottawa by Mr. Racicot who did the inspection in the western part of Quebec. In general, raspberry plantations in the east were badly infected with anthracnose and spur blight during the last season, especially so where cultural methods were neglected.

INVESTIGATIONS OF THE DISEASES OF VEGETABLES

Tomato Streak

(B.90·03)

G. H. Berkeley (St. Catharines, Ont.)

The only aspect of this disease that has received any attention this year is a further test of seed selected from healthy plants as compared with seed from mosaic plants. The results obtained, confirmed those of last year's, namely that the plants from healthy seed, i.e., seeds obtained from healthy plants, were far freer from mosaic than the plants from mosaic seed. The following table shows this tendency:—

TABLE 35

Grand Rapids	Lot No.	Number of plants	Number mosaic plants	Number healthy plants	Per cent healthy
Greenhouse Tomatoes—					
Seed from healthy plants...........	1	52	3	49	94·2
	2	26	2	24	96·1
	3	26	6	20	76·9
Seed from mosaic plants............	1	52	38	14	26·9
Outdoor Tomatoes—					
Seed from healthy plants...........	1	72	6	66	91·6
	2	97	8	89	91·7
Seed from mosaic plants............	1	220	159	61	27·7
Seed from streak plants.............	1	93	85	8	0·86

The above plantings, both indoors and outdoors, were from the same seed. Further tests along this line are being continued at the St. Catharines Laboratory and also at the Vineland Experimental Station in co-operation with Mr. O. J. Robb, Vegetable Specialist at the Vineland Station.

Tomato Breakdown

(B. 90·05)

H. R. McLarty and G. E. Woolliams (Summerland, B.C.)

Experimental work on tomato breakdown was continued during the 1930 season. Our purpose in giving special attention to this disease is two-fold. In the first place, it is a disorder which in some seasons brings about severe losses to the tomato growing industry, and in the second place it is representative of a type of disease which prevails on many fruits grown throughout this district.

For the latter cause, the use of an annual plant in studying this type of disorder has many distinct advantages in that environmental conditions on experimental plants may be more readily controlled, and a supply of plants for any definite phase of the problem may be prepared in a comparatively short time. The breakdown is, therefore, being studied because of its economic importance on the tomato plant itself and in the hope that something may be learned of the factors responsible for breakdown of fruit in general.

In last year's report a description of the symptoms of the disease was recorded, together with observations of the circumstances under which the disease occurs naturally. To this were added the results of the first year's experiments.

In this year's work the experimental area was divided into three plots, varying from each other only in the amounts of water applied. These plots named A, B, and C, received respectively supplies of water designated as normal, 11·76 acre inches, excessive, 16·8 acre inches and deficient, 9·8 acre inches. Hydrogen ion concentration varied slightly, being pH 7·4 in A, pH 7·0 in B, and pH 6·6 in C. The plants used in the experiments were of the Earliana variety. The usual practice of starting them in flats and transplanting them to the field was followed with the exception that the terminal bud was pinched off when the plants were very small and two opposite lateral shoots were allowed to develop into the two main stems of the plant. When the plants were set out in the field, they were put into the ground deep enough to provide a space of two or three inches between the main branches at the ground level. This separation of each plant into two main parts was designed to provide both a treated portion and a check on each individual plant. The same procedure for providing excessive temperature fluctuations was used as that described in the 1929 report (glass cages four feet to the side being placed over the plants) with the exception that one cage was fitted up to provide artificial heat. This cage was used entirely on plot A, the normal moisture plot, the three remaining cages being used, one on each of the three plots. Each plant received only one treatment and each treatment consisted of a series of excessive temperature fluctuations over a three or five day period.

In the cage provided with artificial heat, the required temperatures were obtained by the use of four cone heaters, each of 600 watt capacity. With the aid of these heaters, it was possible to produce high temperature conditions around the plant and yet maintain a low relative humidity, by having the ventilators of the cage continually open. In the three remaining cages the high temperature ranges were procured by tightly closing the cage and utilizing the sun's rays only. In these cages the vents were closed at 7 o'clock in the morning and maximum temperatures were reached generally between twelve and four. At 6 p.m. the vents were all reopened to secure as rapid a drop in temperature as possible. In the heated cage, the current was turned on at 7 a.m. and high temperature maintained until 6 p.m.

Treatments were begun on July 3, at which time the plants had just come into bloom. The following list presents the series of treatments throughout the season:—

Plot	Plant No.	Period of treatment	Plot	Plant No.	Period of treatment
A	1	July 3- 5	C	3	July 14-18
A	2	July 3- 5	A	*7	July 21-25
B	2	July 3- 5	A	8	July 21-25
C	1	July 3- 5	B	8	July 21-25
A	3	July 7-11	C	9	July 21-25
A	4	July 7-11	A	*9	July 28-August 1
B	1	July 7-11	A	10	July 28-August 1
C	2	July 7-11	B	10	July 28-August 1
A	5	July 14-18	C	12	July 28-August 1
A	*6	July 14-18	A	*11	August 4- 8
B	6	July 14-18	A	*13	August 11-15

*Plants treated under heated cage.

During the period of treatment on each plant, records were kept in each cage and in the open of the air temperatures and relative humidities. Soil temperature was also recorded as taken at a three inch depth. Figure Nos. 18 and 19 represent graphically the daily fluctuations in temperature and humidity on the treated and untreated portion of a representative plant, B. 8.

The extremes in fluctuations averaged somewhat greater than in the 1929 season. At that time the maximum temperature reached was 116°F. and the average high temperature was 105°F., while night temperature varied from 40°F.

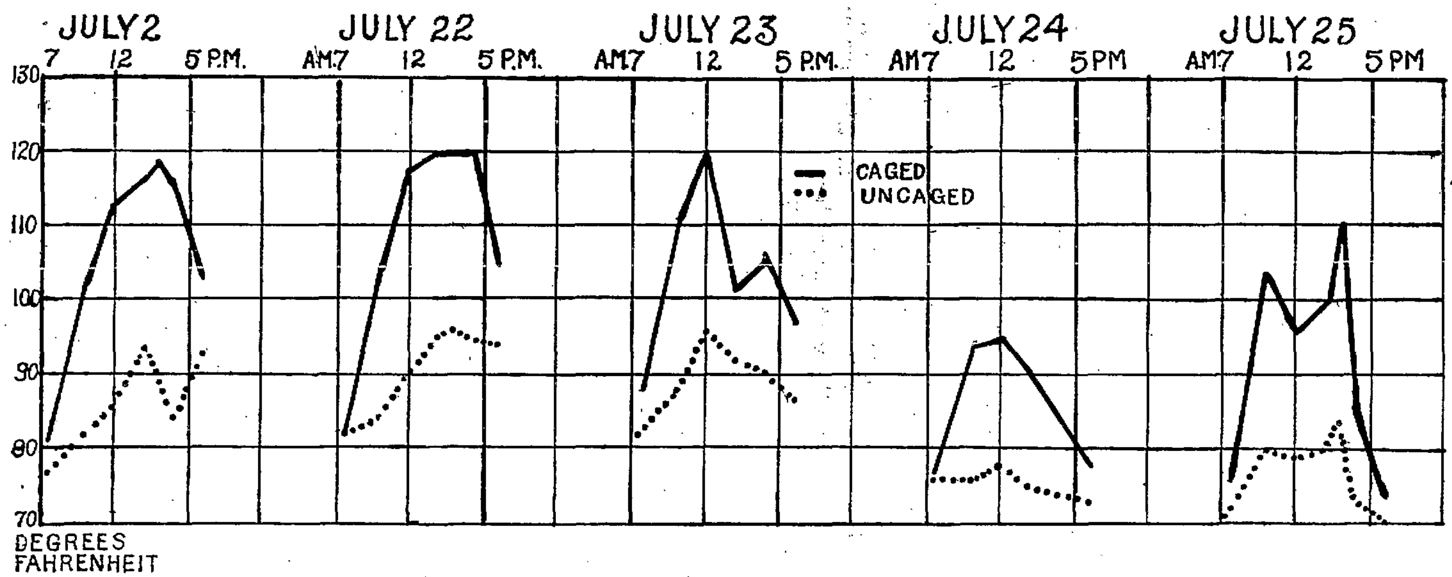

FIG. 18.—Graphical record of the daily temperature of the caged and uncaged portions of a typical plant (B8) during treatment.

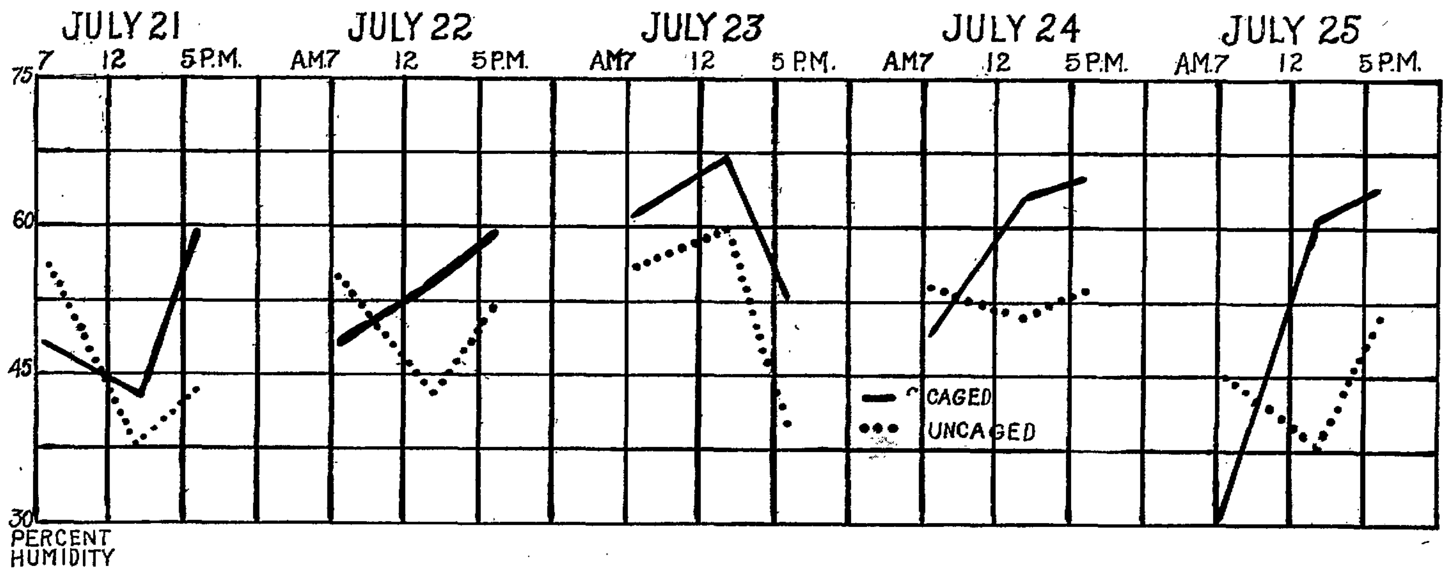

FIG. 19.—Graphical record of the daily relative humidity around the caged and uncaged portions of a typical plant (B8) under treatment.

to 60°F. This year the maximum temperature was 126°F. and the average high temperature 120°F. As night temperatures ranged between 50° and 60°F. there was, therefore, a daily fluctuation of from 60° to 70°. Except for a distinct wilting of the plant on the first day, there appeared to be little ill effect produced by the treatment on the general growth of the plant. At picking time, however, there was a distinct variation between the treated and untreated portions in the time at which the fruit ripened, that of the treated portion being as much as a week later.

RESULTS

The method of determining the results of this treatment on the fruit was:

1. To record the number of fruits which showed typical breakdown in the field, whether from treated or untreated portions of the plants.

2. To measure the firmness of the flesh of treated and untreated fruits when picked at the same stage of maturity.

Under the first heading of typical breakdown, the records gave:

Plot A—Of 53	treated	7	broke down.	Of 50	check	1 broke down
Plot B—Of 19	"	2	"	Of 15	"	1 "
Plot C—Of 20	"	9	"	Of 20	"	3 "

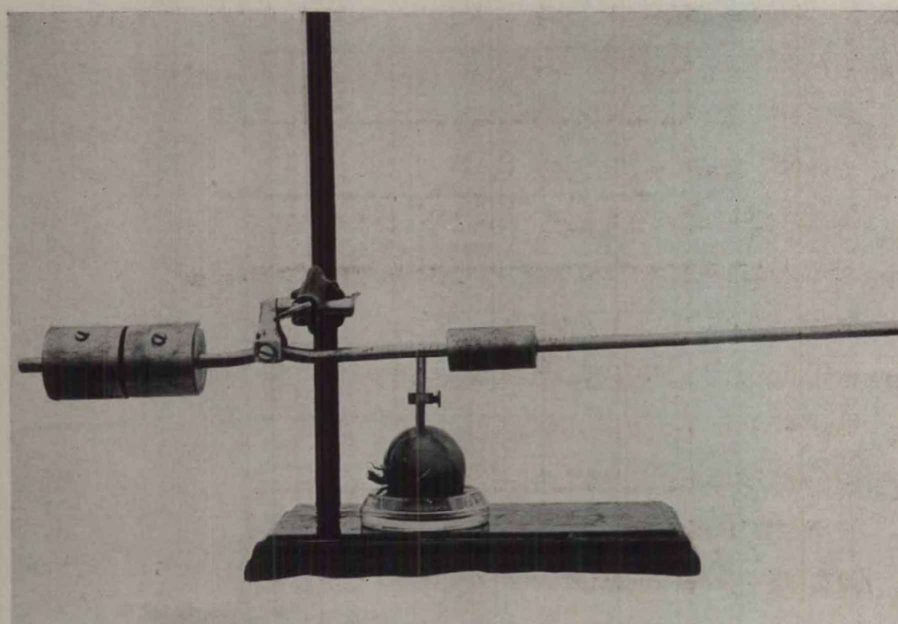

FIG. 20.—Pressure tester used in determining the firmness of fruit.

The firmness of the flesh was determined by the use of a pressure tester similar in principle to that used in 1929, but with a greatly increased sensitivity. The photograph (fig. 20) represents the construction of this tester. The balancing arm of the tester was graduated to indicate difference in pressure by grams at the point of the plunger, the capacity at the end of the arm being 400 grams, and the diameter of the plunger being $\frac{3}{16}$ of an inch. The comparative firmness of the different fruits was obtained by finding the weight required to puncture the peeled flesh when the plunger was dropped from a height of about $\frac{1}{16}$ of an inch. The average pressure of four determinations on different parts of each fruit was the final indicator of its firmness. The accompanying graph gives these records.

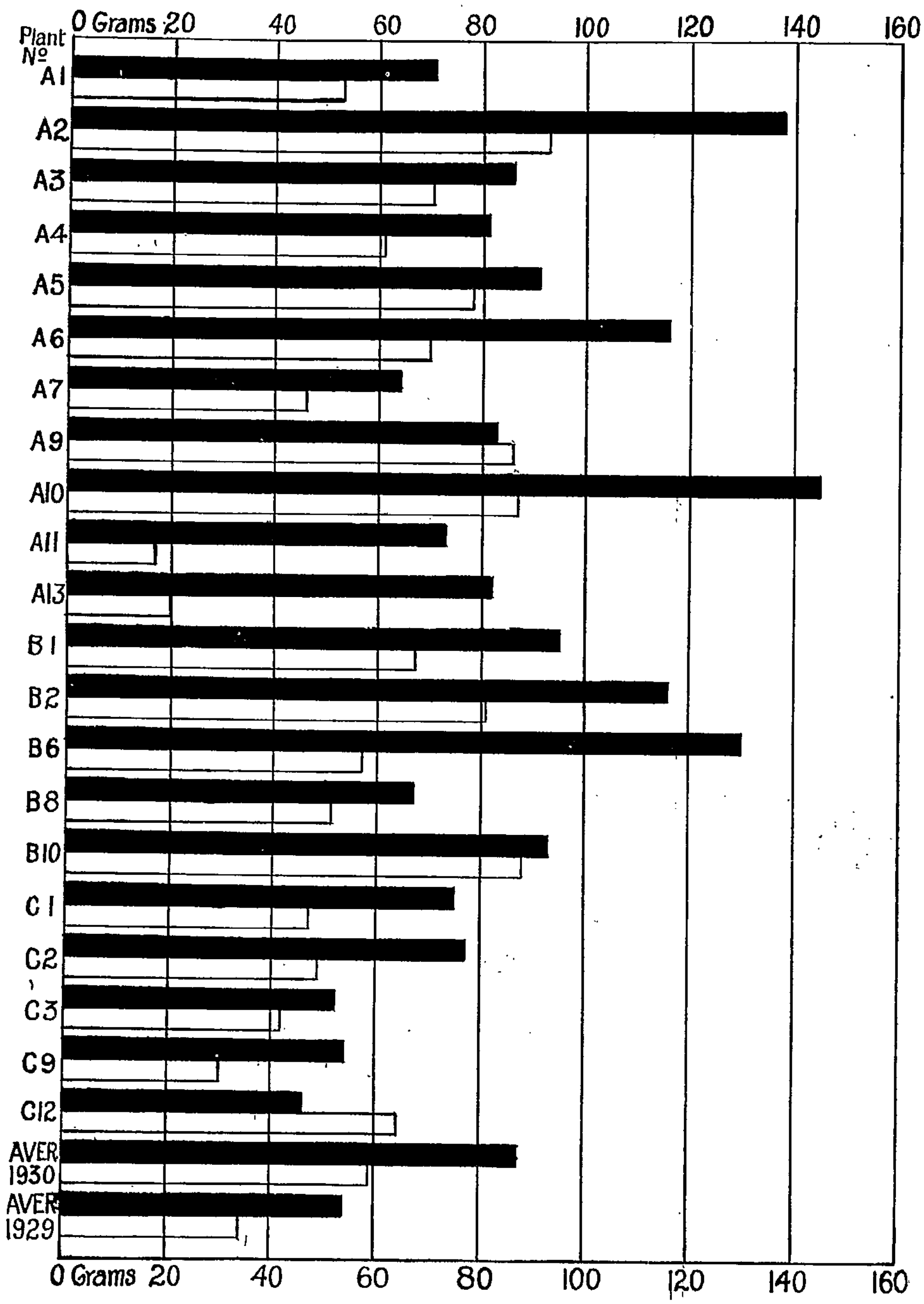

FIG. 21.—A comparison of the average breaking points of the treated and untreated portions of the plants under experiment. The dark blocks represent the breaking points of the fruit gathered from the check portions of the plants and the white blocks that from the treated portions.

The general decrease in fruit pressure, together with an increased amount of breakdown, justify, in our opinion, a continuance of the investigation along similar lines. This we propose to do during the summer of 1931.

Celery Heart Rot

(B.91·06)

J. K. Richardson (St. Catharines, Ont.)

A survey was made through the medium of the agricultural representatives of the province, as to what were the most serious vegetable diseases encountered in their respective counties. Celery heart rot, or black heart as it is called, was reported as being the most general and serious disease, with celery blights second and tomato leaf spot third. Accordingly work was started on celery black heart and it is hoped that control measures relating to celery blights can be started in the summer of 1931. In certain seasons large percentages of the celery crop are affected by black heart, to such an extent as to ruin its marketability. The "Golden Plume" a commonly grown commercial variety is one of the chief sufferers from this disease.

SYMPTOMS

The first abnormal condition observed in a diseased plant is the formation of necrotic areas at the tips and margins of the young heart leaflets. As the disease progresses, this necrosis increases until the entire leaves become involved. The disintegration then descends through the stalks and rots the heart of the plant, fig. 22. Only the outer leaves remain unaffected.

A review of the literature has revealed that diseased conditions of celery plants resembling very closely those under observation here have been attributed to both environmental conditions and invasion by parasitic organisms. It is in an endeavour to ascertain the initial causes of the trouble that a large number of isolations have been made from the diseased tissues of affected plants. The majority of these isolations have revealed that a soft rot-producing bacterium is present in the necrotic tissues but in several cases pure cultures of an unidentified fungus were obtained. The bacterial organism, while able to produce a rot of the stems in vitro has to date remained innocuous on living plants in the greenhouse, while the fungus has as yet revealed no signs of pathogenicity.

In order to procure some preliminary data on the effect of various cultural and environmental conditions on the natural occurrence of the disease the following experiments were instigated on the laboratory farm.

VARIABLE MOISTURE

Local observations, coupled with the fact that recent literature[1] on this disease points out the fact that unbalanced water relations aids its development, led the writer to carry on some preliminary studies to determine the connection between variable moisture and disease severity.

The abnormal water conditions in the soil were obtained by growing celery plants in long wooden boxes 2 feet wide and 12 inches deep. These boxes were thoroughly lined with oiled paper, buried in the ground so that their upper edges were just below the surface, and filled with soil. The object of the paper was to stop the natural capillary action of the soil moisture and to make the plants entirely dependent upon artificial irrigation. The young celery plants were then set out in these boxes in accordance with prescribed field practices.

[1] Foster, A. C. & Weber, G. F.: Celery diseases in Florida. Agric. Exp. Sta. Bull. 173, p. 39, 1924.

Two series of boxes were used, one irrigated to such an extent that the soil was perpetually moist while the second was treated so as to produce alternately moist and dry conditions. A check plot of similar size was planted in the immediate vicinity under field conditions and received only the normal precipitation. The extremely light local rainfall precluded the necessity of covering the artificially irrigated plots.

FIG. 22.—Celery heart rot; (a) early symptoms of marginal necrosis; (b) later symptoms of same; (c) rot of heart of celery plant.

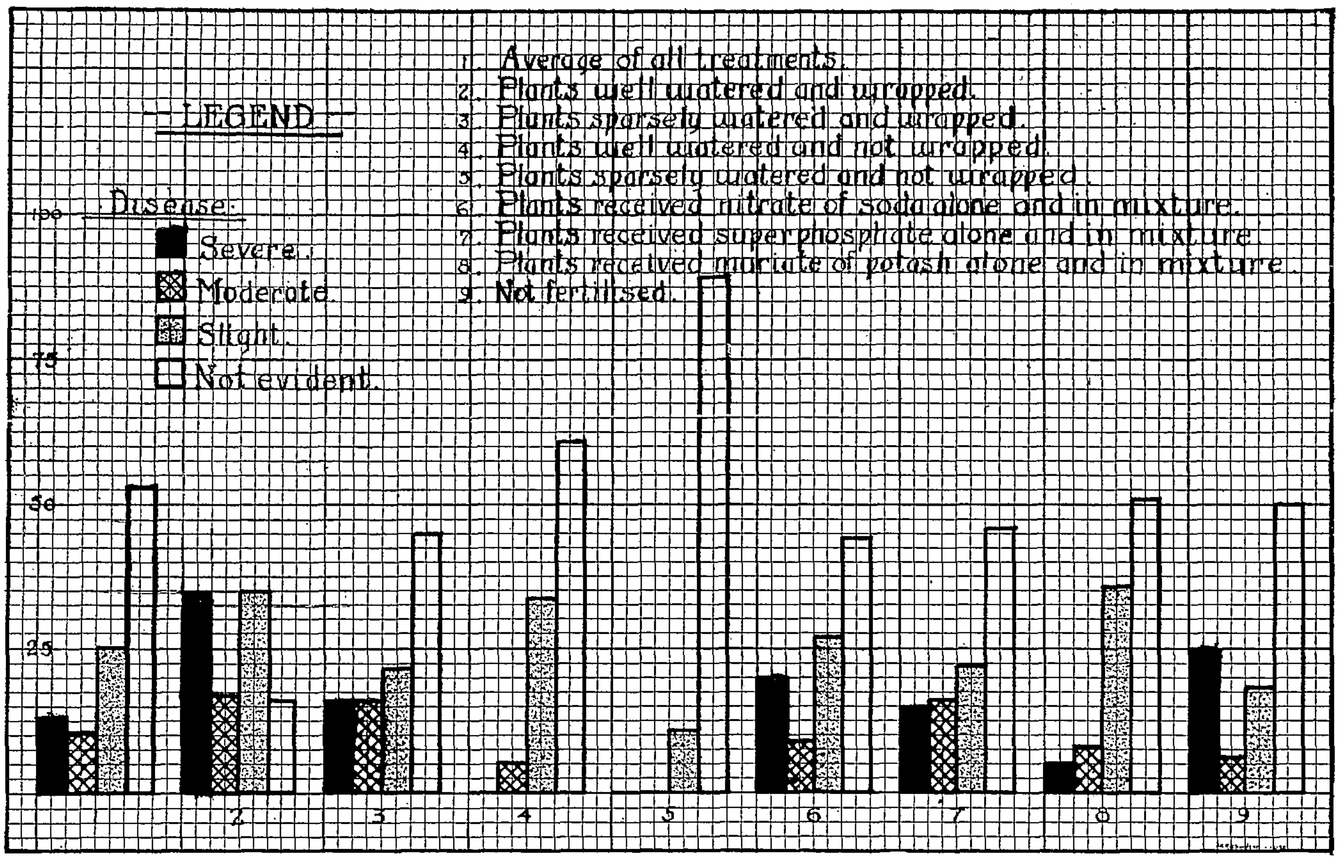

FIG. 23.—Graphs showing severity of diseases as affected by watering, wrapping and fertilization; "severe" denotes necrosis of entire leaf blades accompanied by rotting of heart stalks; "moderate" denotes necrosis of entire leaf blades, and "slight" denotes only a necrosis of tips and margins of leaf blades.

At the termination of the growing season, although the artificially irrigated plots exhibited sub-normal growth, no heart rot had developed.

Experiments were also conducted to compare tile drainage with natural drainage, light soil with heavy soil and spraying and dusting with no treatment, all with similar negative results. The consistent negative results obtained from the entire series of field experiments may be attributed, in a measure, to the abnormal climatic conditions pertaining in this locality. Despite the fact that a rather extensive survey was made during the summer, only one planting was observed which exhibited typical specimens of the disease.

FERTILIZATION AND AERATION

In the greenhouse a large number of celery seedlings were transplanted into nine inch pots and allowed to remain for a few weeks undisturbed in order that they might become thoroughly established. These plants were divided into four groups, A, B, C, and D. Each group was fertilized with a given quantity of a chemical fertilizer, varying from pure nitrate of soda, superphosphate or muriate of potash to combinations of these constituents in varying proportions. In each series A and B were well watered and C and D were watered only when the soil in the pots became thoroughly dry, while A and D were wrapped with brown paper to produce conditions comparable to those occurring in the field during the blanching period.

This experiment was initiated on September 12 and all plants were periodically examined for the appearance of disease symptoms. The final readings, as presented in graph form (fig. 23), were taken on November 13, two months afterwards.

A glance at fig. 23, graphs 2, 3, 4, and 5 clearly shows a larger percentage of plants affected with rot in the wrapped plants (graphs 2 and 3) than in the unwrapped (graphs 4 and 5), and in the well watered plants (graphs 2 and 4) as compared with the sparsely watered (graphs 3 and 5). This condition may possibly be explained by the higher relative humidity in the immediate vicinity of the plant crowns due to added irrigation and decreased air circulation.

Upon comparing the results in graphs 6, 7, 8, and 9 although there is little difference in the total percentage of disease present in the various sections, one clearly notes a gradation in the severity between the various fertilizer constituents from the non-fertilized series. The plants that received potash applications produced a much lower percentage of severely diseased specimens. This fact, however, should not bear too much weight, because as yet the replications have not been sufficiently numerous to make deductions conclusive.

Eggplant Wilt

(B. 91·03)

J. K. Richardson (St. Catharines, Ont.)

Vegetable growers in the vicinity of St. Catharines have suffered considerable loss from a wilt of eggplants which in many cases, has been so severe as to render the culture of this crop unprofitable. Several parties have discontinued its culture entirely on account of the extreme uncertainty of its rendering a remunerative return.

SYMPTOMS

The disease manifests itself first in the older leaves of the plant which gradually turn from their healthy green colour to a greenish yellow shade, commencing at the tips or margins and progressing until the entire leaf becomes involved. This process may be so rapid as to make the leaf appear to wilt in its entirety immediately the yellowing commences. The affected leaves soon

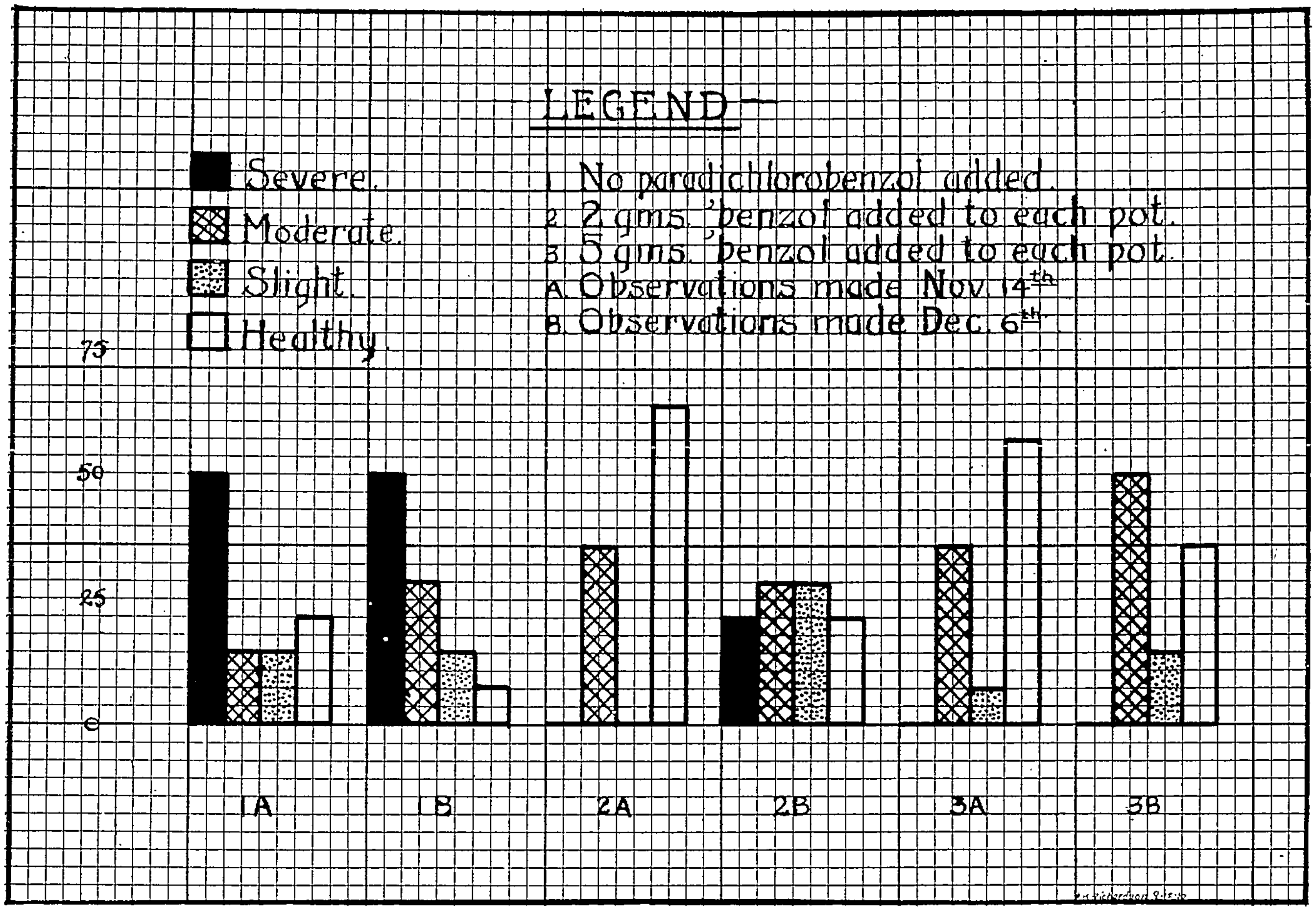

FIG. 24.—Graphs showing severity of disease as influenced by treatment with paradichlorobenzol.

lose their turgidity, become dry and turn brown. Sometimes definite wilting is not pronounced until late in the growth of the plant. The rate of wilting may be so slow that the new growth keeps pace with the wilting process or may be so rapid that the entire plant soon dies. Even when the progress is slow the plants are considerably dwarfed, the blossoms fewer and the fruits reduced in size.

ETIOLOGY

Laboratory isolations from diseased plants have invariably yielded a fungous organism having characters closely resembling in all respects those of the genus *Verticillium*. Inoculations with this organism into healthy plants both in the field and in the greenhouse have produced symptoms identical with those originally observed, and reisolations from the tissues of these plants have yielded organisms with the same characters as those of the original isolations.

CONTROL

An experiment, the result of which is shown in the following graph, was undertaken on September 27 to test the efficacy of paradichlorobenzol as a means of controlling the pathogen. Seedlings were transplanted into pots of sterile soil and allowed to remain for two weeks to become thoroughly rooted. Before inoculation, to each of one-third of the pots five grams of paradichlorobenzol were added; to each pot of the second one-third, two grams and the remainder was left untreated as a check. All the pots were then inoculated with the pathogen, by adding a macerated culture of the fungus to one hundred cubic centimeters of sterile water and pouring the mixture on to the soil. The plants were carefully observed periodically for the presence of wilt which first appeared on October 6; additional plants exhibited symptoms of the disease at irregular intervals from that date. For a means of comparison, the various amounts of disease present on the two dates, namely, November 14 and December 6, are shown in graph form in fig. 24.

Upon an examination of fig. 24 one clearly observes that on November 14 there was a larger number of healthy specimens present in the treated plants 2A and 3A than in the control 1A. This difference was considerably lessened in the December 14 reading, especially in 2B where only two grams of paradichlorobenzol was added, although there was some increase in the disease severity where five grams were applied. In the writer's opinion this increase was due to the fact that the volatilization of the chemical had, by this time, rendered it impotent.

These preliminary observations show that paradichlorobenzol has a definite deterring effect upon the action of the pathogen but further experimentation is necessary before any definite statement can be made as to its efficacy as a means of controlling the disease.

Cause and Control of Field Rot of Onions

(B. 91.02)

G. E. Woolliams (Summerland, B.C.)

THE EFFECT OF SOIL TREATMENTS ON THE DEVELOPMENT OF THE DISEASE

In the spring of 1929 a number of soil treatments were made on soil severely infected with the pathogene causing Fusarium bulb-rot of onions. The chemicals used included copper sulphate (at the rates of 750 pounds, 510 pounds and 255 pounds per acre), hydrated lime and magnesium carbonate, 1:1 (at the rate of 1,020 pounds per acre), ferrous sulphate (at the rate of 1,020 pounds per acre), hydrated lime (at the rate of 2,000 pounds per acre), potassium bichromate (at the rate of 510 pounds, 255 pounds and 125 pounds per acre), and sodium chloride (at the rate of 4,000 pounds per acre). All the plots treated with these chemicals, together with the untreated checks, were sown with Yellow Globe Danvers onion seed which grew normally and produced a crop with all the treatments except the latter two, namely, potassium bichromate and sodium chloride. These chemicals, apparently, are toxic to the onion plant for although the seed germinated well in each of the four plots, very few of the plants reached maturity. Since no data on the efficiency of these chemicals in controlling the disease had been obtained last season these four plots were planted again to the same crop this year. The fact that the onions grew to maturity would seem to indicate that the toxicity of the potassium bichromate and sodium chloride had been removed from the soil during the previous winter. These chemicals, however, do not give any control of the Fusarium bulb-rot, as this disease was just as prevalent in these plots as in the adjacent untreated ones.

Sodium chlorate is now considered one of the best chemicals to use in the eradication of weeds. Its effectiveness, according to Aslander,[1] is due to its rapid penetration through the soil and to its slow decomposition, especially at low temperatures. He also adds that fall applications have no effect on the ammonification and nitrification processes in the soil and that grain planted in the same soil the following spring was not injured by the chemical. As far as can be ascertained, no mention has yet been made of the toxicity of sodium chlorate to soil-borne fungi, and it occurred to us that this compound might possibly be toxic to fungi as well as to higher plants. Therefore, during the latter part of August, 1929, applications of sodium chlorate were made at the rates of 510 and 255 pounds respectively, on two one-sixtieth acre plots formerly used as checks. The chemical was applied in crystalline form and was broadcasted over the ground as evenly as possible. These plots were planted this spring with Yellow Globe Danvers onion. Although the seed germinated well, the seedlings died soon after germination and it would appear as if onions, unlike grain, should not be planted in soil treated with sodium chlorate the previous autumn.

TESTS ON THE CHEMICAL CONTROL OF FUSARIUM BULB-ROT

Treatment of Fusarium-infected soil with various fungicides, have so far given negative results in the control of onion bulb-rot. It was thought possible, however, that if the concentration of the fungicide in the soil was increased around the growing bulb by treating transplanted seedlings at the time of setting out, the disease might be held in check. Poole and Woodside,[2] in their tests on the control of sweet potato wilt, caused by *Fusarium Batatatis*, have shown that little disease develops when young plants inoculated with a heavy spore suspension of the pathogene, are treated with fairly highly concentrated Bordeaux mixtures at the time of planting in the field.

In the tests on the control of the bulb-rot disease, a number of fungicides as dusts and solutions were used in varying concentrations, as follows: Sulphur dust (Kolodust), sulphur dust (Ferrox), copper-lime dust (monohydrated copper sulphate, 20-80), copper carbonate dust (20-80), and magnesium carbonate and hydrated lime dust, (50-50), Bordeaux mixture (50-50-40), Bordeaux mixture (20-20-40), lime sulphur (1-9), Semesan (1-20), mercuric chloride (1-200), copper chloride (1-20), formaldehyde (1-50) and formaldehyde (1-

[1] Aslander, Alfred. Experiments on the eradication of Canada thistle *Cirsium arvense*, with chlorates and other herbicides. Jour. Agr. Res. 36 (11):915-934. 1928.

[2] Poole, R. F., and J. W. Woodside. A chemical control for sweet potato wilt or stem rot. North Carolina Agr. Exp. Sta. Tech. Bul. 35:1-18. 1929.

100). The plants were treated with these fungicides and were then immediately planted in soil infected with the pathogene. As the dust did not readily adhere to the dry plants, they were moistened just previous to treatment.

The onion maggots and wireworms became active in the plots where the treated plants were set out, and caused the death of many. The infestation was not uniform and consequently, there was quite a variation in the number of plants that reached maturity.

The results are shown in table 36. Due to the irregular and poor stand obtained, no conclusions can yet be drawn, until further tests have been made under more favourable conditions.

TABLE 36.—THE RESULTS OF PLANT TREATMENTS FOR THE CONTROL OF ONION BULB-ROT IN THE FIELD

Treatment	Number of healthy bulbs	Number of diseased bulbs	Per cent diseased
1. Sulphur dust (Kolodust)	48	7	12·7
2. Sulphur dust (Ferrox)	51	6	10·5
3. Copper-lime dust (20–80)	73	6	7·6
4. Copper carbonate dust (20–80)	114	14	10·9
5. Magnesium carbonate and hydrated lime (50–50)	37	2	5·1
6. Bordeaux mixture (50-50-40)	97	5	4·9
7. Bordeaux mixture (20-20-40)	78	6	7·1
8. Lime sulphur (1–9)	23	3	11·5
9. Semesan (1–20)	49	4	7·5
10. Mercuric chloride (1–200)	46	5	9·8
11. Copper chloride	11	1	8·3
12. Formaldehyde (1–50)	47	1	2·0
13. Formaldehyde (1–100)	18	3	13·3
14. Check (no treatment)	106	4	3·6

SUSCEPTIBILITY OF VARIETIES OF ONION AND SPECIES OF *Allium* TO FUSARIUM BULB-ROT

As the market in this part of the country demands a yellow globe type of onion, the commercial production of this vegetable is almost entirely restricted to the Yellow Globe Danvers, a variety which grows well under local conditions. There is also a limited demand for white pickling onions and a small acreage is devoted to the production of Silverskins. No red varieties are grown commercially in the Dry Belt of this province.

Several years ago this disease appeared to a slight extent in the principal locality where this vegetable is produced. The Yellow Globe Danvers has proved to be quite susceptible to this malady, which has spread extensively in this area, and now causes losses ranging from slight to 10 or 15 per cent according to the degree of severity with which the soil is infected with the pathogene.

The susceptibility of different varieties of onion and species of *Allium* is being tested out as information on this phase of the subject is desirable for three reasons:—

1. The host range of the pathogene should be determined.
2. As a result of testing different varieties of onions, a variety may be found that is resistant to the disease and yet is of a suitable type for commercial production.
3. In the event that a resistant onion of suitable type cannot be located, there may be found a variety having undesirable qualities, but which is resistant to the disease; from a cross of this with a susceptible onion of desirable type there may be developed a resistant strain having the required characteristics for commercial production.

This past season tests were made with a number of varieties of onions and a few of the species of the genus *Allium* which are used for table purposes. The majority of the seed for these tests was kindly supplied by Vilmorin Andrieux & Cie, at Paris, France, and by Haage and Schmidt at Erfurt, Germany. We are also indebted to Dr. H. Zillig of the Biologische Reichsanstalt für Land-und Forstwirtschaft at Zweigstelle Berncastel-Cues, Germany, who kindly sent us seed obtained from a number of sources, which are indicated in the accompanying table. (Table 37). Some of the different kinds of onion seed received from the various places were either duplicates or were closely related varieties. However, all the seed was planted out as it was considered possibly that there might be a difference in the resistance of the various strains to the disease. The seed was planted out in "Fusarium-sick" soil during the first part of April. The growing plants were cultivated according to the cultural practices used locally in commercial fields and the crop was harvested during the first part of September, when all the bulbs were examined for the presence of bulb-rot.

TABLE 37.—SUSCEPTIBILITY OF VARIETIES OF ONIONS AND SPECIES OF *Allium* TO FUSARIUM BULB-ROT

Variety	English name	Source of seed	Number diseased	Number healthy	Per cent diseased
1. (a) Yellow Bermuda[1]		Stokes Seed Co.	1	366	0·2
1. (b) Yellow Bermuda[2]		" "	0	209	0·0
2. (a) White Bermuda[1]		Burpee Seed Co.	0	199	0·0
2. (b) White Bermuda[2]			0	286	0·0
3. Red Bermuda		Aggeler & Musser	2	310	0·6
4. Earliest Flat Red Giant Tripoli[3].		Haage & Schmidt	0	75	0·0
5. Italian Silver Queen		" "	0	53	0·0
6. Earliest White Vaugirard		F. C. Heineman	1	602	0·1
7. Early Queen		" "	1	403	0·2
8. Silberweisse Queen	Silver White Queen	A. G. Terra	3	754	0·3
9. Heinemann's Round Globe White Giant.		F. C. Heinemann	4	483	0·8
10. Silver-skinned		Henri Nette	8	414	1·0
11. Heinemann's Round Globe Yellow Giant		F. C. Heinemann	3	205	1·4
12. Heinemann's Round Globe Red Giant.		" "	5	327	1·5
13. James' Long Keeping		Henri Nette	6	362	1·6
14. Blood-red		"	5	282	1·7
15. Sulphur Yellow White Spanish.		"	5	289	1·7
16. Pear-shaped		"	8	414	1·8
17. Straw-coloured Flat Keeping.		"	8	366	2·1
18. (a) Riverside Sweet Spanish[1].		Stokes Seed Co.	14	356	3·7
18. (b) Riverside Sweet Spanish.[2]			5	213	2·2
19. Mammoth Silver King		J. Harris Seed Co	8	294	2·6
20. Bluetrote plattrunde harte.	Hard Flat Blood-red	David Sachs	11	383	2·7
21. Schwefelgelbe plattrunde harte.	Hard Flat Sulphur-Yellow.	"	10	360	2·7
22. Strassburgh		Henri Nette	11	366	2·9
23. Blanc hâtif de Barletta	Early White Barletta.	Vilmorin-Andrieux & Cie.	10	326	2·9
24. Schwefelgelbe zittauer	Sulphur-Yellow Zittau.	A. G. Terra	12	380	3·0
25. Blood Red Giant Zittau		F. C. Heinemann	13	384	3·2
26. Blanc hâtif de Mai		Vilmorin-Andrieux & Cie.	6	173	3·3
27. Earliest White Spring		Haage & Schmidt	5	138	3·4
28. Birne gelbe susse	Yellow Sweet Pear-shaped.	David Sachs	14	361	3·7
29. Silver White Giant Zittau		F. C. Heinemann	17	428	3·8
30. Blanc très hâtif de la Reine	Earliest White Queen.	Vilmorin-Andrieux & Cie.	14	340	3·9
31. Stroh gelbe	Straw Yellow	A. G. Terra	22	535	3·9
32. Large Red		Haage & Schmidt	2	47	4·0
33. Espagnol	Spanish	Vilmorin-Andrieux & Cie.	19	348	5·1

TABLE 37.—SUSCEPTIBILITY OF VARIETIES OF ONIONS AND SPECIES OF *Allium* TO FUSARIUM BULB-ROT—*Con.*

Variety	English name	Source of seed	Number diseased	Number healthy	Per cent diseased
34. Silberweisse plattrunde harte.	Hard Flat Silver White.	David Sachs........	27	501	5·1
35. Gelbe export..............	Yellow Export......	A. G. Terra.........	25	433	5·4
36. Très hâtif de Port-Sainte Marie.	....	Vilmorin-Andrieux & Cie.	14	224	5·8
37. Géant de Rocca...........	Giant Rocca........	“ “	1	16	5·8
38. Yellow Globe Giant Zittau	....	F. C. Heinemann...	25	401	5·8
39. Blanc petit à confire (extra-hâtif de Barletta).	Extra Early Barletta.	Vilmorin-Andrieux & Cie.	23	360	6·0
40. Erfurt Pale Red...........	....	Haage & Schmidt..	1	15	6·2
41. Ironhead...................	....	F. C. Heinemann...	29	417	6·5
42. Géant d'Espagne..........	Spanish Giant......	Vilmorin-Andrieux & Cie.	19	272	6·5
43. Brownish Giant Della Rocca Tripoli.	....	Haage & Schmidt..	3	42	6·6
44. Blanc hâtif de Paris.......	....	Vilmorin-Andrieux & Cie.	21	288	6·7
45. Dark Blood-red Brunswick	....	F. C. Heinemann...	27	368	6·8
46. Blanc très hâtif de Vaugirard.	Earliest White Vaugirard.	Vilmorin-Andrieux & Cie.	21	364	7·3
47. Blanc gros plat d'Italie....	Large Flat White Italian.	“ “	33	406	7·5
48. Brown Spanish or Deptford.	....	F. C. Heinemann...	17	207	7·5
49. Hellgelbe plattrunde harte	Hard Flat White Yellow.	David Sachs........	27	324	7·6
50. Bronze Globe............	....	Haage & Schmidt..	2	24	7·6
51. Giant Madeira............	....	F. C. Heinemann...	28	333	7·7
52. Blanc hâtif de Valence.....	Early White Valencia.	Vilmorin-Andrieux & Cie.	29	342	7·8
53. Giant Borna..............	....	Haage & Schmidt..	2	23	8·0
54. Giant Permanence.........	....	F. C. Heinemann...	40	457	8·0
55. Giant Zittau.............	....	Haage & Schmidt..	3	31	8·8
56. De Madere rond..........	Round Madeira.....	Vilmorin-Andrieux & Cie.	26	264	8·9
57. Silvery White Flat Dutch.	....	Haage & Schmidt..	1	10	9·0
58. Blanc très hâtif de Nocera	....	Vilmorin-Andrieux & Cie.	30	289	9·4
59. Rouge gros plat d'Italie...	Large Red Flat Italian.	“ “	14	127	9·9
60. Large Yellow Solid........	....	Haage & Schmidt..	3	27	10·0
61. Yellow Flat Dutch........	....	“ “ ..	3	26	10·3
62. Rouge foncé..............	Dark Red..........	Vilmorin-Andrieux & Cie.	30	245	10·9
63. Jaune de Strasbourg.......	Yellow Strasburgh .	“ “	42	239	11·0
64. Portuguese Delicatesse....	....	Haage & Schmidt..	8	64	11·1
65. Jaune de Moissac..........	....	Vilmorin-Andrieux & Cie.	18	139	11·4
66. Australian Brown..........	....	J. Harris Seed Co..	44	338	11·5
67. Jaune de Lescure..........	....	Vilmorin-Andrieux & Cie.	38	270	12·3
68. Pyriforme jaune hâtif......	Early Yellow Pear-shaped.	“ “	37	257	12·5
69. Jersey Large Red.........	....	Haage & Schmidt..	4	28	12·5
70. *Yellow Globe Danvers*[4].....		J. Spall, Kelowna, B.C.	49	327	13·0
71. Blanc de Bobigny.........	....	Vilmorin-Andrieux & Cie.	8	52	13·3
72. Blanc rond dur de Hollande.	....	Vilmorin-Andrieux & Cie.	54	333	13·9
73. Rouge pâle de Niort.......	....	“ “	9	55	14·0
74. Rouge rond de Toulouse..	....	“ “	15	88	14·0
75. Rouge vif d'Août..........	....	“ “	46	239	16·1
76. Rouge globe..............	Red Globe..........	“ “	29	149	16·2
77. Jaune brun de James.......	James' Dark Yellow.	“ “	2	10	16·6
78. Jaune gros du Nord........	....	“ “	28	136	17·0
79. Blanc gros................	Large White........	“ “	48	227	17·4
80. De Madère plat...........	Flat Madeira.......	“ “	48	218	18·0
81. Jaune de Cambrai.........	....	“ “	34	145	19·0
82. Rosé de bonne garde......	....	“ “	33	125	20·2
83. Jaune de Mazères..........	....	“ “	42	151	21·7
84. Jaune de Mulhouse.........	....	“ “	37	90	29·1
85. Jaune paille des Vertus....	....	“ “	80	118	40·4
86. Jaune de Trébons..........	....	“ “	48	62	43·6

TABLE 37.—SUSCEPTIBILITY OF VARIETIES OF ONIONS AND SPECIES OF *Allium* TO FUSARIUM BULB-ROT—*Conc.*

Species	Source of seed	Number diseased	Number healthy	Per cent diseased
87. Welsh Onion, White or English *(Allium fistulosum)*.	Vilmorin-Andrieux & Cie.	0	about 470	0·0
88. Welsh Onion, Red or French *(Allium fistulosum)*.	Vilmorin-Andrieux & Cie.	37	" 470	7·4
89. Leek *(Allium Porrum)*................	Kew and Zillig...........	0	" 450	0·0
90. Chives *(Allium Schoenoprasum)*........	Vilmorin-Andrieux & Cie.	0	" 800	0·0

[1]Grown from seed. [2]Grown from seedlings. [3]The seed was impure, the colour of the bulbs ranging from white to red. [4]This is the principal variety grown commercially in British Columbia.

The results are presented in table 37. There was a total of eighty-six kinds of onions tried out. They showed quite a variation in the amount of infection with bulb-rot and may be divided into several groups according to the degree of infection.

1. *Resistant.*—Nine varieties showed no or less than 1 per cent infection.

2. *Slightly Susceptible.*—Twenty-three varieties showed 1 to 4 per cent infection.

3. *Moderately Susceptible.*—Twenty-seven varieties showed 5·1 to 9·9 per cent infection.

4. *Very Susceptible.*—Twenty-seven varieties showed 10 to 43·6 per cent infection.

Of all the varieties tested, the three different coloured Bermuda onions appeared to be the only type that show any consistant resistance to the disease. The other varieties of onions seem to show no definite tendencies towards the trouble. Some of the yellow varieties such as the Yellow Globe Danvers, appear to be very susceptible, but others, however, show only slight infection. Similarly, there are white and red varieties showing varying amounts of infection ranging from slight to severe.

Included in this table are several species of *Allium* that are sometimes used for table purposes, namely, Red and White Welsh onion, leek and chives. Both of the latter two appear to be immune, but the Welsh onion, however, only shows partial resistance. All the White or English Welsh onions remained free of the disease, but the Red or French Welsh onions showed an infection of about 7·5 per cent.

Although all the soil in which these tests were made was infected with the pathogene, the distribution of the fungus was not uniform, the disease on the Yellow Globe Danvers, always causing a higher percentage of loss in one part of the field. These tests will, therefore, be repeated before any conclusions can be made on the relative susceptibility of the different varieties.

Tests on susceptibility to Fusarium bulb-rot were not restricted to varieties of onion and some of the more common edible species of *Allium,* but also included some of the less common species of this genus. The seed for these experiments was procured through the kindness of Dr. H. Zillig and Haage and Schmidt of Germany, and the Royal Botanic Gardens, of Kew, England. The seed of all species received was planted in infected soil. Some of the seed was not viable and failed to germinate, but plants of a sufficient number of species were obtained to give an indication of the host range of the pathogene. As shown in the accompanying list (table No. 38) seed of thirty-seven species of *Allium* germinated and produced plants. At the end of one year's growth, none of the plants of any of these species showed any symptoms of the disease. This would seem to indicate that the host range of the *Fusarium sp.* causing onion bulb-rot is not extensive.

TABLE 38.—LIST OF SPECIES OF *Allium* RESISTANT TO FUSARIUM BULB-ROT

Species	Source of seed
1. Allium albidum	Zillig
2. " albo-pilosum	Zillig
3. " angulosum	Zillig, Kew
4. " atroviolaceum	Zillig
5. " Beesianum	Zillig
6. " Caspium	Kew
7. " cilicicum	Zillig
8. " coeruleum	Zillig, Kew
9. " cyaneum	Zillig, Kew
10. " descendens	Zillig
11. " flavum	Zillig, Haage & Schmidt
12. " flavidum	Kew
13. " fuscoviolaceum	Zillig
14. " globosum	Zillig
15. " gracile	Zillig
16. " Huteri	Zillig, Kew
17. " Kansuense	Kew
18. " macranthum	Zillig, Kew
19. " montanum var. glaucum	Zillig
20. " Moly	Zillig, Haage & Schmidt
21. " neopolitanum	Kew
22. " nutans	Zillig
23. " odorum	Zillig, Kew, Haage & Schmidt
24. " paniculatum	Zillig
25. " paradoxum	Kew
26. " polyrhizum	Zillig
27. " Przewalskianum	Kew
28. " pulchellum	Zillig, Haage & Schmidt
29. " rotundum	Zillig
30. " senescens giganteum	Kew
31. " senescens var. pertraeum	Zillig
32. " sibiricum	Zillig, Kew
33. " stellatum	Kew
34. " subhirsutum	Kew
35. " subangulatum	Kew
36. " tanguticum	Kew
37. " ureolatum	Haage & Schmidt

Cause of retarded germination in Cucurbit Seeds

(B. 91·05)

D. J. MacLeod (Fredericton, N.B.)

The Dominion Seed Testing Laboratory at Sackville, N.B., drew our attention to the fact that some difficulty had been experienced in connection with routine tests of certain samples of cucurbit seeds due to some factor retarding the germination of same.

An investigation of this problem revealed that a fungus (*Rhizopus nigricans* Ehr.) is responsible for the failure of these cucurbit seeds to germinate properly. The retardation of germination is in most cases proportional to the degree of infection. When infection is slight, germination is delayed from five to ten days but heavily infected seeds in most cases never germinate.

Seed treatment with standard disinfectants, including formaldehyde, mercuric chloride, Semesan, Ceresan and mercurochrome yielded some encouraging results. There was much injury, however, produced by certain disinfectants which renders it necessary to repeat the tests in order to determine the most effective and least injurious concentrations of these compounds. The project is conducted co-operatively with the Dominion Seed Testing Laboratory at Sackville.

SECTION V

INVESTIGATIONS OF THE DISEASES OF POTATOES AND FIELD CROPS; POTATO CERTIFICATION SERVICE

27559—10½

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SECTION V

Investigations of the Diseases of Potatoes and Field Crops; Potato Certification Service

INVESTIGATIONS OF POTATO DISEASES

Fertilizer injury to Potato Tubers

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

At digging time each year and later during grading operations tubers showing surface blemishes are sent to the laboratory for identification. Many of these injuries are quickly recognized as the more common tuber rots. Frequently, however, instances occur when the injury cannot be attributed to any known cause. Recalling cases of tuber injury due to contact with fertilizer bags in warehouses it was suggested that the same injury may occur to the

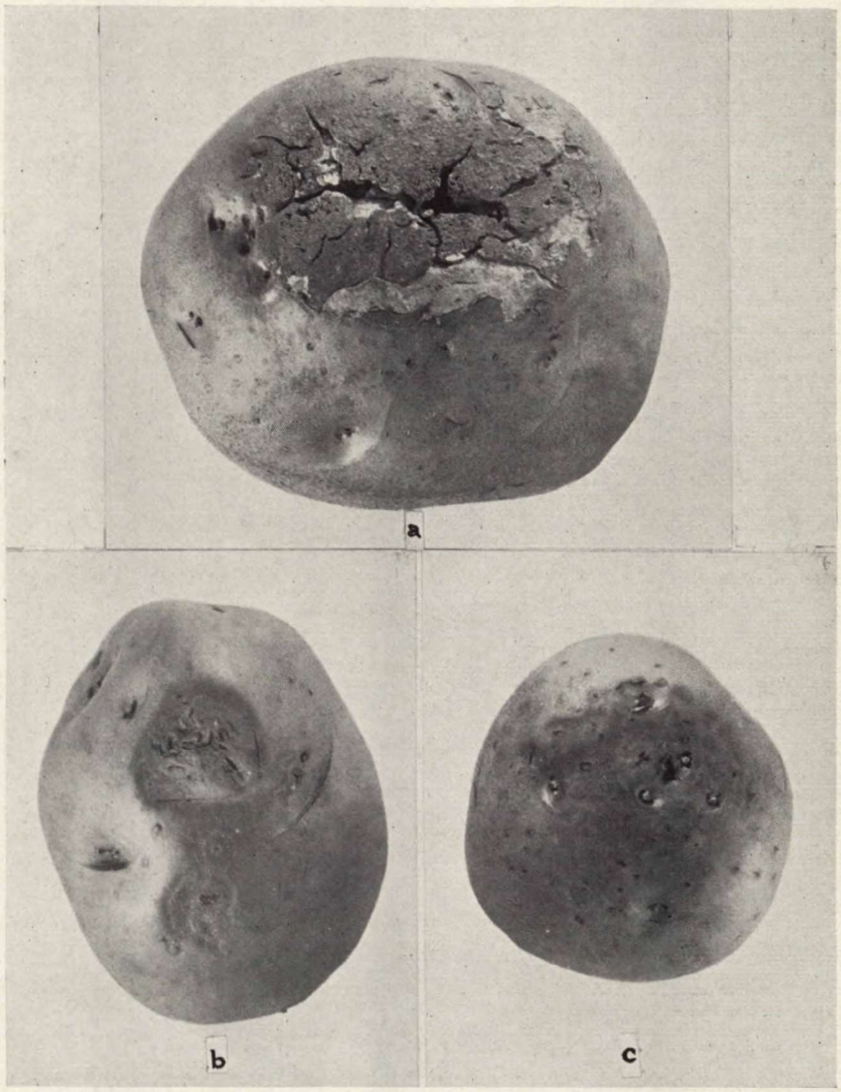

FIG. 25.—Fertilizer injury to potato tubers. (a) Injury caused by potash. (b) Injury caused by nitrate of soda. (c) Injury caused by superphosphate.

growing tubers in the presence of chemical fertilizers in the soil. The appearance of fertilizer adhering to blemished tubers, recently dug, has frequently lent support to this theory which was also partially investigated in 1930.

The different fertilizers were applied during the second week of August. Separate tests were made with nitrate of soda, muriate of potash and super phosphate, applied at the rate of 100 pounds, 50 pounds, and 700 pounds to the acre respectively. These chemicals were thoroughly mixed with the soil surrounding the partially formed tubers. In this manner there were treated fifty hills each of Green Mountains and Irish Cobblers. Alternate plants in the test rows served as checks.

The tests were harvested on September 24. Without exception there was some external indication of fertilizer injury on all of the tubers from the hills treated with chemicals as described above. Not only was this the case but each different fertilizer induced a distinct and different type of injury as illustrated in fig. 25. Potash injury was the most striking, being featured by a cracking and blistering such as one might expect to see if a potato were subjected to intense heat. The tissue underlying this injured area became hard and shell-like, thus preventing a collapse of the surface tissues so noticeable where nitrate of soda came into contact with the tubers. To the casual observer this latter injury might easily be misinterpreted as the disease known as Alternaria rot. Super phosphate was responsible for a milder form of blemish which though but slightly injurious was harmful to the eyes around which small pockets were formed. These features, together with the rather prominent depressions surrounding the enlarged lenticels, are clearly shown in the accompanying photograph.

Date of Digging Potatoes in Relation to Degree of Infection with Rhizoctonia

(B. 80.11)

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

Progress reports[1] have shown that the practice of early digging reduces the amount of rhizoctonia infecting the potato crop. Against this encouraging fact is the predisposition to injuries of early harvested tubers because of their state of immaturity. In addition, there is the question as to the value of such potatoes for seed and table use. Furthermore, due significance must be attached to the inevitable reduction in yield when the crop is harvested before the end of the growing season. Recommendations arising from these investigations must be made accordingly.

Using Green Mountains and Irish Cobblers the plan followed in the past was adhered to in 1930. That is to say, the land devoted to this experiment was heavily infested throughout with rhizoctonia, and the digging dates, replicated four times, were as follows:—

(1) Two weeks before usual date.
(2) One week before usual date.
(3) Usual date. (In Prince Edward Island September 15).
(4) One week after usual date.
(5) Two weeks after usual date.
(6) Three weeks after usual date.
(7) Four weeks after usual date.

[1] Annual Reports of Dominion Botanist for 1925, 1927, 1929.

The area given over to this test received barnyard manure at the rate of 15 tons per acre applied on May first and covered the same day by means of a heavy disc harrow. On each digging date the reaction of the soil involved was determined and expressed in values of pH as follows:

TABLE 39.—pH VALUES OF SOIL IN REFERENCE TO DIGGING DATES VERSUS RHIZOCTONIA INFECTION

Digging date	Soil reaction in pH.*	
	Cobblers	Mountains
September 1	5·00	5·00
" 8	5·00	5·00
" 15	4·83	5·00
" 23	4·83	4·83
" 30	4·76	4·83
October 6	4·66	4·83
" 13	4·83	4·76

*Average of 6 determinations.

Reviewing the results derived from experiments conducted over the past three years—excepting the year 1929 in which Rhizoctonia attacks were unusually mild—it will be seen that the practice of early digging produces tubers showing the least affection. Table 4 shows that the tubers remain free from the objectionable sclerotia of the fungus until around the middle of September, after which date the infection increases in severity throughout the remainder of the season.

TABLE 40.—DATE OF DIGGING AND CONTROL OF RHIZOCTONIA

	Year	Variety	Digging date						
			Sept. 1	Sept. 8	Sept. 15	Sept. 23	Sept. 30	Oct. 6	Oct. 13
Per cent Rhizoctonia Infection	1928	Green Mt.	1	3	10	21	25	47	48
		Irish Cobbler.	4	4	15	40	43	60	64
	1929	Green Mt.	0	0	0	0	0	0	3
		Irish Cobbler.	0	0	0	0	0	5	7
	1930	Green Mt.	0	0	3	10	20	32	41
		Irish Cobbler.	0	1	7	22	31	35	75
Yield in bushels per acre	1928	Green Mt. M.	179	190	225	247	264½	274½	271
		Green Mt. C.	101	102	97	96	65½	81½	79
		Irish C. M.	142	143½	221	253	281	304	301½
		Irish C. C.	83	106½	87	99	78	96	97½
	1929	Green Mt. M.	177	182½	191	201	251½	254½	251
		Green Mt. C.	85	100½	101	109	92½	83½	76
		Irish C. M.	165	128	131	198	241½	243	241
		Irish C. C.	88	192	91	103	100½	78	81
	1930	Green Mt. M.	162½	171	182	203½	228	247½	253
		Green Mt. C.	88	100	103½	110	112	100½	91½
		Irish C. M.	168	182½	184	190½	200½	201	203
		Irish C. C.	61½	67	53	64	71½	63½	65

M = Marketable.
C = Culls.

To determine their actual value for seed purposes as represented by each digging date, the results obtained are represented in Table 41.

TABLE 41.—SEED VALUE OF POTATOES OF DIFFERENT DIGGING DATES

Digging date	Variety	Blemishes when dug			Storage rots, due to saprophytic organisms	Field history*		
		Cuts and bruises	Texture			Stand	Yield per acre	
			Soft	Firm			Marketable	Culls
		%	%	%	%	%	bush.	bush.
Sept. 1	Gr. Mt	3·2	100·0	0·0	5·1	100	230·0	100·4
	I. Cobbler	4·1	51·0	49·0	7·3	100	186·4	101·3
Sept. 8	Gr. Mt	2·5	95·2	5·0	4·1	100	241·2	97·3
	I. Cobbler	3·0	19·0	81·0	4·7	100	251·5	102·1
Sept. 15	Gr. Mt	2·0	10·3	89·7	4·5	100	265·1	105·4
	I. Cobbler	1·2	3·1	96·9	1·3	98	244·3	81·2
Sept. 23	Gr. Mt	1·0	2·5	97·5	1·5	100	250·1	80·3
	I. Cobbler	0·5	0·0	100·0	1·2	96	321·3	81·2
Sept. 30	Gr. Mt	1·3	0·0	100·0	0·1	100	297·4	60·3
	I. Cobbler	2·1	0·0	100·0	1·3	100	240·1	61·2
Oct. 6	Gr. Mt	0·5	0·0	100·0	0·0	99	279·1	88·4
	I. Cobbler	0·1	0·0	100·0	0·2	100	189·2	73·6
Oct. 13	Gr. Mt	1·0	0·0	100·0	0·0	100	233·0	81·7
	I. Cobbler	0·3	0·0	100·0	0·1	99	241·6	73·2

*Dug on September 29.
Size of seed-piece 1½ oz. cut (sound).
Planted by hand May 30.

It is believed that the development of the rhizoctonia fungus on potato tubers is favoured, to a considerable extent, by climatic factors such as temperature and soil moisture influenced by rainfall.

TABLE 42.—RECORD OF PRECIPITATION AND SUNSHINE

Year	Rainfall (Total)		Temperature (Mean Daily)	
	September	October 1-13	September	October 1-13
			°F.	°F.
1928	4·39	0·43	56·538	59·653
1929	3·97	2·58	59·383	16·153
1930	2·50	0·2	59·733	53·846

This supposition was supported by our findings in the years 1928 and 1929. In 1930, however, a year featured by exceptionally dry and warm weather (table 42) rhizoctonia was abundant and early digging was exceedingly beneficial as indicated by the results.

At the outset there is a noticeable effect upon the physical condition of early harvested potatoes in that they are predisposed to cuts, bruises and softness of texture resulting in a corresponding loss in storage due to rot producing organisms. The growing plants, however, were favoured with good stands which promoted equally satisfactory yields.

SUMMARY AND PRACTICAL APPLICATIONS

Early digging affords a satisfactory measure of escape from rhizoctonia infection on potato tubers. The degree of infection increases rapidly after September 15, a fact having direct and significant meaning to farmers grading potatoes for seed certification. It is obvious that the saving effected in time and labour, together with the higher percentage of Rhizoctonia free graded seed, satisfactorily compensate for the loss due to mechanical injuries and reduction in yield.

Determination of the Value of Seed Treatment for the Control of Black Scurf, Common Scab and Blackleg

(B. 80·08)

W. Newton and Staff (Saanichton, B.C.)

The results of the field experiments of 1929 showed that the relative efficiency of specific seed treatments could not be accurately determined by field tests owing to the dominant influence of soil borne infection, a variable factor. The studies during 1930 were confined to pot experiments artificially and uniformly infected with the parasite. These studies are incomplete. The superiority of mercuric chloride compared with formaldehyde with respect to the control of black scurf has been established and no evidence has been obtained that any of the organic mercury compounds are superior to mercuric chloride.

Influence of Environment on Black Scurf

(B. 80·09)

Walter Jones (Saanichton, B.C.)

Field observations of potato crops on Vancouver Island and the lower mainland during the 1930 season indicate that the rhizoctonia disease was less prevalent on land which had been laid down to pasture for a few years, than on land where crop rotation was not practised. Rhizoctonia infection was approximately 40 per cent in the Irish Cobbler variety planted where grain had been grown the previous year. On land which had been in sod the previous year, the rhizoctonia infection was approximately 10 per cent.

Field observations also indicate that a correlation exists between the percentage of rhizoctonia infection, the precipitation and date of planting.

On Lulu Island, a section of field where the soil is a medium loam, was planted with Irish Cobbler tubers in mid-April. Heavy rains followed, and the tubers were checked during germination. Approximately 30 per cent rhizoctonia infection was recorded. In the adjoining section the planting was done after the heavy precipitation and the tubers germinated without being checked, the rhizoctonia infection was approximately 10 per cent. This condition has been noted in several districts and indicates that potato tubers should only be planted when temperature and moisture conditions are favourable for continued growth.

A Study of the Relative Value of the Present Formalin, Corrosive Sublimate and Other Treatments against Common Scab and Rhizoctonia

(B. 80·10)

G. B. Sanford (Edmonton, Alta.)

During the past three years, field and greenhouse experiments have been made to determine the effect on the resulting crop of the various recommended treatments of potato tubers against common scab. In addition to these seed treatments, we have studied the effect on the resulting crop of planting scabby sets; sets heavily smeared with a virulent culture of *Actinomyces scabies;* sets about which were placed a handful of soil inoculum and sets planted in a hill of inoculated soil. With regard to the latter treatments only the tubers which grew in the hill of uniformly inoculated soil were wholly scabby. Virtually no scab resulted from planting sets smeared with *A. scabies* or from scabby sets. Occasionally a scabby tuber appeared in the test where a handful of soil inoculum was placed about the set.

With regard to the chemical soak and dust treatments used, no difference could be seen in favour of any of the treatments over the check hills. The check hills were distributed alternately with the test hills. In the laboratory experiment, formaldehyde, mercuric chloride, semesan bel, carbolic acid, and Bayer 649, were used as soak treatments. Sulphur, Bayer 649 and semesan bel were also applied in a dust form and a liberal quantity of each employed. All of these treatments were applied to a sterile potato core, which was later placed in a pure soil culture of *A. scabies* where visible results could be obtained. In all of the treatments the scab fungus grew well and reached the treated pieces, as was the case with the alternate checks.

These laboratory results substantiate those which were obtained from the field experiments, viz., that seed treatments did not offer to the resulting crop any protection from scab. In the light of these results, from field and laboratory, it seems impossible that differences in the effect of various seed treatments against scab can be detected in field culture. The value of seed treatment against common scab of the potato seems to be wholly limited to killing the scab fungus on the set and not from the standpoint of giving protection to the resulting crop.

Stem End Browning in Hoben Variety

(B. 74)

D. J. MacLeod (Fredericton, N.B.)

The Hoben variety of potato grown in New Brunswick frequently manifests a brownish discolouration, appearing in the form of small streaks or isolated spots in the stem end region of the tuber.

A pathological examination of upwards of 1,500 tubers failed to establish the presence of any pathogenic organisms in the tissues involved. Saprophytic organisms were detected in a small percentage of tubers showing severe symptoms but these proved to have no association with the cause of the trouble under consideration.

Tests were also conducted to determine any relation existing between the condition and virus disease. All of these tests failed to disclose any apparent connection between this type of stem end browning and such diseases as mild and rugose mosaic, leaf roll, spindle tuber, curly dwarf, spindle sprout and net necrosis. No significant difference was observed between the general aspect of plants (including tuber and foliage appearance) grown from tubers showing this type of stem end browning and those from tubers manifesting no evidence of the condition. Plants (including tubers) maintained under various environmental conditions failed to reveal any influence of these conditions upon the development of this abnormality. The results obtained demonstrate that this type of stem end browning is not due to any organic disease but mainly a varietal weakness, due to the imperfect sealing of the stolon scar.

The Use of Calcium Sulphate from Local Deposits and its Relation to the Control of Potato Scab

(B. 80·13)

D. J. MacLeod (Fredericton, N.B.)

The results of preliminary tests on the use of agricultural gypsum (calcium sulphate) for the control of common potato scab appears in this report for 1928 and 1929.

The project was conducted in 1930 as in former years on the same portion of land which is light sandy loam. The results obtained are summarized in the following table.

TABLE 43.—GYPSUM AS A CONTROL FOR COMMON POTATO SCAB

Treatment	Disease content			pH values of soil	Yield per acre
	Free	Slight	Severe		
					bush.
Gypsum 500 pounds per acre	82·19	13·28	4·53	6·31	216·6
Gypsum 1,000 pounds per acre	64·67	29·64	5·69	6·36	191·0
Gypsum 2,000 pounds per acre	67·58	27·73	4·69	6·32	204·1
Lime stone 2,000 pounds per acre	30·83	48·07	21·1	6·86	195·4
Check (no treatment)	72·48	24·41	3·11	6·34	214·6

The results tabulated above show that gypsum increased the amount of scab to a slight degree. This increase is not attributed to a change in soil reaction produced by the gypsum because even after 2,000 pounds have been applied, there appears to be no appreciable variation in the hydrogen ion concentration of the soil in the plots receiving treatment and those remaining untreated. The yield of tubers in each case was practically identical. The results obtained this year combined with the findings of previous seasons demonstrate that gypsum is not sufficiently effective as a control for common scab on light soils to warrant recommendation of its use where such conditions obtain. Further experiments will be conducted to definitely determine the effects of gypsum treatments on heavy types of soils.

Testing Effect of New Chemical Substances on the Control of Tuber Diseases

(B. 80·06)

D. J. MacLeod (Fredericton, N.B.) and R. R. Hurst (Charlottetown, P.E.I.)

The introduction of proprietary organic mercury compounds has given a new impetus to the investigation of seed treatment during the past decade. A project was conducted at the Fredericton and Charlottetown laboratories with the view to comparing the efficiencies of standard disinfectants and recently introduced organic mercurials in the control of tuber diseases of the potato.

The results of investigations conducted from 1927 to 1929, including methods employed, are incorporated in the annual reports of the Charlottetown laboratory for those years. Essential findings in 1930 are as follows:—

RHIZOCTONIA INVESTIGATIONS

Stem infection was materially reduced by all treatments. Best control of this phase of the disease (less than 10 per cent) was obtained with Semesan Bel, hot mercuric chloride, hot formaldehyde, Du Bay 664, and cold mercuric chloride. Untreated infected seed showed a higher percentage of stem infection (54·6 per cent) than the disease-free seed (4·8 per cent) which indicates some correlation between stem infection and infected seed pieces. None of the treatments effected complete control of rhizoctonia tuber infection. Best control (less than 10 per cent severe infection) was obtained with Semesan Bel, Du Bay 664, hot and cold mercuric chloride, hot and cold formaldehyde. The untreated infected seed and untreated disease-free seed showed 17·4 and 2·76 per cent severe infection, respectively.

SCAB INVESTIGATIONS

Complete control of the disease was not obtained with any of the treatments. Best control (less than 5 per cent severe infection) was effected by Du Bay 738 and 664, Sanoseed, hot mercuric chloride, hot formaldehyde, Du Bay 694, and Cal K. The untreated infection seed and the untreated disease-free seed showed 24·48 and 2·86 per cent severe infection, respectively. No significant differences in the vigour of plants were observed in any of the plots under consideration. There were also no important differences in yield among the various plots receiving treatment.

The results in general confirm those of previous seasons further demonstrating that seed treatment as a general rule can only be depended upon to render a partial control of either rhizoctonia or scab. Effective control of these diseases can only be achieved by combining seed treatment with cultural practices which correct soil and other conditions predisposing to these diseases.

The results of the investigation as conducted at Charlottetown, confirmed the findings at Fredericton. The Green Mountain and Irish Cobbler varieties were included in the Charlottetown test. Slightly less effective control of rhizoctonia and scab was obtained with nearly all the treatments in the case of the Irish Cobbler variety. Considerably less disease occurred in all the Charlottetown plots which indicates the soil in these areas is not as conducive to the development of scab and rhizoctonia as that used at Fredericton.

The Effect of Virus Disease upon the Enzymes in Potato Juice

(B. 81·07)

W. Newton and Staff (Saanichton, B.C.)

The influence of virus infection upon the enzymes in potato juice was studied in the hopes of securing a means of measuring by biochemical method the degree of pathogenicity and the progress of the disease after infection. The juice from diseased and healthy plants was expressed in a uniform way, centrifuged and the hydrolysis of starch by the juice under two per cent toluol was followed. The rate of starch hydrolysis was too slow and the influence of the virus too slight to warrant the adoption of this method in following the effect of the virus upon potato plants. In the experiments completed the rate of starch hydrolysis was less in the juice of the foliage infected with rugose mosaic, streak, witches' broom and spindle tuber compared with the juice from healthy foliage grown under the same conditions. No significant differences were found in the juice expressed from healthy compared with virus infected tubers. The enzymes responsible for the precipitation of chlorophyl in the foliage juice appeared to be more active in the infected compared with the juice from healthy foliage.

A Study of Physical Methods of Detecting Virus Infections in Potatoes

(B. 81·10)

W. Newton and Staff (Saanichton, B.C.)

During 1930 a study was made of the specific resistance of the juice expressed from the foliage and tubers of healthy and potato plants infected with mild mosaic and witches' broom. The specific resistance in general was lower in both foliage and tubers in the diseased compared with the healthy plants, but in the case of witches' broom the difference was particularly significant. Titration curves of the juice expressed from healthy and tubers infected with mosaic and witches' broom showed that the juice from healthy and mosaic tubers were similar and that the juice from witches' broom tubers was distinct.

Virus Diseases: Spindle Tuber, Giant Hill, Witches' Broom

(B. 81·11)

Walter Jones (Saanichton, B.C.)

Spindle tuber, giant hill, and witches' broom have been studied in the field and greenhouse to establish the identity of these diseases. Harsh stiff foliage is apparently a symptom common to them. Of the three diseases, giant hill is the most difficult to detect and consequently may be considered as a serious disease of potatoes, for there has been a general failure upon the part of the growers to recognize and eradicate this disease. As in all classes of virus diseases the establishment of an isolated seed plot by the combined tuber and hill unit methods has served to establish beyond doubt the general occurrence of giant hill and the growers are now attempting to free their certified seed potatoes from this disease.

Determination of Spindle Tuber Virus in Potato Tubers (B.C.)

(B. 81·05)

Walter Jones (Saanichton, B.C.)

A systematic study is being made of the effect of dyes and chemicals upon diseased and healthy tissue and a comparison is being made of the dry matter content of different parts of diseased and healthy plants.

No absolute test has yet been found for the presence of spindle tuber virus. The dry matter content of the leaves is somewhat higher and of the tubers somewhat lower in diseased compared with healthy plants grown under the same conditions.

Spindle Tuber Experiments in British Columbia

(B. 81·03)

Walter Jones (Saanichton, B.C.)

In order to develop more satisfactory methods of eradicating the spindle tuber disease of potatoes in British Columbia, field and greenhouse studies were made under distinct environments. The common symptoms are late emergence, harshness or stiffness of the foliage, with leaves often reduced in size and darker than normal. The tubers are often quite cylindrical, spindly or pointed at the ends. On fertile soils the characteristics of the foliage and tubers more nearly approach those of healthy plants.

The Value of Bordeaux Mixture in Controlling Late Blight and its Effects upon Yield

(B. 82·03)

C. Perrault (Ste-Anne, P.Q.)

Experiments were carried out in order to determine: (*a*) The number of applications necessary to control late blight, (*b*) the time when these should be done, and (*c*) if Bordeaux sprays have a beneficial effect upon the yield during blight free years.

Eight plots of eight 20-foot rows each were sprayed at different dates during the season, some of these plots receiving four applications of Bordeaux Mixture, others six applications. Spraying was done every ten days throughout the growing season. These plots were triplicated in order to include the different variations in the composition and texture of the soil.

Late blight made its appearance in the plots on August 13. The disease was noticeable in small patches in the control plots where no spraying was done and in those plots where spraying was discontinued after July 23. On August 19 these plots were completely destroyed while the others were blighted to the extent of 75 to 90 per cent due to the five consecutive days of rain that had washed off, almost entirely, the Bordeaux spray applied on August 11. By the end of August the plants were practically all destroyed.

The average yield of the different plots is given in the table below.

TABLE 44.—RESULTS OF DIFFERENT SPRAYS AGAINST LATE BLIGHT

Plot	Number and date of applications	Average yield per acre	
		Total	Marketable
		bush.	bush.
A	4, beginning on June 23	293	257
A_1	6, beginning on June 23	327	293
B	4, beginning on July 12	331	302
B_1	6, beginning on July 12	321	289
C*	2, beginning on Aug. 1	316	290
C_1	2, beginning on Aug. 1	324	291
D	1, beginning on Aug. 11	275	247
D_1	1, beginning on Aug. 11	309	282
E	Control, unsprayed	264	238
Average yield of sprayed plots		312	281·3
" " plots that received 4 applications		317	279·5
" " plots that received 6 applications		324	291·0
" " plots A, A_1, B, B_1, spraying beginning early		318	285·0
" " plots D, D_1. spraying beginning late		292	264·5

*Due to the heavy blight infection sprayings were discontinued after August 21. Plots C and C_1 received two applications and plots D and D_1 one application.

The above figures show that:—

(*a*) Plots sprayed with Bordeaux gave higher yields than the control plots;

(*b*) Spraying should be started early in the season and continued late;

(*c*) The average yield of plots that received six applications is slightly higher than those that received only four applications;

(*d*) Plots A gave a higher yield than the control plots although they were affected and destroyed by blight at the same time. The fact that at each Bordeaux application some of the fungicide fell on to the soil may have somewhat protected the tubers against late blight, increasing thereby the yield of these plots over the control.

An attempt was made to establish the optimum air temperature and precipitation for late blight infection throughout the province of Quebec.

TABLE 45.—APPEARANCE OF BLIGHT IN RELATION WITH TEMPERATURE AND PRECIPITATION

Region	Appearance of blight	Period preceding blight		During heavy infection	
		Average precipitation	Mean temperature	Average precipitation	Mean temperature
		in.	°F.	in.	°F.
Montreal and Farnham	Aug. 2- 5	0·12	66·6	0·16	63·0
Lennoxville and Sherbrooke	" 5- 7	0·13	63·6	0·11	61·2
L'Assomption and Joliette	" 5- 6	0·22	76·0	0·37	58·7
Berthierville and Trois-Rivières	" 5- 7	0·22	73·0	0·32	61·3
Quebec and Cap-Rouge	" 11-13	0·09	61·5	0·19	60·5
Ste-Anne de la Pocatière	" 13-14	0·07	60·0	0·39	58·6

Control of Late Blight

(B. 82·02)

D. J. MacLeod (Fredericton, N.B.)

The control of late blight in New Brunswick is somewhat different to that obtaining in other sections of the country. This is due in some measure to the unique combination of northern and maritime conditions which results in an unusual intermingling of various factors influencing the development of this destructive disease. In consequence, it is readily apparent that recommendations based on the results of experiments on the control of late blight conducted in other localities where different environmental conditions obtain are not applicable to this part of Canada.

In recognition of the necessity of securing more practical information on the subject of late blight prevention in New Brunswick, a project was initiated in 1930 with the view to determining the most effective and economical type of fungicide for controlling a disease which is one of the most important limiting factors in potato production in the province. The following were included in the preliminary test:—

Bordeaux mixture, 4-4-40, 5-5-40, 6-6-40, 7-7-40, 8-8-40.
Copper-lime dust, 20-80.
Burgundy mixture, 4-5-40, 5-6-40, 6-7-40, 7-8-40, 8-9-40.
Aluminium sulphate and lime, 4-3-30, 4-4-40, 4-6-40, 4-8-40.
Aluminium sulphate and sal soda, 4-4-40, 4-6-40, 4-8-40, 4-16-40.
Aluminium sulphate and lime sulphur, 2-$\frac{1}{8}$-40, 2-$\frac{1}{4}$-40, 2-$\frac{1}{2}$-40, 2-1-40.
Lead arsenate, 2-40, 4-40.
Calcium arsenate, 2-40, 4-40.
Bordeaux mixture and lead arsenate, 4-4-2-40.
Burgundy mixture and lead arsenate, 4-5-2-40.
Bordeaux mixture and calcium arsenate, 4-4-2-40.
Burgundy mixture and calcium arsenate, 4-5-2-40.
Aluminium sulphate, lime and lead arsenate, 4-5-2-40.
Aluminium sulphate, lime and calcium arsenate, 4-5-2-40.
Aluminium sulphate, sal soda and lead arsenate, 4-5-2-40.
Aluminium sulphate, sal soda and calcium arsenate, 4-5-2-40.
Aluminium chloride and lime, 4-4-40, 4-6-40.
Aluminium chloride and sal soda, 4-4-40, 4-6-40.
Aluminium sulphate, lime sulphur and calcium arsenate, 2-1-2-40.

Aluminium sulphate, lime sulphur and lead arsenate, 2-1-2-40.
Iron hydroxide, 1-40, 3-40.
Iron hydroxide and calcium arsenate, 1-2-40.
Iron hydroxide and lead arsenate, 1-2-40.

All the compounds tested were applied in spray form with the exception of the copper-lime dust. Late blight developed exceedingly late in the season. Many of the plants reached maturity before there was sufficiently uniform spread of the disease to warrant making observations. While it was not possible to determine the effect of the different compounds on the development of late blight, an opportunity was afforded for studying the value of these substances for early blight control, which disease appeared earlier in the season in the plots utilized for these tests.

The Bordeaux and Burgundy mixtures in general were practically identical in the control of early blight. None of these fungicides however, reduced the amount of disease less than 60 per cent. Burgundy and Bordeaux mixtures combined with calcium arsenate appeared superior to combinations of these fungicides with lead arsenate or the same fungicides without arsenicals. The aluminium sulphate-lime sulphur mixtures, particuarly those combined with lead and calcium arsenates effected fair control of the disease. These groups show some useful possibilities as fungicides for controlling foliage disease of the potato. The other compounds tested effected practically no control of early blight. The information gleaned from these preliminary trials will enable a more systematic and effective grouping of these compounds for tests conducted on their fungicidal values another year.

Dusting Versus Spraying of Potatoes for Control of Foliage Diseases

(B. 68)

D. J. MacLeod (Fredericton, N.B.)

A series of tests has been conducted at this laboratory since 1925 with the view to comparing the relative efficiencies of spray and dust mixtures for the control of early and late blight of the potato. The project was conducted in 1930 in exact accordance with the plan followed in previous seasons. The following table includes the results obtained in 1930.

Table 46.—Spray and Dust—Comparison

Fungicide	Early blight on the vines			Late blight on the vines			Late blight on the tubers	Yield per acre
	Free	Slight	Severe	Free	Slight	Severe		
	%	%	%	%	%	%	%	bush.
Bordeaux spray (4-4-40)	3·1	96·9	0·0	0·0	98·0	2·0	0·7	292·9
Copper-lime dust (20-80)	0·0	98·4	1·6	0·0	96·0	4·0	0·4	287·6
Check (no treatment)	2·0	84·0	14·0	0·0	59·0	41·0	3·6	264·6

The season was comparatively cool and dry. The average temperature during July, August and September was 6·1 degrees lower and the average precipitation 0·37 inches less than the sixteen year average. Early and late blight were present to a moderate extent. These diseases, appeared later in the season than ordinarily, the plants being in the first stages of maturity when the earliest indications were observed. Both types of fungicides effected approximately the same degree of control of early and late blight on the foliage. The percentage of late blight rot occurring in the tubers was practically identical in the plots which received fungicidal treatments. While the plants in the check plots were severely attacked by late blight, only 3·6 per cent of the tubers showed evidence of the disease. There was no appreciable difference between the yields from the plots which received fungicidal applications. There was a material decrease in the yield from the check plots compared to that produced in the treated plots. An opportunity was afforded this season to compare the behaviour of both types of fungicides when early and late blight were present to an equal degree. The test as conducted this year demonstrated the eminent necessity of protecting the foliage surfaces until late in the season to forestall delayed outbreaks of early and late blight.

The Dissemination of Blackleg by Insects

(B. 83·01)

D. J. MacLeod (Fredericton, N.B.)

The classical researches of Dr. J. G. Leach of Minnesota have proven that *Phorbia fusiceps* Zett. is capable of harbouring the causative organism of potato blackleg and communicating the same to healthy plants. In view of the fact that there are a number of other insects associated with potato plants in New Brunswick, certain of these were studied to determine any additional species contributing to the dissemination of the disease.

In this connection, a survey was conducted with the view to finding insects capable of boring into potato stems and seed pieces which by virtue of such a habit serve as agencies in the transmission of the disease. The following insects were found and experimented with to determine if they acted as carriers of the blackleg organism: *Gortyna micacea* Esp., *Hylemyia* sp., *Agrotis ypsilon* Rott., *Drosophila* sp., and *Phorbia fusiceps*, Zett. Eggs, larvae and adults of each species of insect were inoculated with virulent cultures of the blackleg organism and placed in contact with different parts of potato plants. Uninoculated insects were used as checks. *Phorbia fusiceps* was the only insect which gave positive results. Adults of this insect were found on a number of occasions laying eggs on seed pieces at planting time. Less than 1 per cent, however, of the plants from seed pieces upon which eggs were deposited by the insect, subsequently developed blackleg. The larvae of the insect were also found a number of times in the seed pieces and stems of potato plants affected with blackleg in commercial fields. The insect was not found associated with blackleg developing late in the season.

Treating cut tubers with mercuric chloride, Semesan, formaldehyde, lead and calcium arsenate, hellebore, derris, calcium arsenate and Paris green failed to prevent the insect from boring into the seed pieces. Control of the *Phorbia fusiceps* Zett., appears to the only solution for the prevention of the disease when transmitted by this insect.

Potato Inspection and Certification Service

(B. 84·01)

John Tucker, Chief Inspector (Central Experimental Farm, Ottawa)

PROGRESS

Substantial progress was made in the seed potato certification work during 1930, both in the amount of field inspection work accomplished during the growing season, and in the quantity of seed potatoes inspected for shipment under the official certification tag.

The number of applications requesting field inspections with a view to certification, was 6,870. The number of fields listed for inspection was 9,707, for a total of 34,305 acres. These figures represent an increase of 585 in applications, 866 in fields, and 2,275 in acres inspected, over the 1929 figures.

Approximately 81 per cent of the total acreage entered for inspection passed the two field inspections required for certification; this is the best record in this regard since the work was started. A total of 27,777 acres passed all field inspections.

PRODUCTION

Approximately five million bushels of certified seed potatoes were produced in Canada in 1930. This quantity was ample to supply the usual requirements of the trade, at very reasonable prices. The export demand for certified seed was again remarkably good and fortunately continues to increase each year in spite of increased tariffs against Canadian potatoes The high quality of Canadian seed stock is without a doubt an important factor in the matter of increased sales from year to year.

The spring shipments in 1930 amounted to approximately four hundred thousand bushels and the fall shipments to one million six hundred thousand bushels, a total of two million bushels in all. The bulk of the shipments were from Prince Edward Island, a total of over one million three hundred thousand bushels were shipped from that district alone during the fall season. The export trade continues to take most of the seed shipments although the domestic market also continues to improve materially each year.

It is a comparatively simple matter to secure details of all shipments of fully tagged certified seed potatoes, but these do not include the quantity of potatoes, from inspected fields, that are disposed of locally for seed purposes and sold " bin run " at lower than the regular certified seed prices. No tags are issued for such stock, but the trade in these potatoes is conservatively estimated at fully half a million bushels annually.

POTATO EXPORTS AND IMPORTS, 1930

The exports of potatoes from Canada in 1930 amounted to 7,127,688 bushels, valued at $6,684,019. The principal markets were the United States, Cuba, Panama, Newfoundland, British Guiana, Trinidad, Bermuda, and Jamaica.

The total imports of potatoes into Canada in 1930, amounted to 843,655 bushels, valued at $891,432; imports from the United States, amounting to 842,160 bushels, valued at $889,421. (Dominion Bureau of Statistics.)

Included in the export figures are Certified Seed shipments to foreign countries, amounting to over one and a half million bushels. All certified seed is shipped with an official tag attached to each container of potatoes. The tag describes the contents, variety, certificate and grower's number, etc.

The Bermuda shipments were practically all certified seed. The Cuban shipments were mostly table potatoes, but the trade with Cuba in seed potatoes is increasing rapidly and amounted to approximately a half million bushels in 1930.

Special " Health Certificates " are required by the Cuban Government with every shipment of potatoes for Cuba. Several thousand of these are issued by the seed potato inspectors of this Division annually. This service is performed without charge, for the Canadian shippers. All certified seed shipments to Cuba must also be covered by a special " Seed. Certificate," issued by the district inspectors; over one thousand were issued, without charge, in 1930.

CHANGES IN THE GENERAL REGULATIONS IN 1930

Important changes in the general regulations under the Destructive Insect and Pest Act, P.C. 557, went into effect on March 12, 1930. It is now provided, in the case of potatoes that:—

"No person shall be allowed to sell, or offer, advertise, expose or hold in possession for sale, any potatoes in any manner or form described or designated as certified, inspected, registered, selected, disease free, or otherwise indicating their suitability for seed or seed purposes, unless such potatoes have been inspected in the field and after harvest by an inspector under the Destructive Insect and Pest Act and have been found sufficiently vigorous and free from diseases, to warrant them being classed into either of the two following grades, viz: Certified Seed Potatoes, Grade Extra No. 1, or Certified Seed Potatoes, Grade Small Sized (1½-3 ounces only).

"Certified seed potatoes must be contained in sacks, barrels or other containers, to each of which shall be durably attached a certificate in the form of an authorized official tag, issued by an inspector, and bearing the grower's name or number."

It is now an indictable offence under the Destructive Insect and Pest Act to advertise or sell, in Canada, uncertified potatoes as seed potatoes, or to use any kind of "seed" tag, likely to mislead an unsuspecting public. Growers, dealers and associations are permitted, however, to attach their own tags or brands, or mark any container of seed potatoes with any special description, but such may only be done when in addition the official certification tag is present on the container. Nothing in the foregoing is intended to convey the impression that only certified seed can lawfully be used for seed purposes. Any other kind of potatoes may be used freely by anyone but certified seed potatoes only may be advertised, sold, etc., as seed potatoes.

There was a persistent demand for the certification of small potatoes and the regulations now provide a grade for them. Over fifty thousand bushels of small size seed were sold in 1930 for fall shipment. It is evident that this small seed may become popular especially in districts in which the "seed piece rot of cut sets" has resulted in considerable loss. Under some conditions the small tubers planted whole are decidedly superior to the cut seed; they appear to withstand the excessive hot, or cold, wet weather immediately after planting much better than the cut seed.

The small size seed conforms to the same standard as Grade Extra No. 1, except for size, also not more than three per cent by weight to be above or below the size specified. The small seed should be considered only for the production of commercial table stock potatoes and not to be used as foundation stock for certified seed production.

INSPECTION STANDARD, 1930

No change was made in the standard in 1930 from that in effect the previous year, except to provide for the small size seed, and to include a tolerance for Spindle Tuber, in the field standard. The tolerance for the total disease allowed remains the same as before, namely, six per cent collectively on first inspection and not more than three per cent on second inspection.

SUMMARIES OF THE FIELD INSPECTION WORK, 1930

Table 47 following is a summary of the distribution and the results of the inspections, by provinces, as compared with the work of the previous year. Table 48 is a compilation of the percentages of diseases recorded in the course of the field inspection work on potatoes entered for inspection.

TABLE 47.—COMPARATIVE STATEMENT—FIELD INSPECTION 1929-1930

Province		Number of applicants	Acreage entered	Acreage passed	Per cent	Acreage passed compared with 1929
						%
Prince Edward Island	1929	3,668	22,641	18,257	80·6	+14·6
	1930	3,906	24,874	20,925	84·1	
Nova Scotia	1929	236	535	405	75·7	−23·5
	1930	233	510	310	60·8	
New Brunswick	1929	325	2,850	1,665	58·4	+36·0
	1930	340	2,750	2,265	82·4	
Quebec	1929	1,287	3,091	1,682	54·4	+ 7·1
	1930	1,567	3,169	1,802	56·9	
Ontario	1929	416	1,739	1,405	80·8	+ 7·5
	1930	451	1,786	1,511	84·6	
Manitoba	1929	33	256	254	99·2	+19·3
	1930	50	348	303	87·1	
Saskatchewan	1929	103	331	226	68·3	− 7·1
	1930	88	258	210	81·4	
Alberta	1929	68	185	124	67·0	+ 8·0
	1930	79	174	134	77·0	
British Columbia	1929	149	402	289	71·9	+ 9·7
	1930	156	436	317	72·7	
Total Canada	1929	6,285	32,030	24,307	75·9	+14·3
	1930	6,870	34,305	27,777	81·0	

TABLE 48.—PERCENTAGE OF DISEASE FOUND—BY PROVINCES

—	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia
	%	%	%	%	%	%	%	%	%
Average percentage of disease in total fields inspected—									
Blackleg	0·06	0·06	0·1	0·30	0·48	0·93	0·55	0·24	0·11
Leaf roll	0·02	1·74	0·1	1·54	0·40	0·03	0·01	0·22	0·24
Mosaic	0·66	1·18	1·7	0·93	0·12	0·07	0·06	0·34	1·1
Average percentage of disease in fields passed—									
Blackleg	0·04	0·27	0·1	0·11	0·22	0·30	0·08	0·04	0·11
Leaf roll	0·02	0·58	....	0·14	0·19	0·03	0·01	0·01	0·12
Mosaic	0·08	0·14	0·3	0·32	0·08	0·03	0·05	0·02	0·45
Average percentage of disease in fields rejected—									
Blackleg	0·13	0·15	0·2	0·43	1·77	8·9	4·46	2·10	0·41
Leaf roll	0·03	4·46	0·4	1·59	1·45	....	....	2·16	0·59
Mosaic	3·02	3·65	5·8	1·65	0·36	0·51	0·12	3·33	2·94

FIELD INSPECTIONS BY VARIETIES, 1930

It is evident from the number of inquiries made concerning the acreages of the different varieties entered for inspection, and the distribution, that the following table should be of general interest:—

TABLE 49.—VARIETIES—ACRES

Province	Irish Cobbler			Green Mountain			Bliss Triumph			Other Varieties		
	Passed	Not passed	Total	Passed	Not passed	Total	Passed	Not passed	Total	Passed	Not passed	Total
Prince Edward Island........	13,924	1,077	15,001	6,502	2,842	9,344	80	....	80	419	30	449
										Mostly Spalding Rose		
Nova Scotia....	149	49	198	52	49	101	11	74	85	98	28	126
New Brunswick	272	102	374	1,315	326	1,641	671	53	724	7	4	11
Quebec.........	189	194	383	1,551	1,148	2,699	....	....	....	62	25	87
Ontario.........	399	60	459	90	20	110	....	....	....	1,022	195	1,217
										All Rural New Yorker		
Manitoba.......	162	19	181	....	....	....	....	....	....	141	26	167
Saskatchewan..	88	21	109	20	....	20	....	....	....	102	27	129
Alberta.........	9	8	17	....	....	....	38	1	39	87	31	118
British Columbia...........	34	1	35	14	7	21	1	2	3	268	109	377
Total Canada..	15,226	1,531	16,757	9,544	4,392	13,936	801	130	931	2,206	475	2,681

The Irish Cobbler variety hold the lead in acreage entered for certification; the next in importance is the Green Mountain variety. The combined area, entered for inspection, for these two varieties total 30,693 acres leaving only 3,612 acres for all other varieties.

Next in acreage to the Irish Cobbler and Green Mountain was the Rural New Yorker (Dooley variety) with 1,217 acres entered, followed by the Bliss Triumph with 931 acres, and Spalding Rose with 398 acres. The remaining 1,066 acres were made up principally of the following varieties: Garnet Chili, Early Ohio, Netted Gem, Burbank, Gold Coin, MacGregor, Bovee, Six Weeks, Early Rose, St. George, Epicure, Up-to-Date, and Dakota Red.

FIELD REJECTIONS, 1930

The following table shows in detail the various reasons for field rejections. Altogether there were 2,411 fields rejected, or 24·82 per cent of the total number of fields inspected. The rejected fields were practically all planted with good seed which passed inspections the previous year, but which at the end of the 1930 growing season did not conform to the same high standard as the fields from which the seed originated. These results show clearly the need for continuing the certification work if for no other reason than to hold to the minimum the various diseases against which the certification work is the most logical control measure possible, for the large scale production of seed potatoes.

"Mosaic" of potatoes was responsible for the rejection of 1,278 fields, or 53 per cent of the total number of fields rejected. It is most prevalent in the Green Mountain and Bliss Triumph varieties, both of which are very susceptible to this trouble.

"Black leg" was responsible for the rejection of 227 fields, a slight increase over the previous year's figures. "Mixed varieties" accounted for 136 field rejections; this definitely shows a lack of care on the part of some growers in allowing their seed to become mixed with other potatoes before planting. The 279 rejections listed as "Adjacent" might also be classified as being due, for the most part, to carelessness on the part of growers in not observing the rule to plant certified seed at a reasonably safe distance from other potatoes; in some instances, however, it was found that the seed growers had unwittingly planted close to a neighbour's potatoes which contained considerable disease. The possibility of the spread of disease by insect carriers made it necessary to reject all fields adjacent to disease. The number of rejections for all other causes are considered quite low for the number of fields inspected, except those for the late blight which caused serious losses in parts of Quebec province in 1930.

TABLE 50.—FIELD REJECTIONS, 1930

Province	Mosaic	Blackleg	Leaf roll	Foreign	Adjacent	Lack vigour	Poor Cultivation, insects, etc.	Miscellaneous *	Total fields rejected
Prince Edward Island..	622	47	6	94	149	122	....	40	1,080
Nova Scotia...........	35	1	63	3	10	....	....	2	114
New Brunswick.........	104	6	7	4	16	3	1	2	143
Quebec................	469	111	54	29	84	....	....	†134	881
Ontario...............	4	36	23	2	13	....	9	8	95
Manitoba..............	1	6	....	....	....	....	....	....	7
Saskatchewan..........	....	12	....	2	....	....	....	1	15
Alberta...............	3	4	5	1	....	....	....	1	14
British Columbia.......	40	4	2	1	7	....	....	8	62
Total, Canada......	1,278	227	160	136	279	125	10	196	2,411
Per cent fields rejected.	53	9·42	6·64	5·64	11·57	5·18	0·44	8·13	100
Per cent fields entered..	13·17	2·34	1·65	1·4	2·87	1·28	0·1	2·01	24·82

*Miscellaneous.—Rejections for causes not specified elsewhere, i.e. streak, wilts, late blight.
†Late blight.

OTHER ACTIVITIES OF THE SERVICE

In addition to the two field inspections, the tuber inspections in the storages, and the final shipping inspections at loading points, there were other seasonal activities undertaken by the inspectors as follows:—

Demonstration plots were planted in every province for the study of potato diseases and for the identification of varieties, strain tests, seed treatment tests, etc.

Field demonstrations were put on at the regular field days and organized potato tours, to illustrate the value of certified seed compared with uncertified seed.

Practical co-operation was established with the provincial agricultural authorities by judging the standing field crops and the boys club plots of potatoes, and recording the diseases present in these plots. Over 1,000 such plots were inspected and judged by the seed potato inspectors in 1930. It is evident that this type of work is increasing to such an extent as to seriously tax the inspectors time and also the appropriation provided for inspection work, and may have to be discontinued, especially in view of the annual increase in acreage offered for inspection with a view to certification.

Special potato meetings were held in every province throughout the winter months. The permanent inspectors were in demand for such meetings and all such requests were complied with as far as possible. Other activities on the part of inspectors included the judging of potatoes at fall fairs and exhibitions, the preparation and setting up of exhibits, tuber index work in the greenhouse and tuber unit plot work in the field, etc.

THE INSPECTION STAFF

The staff of inspectors employed throughout the Dominion on the seed potato inspection work consisted of two permanent senior inspectors, eight permanent district inspectors, five seasonal and fifty temporary inspectors. The seasonal and temporary men were employed for periods ranging from three to twelve months according to the requirements of the work in the districts in which they serve. All inspectors engaged on the seed potato certification work were Dominion Department of Agriculture employees.

The Effects of Seed Treatment on Black-Leg

(John Tucker)

The treatment of seed potatoes is now a routine practice followed by many growers. It is intended principally as a control measure in reducing the amounts of common scab, rhizoctonia and blackleg diseases in the potato crop.

For the purpose of securing some information on the actual results in controlling blackleg that are being obtained by growers with their present methods of seed treatments, as practised on the farms under commercial conditions, it was decided to assemble all available data specifying the treatment used and the percentages of blackleg disease present (table 51). The growers supplied the former information, and the field inspectors employed on seed potato certification work, the latter.

There were 9,019 good reports used in compiling the following data, and these reports cover representative potato growing areas, in every province.

TABLE 51.—SEED TREATMENT AND BLACKLEG INFECTION, 1930

District	No treatment			Bichloride			Formalin		
	Total fields	Number of fields infected	Average per cent infection	Total fields	Number of fields infected	Average per cent infection	Number of fields	Number of fields infected	Average per cent infection
			%			%			%
No. 1	2,519	611	0·84	2,517	391	0·61	32	7	0·71
No. 2	187	21	0·79	....	....	....	180	12	0·92
No. 3	508	291	0·48	5	3	0·1	37	18	0·4
No. 4	548	300	2·36	3	....	....	1,297	462	1·27
No. 5	217	155	1·02	215	133	0·93	116	80	0·97
No. 6	86	40	1·98	7	2	0·83	....	....	....
No. 7	90	28	2·05	8	1	0·67	38	8	1·29
No. 8	47	13	1·18	7	....	....	91	14	2·07
No. 9	91	28	1·66	144	23	0·69	29	5	1·15
Total	4,293	1,487	1·37	2,906	553	0·48	1,820	606	1·10

Average Loss of Crop

4,293 growers did not treat	0·47 per cent
2,906 growers treated with bichloride	0·09 per cent
1,820 growers treated with formalin	0·37 per cent

SUMMARY

Seed treatments, as at present applied on farms, reduce but do not altogether control blackleg.

Formalin treatment is of small benefit in blackleg control.

Bichloride is more effective than formalin in blackleg control.

The results, as compiled from field records during the three years 1928-1930, are fairly uniform, as the following condensed table shows:—

TABLE 52.—SEED TREATMENT AND BLACKLEG INFECTION, 1928–30

Treatments	Total number of fields			Average per cent blackleg in infected fields			Average per cent loss of crop, total fields		
	1928	1929	1930	1928	1929	1930	1928	1929	1930
No treatment	3,506	4,690	4,293	1·2	0·93	1·37	0·57	0·42	0·47
Bichloride	2,858	2,702	2,906	0·73	0·72	0·48	0·21	0·20	0·09
Formalin	946	1,001	1,820	0·94	0·99	1·10	0·32	0·35	0·37

Comparison of Disease Resistance in Different Varieties and Strains of Potatoes in B.C.

(B.84.08)

Walter Jones (Saanichton, B.C.)

Field observations on Vancouver island and the lower mainland indicate that some varieties are more susceptible to Rhizoctonia disease than others. It was noticed that the Irish Cobbler variety was more severely infected than the Bliss Triumph variety planted under similar soil and cultural conditions.

Laboratory observations have shown that of the varieties Netted Gem, Burbank, Green Mountain, Manistee and Early Ohio, the Green Mountain variety showed the highest, and the Early Ohio the least degree of Rhizoctonia infection during growth.

Sixteen varieties of potatoes were inoculated with the fungus *Pythium de Baryanum,* Hesse, and all were found to be susceptible. There appeared to be a relationship between the state of maturity and disease resistance of individual tubers, the more mature tubers being less resistant. This relationship has not been determined experimentally.

Tuber Unit Method for the Control of Potato Diseases in B.C.

(B. 84.06)

W. Newton and Staff (Saanichton, B.C.)

Isolated seed plots were established by the combined tuber unit and hill unit methods to determine the most economical means of eradicating the common and less conspicuous forms of virus diseases.

The investigations proved that in the establishment of seed plots by this method, (1) it did not pay to select plants from a potato field planted with commercial seed. On the majority of such fields 10 per cent or over of the plants bore conspicuous virus symptoms and with this high percentage the probabilities were negligible of selecting a large proportion of disease-free plants; (2) it payed to select from fields planted with certified seed potatoes, and to spend considerable time in the selection of plant types that best represented the variety grown as far as vigour, type of plant, character of the foliage and percentage of marketable tubers was concerned. It payed to stake or otherwise mark the ideal plants early in the season and to remove such marks later in the season or at the time of harvest whenever abnormalities or lack of vigour in individual plants appeared. Occasionally, individual tuber units within the hill unit upon the seed plot proved to be infected with a virus disease when the majority were healthy. Although absolute cases were discovered of virus disease in a single plant within a tuber unit with the remainder healthy, such cases were very rare. In general, these investigations proved that there are numerous abnormal types of potato plants whose characters are transmitted to later generations, that are not ordinarily classified as virus infected plants, although they play an important part in the yield of marketable tubers. These abnormal plant types can be eliminated economically by the selection of ideal plants and planting their progeny by way of the combined tuber and hill unit method in an isolated seed plot.

Cut Seed Versus Whole Seed in B.C.

(B. 84.07)

W. Newton and Staff (Saanichton, B.C.)

Owing to the large losses sustained by the potato growers through rotting of the seed pieces, investigations were continued in 1930. Cut and uncut seed were placed in soil infected with *Pythium de Baryanum* Hesse, and a *Fusarium* sp., two of the causal organisms. In all cases the percentage of seed pieces that rotted were greater when the tubers were cut. When the cut tuber pieces were maintained for one week in dark, humid, well aerated chambers the amount of infection was lowered through the suberization of the cut surfaces.

The Isolation, in Tuber Lines, of Disease Free and High Yielding Potatoes (N.S.)

(B. 84.02)

W. K. McCulloch (Kentville, N.S.)

This study in the control of virus and other diseases of the potato consists of two parts. The first is a series of plots each of which is descended from a single tuber and termed a tuber line. The varieties included at present are Irish Cobbler, Green Mountain, Bliss Triumph, Early Rose, Early Noroton, and Early Ohio. The second series consists of new or uncommon varieties collected from different parts of the province, which generally require preliminary treatment in the shape of rogueing to eliminate impurities and diseases.

The first series comprises 108 tuber lines, of which twenty-five were begun in 1924, six in 1926, seventy in 1927, and seven in 1929.

Of the twenty-five lines begun in 1924, one of the Green Mountain units has remained apparently free from virus disease up to the present time, and 32 per cent have been maintained at the certification standard during the five-year period 1925-29. In the season of 1930, 68 per cent of the tuber lines reached the certification standard.

Of the tuber lines begun in 1926 and 1927, one of the Early Rose variety, three of the Green Mountain, and fifteen of Irish Cobbler have remained apparently free from the virus diseases, and 47 per cent have been maintained at the certification standard for the period of three years during which these lines have been growing. In 1930, 76 per cent of these lines reached the certification standard.

In the matter of yield it is interesting to note that the older tuber lines are better than the new. The average yield per hill of the certified units begun in 1924 and 1927, for the two most important varieties, are respectively: Green Mountain, 1·83 pounds and 1·75 pounds; Irish Cobbler, 1·58 pounds and 1·50 pounds.

As stated last year (Report of the Dominion Botanist, 1929), the results obtained in this work bear out the practical experience of the Inspection Service. This experience shows that owing to environmental conditions certain districts which are able to produce excellent crops of commercial potatoes can not advantageously produce certified seed of foundation stock quality.

In the second or preliminary series of plots fifty-one new or uncommon varieties were planted in 1930. Of that number twenty-eight produced white tubers; nine, pink tubers; eight, red; and six, deep purple or black tubers. Six of the white varieties are of the Cobbler type and one of this group, locally known as White Blossom Cobbler, might be used with advantage to replace the standard Cobbler where the latter is too short-lived. Two other white varieties, locally known as "Never Rot" and "Irish Daisy," have shown resistance to late blight rot. This is especially marked in the "Never Rot", but unfortunately it is difficult to find any of the latter free from mosaic disease. In regions where late blight consistently affects Green Mountain, "Never Rot" might be used to advantage. Of the coloured tubers No. 31 is deep purple. It has shown nearly as much resistance to late blight rot as "Never Rot". It is round to oblong in shape, and is probably the British variety known as "Arran Victory".

The Effect of Persistent Selection on the Shape of the Tubers of Potatoes

(B. 84·03)

W. K. McCulloch (Kentville, N.S.)

This work has been in progress for seven years, 1924-30, and records of it are included in the respective reports of the Dominion Botanist. A more complete summary is given in the Report of the Dominion Botanist, 1928, pages 206-207. The following (table 53) are the results to date. The soil has been of the same type throughout the work. The season of 1930 was very dry, with sufficient moisture towards the end to produce a good crop of late potatoes.

TABLE 53.—EFFECT OF SELECTION OF THE SHAPE OF POTATO TUBERS

Grower	Per cent of tubers of ideal shape for the variety			
	Before selection	After selection		
	1923	5-year average 1924–1928	1929	1930
1. E. Jennings	21·6	43·6	41·0	49·0
2. R. K. Loughead	40·0	52·5	49·1	54·0
3. A. Kent	38·6	49·4	57·1	45·0

The Use for Seed of Potatoes Previously Exposed to Freezing Temperatures

(B. 84·14)

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

The possibility of frost injury to seed potatoes presents an important problem each year in Prince Edward Island. This applies to the crop held in late fall temporary storage and, particularly during the early winter period, when seed potatoes are being transported to shipping points. Because of this climatic factor the farmer, through no fault of his own, frequently meets the unfortunate experience of having his otherwise high grade seed potatoes rejected for reason of frost injury.

Inasmuch as frost injured potatoes are unsound it is important that under no circumstances should they be permitted to go on the market. To the producer of this otherwise good stock comes the question of using it for next year's planting. The object of this project is to secure information bearing on the effect of low temperatures on seed potatoes and, especially, to determine the value for seed purposes of frosted and chilled seed potatoes.

Experiments reported in 1929[1] dealt with exposures ranging from 26° to 32° F. for periods varying from 15 to 105 minutes. Stated briefly, lowest yields were obtained from tubers exposed for 65 minutes at a temperature of 26° F.; even in this instance sprouts appeared normal. Temperatures ranging from 29° to 32° F. had no apparent effect. These experiments also afforded a study of the various types of frost injury which were described and recorded as follows: ring necrosis, net necrosis, blotching, and leaky stage.

[1] Report of Dominion Botanist for 1929.

PROCEDURE

In 1930 the exposures were of comparatively short duration and the temperatures lower than those adopted the year previous. Due to this shortness of the exposures it was not difficult to obtain constant temperatures for the required periods. Green Mountains and Irish Cobblers were chosen for this purpose. They were selected from crops harvested before any possibility of injury from field frosts. The two varieties represented were strains favourably known for their vigour and high yielding qualities. In the month of February the tubers were exposed on their sides one layer thick on a one-quarter-inch mesh wire framed and supported by four stakes projecting two feet above the snow level. Upon the termination of each exposure the tubers thus exposed were placed in a paper bag and shaken around vigorously for ten seconds. In this manner it was intended to emulate the jarring occasioned during the process of handling for transportation; for it is known that undercooled potatoes, when jarred, are likely to freeze.[1] The tubers treated in this manner were placed in basement storage until the beginning of planting operations.

At planting time the tubers thus treated were examined and any wet or rotten specimens discarded. Twelve tubers from each test were set aside to be photographed and examined critically. The remainder were used for seed in the field plots. Checks constituted carefully stored tubers which were harvested before field frost set in, the varieties and strains being the same as those referred to above.

RESULTS

Frost injury was responsible for the complete destruction of a number of tubers, stored subsequent to exposure, and, as might be expected, this feature was associated with the longer exposures at the lower temperatures. The facts in this connection were as follows:—

TABLE 54.—RESULTS OF EXPOSURE TO FROST

(30 Tubers exposed)

Temperature	Exposure minutes	Tubers destroyed	
		Cobblers plants	Mountains plants
32° F.	10	0	0
32° F.	15	0	0
32° F.	20	0	0
32° F.	25	0	0
26° F.	5	0	0
22° F.	5	0	0
22° F.	10	0	0
22° F.	15	0	1
22° F.	30	0	0
17° F.	30	0	1
17° F.	60	1	1
12° F.	15	1	2
10° F.	5	1	0
10° F.	10	2	3
10° F.	15	2	4
10° F.	30	5	4
10° F.	45	4	6
10° F.	90	30	30

Bearing in mind that all soft and wet tubers were removed immediately after each exposure it is evident in the light of the foregoing figures that frost constitutes one of the most serious losses in stored potatoes. As an illustration of the duration effect of low temperatures it should be pointed out that of the thirty tubers each of Irish Cobblers and Green Mountains exposed forty-five

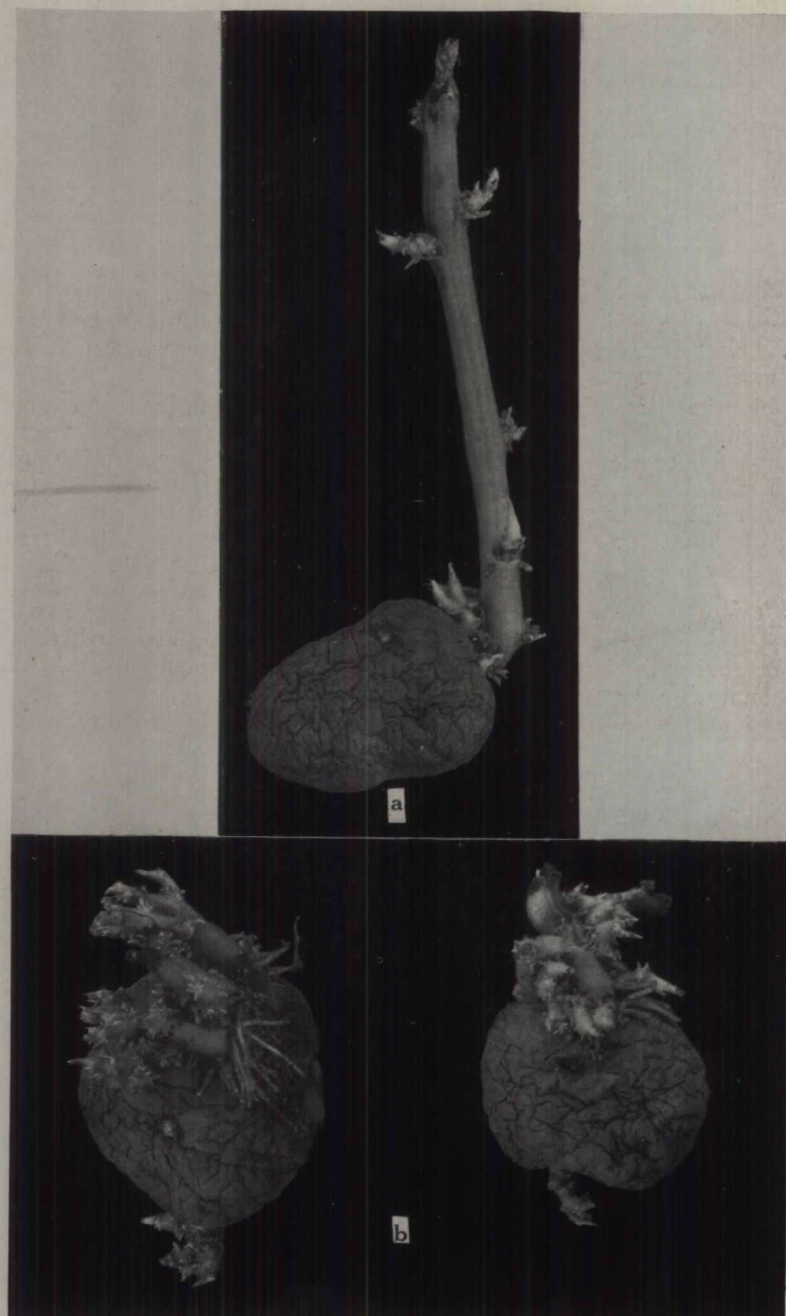

FIG. 26.—Effect of low temperatures upon sprouts of potato tubers. (a) Exposed for 5 minutes at 10° F. (b) Exposed for 15 minutes at 10° F.

minutes at 10° F. four and six tubers respectively were completely destroyed by the end of the storage period; whereas, of those exposed ninety minutes at the same temperature all of the tubers were destroyed.

SEVERITY OF EXPOSURE AND SPROUT DEVELOPMENT

Observations indicated that sprouting capacity was influenced by exposures to low temperatures. As illustrated by one instance tubers of the Irish Cobbler variety developed vigorous and normal sprouts after an exposure of five minutes with the temperature 10° F. Again at the same temperature but with exposures

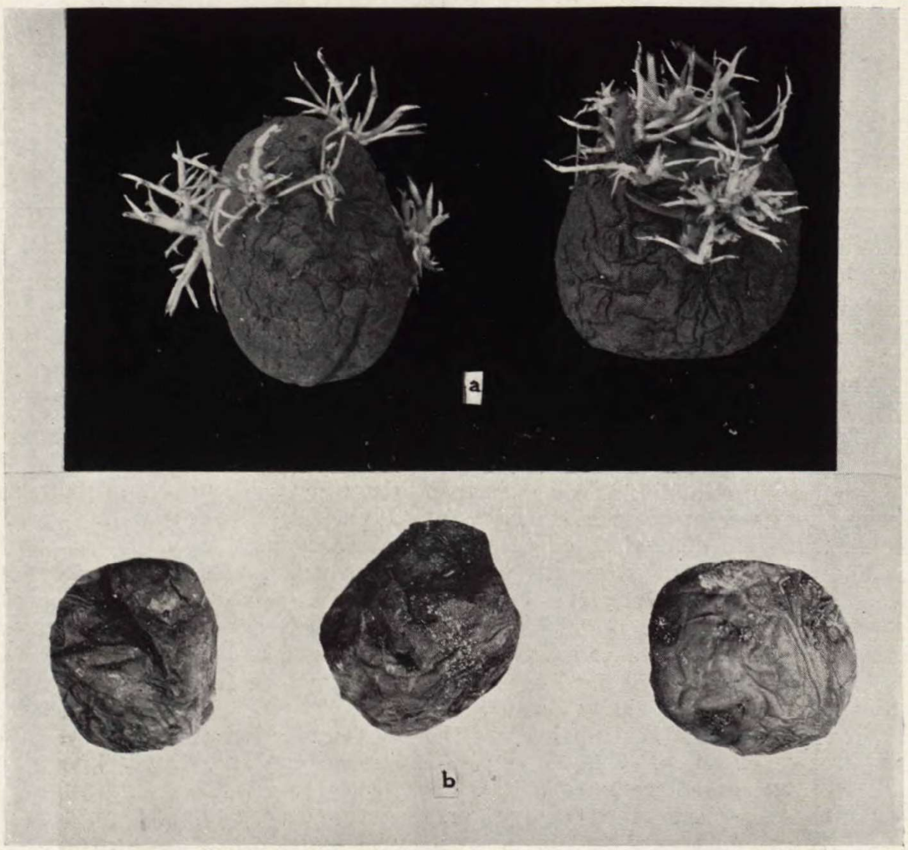

FIG. 27.—Effect of low temperatures upon sprouts of potato tubers. (a) Exposed for 45 minutes at 10° F. (b) Exposed for 90 minutes at 10° F. In this instance there was no sprout development and the tubers were destroyed by storage rots.

of fifteen minutes sprouts were much reduced in length and became bunched, a tendency which was still more noticeable after an exposure of forty-five minutes, all of which shows evidence of the harmful influence of frost. In the case of Green Mountains the same conditions prevailed. The consistent nature of these facts was recorded by numerous photographs, several of which are reproduced in figs. 26 and 27.

TABLE 55.—THE USE FOR SEED OF POTATOES PREVIOUSLY EXPOSED TO FREEZING TEMPERATURES

Exposure	Time in minutes	Stand		Yield per acre	
		Cobblers	Mountains	Cobblers	Mountains
		%	%	bush.	bush.
32° F.	10	100	100	309·5	415·7
32° F.	15	100	100	312·4	425·9
32° F.	20	100	100	351·8	401·2
32° F.	25	100	100	325·2	399·5
26° F.	5	100	100	298·6	403·1
22° F.	5	100	100	301·3	302·4
22° F.	10	100	100	300·75	398·7
22° F.	15	100	100	297·5	401·0
22° F.	30	100	100	275·8	341·3
17° F.	30	100	100	281·9	355·6
17° F.	60	100	100	301·2	347·2
12° F.	15	100	100	275·7	351·6
10° F.	5	100	100	289·4	362·4
10° F.	10	100	100	271·5	307·4
10° F.	15	100	100	275·4	310·7
10° F.	30	100	100	281·3	309·5
10° F.	45	100	100	272·4	301·0
Check	....	....	....	310·7	347·5

While these features occurred with remarkable regularity it must be remembered that the exposures did not necessarily imply actual injury by frost to the extent which one might expect.

In other words, the ability of tubers to develop normal, vigorous sprouts may have been due to inherent vitality, and, if this is so, possibilities favour selection for frost resistance.

EFFECT OF EXPOSURE UPON YIELD

From a study of table 55 we see that tubers injured by short exposures to frost are not necessarily rendered unfit for seed purposes. In fact we may safely conclude, in spite of evident frost injury, that seed-pieces from tubers having reasonably vigorous sprouts will produce plants which will return acceptable yields. There is no conclusive evidence in these results to indicate that moderate frost injury promotes increased yields. It is apparent, however, that the yields decrease as the temperature becomes lower, a feature which is even more noticeable with prolonged exposure. In the case of Irish Cobblers results in this respect were decidedly consistent.

It will be noted that in all cases there was a perfect stand regardless of the degree of exposure. Careful hand-planting and an exceedingly favourable early growing season were responsible to a large measure for this condition. Some of the seed-pieces representing the more severe exposures and showing weak sprouts undoubtedly would rot before root development when growth conditions are less favourable. That this is a justifiable belief is further supported by the observation that severely injured sets produced plants lacking vigour; an occurrence which was overcome, however, by mid-season when all of the plants in the test were large, vigorous and evidently competing on an even basis. At the same time this early season disparity in growth should, to a considerable extent, account for the difference in yield favouring the less severe exposures.

PRACTICAL APPLICATIONS

Potato tubers affected by frost are predisposed to decay, thereby constituting a menace in the stored crop. This is a disadvantage and must receive due consideration when storing a crop, or portion thereof, injured in this manner.

When considering the seed possibilities of frost-injured potatoes one must be guided by the condition of the crop at the end of the storage period. All tubers having weak sprouts, particularly those exhibiting a lack of vitality, should be discarded. At cutting time all sets showing decay, necrosis, or other evidence of severe frost injury should be thrown out as unsuited for seed purposes.

Shortening of Period of Dormancy in Seed Potatoes

(B. 84.04)

D. J. MacLeod (Fredericton, N.B.)

Southern countries such as Cuba and Bermuda use considerable Canadian-grown seed for the early winter crop planted in September and October. Potatoes harvested during the months of August and September are not suitable for immediate planting owing to the fact that they will not sprout properly, due to the incompletion of the normal rest period of the tuber.

The treatment of potato tubers with various substances to abbreviate the period of dormancy has been extensively investigated from time to time, but no method of treatment has been found which is suitable for commercial use.

Accordingly, experiments were conducted with the view to determine the most effective and economical methods for inducing early germination in seed potatoes intended for southern markets. The Bliss Triumph and Spaulding Rose were used because there is more demand for these varieties in southern countries than others grown in the Maritime Provinces. Twenty-two substances were tested as follows: Oxygen, nitrous oxide, acetylene, ethylene, ethylene dichloride, trichloroethylene, ethyl chloride, ethyl bromide, ethyl iodide, ether, chloroform, carbon tetrachloride, carbon bisulphide, ammonia, ethylene chlorohydrin, thiourea, sodium thiocyanate, sodium nitrate, sodium sulphate, potassium thiocyanate, ammonium thiocyanate, potassium permanganate (in acid and alkaline solutions).

Oxygen, acetylene, ethylene dichloride, trichloroethylene, ethyl chloride, ethyl iodide, sodium nitrate, sodium sulphate and potassium thiocyanate effected only slight stimulation as evidenced by the appearance of feeble sprouts at the end of six weeks. Ether, chloroform, carbon bisulphide, carbon tetrachloride and ammonia failed to stimulate germination in most cases and produced varying degrees of injury. Nitrous oxide, potassium permanganate (acid and alkaline) induced germination after three weeks but caused considerable injury in several cases. Tubers exposed to ethylene, ethylene dichloride, ethyl bromide, ethylene chlorohydrin, thiourea, sodium thiocyanate, and ammonium thiocyanate germinated in from six to eighteen days after treatment. No apparent injury to the tubers was caused by these compounds excepting where maximum concentrations were used. The results with ethylene, thiourea and ethylene chlorohydrin were particularly encouraging, foreshadowing some practical use of these compounds for hastening the sprouting in potato tubers and stimulating the vigour of plants produced from such tubers. A specially constructed chamber, fully equipped with mechanical devices for controlling temperature, humidity and regulating the stimulating agent, very generously placed at our disposal by the Dominion Experimental Station, will be used in connection with this experiment in 1931.

DISEASES OF FORAGE CROPS

The Nature, Cause, and Prevention of Brown-heart in Turnips

(B.30·02)

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

That brown-heart constitutes a problem of major importance is shown by the fact that turnips valued in the vicinity of $50,000 are rejected at shipping points in Prince Edward Island alone. This estimate disregards the enormous additional losses represented by field and bin rejections. Brown-heart of turnips is frequently referred to as water-core, black-heart, water-heart and punky core. Any one of these terms, however, may be sufficiently descriptive to leave no doubt as to the correct identity of the disease, since the corresponding symptom is usually present to a greater or less degree. Failure in this respect explains the confusion which exists. Under Prince Edward Island conditions the outstanding symptoms have suggested the name brown-heart, a term which has become established by its universal usage throughout the province.

DISTRIBUTION

The occurrence of brown-heart in Canada has been reported in Prince Edward Island, Nova Scotia, New Brunswick, Quebec, Ontario, and British Columbia. The only reference in Canadian literature of this disease is contained in a report of the evidence given by the Dominion Botanist before the House of Commons in 1910. In 1914, Charles D. Woods of Maine[1] reported on "Black hearted" turnips and from his descriptions there can be no doubt but this and brown-heart are one and the same.

CAUSE

There is nothing to suggest that brown-heart is of parasitic origin. It probably represents a physiological disturbance within the plant tissues brought about by physical or chemical agencies, either singly or combined. These influences have been favoured by the highly specialized nature of the turnip root which differs greatly from its ancestral wild form.

SYMPTOMS

Brown-heart can only be detected by cutting into the turnip. From our present knowledge of the symptoms there is no reliable external indication which would lead one to suspect the presence of this trouble. A few observers, when discussing this situation, have stated that affected turnips show a cracking of tissues at the neck of the turnip. This belief, however, is not supported by careful observations made during the late summer of 1930. After turnips have been in storage several weeks those badly disorganized by brown-heart will be comparatively light in weight. Upon making a transverse cut through an affected turnip the symptoms are recognized by a well-defined brownish mottled and more or less watery area, which never extends past the layer of cambium. Not an uncommon feature is the development of concentric light and dark rings indicating growth periods.

On examining several specimens it will be seen that the affected area may be restricted to the size of a small coin or it may involve a considerable portion of the turnip. Figures 28 and 29 illustrate the outstanding symptoms in this connection. As turnips advance in age the brownish character is less

[1] Woods, Chas. D. Field experiments in 1914. Me. Agr. Exp. Sta. Bul. 236: p. 57. 1915.

FIG. 28.—Brown-heart of turnips. Note the clearly defined light and dark concentric rings. The dark areas represent the injured tissue which appears to be water-soaked.

FIG. 29.—Brown-heart of turnips. Note the white tufts of dead tissue lining and scattered through the dark patches. This section was cut across the lower end of a large turnip where the concentric rings are usually less apparent.

noticeable, and mottling may disappear entirely leaving a greyish brown, dry, punky mass,, which, upon close inspection, is found to be composed of dried out and broken down cellular tissue. Cooking renders affected turnips unpalatable and woody. A destructive rot which is frequently attributed to brown-heart is known as Phoma rot. There should be no confusion, however, when it is known that turnips suffering from brown-heart do not rot.

It has been stated frequently that brown-heart symptoms may disappear entirely in storage and even while affected turnips are yet in a growing condition. Our observations have never supported this opinion. It is not an uncommon thing, however, to find specimens lacking, to some exent, the watery appearance and the brown markings, showing that these characters, under certain influences, become modified.

INVESTIGATIONAL WORK

A fund of useful information has been secured by the extensive use of questionnaires. By this method valuable data were gathered from the provinces named above. The nature of the inquiries was as follows:—

QUESTIONNAIRE RELATIVE TO BROWN-HEART OF TURNIPS

Grower's name..
Address..
Variety grown..
Seeding date (S)...
If several seedings state which most affected..
Rotation practised...........................Preceding crop (last year)..................
Nature of soil............Sandy............Clay............Light........Heavy.........
Nature of subsoil..
Drainage...
State nature and condition.
Cultivation..
Weather conditions during growing season...

—	Rainfall?	Dry?	Hot?	Cool?	Moderate?
June..................................	....	....	....	....	....
July..................................	....	....	....	....	....
August................................	....	....	....	....	....
September.............................	....	....	....	....	....

Fertilizer applied, rate per acre.
How?...................Kind?.........................When?.......................
Manure applied, rate per acre..
How?...................Kind?.........................When?.......................
First appearance of brown-heart (please start examining when turnips are about size of hen's egg), and keep a record throughout season.
Date?...
Size of plant?..
Any outward symptoms? as wilting, etc.
Does brown-heart occur more generally in sections of the field where the turnip tops wilted during hot days?........................
Did you ever notice any checking in growth?.................When?......................
Percentage brown heart present in each variety, estimated at end of growing season (cut a definite number of turnips and state number of defective ones).
Harvesting date..
Do you feed to live stock turnips affected with brown-heart?..............................
Do turnips affected with brown-heart rot in storage?......................................
Do they rot more readily than turnips not affected with brown-heart?......................
What varieties of turnips have you found immune to brown-heart?...........................

A summary of the facts derived from this source contains some important information. Of noteworthy significance was the absence of brown-heart where manure was used in abundance. Furthermore, brown-heart was less severe when the manure was applied in the fall before seeding time. The same condition prevailed, however, when heavy applications of manure in the form of compost were made shortly before seeding time. Conversely, brown-heart increased with lighter applications of manure. In the entire absence of manure brown-heart was abundant in amounts ranging from 50 to 100 per cent. When no fertilizer was applied brown-heart was consistently absent. In such instances, however, the land had received comparatively heavy amounts of manure.

Through the kindness of Mr. J. P. Hooper of Charlottetown, our attention was drawn to a most striking development of far reaching importance. In two fields of the farm owned and operated by this gentleman brown-heart was particularly severe, in fact, the worst cases recorded by us. In each field, however, a circular area approximately sixty feet in diameter produced turnips absolutely free from brown-heart, notwithstanding its abundance throughout the remainder of the fields. Upon examination it was found that the soil in these restricted areas was of the finest compost to the depth of six inches; the inference being that manure had been piled there previously, a belief later proven by enquiry. A third report of this nature was communicated by Mr. E. Howatt, North Wiltshire, who wrote as follows: "The turnips were a good crop but all brown-hearted except where the manure was piled in the winter time, and in this area one would not find a single brown-heart specimen."

From Ronayne Bros. of Pemberton, B.C., came still further evidence of a similar nature, Mr. Robert Sutton being the informant as follows: "Another interesting point submitted by Mr. Ronayne is that one field planted to turnips in 1930 was previously well manured. The only evidence of water-heart in the roots from that field came from one corner where cattle had tramped the clay and it had baked and resisted tillage operations, remaining dry and lumpy." (See also under small plot experiments.)

Based upon facts given in questionnaires, type of soil seemed to have no bearing upon the situation, inasmuch as brown-heart was associated with soils of a gravelly or sandy nature, as well as clay soils both light and heavy. Likewise development of brown-heart was indifferent to the type of drainage, whether good or poor.

The regularity with which brown-heart developed throughout the fields indicates soil inequalities rather than such factors as varietal tendencies, exposure to sunlight, and intermittent climatic conditions. This was supported by many replies stating that the trouble would appear only in certain sections of fields. Until dealt with experimentally we cannot regard these indications with confidence.

We found no indication whatsoever that commercial fertilizers promoted or favoured brown-heart. Reports from Waterloo county, Ontario, show that turnips are affected where commercial fertilizer has never been added to the land. In the locality referred to brown-heart is more common in soil receiving light coats of manure and less severe when larger amounts were added.

SMALL PLOT EXPERIMENTS

It was evident from observations that brown-heart is favoured by certain unknown soil factors. This feature was dealt with in a series of tests using soils of four types, as follows:—

(1) Alkaline soil.
(2) Normal soil (soil known to have produced brown-heart.)
(3) Woodland soil (from hardwood grove where the land had never been cultivated.)
(4) Sand (pure washed quartz sand.)

By careful planning, it was made convenient to incorporate with each soil type a number of relationships hitherto not dealt with experimentally as follows:—

(1) Role of magnesium sulphate.
(2) Drought versus soil moisture.
(3) Fertilizer versus manure.

Each experimental unit represents an eight-inch pot containing the soil specified and buried in earth to within one inch of the top of the pot. Twelve turnip seeds of the variety Millpond were sown in each pot, and periodically as the season advanced a turnip plant was removed from each pot for the purpose of making histological studies as well as for observing the progress of brown-heart. At the termination of the growing season one turnip root remained to a pot. Fertilizer was applied where specified at the rate of 1,100 pounds per acre, the mixture being composed of ammonium sulphate 100 pounds, muriate of potash 200 pounds, acid phosphate 800 pounds. Barnyard manure was applied at the rate of 20 tons per acre. By adopting four replications each soil type was represented by three different amounts of magnesium sulphate. The fourth series in each test was untreated in this respect and therefore constituted a check. The moisture factor was arrived at by administering each morning and evening a heavy application of water by means of a gardener's watering can. One-half of each test was thus treated, the other half receiving no moisture except that which was provided by normal precipitation. While a high state of drought was not arrived at, nevertheless, because of the unusual scarcity of rain, the plants in question were grown under dry conditions.

The results obtained showed that brown-heart thrived in normal soil, or in other words, the soil which gave rise to affected turnips in 1929. (It should be noted that this particular soil came from a restricted area which had received a heavy dressing of mussel-mud, this being the only section of the field in which brown-heart was found.) In this particular soil brown-heart was more abundant in the fertilizer section of the experiment, there being traces only in the flower pots containing manured normal soil. Apart from this one interesting case there was no sign of turnips being affected with brown-heart in the remaining manured soils. With the exception of sandy soil affected turnips were found wherever fertilizer alone was used; a feature to which must be attached some importance, without being misled into attributing brown-heart to fertilizer.

Investigations of histological nature conducted to date give every indication that brown-heart begins to develop when the plant is in the seedling stage, having its origin in the lower section of the tap root. As far as we are aware at the present time brown-heart symptoms are associated with abnormal development of the xylem vessels.

SOIL REACTION

An attempt was made to determine whether or not soil acidity or alkalinity had any bearing upon brown-heart incidence. Thus hydrogen-ion determinations were made of a great many soil samples taken from the roots of both affected and non-affected turnips.

The pH values given in table 56 represent the average of twelve determinations.

TABLE 56.—TURNIP BROWN-HEART AND SOIL REACTION

Field number	Brown-heart incidence	pH value	Remarks
1	Traces	5·08	Restricted to small area in field. Moderate coat of manure.
2	Absent	5·85	Light coat of manure.
3	Absent	5·60	Light coat of manure.
4	Moderate	5·79	Light coat of manure.
5	Moderate	5·49	Light coat of manure.
6	Moderate	5·96	Light coat of manure.
7	Severe	6·07	No manure.
8	Absent	5·02	Heavy application of manure.
9	Absent	6·31	Heavy application of manure.
10	Severe	5·23	Fertilizer; light coat of manure.
11	Traces	5·20	Fertilizer; heavy coat of manure.
12	Traces	6·11	Light coat of manure. Club-root severe.
13	Moderate	6·56	Light coat of manure. Ten ton lime.
14	Absent	6·69	Fertilizer. Heavy application of manure.
15	Severe	5·35	Fertilizer for many years. Light coat of manure.
16	Severe	5·36	Fertilizer for many years. Light coat of manure.
17	Severe	6·12	Limed; no manure.
18	Traces	5·64	Heavy coat of manure.
19	Absent	6·26	Heavy coat of manure.
20	Absent	6·12	Heavy coat of manure.
21	Absent	5·73	Heavy coat of manure.
22	Absent	5·03	Heavy coat of manure.
23	Severe	5·22	Fertilizer. No manure.

From the foregoing tabulation it is indicated that well-manured fields discouraged the development of brown-heart. It was certainly more common, however, where manure was applied in lighter quantities; and in its entire absence there was severe brown-heart. Its presence or absence, however, on a basis of the evidence here advanced, does not seem to be correlated with pH values.

PRACTICAL APPLICATIONS

Examining the data supplied by questionnaires, experiments, and carefully conducted field observations, we find that the amount of manure applied to the land bears a definite relation to brown-heart. We are not in a position to state whether or not the manure retarded brown-heart by providing increased fertility, improved aeration or a more favourable supply of moisture. These relationships are being dealt with through the medium of laboratory research.

Fertilizer and manure combined discouraged brown-heart development which was favoured by the use of fertilizer alone. This does not necessarily imply that fertilizer was the harmful principle, but rather that manure is required to create the conditions favourable to the growth of sound turnips. The frequent irregularity with which this disorder occurs in fields is an indication that it is not governed in a limited way by weather conditions.

Resistance of Varieties of Turnips to Club Root

(B. 30·01)

D. J. MacLeod (Fredericton, N.B.)

Further encouraging results were obtained this year in the direction of securing strains of turnips resistant to club root, which is one of the most important limiting factors in the production of this useful crop in the Maritime Provinces.

The soil used for these tests is much more heavily infested with the club root organism than even the most highly contaminated commercial soils. Club root material from various sources and soil harbouring the club root organism from several localities in the Maritime Provinces have been added from time to time to render the plot eminently suitable for testing the resistance of turnips to this destructive disease.

In 1930, 112 commercial varieties and strains of swedes and turnips were tested for club root resistance. Sixty-nine of these gave no evidence of resistance to the disease. Forty-one varieties showed from 20 to 75 per cent severe infection. Two varieties, the White and Aberdeen, developed only slight infection in the rootlets in each case. Fifty-nine selections from different commercial varieties and forty-one crosses made in 1929 at the Dominion Experimental Station were also tested for resistance to club root. Fifty-three of these selections showed practically no resistance to the disease. Six varieties manifested varying degrees of resistance, ranging from 30 to 90 per cent freedom from disease. Twenty-five of the crosses showed no evidence of resistance. Sixteen crosses appeared to be highly resistant ranging from 25 to 100 per cent freedom from club root. Selections from the White swede, annually tested and reselected since 1926 are stabilized with a high degree of resistance. Combinations of this variety with certain other varieties manifesting different degrees of resistance have proven highly resistant in most cases. One of the most promising combinations is that with the Bangholm Sludsgaard which is practically immune to club root and possesses most of the desirable qualities of the latter.

A Study of the Root-rots of Sweet Clover in Western Canada

(B. 37·02)

G. B. Sanford (Edmonton, Alta.)

The study of the root-rots of sweet clover, common clover and alfalfa has been continued at this laboratory. It has already been shown that at least a part of the so-called winter-killing of these crops, under western conditions, is caused by *Plenodomus Meliloti* Dearness and Sanford. This is a new soil inhabiting fungus which is fairly common to the soils of Alberta and Saskatchewan. The fungus has been isolated, studied and described and its pathogenicity established to all three legume crops mentioned (see Proc. Can. Phytopath. Soc. Ottawa, 1929, and Annales Mycologici 28: 3, p. 4, 1930). This disease has been called the "brown rot", from the characteristic brown colour of the lesions, to distinguish it from the softer, colourless rot produced by *Sclerotinia Trifoliorum.*

The Sclerotinia rot has been found to be more prevalent and serious in Alberta than at first anticipated, particularly with regard to common and sweet clover. As both Sclerotinia rot and brown rot are associated with the winter-killing of the clovers and alfalfa these diseases are being studied further with regard to favouring factors of soil, culture, climate and spread, and also varietal resistance.

Other ailments associated with winter-killing of these crops have received attention, but results are not yet ready for report. Specimens of sclerotinia rot, and brown rot caused by *P. Meliloti*, are shown in fig. 30.

Acknowledgment is here made of the assistance in these studies of Mr. M. W. Cormack, Seasonal Assistant at this laboratory, and also of the Lacombe Experimental Farm, which is co-operating in planting and caring for certain essential field experiments and in placing at our disposal their extensive varietal test plots of the clovers and alfalfa.

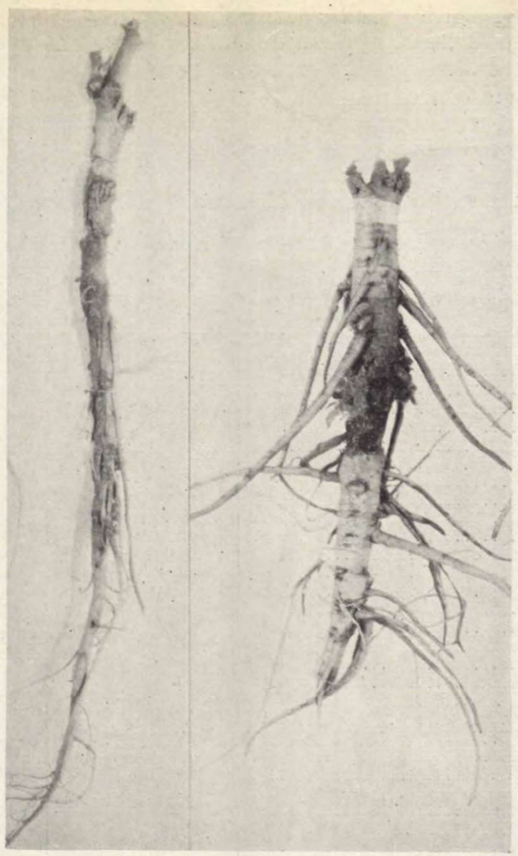

FIG. 30.—Root rots of sweet clover. Left: *Sclerotinia* root rot. Right: Brown root rot (*Plenodomus Meliloti.*)

The Resistance of Varieties and Strains of Clovers to Mildew

(B. 31·01)

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

Powdery mildew of clover is caused by the fungus *Erysiphe Polygoni* D. C. The following clover species are named by Salmon[1] as hosts for this disease: *Trifolium agrarium, T. alpestre, T. arvense, T. filiforme, T. hybridum, T. incarnatum, T. involucratum, T. longipes, T thum, T pauciflorum, T. pratense, T. procumbens, T. repens,* and *T. rubens.* Additional work by Salmon[2] goes to show that the form of mildew on *Trifolium pratense* (Red Clover) is a race restricted to this species and is therefore highly specialized.

Powdery mildew of clovers has been found in every province in Canada. Each year in Prince Edward Island it is particularly troublesome and the failure of plants to set seed is attributed to the detrimental effect of this disease. While it is exceedingly difficult to estimate the damage from this source, nevertheless, we believe that the destruction of leaves alone represents a significant loss to

[1] Salmon, Ernst S. A monograph of the Erysiphaceae. Mem. Torrey Bot. Club. 9:1-292. 1900.

[2].......On specialization of Parasitism in the Erysiphaceae. Beihefte B. Centralbl. 14:261-315. 1903.

the farmers. In view of the lack of control for mildew the logical line of attack seems to be the development of disease resistant strains of clover; which in turn involves a biological study of the organism responsible for the condition. The report at this time is concerned with the reaction of thirty-seven strains of red clover. The project was begun at Kentville, N.S., in 1925, by Mr. J. F. Hockey, who furnished the necessary seed when the work was transferred in 1928 to Charlottetown.

One year's observations yielded the results summarized in table 57.

TABLE 57.—SUSCEPTIBILITY OF RED CLOVER TO MILDEW

Seed source	Degree infection	Growth habit	Maturity
Ottawa	Moderate	Tall	Late
Ottawa	Moderate +	Tall	Late
Oxdrift, Ont	Moderate + +	Low	Late
Alfred, Ont	Moderate +	Tall	Late
St. Clet, P.Q	Trace − −	Tall	Late
Chateauguay, P.Q	Trace − −	Tall	Late
Alta, Swede	Moderate	Low	Late
2474, Oregon	Moderate + +	Low	Late
05066, Chile	Moderate	Tall	Late
Hamo Ten Have Co	Moderate	Tall	Late
58476, Danish Tystofte	Trace	Tall	Late
Early Swedish	Trace	Tall	Late
Medium late Swedish	Moderate	Low	Late
Late Swedish	Moderate	Low	Very late
2426, Belgian	Trace	Tall	Early
2515, Palatinate	Trace	Tall	Early
58856, Poland	Row missed	No growth	
2517, Bohemia	Moderate	Tall	Early
59299, Central Hungary	Moderate +	Tall	Early
59300, Western Hungary	Moderate	Tall	Early
58548, Switzerland	Moderate +	Tall	Early
2423, Roumanian	Moderate +	Tall	Early
58472, Valence, France	Trace	Tall	Early
59291, French Aisne	Severe	Tall	Early
Dauphine	Trace	Tall	Late
2533, French	Trace	Tall	Late
2428, Italian	Trace	Tall	Late
Padova Italy	Trace	Tall	Late
56880, Italy	Row missed	No growth	
Bologna, Italy	Trace	Tall	Early
2429, Italian	Trace −	Tall	Early
Unbria, Italy	Trace −	Tall	Early
Marche, Italy	Moderate	Tall	Early
56440, Italy	Trace + +	Tall	Late
Sicily, Italy	Trace	Tall	Late
56661, Sicily	Trace	Tall	Late
From plant potted Oct. 1924 in greenhouse—no mildew in field, developed indoors	Moderate +	Tall	Early

The foregoing results are encouraging inasmuch as definite indications of mildew resistance occurred in sixteen of the thirty-seven strains. Plus and minus signs in the table of results represent degrees of infection within the expressions "moderate" and "trace." Thus it will be observed that strains five and six were practically immune to mildew, and it should be noted in this connection that these two strains originated in the province of Quebec at St. Clet and Chateauguay respectively. The remaining Canadian varieties failed to give any indication of resistance or immunity. Plant number eight, a low growing type originating in Oregon, exhibited a high degree of tolerance to mildew. Varieties from Europe were, in the main, quite resistant to infection. This occurrence is of interest in the light of investigations conducted by E. B. Mains,[1] who observed that European varieties of clover showed well-defined resistance to mildew.

[1] Mains, E. B. Differences in the susceptibility of clover to powdery mildew. Proc. Ind. Acad. Sc. 38: p. 313. 1922.

Sclerotinia sclerotiorum Wilt of Sunflower

(B. 32·01)

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

The amount of wilt in 1930 was from one-half to one-third of that present in the 1929 plots. Low precipitation would probably explain the differences.

The experiment on the control of wilt by soil treatments with sulphur and hydrated lime was carried further. The identical plots of the previous year were replanted but additional chemicals were not added as it was thought advisable to see if there might be a residual effect from the applications of the previous year. It was noted that again there was a reduction in total yield on the sulphur plots compared with those receiving hydrated lime. The significance is doubtful.

A study of the per cent wilt for three years from which data are available indicates that the location of the plot in the field has a greater influence on the per cent of disease than the soil treatment. There is an apparent reduction in the amount of wilt where the check is compared with the heaviest application but it is not considered of significance from a commercial viewpoint.

The results from the two years' observations on soil treatments with sulphur and hydrated lime are presented in table 58.

Table 58.—Average per cent Wilt for Two Seasons on Sunflower Plots Treated with Chemicals in 1929

Sulphur				Hydrated lime			
Plot	Pounds per acre	Per cent wilt		Plot	Pounds per acre	Per cent wilt	
		1929	1930			1929	1930
1	246	84·25	32·13	5	492	80·35	27·4
2	492	89·10	36·19	6	738	73·50	21·9
3	738	81·40	38·04	7	984	62·70	19·66
Check	0	83·93	33·51	Check	0	66·10	19·54

The figures in the above table are compiled from the averages of quadruplicate treatments.

The experiment to test the control through spacing was repeated in duplicate with results somewhat at variance with those obtained the first year. The maximum crop in 1929 was from plants spaced twelve inches apart but in 1930 with the lower amount of disease present and drier growing conditions it was from plots spaced nine inches apart. Plants from the wider spacing are distinctly coarser as pointed out in the 1929 report.

The test of various pure line strains of sunflowers that have been originated by the Dominion Agrostologist, Ottawa, has been continued on infested soil. Four hundred and fifty (450) pure lines were planted and observed during the season. Notes have been taken on their reaction to wilt, rust, and leaf spot, type of plant, and type of bloom. Marked resistance was shown by several of the pure lines.

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