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I. DEPARTMENT OF PLANT PATHOLOGY OF AGRICULTURAL RESEARCH CENTRE.

The Department of Plant Pathology of the Agricultural Research Centre was established in 1911 at Tikkurila, near Helsinki, as a Department of Plant Pathology of the Institute of Agricultural and Economical Research. Besides being a Research Institute of the State the Institute was, as an experiment station, subordinated to the Faculty of Agriculture and Economies of the University. In 1924 the Institute with its Departments was made a separate Agricultural Research Centre of the State.

The most important earlier achievements of the Department were the research on the smut diseases in Finland[1], and the research on the potato wart disease and its control[2] which were carried out under the direction of the renowned mycologist Professor J. I. L i r o when he held the directorship of the Department of Plant Pathology until 1937, besides his professorship at the University[3]. After him the directorship was held by Professor A.J. R a i n i o until his death in 1944. The most important of his investigation were research on the

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1) LIRO, J.I. 1924 and 1928 - Die Ustilagineen Finnlands I-II. Ann.Acad.Sci.Fennica, 1924, A 17:1, p. 1-636, and 1928, A 42, p. 1-720.

KITUNEN, E. 1922 - Tutkimuksia kauran nokisienistä ja eri kauralaatujen alttiudesta nokitartunnalle. Referat: Untersuchungen über den Haferbrand und die Brandanfälligheit der verschiedenen Hafersorten. Suomen maanviljelystaloudell.koelait.tiet.julk.(Publ. of the Institute of Agricult. and Econom. Research), 15, p. 1-126. Disseratation.

LEHTOLA, V.B. 1940 - Untersuchungen über einige Brandpilze der Gattung Cintractia CORNU. Acta agr.Fenn., 42, p. 1-136. Disseratation.

2) HILLI, A. 1932 - Perunasyövän (Synchytrium endobioticum (SCHILB.) PERS.) leviämisen syistä Suomessa ja ulkomailla. Abstract: The reasons of the spread of potato wart (Synchytrium endobioticum (SCHILB.) PERS.) in Finland and abroad. Valt. maatalouskoetoim. julk. (Publ. of Finnish Sta.Agr.Res.Board), 46, p. 1-249. Dissertation.

3) JAMALAINEN, E.A. 1949 - J.I. Liro. Systemaattisen sienitieteen merkkimies ja kasvinsuojelun uranuurtaja Suomessa. J.I. Liro. The distinguished mycologist and pioneer of plant protection in Finland. Arch.Soc.Zool.Bot. Fenn. Vanamo, 3 (1948), p. 1-31.

Fusarium mould of oats (Fusarium roseum)[1], research on the bacteria diseases of Gladioli[2] and a report on the potato blight and its significance in Finland[3]. Since 1925, when the Plant Protection Act became valid, the Department has been responsible for the statutes of the control of plant diseases being observed. The Act has been widely applied to practice in order to prevent the spreading of potato wart disease. Instruction work in the field of plant protection has continuously been an important part of the activities; for example in the middle of the 1930's instruction for controlling grain diseases was arranged in cooperation with the instruction organizations throughout the country.

The research work carried out during the last two decades has extended to comprise besides diseases caused by parasitic fungi also non-parasitic (physiogenic) plant diseases and virus diseases. Of minor elements, boron was the first research object of the Department of Plant Pathology in Finland, and it was shown that the brown heart disease of swede is caused by deficiency of boron[4]; also other plant diseases caused by deficiency of boron were found to occur in Finland, such as the heart rot of sugar beet and cork disease of apple[5]. Continued research on boron has shown that in wide areas of our country this element is a necessary nutrient for many plant species[6]. Other publications describing the activity of the Department of Plant

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1) RAINIO, A.J. 1932 - Punahome Fusarium Roseum LINK, Gibberella Saubinetii (MONT.) SACC. ja sen aiheuttamat myrkytykset kaurassa. Referat: Fusarium roseum beim Hafer und dadurch hervorgerufene Vergiftungen. Valt. maatalouskoetoim.julk. (Publ. of Finnisch Sta.Agr. Res.Board), 50, p. 1-39.

2) - " - 1936 - Tutkimuksia Gladiolus-kasvien bakteeritaudeista (Pseudomonas marginata Mc.Cl., Ps. gummisuda[illegible] Mc.Cl., Bacillus omnivorus Hall ja B. variegatus n[illegible] spec.) ja niiden torjuminen. Referat: Untersuchungen über Bakterienkrankheiten der Gladiolen (Pseudomonas marginata Mc.Cl., Ps. gummisudans Mc.Cl., Bacillus omnivorus Hall. und B. variegatus Rainio nov. spec.) und ihre Bekämpfung. Ibid., 84, p. 1-102.

3) - " - 1937 - Perunaruton aiheuttamat tuhot Suomessa ja sen esiintymiseen vaikuttavista tekijöistä. Referat: Die durch den Kartoffelschimmel verursachten Schaden in Finnland und über die auf sein Auftreten einwirkenden Faktoren. Ibid., 95, p. 1-47.

4) JAMALAINEN, E.A. 1935 - Tutkimuksia lantun ruskotaudista. Referat: Untersuchungen über die "Ruskotauti"-Krankheit der Kohlrübe. Ibid., 72, p. 1-117. Dissertation.

5) - " - 1936 - Boorin vaikutus kuoppataudin esiintymiseen omenissa. Summary: The Effect of Boron on the Occurrence of Cork Disease in Apples. Ibid., 89, p. 1-19.

6) - " - 1949 - Boorin puutteesta aiheutuvista kasvitaudeista ja boorin merkityksestä maamme kasvinviljelyssä. Summary: On boron deficiency diseases and on the role of boron in the finnish plant cultivation. Valt. maatalouskoetoim.julk. (Publ. of Finnisch Sta.Agr. Res.Board), 130, p. 1-48.

Pathology have been reported in detail in the periodical Nordisk Jordbruksforskning[1]). Of this work, the following objects of research may deserve particular mentioning in this connection: the Fusarium-fungi in Finland[2]), the significance of potato virus-diseases in our country[3]), the fungus Sclerotinia borealis causing damage in winter cereals and grasses[4]), and the storage of potato and carrot[5]).

PRESENT ACTIVITIES AT THE DEPARTMENT OF PLANT PATHOLOGY.

At present the work of the Department of Plant Pathology contains the following activities: 1) research on plant diseases injurious to cultivated plants and their control methods, 2) experiments on the effectiveness of fungicides, 3) inspection duties according to the Plant Protection Act and 4) instructive work.

The present Director of the Department of Plant Pathology is Professor, Dr. E.A. J a m a l a i n e n, and the Senior Research Assistants are Mr. H. J. E. H å r d h, B. Agr. & Forest. and Miss A n n i k k i L i n n a s a l m i, B.A. The Plant Protection Inspector is Mr. A. Y l i m ä k i, B. Agr. & Forest. In addition to these persons, the staff consists of two junior research workers, temporaty research workers, one office clerk, two laboratory assistants, two field assistants, and practising undergraduates.

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1) JAMALAINEN, E, A, 1950 - Den växtpatologiska litteraturen och kulturväxterna i Finland under de senaste halvtandra decenniet. In Swedish (The literature of the field of plant pathology in Finland during the last 15 years). Nordisk Jordbruksforskning, No. 1, 1949/1950, p. 12-29.

2) - " - 1943 and 1944 - Über Die Fusarien Finnlands, I-III. With Finnish Summary. Valt. maatalouskoetoim. julk. (Publ. of Finnish Sta.Agr.Res. Board), 122, 1943, p. 1-26 (I); 123, 1943, p. 1-25 (II); 124, 1944, p. 1-24 (III).

3) - " - 1946 - The Significance of Potato Virus Diseases in Finland. With Finnish Summary. Maataloustiet. Aikakauskirja (Journ.Sci.Agr.Soc. Finland), 18, p. 134-146.

4) - " - 1949 - Overwintering of Gramineae-Plants and Parasitic Fungi. I. Sclerotinia borealis Bubák & Vleugel. With Finnish Summary. Ibid., 21, p. 125-142.

5) OLLILA, LAILA 1947 - Tuhosienien merkityksestä perunavarastojen turmelijoina Suomessa. Summary: On the significance of fungous diseases in stored potato in Finland. Ibid., 19, p. 89-98.

MUKULA, J. 1950 - Säilytysaineiden käytöstä porkkanan varastoimisessa. Summary: On chemical prevention of storage rot of carrots. Ibid., 22, p. 86-92.

1. Investigations and experiments.

OVERWINTERING OF CEREALS, GRASSES, AND CLOVER. Though most of the cultivated fields in Finland are given to overvintering plants (winter ray and wheat, grasses, and clover), our knowledge about the reasons for poor overwintering is in many cases insufficient. In the investigations carried out by the Department of Plant Pathology, special attention has been paid to parasitic fungi damaging young crops of cereals, grass, and clover during winter. As there is much snow in winter in Finland, these so called overwintering fungi often play an important part in poor overwintering. With winter cereals and grasses damage is caused by snow mould (Fusarium nivale), in many cases also by the fungi of Typhula spp. and in central and northern parts of the country by Sclerotinia borealis. With clover, damage is often caused by rot of clover (Sclerotinia trifoliorum). Different varieties of winter cereals and different strains of grasses show great differences with regard to their resistance to damage caused by fungi. Poor overwintering of clover, winter cereals, and grasses is also due to many other factors, such as effects of successive freezing and thawing of soil, soil-ice needles, and real frost injuries, especially in districts and in winters with little snow. At the Department of Plant Pathology, the object of the investigations has been to define overwintering fungi to find out their occurrence in different parts of the country and damage caused by them, the resistance of different strains of grasses and clover, and winter cereals to winter damage, the importance of seed treatment with chemicals at the control of snow mould, and the effect of fertilizers and chemicals for disinfestation of soil on the overwintering of plants.

FOOT ROT DISEASES OF SPRING CEREALS. In a wide area in the part of Finland next to the Gulf of Bothnia, spring wheat thrives poorly because the kernels are scabbed. Investigations have shown that one reason for this, at least, has been a type of insects, Amblymerus graminum HÄRDH, hitherto unknown to science. In addition to this, it has been observed that also parasitic fungi, in the first place Cercosporella herpotrichioides FRON (eye spot disease) as well as some species of Fusarium can cause foot rot diseases. Foot rot diseases of spring cereals caused by parasitic fungi are also common in other parts of Finland.

RESISTANCE OF CROP PLANTS TO DISEASES. The Department has made continuous experiments on the resistance of new varieties of wheat to stinking smut and on the resistance of new varieties of potato to potato wart disease. The results have been reported to plant breeding stations. It was mentioned above that in the investigations of the overwintering of plants, attention was paid to the resistance of different varieties of winter cereals, and different strains of grasses and clover to winter. In addition to this, experiments have been carried out with varieties of cucumber in order to find out their resistance to antrachnose of cucumber (Cladosporium cucumerinum), of different varieties of raspberry to spur blight (Didymella applanata), and the resistance of different varieties of pea seeds to mould fungi (Fusarium spp.).

PLANT DISEASES DUE TO DEFICIENCY OF NUTRIENTS. As was already mentioned, the Department has earlier investigated the significance of boron in the plant cultivation in Finland to find out to what extent it improves the quality of yields and increases them. At present the Department is investigating manganese and magnesium deficiency diseases, which have been found in certain parts of the country in some field and garden plants.

DISEASES OF VEGETABLE AND ROOT CROPS. In Finland vegetable and root crops suffer during the growth period from several injurious diseases whose control is difficult. The most important of these are: downy mildew of onion (Peronospora destructor), anthracnose of cucumber (Cladosporium cucumerinum), leaf mould of tomato (C. fulvum) streak of tomato, club root of crucifers (Plasmodiophora brassicae), Sclerotinia disease (Sclerotinia sclerotiorum), and damping-off (caused by Pythium and Rhizoctonia fungi). This last mentioned disease has been thoroughly investigated by the Department, as well systematically as biologically. The Department has tried to find effective and usable substances for controlling all these diseases.

DISEASES OF FRUIT-TREES AND BERRIES. Of the diseases occurring in fruit-trees and berries, the Department has investigated the control of apple scab (Venturia inaequalis), brown rot (Sclerotinia fructigena), American mildew (Sphaerotheca mors uvae), and spur blight of raspberry (Didymella applanata). The effectiveness of different sprays against fungi has been investigated and observations made on their effect on the plants to be protected. It may be mentioned that Tricarbocol (preparation from Belgium) gave promising results for controlling American mildew and sprays of parathion-preparations seem to be of importande in controlling brown rot.

INVESTIGATIONS OF STORAGE. During the last few years the Department has conducted extensive investigations to find out what effects the fungi damaging plant products in storage and other injurious factors have on the stored plants. Most experiments were made with potato, carrots, and onion. At the storage of carrots good results were obtained with some conserving substances (cp. literature cited p. 3). In addition to this, also swede, cabbage, apples, and some vegetable crops have been used for experiments. Storage of onion has been an important problem, because especially the set onion (Allium cepa aggregatum) grown in Northern Finland has lately shown tendency to decay during storage. The experiments have thrown light on the effect of some chemicals, of different ways of storage, and of other facts on the stored plants and on the storage resistance of different varieties and strains. At the same time, some of the fungi found in the stored plants have been defined and biological experiments have been made with them.

2. Experiments with regard to the effectiveness of plant protectants.

Experiments conducted in order to find out the effectiveness of plant protectants have lately given the Department much work, because several new chemicals have been sent and are being sent to shops for sale, and it must be investigated whether they are suitable to be used in this country. It may be mentioned that in 1950 the Department of Plant Pathology investigated the following number of different substances and compounds in connection with various experiments: 11 seed treatment chemicals, 2 substances for treating bulbs, 11 sprays and dusts for fruit-trees, 5 sprays for berries, 13 sprays and dusts for vegetable crops, 13 soil disinfectant chemicals, and 10 conserving substances for plant products. Investigating the effectiveness of plant protectants does not only mean that

preparations of different names are compared to one another and compounds suitable for use are recommended. At this work, the Department has also deliberately searched among foreign preparations for such protectants as are necessary in Finland for preventing damage caused by injurious diseases whose control is difficult.

In 1951 the Finnish Parliament passed an act for examination of plant protectants, and this will come into force at the beginning of 1952. This law which regulates the trade of plant protectants will also greatly add to the work of the Departments of Plant Pathology and Pest Investigation of Agricultural Research Centre.

3. Supervision of plant protection.

According to the Plant Protection Act passed in 1925 and to the statutes and decisions connected with it[1] the Department of Plant Pathology must attend to measures controlling dangerous plant diseases. At this work, main attention has been given to potato wart disease and its control. This problem has become actual especially because Finland at present exports considerable amounts of nursery seedlings to neighbouring countries, and lately there has also been demand for export potato. The inspection of plants to be imported or exported takes place through the action of the Departments of Plant Pathology and Pest Investigation of Agricultural Research Centre. The Department of Plant Pathology examines the exported plants and the imported potato and gives the necessary certificates. Inspections of garden nurseries, their cultivations and stores are also related to this activity and conducted by the Department of Plant Pathology when possible.

4. Instruction concerning the control of plant diseases.

Because of numerous plant diseases and methods of controlling them the Department must devote much time to purely instructive work. The Department answers annually about a thousand questions about plant diseases put by growers. Agricultural and horticultural organizations have greatly increased their instructive activity with regard to plant protection. At this activity, the Department gives the directions concerning plant diseases. Firms preparing, importing, and selling fungicides and plant protection equipment continuously apply to the Department for information concerning the possibilities of using these fungicides and equipment in Finland. In cooperation with

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1) Plant Protection Act, June 5, 1925, No. 202.
Decision of Ministry of Agriculture concerning the conditions of importation and transit of potato, Sept. 9, 1935, No. 282.
Decision of Ministry of Agriculture concerning the conditions of importation and transit of plants and parts of plants from Belgium and the Netherlands, May 13, 1947, No. 395.
Decision of Ministry of Agriculture concerning the conditions of importation and transit of living plants and parts of plants, May 13, 1947, No. 396.

instructive organizations a campaign for promoting plant protection in gardens has been going on throughout the country since 1950. For this purpose, a plant protection assistant, at present O. S i l v o, B.Agr. and Forest., is working under the supervision of the Departments of Plant Pathology and Pest Investigation of Agricultural Research Centre. Part of this work was e.g. the instructive booklet on current activities for plant protection which was published in 1950 as an edition of 18.000 copies.

II. THE MOST IMPORTANT DISEASES OF CROP PLANTS IN FINLAND.

During its period of activity the Department of Plant Pathology has collected information about nearly 550 diseases occurring in crops, and about 100 of these diseases must be considered to be common and injurious.

It is difficult to present detailed calculations about the losses caused by plant diseases, as the damage naturally varies considerably in different years and in different parts of the country. The Department of Plant Pathology, however, has tried to give rough estimates on basis of the material gathered during several years, and the following figures were obtained: parasitic fungi, bacteria, and viruses destroy yearly 8-10 % of spring cereals and leguminous crops, 8-15 % of winter cereals, 12-18 % of potato, 8-12 % of vegetable and root crops, 8-12 % of yields of fruits and berries, and 8-15 % of fodder plants. In addition there are also non-parasitic plant diseases caused by unfavourable climatic conditions, deficiency of nutrients etc.

Of the diseases of c e r e a l s, smut fungi are common in Finland as well as in other countries. The most important of them is the bunt or stinking smut of wheat (Tilletia caries) damaging both winter and spring wheat. Other smut fungi to be found in Finland are loose smut of barley (Ustilago nuda), loose smut of wheat (U.tritici), covered smut of barley (U. hordei), loose smut of oats (U. avenae), and stripe smut of rye (Tuburcinia occulta), Increasing seed treatment with chemicals and new vatieties more resistant to smut diseases have recently diminished the significance of smut fungi. Leaf stripe of barley (Helminthosporium gramineum) is common and injurious in some parts of the country. In Finland considerable damage in winter cereals is often caused by overwintering fungi, which were described earlier in this paper. The most important of them is snow mould (Fusarium nivale), fungi of Typhula sp. are also common. Sclerotinia borealis only occurs in central and northern parts of the country, causing damage in some years. Rust fungi of cereals (Puccinia graminis, P. glumarum, P. coronata, P. triticina, P. dispersa, and P.hordei) are more or less common in Finland. Considerable damage,however, is only caused by them in certain years favourable for the occurrence of rust fungi. At present, the brown rust of wheat must be considered the most injurious of the rust fungi. Foot rot diseases (caused by Cercosporella herpotrichoides and Fusarium spp.)seem to be common, especially in spring wheat. Ergot (Claviceps purpurea) is common in winter rye and barley.

One of the most important means of controlling diseases of cereals is seed treatment with chemicals, which, however, is not yet so common in Finland as in many other countries. According to experiments, especially seed treatment of winter rye has considerably increased yields. In local experiments conducted in different parts of the country the increase in the yield of winter rye averaged 19 %. Local experiments have also resulted in considerable increases in the yields of spring crops: wheat 7.3 %, barley 7.5-12.5 % and oats 11.6 %. In the attempts of controlling overwintering fungi and rust fungi, chief attention has been paid to cultivating varieties resistant to these diseases.

With g r a s s e s, winter injuries are caused by the same fungi as with winter cereals. Winter injuries of clover are often due to the most important fungus of c l o v e r, rot of clover

(Sclerotinia trifoliorum). Also Typhula trifolii seems to occur in clover causing damage during winter. Poor overwintering of winter cereals, grasses, and clover is often also due to damage caused by successive freezing and thawing of soil, soil-ice needles, and frost (cp. p. 41).

The most injurious disease of the p o t a t o is potato late blight (Phytophthora infestans). In northern parts of the country the blight, however, cannot cause considerable damage because of early autumn frosts. Potato wart disease (Synchytrium endobioticum) chiefly occurs in southern parts of the country where it has spread especially in some towns and other thickly populated areas. Other fungus diseases of potato are e.g. Alternaria blight (Alternaria solani), Verticillium wilt (Verticillium albo-atrum), and common scab and powdery scab (Actinomyces sp. and Spongospora sp.). Virus diseases (streak, crinkle, and mild mosaic virus) are found in the potato fields of our country, but they are not of the same importance as in many more southern countries where seed potato must be changed every year, or at least every two or three years. Leaf roll of potato is practically not found in Finland at all. Finland ought to have good possibilities of exporting to other countries seed potatoes which are free of virus diseases. The most important of the diseases damaging potatoes in storage is potato blight. The second place is taken by bacteria rotting potato tubers. Even dry rot caused by Fusarium fungi (Fusarium coeruleum) is found in stored potatoes.

One of the most important means of controlling potato diseases is the cultivation of varieties resistant to blight, and during the independence of Finland farmers have more and more begun to grow such varieties. It is greatly due to this that the yields of potato have increased and at present average 15 tons per hectare in the whole country. In Finland sprayings for controlling potato blight are not in common use. It is possible that they might be used profitably in the southern parts of the country.

The most important of the diseases affecting v e g e t a b l e and r o o t c r o p s during the growth period are, with several plants, damping-off (caused by Rhizoctonia solani and Pythium de baryanum), Sclerotinia disease (Sclerotinia sclerotiorum) (especially in tomato, cucumber, and bean), Verticillium wilt (Verticillium albo-atrum), club root of crucifers (Plasmodiophora brassicae), heart rot of sugar beet (caused by deficiency of boron), anthracnose of cucumber (Cladosporium cucumerinum), downy mildew of onion (Peronospora destructor), virus disease of onion (Allium virus 1), blossom end rot of tomato, streak of tomato, potato late blight (Phytophthora infestans), and leaf mould (Cladosporium fulvum) in tomato, and anthracnose of beans (Colletotrichum Lindemuthianum). Of the diseases damaging stored plant products may be mentioned Sclerotinia disease (Sclerotinia sp.) and grey mould (Botrytis sp.), especially grey mould of onion (B. allii).

The control of the diseases of vegetable crops presents difficult problems, as the protectants used against them have not always proved effective enough.

Of the diseases of f r u i t - t r e e s, apple scab (Venturia inaequalis) is common and injurious. Brown rot (Sclerotinia fructigena) often damages the yield of apples, as does also cork disease (due to deficiency of boron). The greatest damage in cultivations of fruits and berries is caused by frost. 60-70 % of the fruit-trees in Finland were destroyed during the severe frost winters 1939-1942. Considerable frost injuries have occurred in many winters even

after that. Of other diseases of fruit-trees may be mentioned grown gall (Agrobacterium tumefaciens), pocket plums (Taphrina pruni), shot hole in plums and cherries, and silver leaf.

The following diseases occurring on cultivations of b e r r i e s, may be mentioned: American mildew (Sphaerotheca mors uvae), spur blight of raspberry (Didymella applanata), yellowing ov leaves of raspberry, leaf spot of Ribes species (Pseudopeziza ribis), Septoria leaf spot (Septoria ribis), rust fungi (Cronartium ribicola, Puccinia ribesii-caricis, and P. ribis), leaf spot of strawberry (Mycosphaerella fragariae), and grey mould (Botrytis sp.) in the berries of strawberry.

Spraying of fruit-trees in order to control parasitic fungi has lately become more and more common in Finland. Programmes for spraying fruit-trees and berries have been presented by the Departments of Plant Pathology and Pest Investigation of Agricultural Research Centre.

The cultivation of o r n a m e n t a l p l a n t s is at present of considerable economic value even in Finland. Diseases caused by fungi as well as physiogenic diseases are significant factors inhibiting the cultivation of these plants. For this reason, the Department of Plant Pathology has been obliged to give growers some instruction concerning the diseases of ornamental plants, chiefly on basis of information obtained from literature and observations. The Department has had only very limited possibilities of conducting investigations of the diseases of ornamental plants.