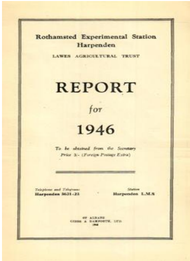
ROTHAMSTED RESEARCH

Rothamsted Report for 1946



Plant Pathology Department

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DEPARTMENT OF PLANT PATHOLOGY

By F. C. Bawden

Mr. L. Broadbent was given a grant by the A.R.C. for work on potato aphides and replaced Mr. J. P. Doncaster, who returned to the British Museum in January, 1946. Mrs. J. Bradley resigned her post as assistant to Mrs. Watson and was replaced by Miss B. M. Hamlyn in November, 1945. Dr. A. Kleczkowski, who has worked in the Department with a Beit Memorial Fellowship and other awards since 1940, was appointed to the staff in January, 1946. In June, 1946, Mr. J. Blencowe was awarded a research grant by the Sugar Beet Research and Education Committee to work with Mrs. Watson on sugar beet yellows. Mr. I. Macfarlane, Mr. R. P. Chaudhuri and Dr. K. S. Bhargava joined the Department as voluntary workers. During the course of the year the Department has had many visitors, from all parts of the world, who have stayed for periods ranging from one day to six weeks.

In November, 1945, Mr. Bawden visited Spain at the invitation of the Higher Council for Scientific Investigations and gave a course of lectures on virus diseases in Madrid. Mr. Bawden also gave the Cantor Lectures of the Royal Society of Arts. At the invitation of the Directie van de Zuiderzee Polders, Mr. Garrett visited Holland in July, 1946. Miss Glynne also visited Holland in connection with her work on eyespot of wheat and Mrs. Watson visited Holland and Belgium on behalf of the Sugar Beet Research and Education Committee. At the request of the Irish Sugar Corporation Mrs. Watson also visited Eire.

Virus diseases

1. *Laboratory work*

Considerable attention was again given to the various treatments that liberate viruses from infected leaves, and it was found that tobacco plants suffering from mosaic contain much more virus than was previously suspected. This virus sometimes amounts to one-third of the total insoluble nitrogen of the leaf, and accounts for as much as 10 per cent. of the dry matter. Less than a third of the total virus is obtained in the sap (68).

Electron micrographs of preparations of tobacco mosaic virus fractionated by differential ultra-centrifugation revealed particles of different sizes and lengths. The most slowly sedimenting fractions were mainly composed of small, almost spherical particles, but these particles readily aggregated to produce rods of various lengths (74).

The joint work with Mr. L. V. Chilton of Messrs. Ilford, directed to producing more suitable emulsions for the electron microscope, has continued. Attention has this year been directed chiefly towards emulsions desensitized to light, more concentrated and more highly conducting emulsions.

Potato virus X was also obtained from leaf residues by fine grinding and incubation with snail enzymes, but not by trypsin which destroyed the virus in the residues. As with tobacco mosaic virus, potato virus X preparations obtained by grinding leaf residues have different properties from those of preparations made in other ways, probably because they contain a greater proportion of small particles. These particles can be aggregated into long rods by suitable treatments. New strains of virus X have been found which reach higher concentrations in infected sap than those previously used. Yields of 2 g. per litre of sap have been obtained with some of these. The manner in which this virus inactivates and breaks down with various treatments has been studied.

A study was made of substances that reversibly inhibit the infectivity of tobacco mosaic virus. Most of these are substances charged oppositely from the virus and combine with it, often to produce a visible precipitate. The enzyme ribonuclease inhibited infectivity of the virus much more strongly than did other tested proteins which combined with it (78).

2. *Glasshouse work*

Considerable attention has been given to the conditions that affect the susceptibility of plants to infection with viruses. Light intensity was the most important of the variables tested. Reducing illumination in summer to one-third increased susceptibility to tobacco necrosis, tomato bushy stunt, tobacco mosaic and tomato aucuba mosaic viruses by more than five times. Reducing the light intensity also increased the virus content of sap from infected leaves (69).

Fertilisers also influenced susceptibility of plants to infection and the concentration of virus attained in infected plants. Increases of both nitrogen and phosphate reduced the number of local lesions produced by tobacco mosaic virus on *Nicotiana glutinosa* and by aucuba mosaic virus on tobacco. Potash had no significant effect. Phosphate significantly increased the virus content of infected plants, whereas nitrogen gave only a slight increase, and that only in the presence of sufficient phosphate. Virus preparations made from plants given widely different fertilisers did not differ from one another in their infectivities.

Several strains of potato virus Y have been differentiated by their reactions on a range of commercial potato varieties. These vary in the symptoms caused on Majestic from a severe leaf drop streak to a faint mottle. All these forms were transmitted by a number of different aphides, but no vector has been found for the aberrant strain, potato virus C, which causes top-necrosis in Majestic.

Different strains of potato virus X spread at different rates in the field, but even the most rapidly spreading strains infected only 10 per cent. of the healthy potato plants in contact with infected ones. Spread occurs much more rapidly between infected and healthy tomatoes, and in this plant root contact is as effective as foliage contact in spreading virus X (79).

A tobacco necrosis virus was isolated from the leaves and flowers of a naturally-infected *Primula obconica*, which showed no symptoms and in which the virus seemed to occur only in isolated areas. Tobacco necrosis viruses enter and multiply locally in primulas without producing symptoms; movement from the inoculated regions occurs only rarely and fails to give a full systemic infection (67).

The properties of dandelion yellow mosaic virus which causes a severe necrotic disease of lettuce were studied. It is transmitted by the aphides *Myzus ornatus*, *M. ascalonicus* and *Aulacorthum solani*, whereas lettuce mosaic virus is not transmitted by any of these vectors, but by *Myzus persicae* (77).

A yellowing disease has been found associated with a new variety of sugar beet in Ireland. All stocks of the variety were affected, and as the condition appears to be spreading to other varieties it may be a virus disease, possibly related to virus yellows, but this awaits confirmation.

Most of the diseased turnips and swedes examined during the year proved to be infected with cauliflower mosaic virus; the symptoms caused by this vary greatly with fertiliser treatment, and can be completely inhibited by potash deficiency. Both cauliflower mosaic and cabbage black ring-spot viruses (Turnip Virus 1) were shown to be non-persistent viruses.

Common pea mosaic virus was also shown to be a non-persistent virus. Of the three aphides, *Myzus persicae*, *Macrosiphum pisi* and *Aphis fabae*, *M. persicae* proved to be the most effective and *M. pisi* the least effective vector. For enation pea mosaic virus, on the other hand, *M. pisi* proved the best vector.

3. *Field work*

In cooperation with the Crop Physiology Section an experiment was made to determine the effect of infection with sugar beet yellows and mosaic viruses on growth and yield of beet. With the Insecticides Department experiments were made to test the effect of various insecticides, including D.D.T. and Gammexane, on spread of beet yellows virus from infected seed plants. An experiment was also arranged for the British Sugar Corporation to provide material for testing the effect of yellows on sugar content and "Noxious Nitrogen" of the beet.

In cooperation with Advisory Mycologists and others experiments with potato crops on the effect of date of planting and date of lifting, and on the effect of roguing on the spread of rugose mosaic (potato virus Y) and leaf roll, have been continued in Herts., Lincs., and Derby. Results of these experiments will be available in 1947. In 1945 the spread of rugose mosaic was smaller than usual. Leaf roll also increased less than usual in the Southern counties, but more than usual in Northern counties. Most of the transmission of rugose mosaic, and approximately half that of leaf roll, had occurred by the beginning of August. At Rothamsted roguing secondarily diseased plants in mid-July did not substantially reduce the spread of either rugose mosaic or leaf roll. In 1946 the survival of volunteer potatoes from the previous year's crop was of the usual order of from one thousand to four thousand per acre, but only few volunteers survived on the Rothamsted and Woburn Experimental Farms.

A survey of aphides overwintering on field and garden Brassicae, in glass and chitting houses, and on *Prunus* spp. was made during the early months of the year in Beds., Derby., Herts. and Lincs. The relatively mild winter and warm spring enabled the aphides

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to overwinter and achieve large populations on their winter hosts in many districts. A new site for the overwintering of aphides in this country was discovered, large numbers of the insects being found in mangold and swede clamps. During the autumn counts of aphides were made on mangold and swede crops in Derbys., Herts. and Lincs. Aphis counts were made on potatoes at Rothamsted, in Notts., Lincs., and Derby. Counts were also made by advisory entomologists and other cooperators at nine additional centres. Eighteen adhesive aphis traps were operated in connection with these experiments. Aphis populations of potatoes in the south of England were very small throughout the season; in Derby. and Lincs. they were below those of the previous year, but were still considerably higher than in the south. Trap catches were very small compared with past years.

Mycology

Violet root rot (Helicobasidium purpureum)

A laboratory study of factors affecting the production and growth of the mycelial strands of *H. purpureum* was completed during the year. Progressive infection and rotting of the potato tubers used in this study was obtained only when the tubers were attached to the parent plant and still growing; harvested tubers buried in glass jars of soil could be used, however, for measuring the production and epiphytic growth of mycelial strands in the laboratory. Production and growth of strands increased with concentration of nutrients in meat-malt agar, and especially with that of the malt constituent. Soil acidity depressed strand growth at medium and low but not at high soil moisture content, and not in the soil sand mixture (85).

A technique has been devised for investigating the survival in soil of the sclerotia of *H. purpureum*. Sclerotia are produced on agar plates and buried in glass jars of soil kept in the laboratory, and samples are tested at intervals for viability on carrot seedlings raised in the glasshouse. A new mycological tool, the multiple-point inoculating needle, was devised for this work (86). Preliminary results have indicated that longevity of sclerotia decreased with increase in nutrient concentration of the substrate on which they were formed, and especially with increase of nitrogen.

Clubroot (Plasmodiophora brassicae) of crucifers

A study of resting spore survival in *P. brassicae* by means of the infected root hair count method has indicated that, under suitable soil conditions of light texture, moderate acidity (pH 6·0) and high moisture content (80 per cent. of saturation), some 90 per cent. of the resting spores may germinate spontaneously in the first few weeks, or even days, after their incorporation with fallow soil, in spite of the absence of host plant roots. A proportion of the spores, however, do not germinate spontaneously in fallow soil, and so serve to perpetuate the organism. Experiments with dormancy-breaking stimulants are in progress.

Eyespot (Cercosporella herpotrichoides) of cereals

Regional surveys in E. Anglia and Northants showed increasing trouble from eyespot resulting from intensive cereal cultivation.

The yield of wheat grown in pots and infected by *Cercosporella* *herpotrichoides* was depressed while that in healthy control plants was little affected by too high a seed rate. Spraying with sulphuric acid in March increased the yield of infected plants, but not of healthy control plants. Spraying too late, i.e. mid-April, had little effect on yield of infected but reduced that of control plants. In a factorial field experiment on infected wheat, spraying with sulphuric acid in March reduced the area lodged from 90 to 30 per cent. Increase in seed rate and increase in top dressing with ammonium sulphate increased the area of crop lodged. Late-sown crops generally yielded less than early sown except with long strawed varieties which were badly lodged through disease in the earlier sowings.

The susceptibility to *C. herpotrichoides* of different hosts decreased in the following order: wheat, barley, oats, wild oats, rye.

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Take-all of Wheat and Barley

The take-all disease of wheat and barley, caused by *Ophiobolus graminis* Sacc., has been one of the main problems studied in the Department for the past 10 years. Mr. S. D. Garrett started his investigations of soil conditions that influence the occurrence of take-all at the Waite Agricultural Research Institute of Adelaide, South Australia, in 1932, and continued them when he came to Rothamsted in 1936. With the successful completion of a field experiment on the control of take-all, this comprehensive investigation has now been concluded. In the succeeding pages Mr. Garrett summarizes the results and conclusions to be drawn from his work.

Preliminary investigations in the glasshouse using earthenware pots containing 4 kg. of soil gave disappointing results, so a more precise method was sought. This was achieved by working in the laboratory and using glass tumblers holding 2–300 gm. soil as containers. The glass-tumbler method was first used to study the effect of soil conditions upon the rate of growth of the runner hyphae of *O. graminis* along the roots of wheat seedlings; growth was more rapid in light-textured than in heavy-textured soils, which agreed with the greater prevalence of take-all on light-textured soils in South Australia. Growth of the runner hyphae was found to be most rapid around 24° C., and wheat seedlings were most severely affected by the disease at this temperature (1).

Growth of the hyphae of *O. graminis* along wheat seedling roots was found to increase both with improvement in soil aeration and with rise in pH value of the soil, being most rapid in light-textured alkaline soils. Evidence was put forward for the hypothesis that the factor limiting rate of growth of the runner hyphae in heavy-textured and in acid soils was the accumulation of respiratory carbon dioxide in the micro-climate of the root surface zone. Good correlation was obtained between soil conditions optimum for growth of runner hyphae along the roots in these laboratory experiments, and those known to favour the field incidence of take-all in South Australia and elsewhere. This coincidence was epitomised as follows: "Rate of growth of the fungus along the root system must be one of the chief factors determining whether

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