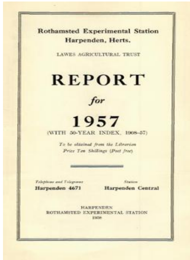
ROTHAMSTED RESEARCH

Report for 1957

Full Table of Content


Rothamsted Experimental Station
Harpenden, Herts.
REPORT
for
1957

Plant Pathology Department

F. C. Bawden

F. C. Bawden (1958) *Plant Pathology Department ;* Report For 1957, pp 104 - 123 **- DOI: https://doi.org/10.23637/ERADOC-1-90**

PLANT PATHOLOGY DEPARTMENT

F. C. Bawden

Staff changes were unusually numerous. Margaret M. Browne, whose work for the department as superintendent of the glasshouses for thirty years has been of inestimable value, retired in September and was succeeded by G. H. King. To the great pleasure of everyone, her meritorious service was acknowledged by the award of the M.B.E. in the New Year's Honours List. J. W. Blencowe and T. W. Tinsley both left to take posts at the West African Cocoa Research Institute and L. J. Cock to join the National Agricultural Advisory Service; A. J. Gibbs, B. D. Harrison and Judith Cox were appointed in their places. L. F. Gates left the Dunholme Field Station, and his successor has yet to be appointed. R. A. Dunning was appointed to a new post of entomologist at Dunholme.

E. W. Buxton was awarded a Kellogg Fellowship and spent three months at the University of California and visiting research stations in the U.S.A. L. Broadbent and B. Kassanis attended the Third International Congress on Potato Virus Diseases in Holland. As the guest of the organizers, F. C. Bawden took part in the International Congress for Poliomyelitis at Geneva, Switzerland, in July, and in symposia on viruses and virus diseases at New York in January and Madison in September. He also attended the meeting of the Advisory Committee for Agricultural Research in the Sudan at Khartoum. J. W. Blencowe and R. Hull attended the meeting of the International Institute of Sugar Beet Research Virus Committee in Holland in January. R. Hull also attended the Summer Congress in Italy in May and L. F. Gates the Winter Congress in Brussels in February.

L. Broadbent was awarded the degree of D.Sc., and R. S. Badami the degree of Ph.D., of London University.

Viruses and Virus Diseases

Work in collaboration with N. W. Pirie confirmed German and American reports that preparations of the nucleic acid from tobacco mosaic could be infective but did not substantiate claims by American workers that infective particles could be synthesized by recombining non-infective nucleic acid with virus protein. Preparations of nucleic acid remain infective for long periods at -15° C., but lose their infectivity rapidly when exposed to many conditions that do not affect intact virus particles, and recombination with the protein may protect against these types of inactivation. Exposure to many biological fluids inactivates the nucleic acid, perhaps because the fluids contain ribonuclease, but this is not a necessary conclusion, because many other substances, both organic and inorganic, are also powerful inactivators. The relative infectivity of nucleic acid and intact virus depends on the physiological state of inoculated leaves; exudates from leaves resistant to infection by nucleic acid sometimes inactivated nucleic acid more than did exudates from susceptible leaves, but the results were inconstant, and the identity of the inactivators remains undetermined. (Bawden.)

When the phenol method of preparing infective preparations of nucleic acid from tobacco mosaic virus was applied to potato virus X, it gave infective solutions in which no usual virus particles were detected by electron microscopy or serological tests. However, the infectivity was always too slight to be sure that residual virus was not responsible, though this possibility was partly excluded by finding that infectivity was lost in conditions in which normal virus is unaffected. The nucleic acid was also separated electrophoretically from the protein of potato virus X after disruption by exposure to alkali, but this was not infective. This virus does not move in an electric field at pH 7, but both the protein and the nucleic acid do after the particles are disrupted by alkali. (Bawden and Kleczkowski.)

The protein produced by alkali from tobacco mosaic virus moves more slowly than intact virus particles at pH 7; when it is recombined with the nucleic acid its mobility is increased but not restored to that of the original virus. Japanese workers claimed that exposing tobacco mosaic virus for a few minutes at 60° to a potential gradient of 160 V/cm. completely destroys its infectivity and precipitability by its antiserum. This was not confirmed, though both properties were somewhat affected by the treatment.

Experiments on the electrophoresis of antigen–antibody compounds suggested that there was only one kind of bonding between tobacco mosaic virus and its antibody but two between serum albumin and its antibody. (Kleczkowski.)

Electron microscopy

The new Siemens electron microscope installed during the year proved both reliable and satisfactory to use, and the amount of routine examination of virus preparations greatly increased. Using specially prepared test specimens, this machine can give resolutions of the order of 1 mμ, but no such results are obtainable with viruses. Much time has been spent trying to identify and eliminate the limiting factors, but the techniques of making specimens still prevent the microscope from revealing all the details of structure that are theoretically possible. The granular structure of the metal films in shadow-cast preparations of viruses is one limitation, but it is difficult to distinguish this from other sources of granularity, derived from the supporting film, the surface from which it was cast and minute contaminants derived from distilled water, glassware and the air. The presence of oil droplets in the evaporating plant, the rate at which metal is evaporated and the thickness of the final metal film all combine to limit the effective resolution in shadowed pictures of virus particles to about 3 mμ. The greater contrast given by the new microscope when unshadowed mounts of purified viruses are used show that these also are granular, with a grain size similar to that in shadowed mounts, so that improvements in the methods of shadowing seem unlikely to give much more information on the detailed surface structure of the virus particles.

Electron " stains " seemed to offer some prospect of using the full resolving power to gain information on structure, but unfortunately the small particles of most of the plant viruses are so closely packed internally that too few heavy atoms become attached to give more than a slight increase in contrast. Of the many " stains " tested, only iodine and uranyl acetate stained tobacco mosaic virus appreciably, and neither did so enough to resolve any internal structure. The salt-outlining technique described by Mercer had the serious disadvantage that it gave sufficient contrast only when the contrast medium was present in amounts that prevented high resolutions. Intact rods of tobacco mosaic virus did not stain in the way Mercer described.

There is no problem in determining the gross size and shape of virus particles, but it seems at the moment that most information about their detailed structure is likely to be gained by studying fragmented particles and using their own power to scatter electrons, rather than adding high-contrast material that introduces its own artefacts.

Thin-section work was resumed to study the effects of infection on the leaf components and to try to find the sites of virus multiplication, and was extended to work on the infection of root hairs by *Rhizobium* sp. The structure of montmorillonite was further studied by electron microscopy, and a start was made to explore the value of electron diffraction for this kind of subject. (Nixon.)

Virus multiplication and inactivation

Attempts were made to free chrysanthemum plants from infection by seven different viruses, by growing them for 4 weeks at 36°, after which cuttings were taken from the treated plants. Many of the cuttings were free from tomato aspermy, stunt and ring pattern viruses, but the method did not get rid of vein mottle, viruses B or D, or an unnamed one. Treatment at 36° also failed to free narcissus bulbs from stripe or Wedgewood iris from a virus causing a mosaic disease. (Kassanis and Broadbent.)

Previous work suggested that the ability of thiouracil to prevent the multiplication of viruses was determined more by the identity of the infected host than by the identity of the virus, for all viruses tested in tobacco were affected, whereas none was in beans. However, tests with cucumber mosaic virus suggest that inhibitors of multiplication may act more against some viruses than against others. The multiplication of cucumber mosaic virus in tobacco was only slightly decreased by thiouracil, which almost prevents the multiplication of tobacco mosaic and several other viruses, whereas it was almost wholly prevented by 8-azaguanine, which has only a slight effect on the multiplication of tobacco mosaic virus. (Badami.)

In growing plants such inhibitors prevent virus multiplication but have not yet been found able to free systemically infected plants from infection. Thiouracil, however, freed tobacco callus growing in tissue cultures from infection by potato virus Y. When kept for 6 weeks in media containing 100 mg./litre of thiouracil, the tissues

https://doi.org/10.23637/ERADOC-1-90

grew poorly, but they grew normally when again transferred to normal media, and some of such treated cultures have remained apparently free from virus for many months and after many sub-cultures. The amount of virus Y in systemically infected plants was decreased by spraying with thiouracil, but the virus was not eliminated. (Kassanis.)

The knowledge that various treatments decrease virus content suggests that they might be combined to produce virus-free clones from infected varieties that are not cured by one treatment alone. Excising apical meristems from infected plants first grown at high temperatures or treated with thiouracil now obviously warrants testing. Gibberellic acid, too, although it does not much affect virus content, might be of help, as it causes stems to elongate rapidly. Spraying tobacco plants infected with tobacco etch virus with gibberellic acid partially overcame the stunting usual to this infection. Infected plants normally stay in the rosette stage for long periods, but when treated with gibberellic acid their stems almost immediately began to elongate; after two months, however, the growth rate of sprayed infected plants decreased to that of unsprayed ones. The acid makes the leaves more fragile and lighter green than usual, but the seeming similarity of the effect to growing in shade was not accompanied by any increase in susceptibility to infection by tobacco mosaic virus.

Previous experiments showed that the damaging effects of ultra-violet light on plants and viruses could be counteracted by exposure to visible light. The photo-reactivation of viruses, of damage to the epidermis of beans leaves and of the susceptibility of leaves to infection by virus were all produced by visible light of the same wavelengths, and only by wavelengths shorter than 4,700 Å. (Chessin.)

Potato viruses

The aphid infestations of potatoes in 1957, as of most other crops, were greater than in any year since 1940, when we first started observing them. At Rothamsted *Myzus persicae* was even more numerous in May and June than at other places where traps were operated. Other species were also plentiful, and during 10 days at the end of May 5,205 aphids were caught on a trap at Harlow, more than twice as many as were ever caught in previous years during a period of the same length. Potatoes were also infested unusually early, and there were winged and wingless aphids on the Rothamsted crops before most of the plants had emerged above ground. Parasites and predators multiplied rapidly and caused the aphid population to decline; the table shows the course of the infestation of an unsprayed potato crop at Rothamsted and that there was no summer migration of winged aphids from the crop. As a result of the early and heavy infestation there were more plants with symptoms of primary leaf roll and of infection with potato virus Y than have been seen at Rothamsted previously. Whether the beneficial effects of spraying with insecticides in decreasing the spread of virus diseases, found in earlier years, will be obtained in 1957 will not be known until next year, but it seems improbable. Aphids were on the plants before the first spray was

https://doi.org/10.23637/ERADOC-1-90

applied, and as DDT did not kill those under the leaves of very small plants, " Metasystox " was also used on the first and second occasions plants were sprayed in the insecticides trial.

Numbers of aphids per 100 *potato leaves*

Date	*Myzus persicae* Winged	*Myzus persicae* Wingless	Other species
31 May *	90	288	108
12 June	69	371	102
19 June	14	531	243
26 June	35	213	566
3 July	0	30	125
8 July	0	18	54
22 July	0	0	48
20 August	0	4	15
5 September	0	3	158

* On 31 May only one-third of the plants had emerged above ground.

In 1956 DDT emulsion controlled aphids excellently and satisfactorily decreased the spread of virus diseases. Bulk samples of " seed " saved from an experiment in which Stock Seed Majestic was contaminated by 0·8 per cent plants with leaf roll and 0·8 per cent with potato virus Y, gave 6 per cent plants with leaf roll and 4 per cent with virus Y when unsprayed, compared with 1 per cent and 1·5 per cent when sprayed four or six times, with either low- or high-volume applications. Samples of " seed " saved from plants adjacent to the contaminators, gave 24 per cent plants with leaf roll and 18 per cent with virus Y, compared with 0·4 and 3 per cent in sprayed plots. Spraying again increased the yield of tubers; the increase of 6 per cent, 16 cwt./acre, more than balanced the loss of 12 cwt./acre caused by the passage of the tractor through the crop when spraying.

Experiments with insecticides at other places in 1956 gave equally satisfactory results. At Lymington spraying the variety Ulster Prince fortnightly with DDT almost prevented spread, whereas in unsprayed plots the incidence of leaf roll increased nine times and of virus Y by three times. A stock of this variety now in its fourth year at Lymington has only 1 per cent plants with leaf roll and 0·3 per cent with virus Y, whereas at the indicated rate of spread in unsprayed crops the whole stock would now be infected but for the spraying with DDT.

Tests in which seed tubers were planted on top of a small quantity of the systemic insecticide " Thimet " adsorbed on charcoal showed that the treatment prevented aphids from breeding on the plants for at least 4 weeks after they emerged above ground, though it did not prevent winged ones from alighting on them. (Broadbent and Heathcote.)

We have previously reported producing a clone of King Edward VII potatoes free from paracrinkle virus. This year there were enough glasshouse-grown tubers to grow twenty-five in the open, and their performance was compared with that of twenty-five similarly grown but infected tubers. Although there was no obvious difference between the growth or appearance of the two lots of plants, the virus-free clone yielded better than the other. (Kassanis.)

The interactions between potato viruses C and Y were further studied. As obtained from Edgecote Purple potatoes, virus C is not transmissible by *Myzus persicae* and gives only necrotic local lesions when inoculated to the variety Majestic. Our type strain of virus Y is readily transmitted by *M. persicae*, and gives no local lesions in Majestic but a rapidly developing systemic disease, with mosaic and necrotic lesions. From tobacco plants infected simultaneously with both viruses, virus C is often transmitted by *M. persicae*, but transmissions to Majestic potatoes also show that these mixed infections yield a range of variants that differ from both C and Y. Isolates derived from single local lesions in Majestic differ in their ability to invade Majestic systemically and in the severity and type of lesions they cause in uninoculated leaves. Some affect the stems, and may kill parts or all of the plant; others affect only a few of the older leaves. Some are unstable and when continued in tobacco change to forms more nearly resembling the type strain of virus Y. The ability of different isolates to be transmitted by *M. persicae* differs and is decreased by passage through Majestic potatoes. Some, although coming from tobacco plants infected by aphids, could not be transmitted by aphids after being returned to tobacco from local lesions in Majestic. (Watson.)

What seems an unusual strain of potato virus Y was also obtained from a plant of *Solanum jasminoides* sent from India, where the presence of this virus was suspected. From its behaviour in Majestic and other potato varieties, the strain closely resembled our stock of potato virus C, but unlike this one it was readily transmitted by *Myzus persicae*. At least it was so when it was separated from two other viruses present in the *S. jasminoides*, for these decreased the multiplication of the strain of virus Y and its transmissibility by aphids. The other two seem not to have been previously described, and are not serologically related to virus Y or to one another, though all three have long flexible particles of similar size and shape. One was transmitted by *M. persicae*, though only rarely, and no vector was found for the other. (Badami and Kassanis.)

Viruses of cereals and grasses

Symptoms suggestive of infection with cereal yellow dwarf virus were widespread in cereal crops, but the virus could not be recovered from many plants sent here for diagnosis. It was unusually prevalent at Rothamsted, but there is also the possibility that there was some other cause of yellowing. Another small trial to measure the effects on yield of infection introduced at different times gave results different from 1956 and difficult to interpret with certainty. The yield of two wheat and two barley varieties was barely affected, and only oats behaved as in 1956 and gave losses of 17–37 per cent. The apparent lack of effect on yield of wheat and barley could partly be explained by the plants in the control plots becoming naturally infected at the time the second lot of plants were infected artificially. However, unless the strain spreading naturally was more virulent than the one introduced, this seems unlikely to be the whole explanation, for not all the plants in the control plots showed symptoms. Isolates that were more virulent than the one used in the field trial were obtained from naturally infected plants in different localities, but none was so virulent as some that have been described in the U.S.A. Also, not all isolates seem to have the same host range, and we have failed to infect Cock's foot, which is a host of American strains. Our isolates infected perennial ryegrass, Timothy, crested dog's tail, black twitch, meadow foxtail and *Poa annua*; false oat (*Avena elatior*) became yellow, but attempts to recover the virus from it failed.

All the isolates were transmitted by the aphids *Rhopalosiphum padi*, *Sitobium fragariae*, *S. granarium* and *Myzus circumflexus*. In comparable conditions, *S. fragariae* infected only about one-third as many plants as did the other species.

In tests with *R. padi* the proportion of test plants that became infected increased with increasing time the aphids spent on both infected plants and test plants. No infections occurred when the total time on the two was less than 10 hours, and few in less than 24 hours when the infection-feeding time was only 2 hours. With infection-feeding times of more than 8 hours, infections were sometimes obtained in test feedings of 2 hours, so that the period of inability to transmit was shortened by lengthening the infection-feeding time. (Watson and Mulligan.)

Wheat striate mosaic virus was transmitted by all forms and stages of *Delphacodes pellucida*. The insects needed to feed for periods of 9–24 hours to become potentially infective, and the longer the infection feeding was prolonged, the more likely it was that the insects became able to transmit. After leaving infected plants, there was a period of from 7 to 30 days during which they were unable to transmit; once they passed this period, most infected in test feedings of 24 hours and about one in fifty did so in only 20 minutes' feeding on healthy plants. Insects remained infective for weeks or months, and as the virus is egg-transmitted, many progeny of infective females became infective without having themselves fed on infected plants. Some of the progeny of infective females failed to infect wheat plants on which they fed, although it seems they contained virus, for progeny from them were infective.

Wheat striate mosaic virus infected all varieties of wheat, oats and barley that were tested; also rye and ryegrass, but not maize or rice. It was not common enough in cereal crops to be economically important, but it seems to be widely distributed and merits watching. Different strains of *D. pellucida* differed considerably in their ability to transmit, and the occurrence of efficient vectors in large numbers might increase the prevalence of the virus in crops. At the moment it is mainly of interest because of its unusual behaviour in its insect vector; it seems primarily a virus inhabiting the insect and weeds and which only occasionally gets into cereal crops. (Watson and Slykhuis.)

The transmission of ryegrass mosaic virus by eriophyid mites, suspected last year, was confirmed, and the vector identified by Dr. H. H. Keifer as *Abacarus hystrix* (Nalepa). The results of early experiments were inconclusive because the symptoms were slight and transient, but with the use of a more virulent strain of the virus diagnosis became more certain. Of forty-five types of ryegrass inoculated mechanically, more than twenty showed symptoms, which were more evident in Italian than in perennial types. Three weeks after being inoculated in the three-leaf stage the strain S22 IRG had only two-thirds the dry weight of comparable uninfected plants. The virus also infected *Festuca pratensis*, *Cynosurus cristatus* and *Poa annua*, which promises to be a useful test plant, as it showed a bright mosaic and yellowing of the leaf tips. The virus sedimented when ultracentrifuged for 90 minutes at 20,000 r.p.m., and such sedimented material contained rod-shaped particles about 20 mμ wide and 400 mμ long. (Mulligan.)

The properties of the seed-transmitted barley false stripe virus, reported last year to have been encountered in the French variety Gloire du-Velay growing in Cambridge, were studied. It has stiff particles, about 30 mμ wide and 150 mμ long. Preparations can be fractionated by precipitation with ammonium sulphate (40 per cent saturation) and alternate low- and high-speed centrifugation; like potato virus X, the virus tends to go insoluble, but this tendency can be checked by dissolving the sediments in pH 7·5 citrate buffer. Although sap is not highly infective, it contains much specific nucleoprotein, and an antiserum was readily prepared against it. The virus is inactivated by freezing sap at —15°, but not if sodium chloride or sucrose are added. Barley false stripe virus infected summer spinach, causing a bright mottle and ring pattern. (Kassanis and Slykhuis.)

Virus diseases of sugar beet

Sugar beet yellows was more serious than for several years, an unexpected happening, because the disease was less prevalent at the end of 1956 than in any year since 1942. The unprecedently rapid spread of the disease early in 1957 is attributable to the mild winter, which led to an unusually early and heavy infestation of the crop by *M. persicae*. At the end of May there was an average of twenty-seven *M. persicae* per twenty plants in 150 sampled root crops, compared with the highest previous figure of 1·5. Many of the aphids that came early into sugar-beet root crops in south Cambridgeshire, Essex, Suffolk and the south-east of England must already have been infective, for despite spraying with insecticides in May, all the plants were showing yellows by mid-June. In other fields the same insecticidal treatment decreased the incidence of yellows. This early invasion of the root crop by many infective aphids suggests there may be some previously unsuspected overwintering source of the virus, but the virus may have come from known sources, such as wild beet, clamped mangolds and weed hosts, which may have survived through the mild winter in unusually large numbers. (Hull.)

Wild beet, which continued to increase in many parts of East Anglia, was certainly locally important. In some places the plant grows so vigorously as to present the same general appearance as a densely grown seed crop of beet or mangolds. In the spring *M. persicae* was found breeding freely on wild beet, and aphids were found on about half of the plants examined. There can be little doubt that the insects had over-wintered on them and that they provided one source of virus for the early outbreak of yellows in the beet crops of south-east England.

During the late spring an effort was made to eradicate wild beet from parts of the beach on the Shotley Peninsula of Suffolk. The plants were sprayed to run-off with an MCPA-type weed-killer, at the concentrations recommended for weed-control in cereal crops. Knapsack and barrow-mounted spraying machines were used, and most of the wild beet was found to be moribund within a few weeks. However, many beet seedlings grew around the dead plants, and it is obvious that spraying would need to be continued for several years to eliminate all plants coming from seed lying dormant on the beaches. Only then would it be possible to observe the rate at which beaches became re-infested by beet seed floating ashore from other parts of the estuaries or coast-line. This test showed that farmers could control the wild beet growing on their own foreshores but an attempt to eradicate the plant from large stretches of beach, would meet many technical and administrative difficulties. (Blencowe.)

Because of the early aphid infestation, crops were examined daily by the staff of the British Sugar Corporation, and warnings were issued of the need to spray when numbers reached an average of one per plant. In consequence, 100,000 acres were sprayed, mostly with beneficial effects, but growers who delayed until the infestation was heavier did not derive the full benefit. Spraying with "Metasystox" decreased the incidence of yellows in all eighteen experiments done in conjunction with the Sugar Corporation and increased yield in twelve. In the south-east, where aphids arrived early, spraying in May increased yield, but in mid-June was ineffective. Further north, a spray in mid-June gave some increase in yield over that obtained by an earlier spray. In crops with less than 20 per cent of the plants affected by the end of August, spraying did not increase yield. Where the incidence in unsprayed crops exceeded 90 per cent, two sprays increased yields by amounts up to 4·5 tons of roots/acre, increased sugar content by 1 per cent and also improved the purity of the juice. " Metasystox " was almost as effective when applied at low as at high volume; other proprietary organo-phosphorus insecticides were less effective, and a proprietary formulation of benzene hexachloride, which was used on some commercial crops, was ineffective.

In previous years when yellows has caused serious losses the disease was worst in regions, mainly the Fens, where seed crops are grown. This year, however, these regions were less affected than the south-east, no doubt because the seed crops started the year healthy because of the certification schemes now operated to provide virus-free stecklings. Only a few stecklings were infected in the autumn of 1956, and counts in June showed only an average of 3·9 per cent plants with yellows in beet seed crops and 6·8 per cent in mangold seed crops. Later, however, the disease increased rapidly because of infective aphids coming into the crops, and some became 100 per cent infected.

In the autumn of 1957, 133 sugar-beet steckling beds had 0·50 per cent of plants with yellows. Five beds were rejected because they had over 1·5 per cent. Four hundred and twelve mangold steckling beds had an average of 4·1 per cent of infected plants; 192 beds had less than 2 per cent infected plants, 174 had between 2 and 10 per cent, and 46 had over 10 per cent. This is the highest incidence of yellows in stecklings since the certification scheme was started in 1951.

In the autumn of 1957 few stecklings had yellows in a crop raised under barley for the second of the series of experiments to compare a transplanted crop with that grown-on where sown. In June the grown-on plots looked as though they would yield better than the transplanted ones and thus confirm the previous year's results that the grown-on plots gave $11\frac{1}{2}$ per cent more seed than the transplanted ones. Spring applications of TCA at 10 lb./acre and IPC at 6 lb./acre decreased weeds and volunteer barley without visibly injuring the beet plants. In contrast to 1956, autumn treatments were not as effective as spring treatments. (Dunham, Gates and Hull.)

Seed treatment, and applying "Thimet" and Disyston to soil at sowing, gave beet seedlings which were toxic for up to 6 weeks to aphids in Petri dishes. The treatments did not control yellows in the root crop at Dunholme, where most spread of yellows occurred after the toxic effects had worn off. Stecklings from seed sown in August with similar treatments were also toxic to aphids; the effects on yellows incidence will not be known until next June. (Gates.)

Seed of inbred lines of sugar beet selected over 10 years for resistance to yellows was distributed in the spring to commercial breeders and to the Plant Breeding Institute. In a trial near Ipswich, where yellows was severe, line A7S/1 outyielded Sharpes E and Battles E in sugar per acre by 13 and 27 per cent respectively, and line Q1S/1 outyielded them by 16 and 30 per cent respectively. Some lines showed symptoms of yellows later than others; for instance, in early July line 55/21/6 had 14 per cent of plants with yellows, whereas Sharpes E had 73 per cent. Production of seed and testing of other selections was continued. (Hull.)

Myzus persicae multiplied more rapidly on plants with yellows than on healthy plants in the glasshouse, and more rapidly on plants infected with an avirulent than with a virulent strain. (Baker.)

The virus isolated previously from wild beet, and called water mottle, appears to be related to beet mosaic virus. It does not protect plants against infection with the mosaic virus, and the two viruses can multiply in the same plant, but the necrotic local lesions characteristic of infection with water mottle do not develop when the virus is inoculated to leaves with symptoms of beet mosaic. The type of symptom caused varies widely with the genetical constitution of the beet. Five inbred lines from Dunholme were compared with Kleinwanzleben E for the amount of stem necrosis produced. Two lines developed none, and their symptoms resembled those of beet mosaic. One was nearly defoliated by stem necrosis, one had about the same amount of necrosis as Klein E and the fifth had about half as much stem necrosis. The necrosis increased as light intensity and day-length decreased. The virus was transmitted by both *M. persicae* and *M. ascalonicus*, but much less readily than beet mosaic virus. All beet mosaic viruses obtained from wild beet contained the water-mottle virus, but one from Barnfield 1957 did not. (Watson.)

Gamma-rays prevented sprouting of stored mangolds (*Beta vulgaris*) in a trial carried out in the winter of 1956–57. Orange

https://doi.org/10.23637/ERADOC-1-90

Globe Mangolds, in batches of five, were irradiated at Harwell on 7 November 1956. After treatment the mangolds were bedded in damp sand in an unheated building at Dunholme. On 8 April 1957 the mean lengths of the sprouts were 5·7, 3·2, 1·5, 0·0, 0·0 and 0·0 inches on the batches given 0, 5,000, 10,000, 20,000, 30,000 and 40,000 rads respectively.

Apterous viviparous *M. persicae* were irradiated at Wantage with gamma-rays and returned to Dunholme, where they were cultured for about 10 days on young turnip plants in the glasshouse. Doses of 14,000 and 12,000 rads arrested reproduction; doses of 10,000, 8,000 and 6,000 reduced it, and a dose of 4,000 rads had no perceptible effect on it.

Tetrachloronitrobenzene was more effective as a sprout depressant on topped than on untopped mangolds, when, after treatment, they were bedded in damp sand in an untreated building during the winter. The tetrachloronitrobenzene inhibited the sprouting of a mangold but only when actually touching it, and ceased to act in this way as soon as the powder was washed off. (Cornford.)

Mycology

Potato diseases

The early phases of potato-blight epidemics were studied for the fourth successive year: 580 naturally and 590 artificially infected tubers were planted among 1,500 healthy guard tubers. For the first time in the open *Phytophthora infestans* invaded stems from naturally infected tubers (two), and again it did so from two artificially infected tubers. Part of the plot was irrigated to make the mean weekly precipitation equal to 1 inch, about twice average rainfall. The purpose was to test whether this increased or accelerated the invasion of stems by the fungus, but there was no evidence that it did. However, there were several pockets of infected plants in the irrigated plot that could not be associated with fungus coming from invaded stems, a phenomenon not found before.

The first invaded stems were found on 16 July 1957, considerably later than in 1954 (28 May) or 1956 (12 June). In 1955 no invaded stems were found. The late appearance in 1957 may have resulted from the hot sunny weather during most of June, which gave soil-surface temperatures over 100° F. July was cool and wet, and the disease spread from the initial sources more rapidly than previously recorded. Only 4 weeks elapsed between the outbreak starting and all plants in the plot being infected, compared with 8 weeks in 1954 and 7 in 1956. The rapid spread compensated for the late appearance of the fungus above ground, and as usual blight outbreaks were common in the district during the first half of August. The disease then developed slowly until mid-September, when both sprayed and unsprayed plots were rapidly destroyed. Increase of yield (0·72 tons/acre) from two protective copper oxychloride sprays was not statistically significant; nor was tuber infection (1 per cent) important on the variety Majestic at lifting.

Last year we reported a first estimate of the proportion of infections on plants within a crop that results from spores transferred by leaf contact or dripping water. Repetition of the experiment in

1957 again suggested that about half (43 per cent) of the infections originated in this way.

Records from a surface-wetness recorder exposed beneath an undisturbed potato canopy were compared with those of a similar instrument exposed at the level of the canopy. Leaves below the canopy remained wet considerably longer after rain, but the reverse applied on dew nights when lower leaves often remained dry. (Hirst and Stedman.)

In 1956 the rates at which the varieties Up-to-Date, King Edward, Majestic and Arran Viking were attacked by blight in small plots, planted as a 4 × 4 Latin Square in a crop of Majestic, were unexpectedly similar. To test whether differences in field resistance were obscured by this arrangement, two differently placed 4 × 4 Latin Squares were used in 1957; in one the plots were surrounded by guard rows of the same variety as in the plot, which allowed interactions between varieties to be studied in the guards, and in the other the varieties were surrounded by an equal area of kale.

The tall dense canopy of Up-to-Date affected the microclimate in adjacent rows of other varieties, but there was no obvious spread of blight from plots of one variety to those of another. The rate at which different varieties were destroyed by blight differed no more than in 1956, but the two experiments gave different results. In the experiment with plots surrounded by potato plants all the varieties were 50 per cent defoliated within 3 days of each other, with Arran Viking rated to be as susceptible as Up-to-Date. In the other experiment there was a difference of 6 days, and Arran Viking became 50 per cent defoliated 3 days later than Up-to-Date. King Edward was the first variety to be 50 per cent defoliated in the experiment with guard rows of potatoes and the last in the one with guard rows of kale.

Blight appeared in both experiments in early August, but developed more slowly in the plots surrounded by kale, which reached 50 per cent defoliation 7–10 days later. Unfortunately this experiment was planted 14 days later, so that the two crops were not comparable when blight appeared. Whether differences in microclimate or supply of inoculum determined the rate at which blight developed is difficult to assess.

Other studies suggested differences between the varieties that might determine the rates at which they are destroyed. Inoculating the leaf axils of plants in the glasshouse with drops of a spore suspension showed varietal differences in the susceptibility of petiole and stem. Thirty such inoculations to Up-to-Date, King Edward, Majestic and Arran Viking produced 13, 8, 1 and 0 stem lesions and 19, 20, 2 and 1 petiole infections respectively. In the field in 1957 stem lesions were very frequent in Up-to-Date and King Edward, few in Majestic and even rarer in Arran Viking. Observations of marked leaflets in the field showed that petiole infection killed 30, 25, 16 and 6 per cent of leaflets in the four varieties. Lesions on leaflets occurred most often at the tips and edges, places where water persisted. No difference was noted in the time between infection and lesion formation or spore production on the four varieties, but as in 1956 the extent of sporulation differed in different varieties.

Resistance of tubers to infection increased in the order Up-to-Date, King Edward, Majestic and Arran Viking.

The common race of the fungus was Race 4, but plots of the hypersensitive varieties Orion (R_1 gene) and Pentland Ace (R_3) became infected at the beginning of September, and the races responsible were identified as 1, 4 and 3, 4 respectively.

A report that a spray containing potassium silicate controlled blight on outdoor tomatoes led to small-scale tests in the laboratory and glasshouse. Commercial potassium silicate (66° TW) incorporated in a chick-pea agar at 0·5, 1·0 and 5·0 per cent concentrations prevented the growth of the fungus, and in water inhibited the germination of sporangia. When sprayed on tomato plants, 5 per cent silicate was phytotoxic, but this and lower concentrations applied a few days or hours before inoculation with *P. infestans* failed to prevent blight. The effects in agar and water probably result from the pH of 9–10.

The incorporation of a sticker (2 per cent Celacol) and/or a wetter (1 : 8,000 Manoxol) with the spray decreased the mean number of lesions per leaf from 217 (1 per cent silicate) to 18 (silicate plus wetter and sticker), but wetter alone also decreased lesions from 158 to 6 lesions per leaf. Some batches of the commercial silicate were contaminated with traces of soap, which may explain the control claimed. (Lapwood.)

Two fungicides, thiram and PCNB, which decreased the incidence of the browning caused by *Oospora pustulans* on potato roots and stolons in 1956, were used again in 1957 at Rothamsted and Woburn. A 10 per cent thiram dust applied to the seed and the furrow at 150 lb./acre decreased the disease rating (DR) from 54 to 41 per cent at Rothamsted, and from 48 to 21 per cent at Woburn. Applied only to the furrow, it had no effect, and applied only to the seed, it decreased the DR at Woburn (21 per cent) but not at Rothamsted (53 per cent). Similarly, a 20 per cent PCNB dust applied to the seed and to the furrow at 300 lb./acre decreased the DR at Rothamsted (19 per cent) and at Woburn (34 per cent), and also at Woburn (19 per cent) when applied only to the seed. Dung at 15 tons/acre had no effect on the disease. Seed and furrow treatment with thiram and PCNB also decreased eye infections and the incidence of skin-spot lesions when the tubers were stored. In the clamp skin spot developed on 74 per cent of tubers from untreated plots and on only 28 and 39 per cent from plots and seed treated respectively with thiram and PCNB.

Majestic seed tubers free from *O. pustulans* were used in a small field trial to test the effect of inoculation at planting time. Tubers dipped in a mycelium and spore suspension all produced shoots with severely browned roots and stolons, whereas most uninoculated plants had no browning. Inoculation decreased the number of tubers at lifting time by 24 per cent, but their weight by only 9 per cent.

The incidence of lesions on root and stolons was recorded late in July on maincrop varieties at six National Institute of Agricultural Botany centres. As in previous years, it varied considerably with locality and variety. The DR was lowest on black fen soil (18 per cent) and highest on medium loam at Sprowston (48 per cent) and heavy silt at Terrington (40 per cent). The average DR at all centres was highest on Majestic (57 per cent) and Ulster Torch (50 per cent) and lowest on Ulster Supreme (10 per cent) and Arran Viking (9 per cent); this reflected the extent to which eyes on the original seed tubers were infected. Only the Majestic seed had appreciable skin spot postules; Ulster Torch had none. (Salt.)

Apple scab

Work on apple scab, caused by *Venturia inaequalis*, was continued in attempts to improve the forecasting and prevention of outbreaks. In the Wisbech area of Cambridgeshire spraying of Bramley's Seedling was again done with phenyl mercury compounds applied to act therapeutically soon after weather favouring infection occurred. Since introducing this practice, the disease has become much less prevalent, even though only about half the number of sprays formerly given are now applied. Our observations are necessarily restricted to sprayed orchards, and so we cannot establish how much of the improvement results directly from the new practice, but there is circumstantial evidence that much does. For example, in the 2 years since the accurately timed sprays have been applied in one orchard the ascospores caught have averaged only 4 per cent of the number caught during the three previous years; and in a second orchard a similar decrease occurred between 1956 and 1957 with the introduction of the timed sprayings. Also, whereas dead leaves from other orchards in the district continued to produce many ascospores in the spring, leaves from these two produced few.

The number of ascospores to which trees are exposed in the spring depends on two factors; the amount of dead leaves per unit area of ground and the yield of ascospores per unit area of dead leaves. The accurate timing of curative sprays controls scab so well that infections occur only on leaves formed at the tips of extension growths after spraying is stopped, but in different orchards different quantities of dead leaf survive through the winter. In three sampled in December 1956 the dead leaf (dry matter) amounted to 1,395, 990 and 860 lb./acre, whereas in March 1957 these weights had fallen to 718, 92 and 29. Attempts will be made to find what causes such differences and the importance of surviving leaves in initiating scab outbreaks.

The simplified surface-wetness recorder, used to indicate periods suitable for infection by *V. inaequalis*, was developed further in conjunction with the Meteorological Office, and a prototype, which was tested successfully, has now gone into production. Valuable as it is, however, the instrument does not provide the complete answer for detecting meteorological conditions that allow infection. Further information is needed on how temperature affects the required period for leaves to remain wet, and on the duration of dry periods, within wet spells, that are lethal to the fungus. (Hirst and Stedman.)

Cereal diseases

Stunted plants and whiteheads caused by *Ophiobolus graminis* occur most years on Broadbalk, but 1957 was the first year in which the attack was so severe that patches of plants were killed. The take-all patches were all on the east half of the field, and their outlines spread over plot boundaries; they all occurred on plots that had been limed, and they were worse on land that had been acid before it was limed. As usual, the disease was negligible in the crop after fallow, but unusually it was worse on plots 8, 13, 14 and 15, which received nitrogenous fertilizers, than on plots which did not. The unprecedently low yield of 7·1 cwt./acre for plot 8 VB was correlated with 85 per cent of the plot showing take-all patches; 8 VA, of which only 12 per cent showed take-all, yielded 19 cwt./acre. (Glynne.)

Preliminary experiments, in which wheat was grown in pots containing soil from different fields, suggested that this method might indicate the amount of *O. graminis* present, for the incidence of take-all in the test wheat was correlated with its incidence in previous crops in fields from which soil was taken.

Earlier experiments showed that the identity of preceding crops greatly affects the incidence of take-all and eyespot (*Cercosporella herpotrichoides*) and the yield of wheat. The land from the discontinued four-course rotation experiment was used to try to assess the relative effects on yield of these two diseases and other factors; for this purpose wheat, spring barley and oats were taken where wheat or barley had been grown in 1955 or 1956. The 1957 wheat crops following wheat or barley in 1956 had an average of 78 per cent straws infected by *C. herpotrichoides*, and 11 per cent of the plants had *O. graminis* on their roots in July. On land where wheat or barley in 1955 was followed by potatoes or beans in 1956 the 1957 wheat had 22 per cent of straws infected with *C. herpotrichoides* and 0·3 per cent with *O. graminis*. The 1957 barley suffered little from either disease, and the oats appeared free from both. All three yielded better on land which carried potatoes or beans in 1956, but whereas oats yielded only 6 per cent less on land that carried wheat or barley in 1956, barley yielded 13 per cent and wheat 29 per cent less.

The survival of *C. herpotrichoides* was estimated by finding the number of pieces of straw on the surface that produced spores when incubated in the laboratory. The average number per square yards was twenty-seven where wheat or barley was taken in 1956 and only one where it was taken in 1955. In February the incidence of eyespot lesions was 46 per cent in wheat growing on the first and 2 per cent on the second plot of land. (Glynne and Cock.)

In the second year of an experiment measuring effects of sowing date, seedrate and nitrogen, Cappelle wheat was grown on rich land free from eyespot and take-all. Mean grain yields (excluding edge rows) were 51·9, 50·8, 49·1, 46·7 cwt./acre for plots sown 18 September, 15 October, 8 November and 4 December respectively. Early sowings yielded less, and later ones more than last year, except that Koga II wheat sown in March yielded only 39 compared with 46 cwt./acre last year. The September to November sowings yielded most at 1½ and the December sowing at 4½ bushels/acre. Last year nitrogen affected yield little, but 6 cwt. sulphate of ammonia gave the highest mean yield. This year added nitrogen depressed yields, especially of the October and November sowings; plots that received

3, 6, 9 cwt./acre sulphate of ammonia respectively gave mean yields of 52·4, 49·6 and 46·8 cwt./acre. Although the crop was apparently supplied with ample nutrients, the outside rows yielded more than the inner ones, and those on the south side yielded more than those on the north; in both years the relative difference between outside and inside rows decreased with lateness of sowing. The winter wheat was attacked by larvae of *Opomyza florum*, which entered and killed tillers in March and April. Early sown wheat was more heavily infested than late; on 2 April wheat sown in September, October, November and December had respectively 83, 32, 7 and 5 per cent plants and 36, 9, 2, 2 per cent shoots infested. The tillers damaged were mostly late formed ones, and the effect on yield did not seem serious. (Glynne and Slope.)

To measure the loss in yield of wheat caused separately by take-all and weeds, a site was selected on Highfield which had grown five successive wheat crops, the last two of which have failed because of severe take-all and weeds. In preparation for the experiment in 1957, the site was cropped in 1956 with Cappelle wheat, and S 172 winter oats, to give contrasting levels of take-all infestation without interfering greatly with the weed population or soil fertility. At harvest 70 per cent of the wheat straws were severely affected by take-all, and 98 per cent had infected roots. The oats were not infected. In 1957 Koga II wheat was drilled over the whole site, but the results were disappointing because in spite of its previous severity, take-all was not sufficiently prevalent to cause appreciable loss. Spraying with CMPP (4-chloro-2-methylphenoxy proprionic acid) controlled chickweed and other weeds which became abundant in unsprayed plots, but it also increased severe take-all from 14 to 26 per cent straws infected after wheat, and from 8 to 16 per cent after oats. The increased grain yield from spraying, 0·7 cwt./acre after wheat and 1·3 cwt./acre after oats, was too small to be significant statistically; the gain from weed control was apparently offset by the increase in take-all. (Salt.)

A new cereal rotation experiment was begun on land previously cropped with beans in 1956 and spring wheat in 1955. The crops to be used, viz., winter and spring wheat, spring barley, spring oats and field beans, can all be machine-drilled and combine-harvested, and the object of the experiment is to grow these crops in a sequence in which neither eyespot nor take-all becomes severe enough to reduce yields. In July this year 1 per cent of the straws of the winter wheat were infected by eyespot, but there was no infection of the spring-sown cereals. The grain yields were: winter wheat 45·5, spring wheat 39·7, barley 40·7, oats 27·3 cwt./acre. (Slope.)

Changing temperature affected different attributes of *C. herpotrichoides* differently. Spores were produced on discs of pure culture more quickly at 10° C. (3 days) than at 5° C. (10 days), and discs at 15°, 20° or 25° C. produced no spores. Discs that had been at 15–25° C. for periods up to 17 days began sporing within a week when transferred to 10° C. Naturally infected straws which were already sporing stopped sporing within 3 days at 25° C., between the 6th and 10th day at 20° C. and between the 12th and 14th day at 15° C. Increasing temperature increased the rate at which spores germinated; 80 per cent germination required 20 hours at 15–25° C., 44 hours at 10° C. and 92 hours at 5° C. Lesions also develop on wheat seedlings quicker at the higher temperatures. Single seedlings growing in test-tubes containing culture solution were inoculated on the coleoptile with one drop of spore suspension and placed in humid chambers, where they developed black stromata on the first leaf sheath within 21 days at 25° C., 14 days at 20° C., 24 days at 10° C., 28 days at 5° C. The only sporing occurred within 14 days on the coleoptiles of plants at 10° C. although there were no visible lesions. (Salt.)

Diseases of peas

The mechanisms of variation in *Fusarium oxysporum* f. *pisi*, the cause of pea wilt, were further studied to see whether changes in pathogenicity were influenced by the host. There is good evidence that exposing bacteria to appropriate substrates induces them to form enzymes that attack the substrates, but little is known of the ability of fungi to adapt when exposed to host-produced substrates. The pea wilt fungi provide an opportunity to study this problem, for exudates from roots of pea varieties that are hosts for different pathogenic races affect the spores of different races differentially. For example, spores of race 1 cannot grow in exudate from the roots of the variety Alaska, which resists it, whereas the growth of race 2, which can wilt Alaska, is stimulated by the exudate. Tests were therefore made of the pathogenicity of race 1 spores after exposing them to root exudate from the variety Alaska. Spores were kept for 14 days in concentrated exudate, or were transferred at periods of 48 hours to a series of increasing concentrations of exudate for 14 days, when they were inoculated to the susceptible pea variety Onward and to the resistant Alaska. After 26 days, 84 per cent wilt was recorded in Alaska inoculated with spores kept in concentrated exudate and 100 per cent with those exposed to higher concentrations. Alaska inoculated with spores kept in sterile water did not wilt. Similar results were obtained whether the spores grew in the exudate (incubation at 25° C.) or were in a resting state (incubated at 4° C.). Not only did the exudate-treated spores infect and wilt Alaska, but their usual 100 per cent ability to wilt the susceptible variety Onward was decreased to a mean of 73 per cent.

This action of Alaska root exudate in conferring pathogenicity towards Alaska, and simultaneously decreasing the virulence of race 1 towards Onward, may occur because of a mechanism similar to enzymatic adaptation, or because mutants of altered pathogenicity were selected by the exudate. The fact that there were no wilted plants in the controls inoculated with spores kept in sterile water, nor any healthy plants among those inoculated with exudate-treated spores, however, makes it unlikely that selection of random mutations was responsible.

The adapted cultures of race 1 maintained their changed pathogenic abilities through six successive isolations from and re-inoculations to Alaska peas. Preliminary tests do not suggest that the changes in pathogenicity are accompanied by ability of the spores to germinate in Alaska root exudate.

Exposure to products of the actinomycete *Streptomyces albido-*

flavus also produced changes in the pea-wilt fungus, which after such exposure grew in solutions that previously inhibited growth.

Solutions of DNBP applied to a wilt-sick field at Rayne, Essex, delayed the onset of wilt, but towards the end of the season the disease was equally severe on treated and untreated plots. Of new pea varieties from New Zealand (supplied by the National Institute of Agricultural Botany, Cambridge), tested at Rayne, Blue Prussian had 28 per cent plants wilted, Greenfeast 35 per cent and Resistant Onward 46 per cent, compared with English Onward 100 per cent; wilt occurred 3 weeks sooner in the English than in the New Zealand varieties. Tests for resistance in glasshouses at Cambridge and at Rothamsted, using three soil types, gave results similar to those obtained in the field. (Buxton.)

When *Fusarium oxysporum* f. *pisi* and *F. solani* f. *pisi* (the cause of wilt and foot rot of peas respectively) are inoculated together to peas, variety Onward, wilt occurs more slowly and is less severe than when *F. oxysporum* is inoculated on its own. This effect occurred with both race 1 and race 2 of *F. oxysporum* f. *pisi*, and it was increased by increasing the amounts of *F. solani* added to a constant amount of *F. oxysporum* in the inoculum. It also occurred in both sterile and non-sterile soil, showing that other soil-borne micro-organisms are not involved in the effect.

F. solani has no antagonistic effect on *F. oxysporum* when the two are grown together on agar media, and culture filtrates of *F. solani* do not affect the growth of *F. oxysporum*. It seemed that the host plant may be affected by *F. solani* so as to affect the entry or development of *F. oxysporum*, but root exudate from a plant infected with *F. solani* did not inhibit the germination of spores of *F. oxysporum* and extracts from foot-rot lesions inhibited only slightly.

The interaction seems of little practical importance in the field, for many plants of the variety Onward growing in a wilt-sick field contained *F. solani* f. *pisi* in the stem before *F. oxysporum* f. *pisi*. Later, when pods were beginning to form, *F. solani* f. *pisi* was found in 50 per cent and *F. oxysporum* f. *pisi* in 90 per cent of the plants examined. The peas died soon after, and at most it seems *F. solani* only delayed the development of the disease. (Perry.)

Clubroot of crucifers

As part of an attempt to find better differential hosts for strains of *Plasmodiophora brassicae*, radish varieties were tested for their susceptibility to several isolates. No useful differential effects were observed, but the varieties differed greatly in their susceptibility to all isolates. For example, almost all plants of the variety Woods Frame, a long radish, showed symptoms, whereas the turnip radish, Red Forcing, was highly resistant. The types of symptom varied from well-developed clubs to small black necrotic lesions, a symptom recorded only for radishes.

As alternatives to mixtures of sand and soil as media for growing clubbed plants, trials were made with mixtures of sand and peat. Cabbage seedlings were transplanted to the mixtures in pots, inoculum was poured on to the surface and nutrients added in solution. With sphagnum peat and sand in equal volumes, growth of the plants was retarded at first and there was little or no infection, but clubs developed when the peat was diluted with three times its volume of sand. Sedge peat was better and clubs formed consistently and more quickly in mixtures of it with sand in the proportions of 1 : 1 or 1 : 3, and such mixtures may be preferable to many soils for clubroot experiments.

The technique devised by Fahreus of growing clover seedlings in agar between a slide and a cover-glass for observing infection by *Rhizobium* was used successfully with crucifer seedlings and *P. brassicae* by incorporating spores in dilute Hoagland's solution with the agar just before it sets. The method promises to be useful in studying, for example, penetration by the zoospores and for experiments where it is important to keep the inoculum in a fixed position near the root.

Before counts of root-hair infections can be analysed statistically they must be transformed to a logarithmic function to make the standard errors independent of the mean. Several such transformations were tried on many results, and the most generally applicable was that devised by Kleczkowski for virus local-lesion counts.

Several questions relating to the sampling of seedlings with root-hair infections were investigated. There is no evidence of any correlation between the length of the root and the number of infections sustained by it, but in one experiment with seedlings 4·6–5·5 cm. and 5·6–6·5 cm. long the most infections occurred on 2nd, 3rd and 4th cm. of root, measured from the junction with the hypocotyl, with few near the hypocotyl or tip. The distribution of infections was affected by treatments, and although sampling only a part of the root has the advantages of easier handling on the microscope, at present it seems safer to sample along the whole root. (Macfarlane.)

Sugar-beet diseases

The effects of seed treatment with fungicides and insecticides were again determined at seventeen centres in co-operation with the British Sugar Corporation. Fungicides increase the stand of seedlings by about 40 per cent, but insecticides gave little additional increase. Seed steeped in ethyl mercury phosphate solution gave 10 per cent more seedlings than seed treated with dry organo-mercury dressings. Ten tons of seed steeped in ethyl mercury phosphate proved satisfactory when used commercially, and in the Sugar Corporation's trials with low seeding-rate, precision drills gave 10 per cent better stands of seedlings than dry-dressed seed.

Seed of a polyploid variety of sugar beet, which had shown severe injury by γ-BHC seed dressing in 1956, was treated with various dosages of different γ-BHC formulations. No injury to foliage or roots was observed this year; evidently the injury in 1956 had seasonal causes. (Gates.)

Sprays containing 0·1 and 0·05 per cent streptomycin, applied 1 day before the plants were artificially inoculated, effectively controlled downy mildew (*Peronospora schachtii*) on sugar-beet seedlings in the glasshouse. The sprays were less effective when inoculations were made 5 or 7 days after the seedlings were sprayed, and they had no effect when inoculations were made 11 days after.

Pleospora betae Bjorling, the ascigerous form of *Phoma betae*

https://doi.org/10.23637/ERADOC-1-90

Frank, was first found in this country at Dunholme, Lincs, in October 1957. The black hemispherical perithecia, about 300 μ in breadth, were found in abundance on the bark of dried stems of wild beet (*Beta vulgaris*). Cultures obtained by the Commonwealth Mycological Institute from the transversely and vertically septate ascospores were found by them to be identical with cultures obtained from the pycnospores and from a black-leg lesion on a sugar-beet seedling. (Cornford.)

Clamped sugar beet decomposing in January in Essex were invaded by many different fungi and bacteria. It was concluded that they were not primary pathogens but were growing on beets injured by severe frosts in November. (Hull.)

Entomogenous fungi

In collaboration with D. Long (Entomology Department), wheat-bulb flies (*Leptohylemyia coarctata*) showing symptoms that appeared to be correlated with fungal attack were examined. Three major symptoms were distinguished:

(1) Cysts in abdomen, internally covered by sporulating fungi.
(2) Abdomen converted to a white non-sporing mycelial mass.
(3) Abdomen distended and full of spores of a red fungus.

Among many fungi isolated, *Entomophthora grylli*, *E. muscae*, *E. coronata*, *Cephalosporium* sp., *Penicillium* sp. and *Mucor hiemalis* were common and *Fusarium roseum*, *Stemphylium* sp. and several bacteria more rare.

Spore suspensions were prepared from cultures of *E. grylli*, *Mucor hiemalis* and *Cephalosporium* sp. and sprayed on live flies in cages kept in the laboratory, or sprayed on live flies in nylon cages kept outside. Flies were also fed on fungus cultures before they were released into cages outside.

Control flies were sprayed with water or fed on plain agar media. Daily observations of death rates showed that, 10 days after inoculation, a mean of 40 per cent had died in each of the three treated sets, and the fungi used as inoculum were readily isolated from flies bearing the original symptoms. The controls, which remained healthy at first, had an equally high death rate after 10 days, although deaths were mostly from causes unrelated to those in the inoculated sets. (Buxton.)

https://doi.org/10.23637/ERADOC-1-90