ROTHAMSTED RESEARCH

Rothamsted Report for 1967

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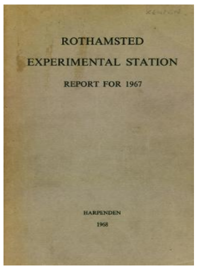

General Report

F. C. Bawden

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GENERAL REPORT

F. C. BAWDEN

P. H. Gregory retired from the post of head of the Plant Pathology Department and J. M. Hirst was appointed to succeed him. Gregory first joined the department in 1940, to study the spread of viruses in potato crops, and his work with J. P. Doncaster on this subject provided a model for future epidemiologists. However, primarily a mycologist, he later turned his attention to the spread of fungi and general aerobiology, again pioneering in a subject that has developed rapidly. In 1954 he left to become Professor of Botany at the Imperial College, University of London, but returned in 1958 as head of the department. Two others who retired after also giving notable service to the Plant Pathology Department were Beatrice Allard, who first came to the Station in 1921, and G. Hooper, who came in 1934. P. J. G. Mann, who came to the Station in 1940 and was a founder member of the Biochemistry Department, also retired. A meticulous biochemist and consistently productive, he was a world authority on plant enzymes.

Four senior members of staff left to take up appointments elsewhere: R. K. Cunningham to become an adviser on agricultural research in the Ministry of Overseas Development; J. Monteith to become Professor of Physiology and Environmental Studies in the Faculty of Agriculture, University of Nottingham; H. D. Patterson to join the Agricultural Research Council Unit of Statistics at the University of Edinburgh; F. Raw, to become Professor of Applied Entomology in the University of Queensland, Brisbane, where, it is tragic to report, he died in October.

Computer Department. The National Committee for Computers has recommended that we shall have a new computer, and a new building was planned to house it and the members of a new Computer Department, to be formed on 1 January 1968 with D. H. Rees as its head. The new department will be responsible for operating the computer and for applying it to problems not involving statistics, for which both the demand and needs grow rapidly. As the Statistics Department does for statistics, so the Computer Department will provide a service not only to workers at Rothamsted but also at other agricultural research stations. The Statistics Department will continue to be responsible for statistical computer programs and for work on the computer needing statistics.

Mr. J. A. Nelder, head of the Statistics Department of the National Vegetable Research Station, Wellesbourne, was appointed to succeed F. Yates as head of the Statistics Department from 1 April 1968.

Buildings and equipment. A new instrument workshop was finished and occupied, and at the end of the year a building to house our long-planned rooms and cabinets for growing plants in controlled environments was nearly complete.

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The farmhouse and buildings at Scout Farm, together with 4 acres of land adjoining, were sold.

Major items of new equipment acquired were a second electron microscope, a vacuum spectrometer for X-ray fluorescent analysis and a mass spectrometer with gas-chromatograph attachment. The new electron microscope will mainly be used to study fine structure, such as the morphology of viruses, and the old one mainly for work with sectioned material, a type of work that is increasing greatly. X-ray fluorescence has proved even better than expected for analysis of some elements in soil, and is not only more sensitive than previous methods but also faster. The mass spectrometer, also, has soon proved its value in separating and characterising molecules with specific biological activities.

Honours and awards. Her Majesty the Queen conferred the honour of Knight Bachelor on F. C. Bawden; he was also elected an Honorary Fellow of Emmanuel College, Cambridge, and awarded the degree of Doctor of Technology (*Honoris causa*) of Brunel University. G. W. Cooke was awarded the Research Medal of the Royal Agricultural Society of England. D. J. Watson was elected President of the Association of Applied Biologists and F. Yates President of the Royal Statistical Society.

Visitors and visits. The many visitors we welcomed from home and overseas included the Ministers of Agriculture for Thailand and for Ceylon, and the Deputy Minister of Agriculture for Rumania.

As the departmental reports show, several members of staff are active in the International Biological Programme, which adds another reason to older ones, for travel overseas, such as attending international congresses, lecturing or advising. Eleven members of staff were seconded to work overseas, two in Australia, Ghana and the United States of America and one in Fiji, Kenya, Malaysia, Pakistan and Trinidad. F. C. Bawden attended a meeting of the Technical Advisory Committee of the Faculty of Agriculture, University of the West Indies, at Trinidad in January and afterwards visited Clemson University, Carolina. In March he was chairman of the last meeting of the Agricultural Research Council of Central Africa, held in Malawi, and afterwards visited the Experiment Station of the South African Sugar Association, Mount Edgecombe, Natal, where he gave the opening address at the Association's Annual Meeting; on the homeward journey he visited the East African Agriculture and Forestry Research Organisation at Mguga, Kenya. In August he was a guest speaker at the International Congress of Agricultural Economists in Sydney, and on his way to and from the congress visited agricultural research centres in Ceylon, Malaysia, Australia, New Zealand and the United States of America.

The weather and crops. Although rain was nearly 3 in. more than average and sunshine 30 hours fewer, the year favoured most crops, and yields were good. Indeed, in the Ley–Arable Experiment at Rothamsted, which over the past few years has consistently yielded more than 60 cwt/acre of winter wheat on some plots, yields exceeding 70 cwt were obtained for the first

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time. The excess rain fell mainly during May, after the spring crops were planted, and in October, after most crops were harvested. The rain in May leached much nitrogen from the soil (at Saxmundham the drainage water carried away nearly as much nitrogen during one day in May as during the whole period between October 1966 and March 1967), and the cereal crops later were patchy and yellow. However, the pastures benefited from the rain and yielded large crops for silage and hay; also, with fine weather in June, the hay was of excellent quality.

Attempts to grow winter wheat by direct seeding in unploughed land sprayed with herbicide again failed at Rothamsted, because on this heavy land too many grassy weeds survived. At Woburn, where the method has previously been satisfactory, it was not in 1967, because slugs killed many of the young plants in the unploughed plots. Slugs are not usually an important pest on the light Woburn soil and did little or no damage on the ploughed plots, but they were seemingly favoured by the shelter given to them by the debris remaining on the sprayed plots, and the temperatures early in the year allowed them to be active.

June, July, August and September all had less rain than average, and cereals ripened early at Woburn and Saxmundham, where the soil holds less water than at Rothamsted. At Rothamsted irrigation during June increased the yield of barley by 3 cwt/acre and of beans by 6 cwt/acre. At Woburn irrigation increased the yield of spring wheat by an average of 8 cwt/acre, and gave a notable maximum yield of 59 cwt/acre; yield of maincrop potatoes was increased by about 3 tons of tubers, and irrigation that kept the soil moist during the early life of the tubers also prevented them from becoming scabbed.

At Rothamsted potatoes yielded well, Majestic and King Edward both averaging about 22 tons/acre, but at Woburn yields were smaller and differed greatly in different fields. Some crops died prematurely, possibly because of infection with *Verticillium* aided by nematodes. Potato blight was unimportant, but in this year of abundant aphids potato virus Y, which causes leaf-drop-streak in plants newly infected and severe mosaic in plants raised from infected tubers, spread more than for many years past; fortunately, our home-grown seed produced only few plants with severe mosaic, for around each of these the virus spread widely and gave a large patch of plants with leaf-drop-streak, resembling the usual appearance of a patch around a primary focus of potato blight.

Beans yielded less than in 1966 and, exceptionally, two sprays with insecticide were needed to control black aphids. They were also infected by viruses transmitted by other aphids. A main source of these viruses and aphids, for peas no less than beans, is lucerne (alfalfa). The recommended treatment for controlling weeds in lucerne, spraying with paraquat during winter, may help to lessen the spread of viruses from the crop because sprayed plots carried many fewer aphids during April than unsprayed plots.

Except on light land infested with free-living nematodes, where "Docking disorder" was unusually prevalent and damaging, sugar beet did well. In earlier years with such mild winters and June so favourable to aphids, yellows spread early and caused much loss. However, with spray warnings

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going out early, most of the acreage was sprayed at least once with a systemic insecticide, and at the end of August the incidence of yellows in the general crop was less than 8%. In experiments, sowing seed treated with a systemic insecticide checked yellows and increased yields of sugar by 7 cwt/acre, and there was no further gain from spraying the crop.

In past years when aphids have been so abundant and active, yields of carrots at Woburn have been small because they were infected early with carrot motley dwarf virus. However, sprayed three times with a systemic insecticide, they were largely protected from it in 1967 and yielded 30 tons/acre.

Disinfection of soil and the control of soil-borne pests and diseases. The large yields of wheat from the Ley–Arable Experiments, already mentioned, are not restricted to the sections where arable crops alternate with leys, but are also obtained in the sections where arable crops are grown each year, provided enough fertiliser is given. However, comparable manuring usually fails to produce the same yields on other arable fields, and most of the difference must be attributable to the fact that the rotation of crops in the Ley–Arable Experiment is designed to avoid damage by soil-borne pests and diseases, many of which are also favoured less by the heavy soil at Rothamsted than by light land. More direct evidence of the losses these pests and diseases can cause comes from the increased yields reported by several departments from applying various pesticides to soil. An increased yield, however, is no immediate proof that a pest or disease has been controlled, for partial sterilisation of soil has other effects than killing harmful organisms and, in particular, by killing other organisms it releases much extra nitrogen that benefits the succeeding crop. Hence, only where yields after using a disinfectant exceed those obtained by manuring generously with nitrogen can the benefit be with certainty attributed to the control of soil-borne pathogens. We not only report examples of each kind of benefit but also of the fact that crops with damaged roots need more nitrogen to produce only a moderate yield than crops with healthy roots need to yield well.

There is nothing new in the knowledge that partial sterilisation of soil benefits the growth of plants, for this was established here about 60 years ago and was soon applied in the glasshouse industry, where the continued growing of such crops as tomatoes and cucumbers has depended on the soil being regularly steamed or treated with a disinfecting chemical. There is, too, nothing new in the idea that it might be equally useful to agriculture, if only it could be done cheaply enough. As early as 1913, Russell and Buddin wrote, in the *Journal of the Society of Chemical Industry*, "The present cost of an antiseptic is not necessarily a bar to its use in practice. Long before Lawes started the manufacture of superphosphate it was known from laboratory experiments that addition of calcium phosphate to the soil increased plant growth. In the year 1842, this substance appears in a popular price list at 3*d.* per oz, a wholly impossible price for practical agricultural purposes. Yet 1843 saw the manufacture of superphosphate at a price well within the means of a farmer, and a few years later this fertiliser was coming into widespread use. If effective antiseptics are found

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fulfilling the requirements of the grower, there is every reason to anticipate a satisfactory demand for them."

More than 50 years later, we seem to be near fulfilling the requirement of some growers whose crops are harmed by nematodes. Regrettably, there is still no fungicide we can recommend to control such soil-borne diseases as take-all of cereals, although the need becomes ever more evident as the number of recognised soil-borne pathogens increases and farming becomes more specialised, with cereals being grown increasingly often on the same land. The problem remains one of cost, for take-all and various diseases caused by soil-borne fungi can be controlled by applying formalin to the soil. However, the beneficial effect lasts for one crop only, and although the annual use of formalin is worth while on the small area of land used to raise forest-tree seedlings, it is not an economic proposition for cereal growing. Also, formalin is not a good nematicide, and there is some evidence that its use may encourage cereal cyst-eelworm to multiply more than it otherwise would. Except for this, its effect on take-all is much the same as growing an insusceptible crop, that is greatly diminishing the incidence in the first cereal crop but tending to make it more in succeeding ones than had it not been used.

The fact that the year favoured the free-living nematodes that cause "Docking disorder" of sugar beet also favoured work on its control, and several experiments showed large increases in yield from using such well-known nematicides as "D-D", applied not only as usually recommended to whole fields but in smaller amounts to pre-determined rows where the beet was later to be sown. In addition to benefiting greatly from these nematicides, sugar yield was increased from 29 to 62 cwt/acre in one experiment, and from 48 to 80 cwt/acre in another, by the simple treatment of drilling a few ounces per acre of a systemic pesticide in the furrow with the seed. Obviously with such a response, a direct chemical attack on these nematodes is a very practical proposition, even though it may benefit only the one crop.

A direct attack by chemicals seems the only way to control losses from these nematodes because they feed on the roots of almost any kind of plant and a rotation of different kinds of crops is no safeguard against them, as it is against more specialised parasites such as the cyst eelworms or the take-all fungus. Fortunately, the populations of these free-living nematodes are diminished by fumigation with nematicides for longer than are those of the cyst eelworms. "D-D" can give excellent crops of potatoes on land so infested with the potato cyst-eelworm that yield otherwise would be less than a ton of tubers per acre, but when the good potato crop is harvested the population of cysts will be as great, or even greater, than before the fumigation. The free-living nematodes recover much less rapidly; indeed, beet in 1967 yielded more on plots fumigated in 1965 than on those fumigated late in 1966, suggesting that the more recently applied "D-D", although it greatly increased yield by killing nematodes, also adversely affected the growth of beet, perhaps because it inhibited the nitrification of ammonium nitrogen. Harmful effects of "D-D" were more evident in wheat, which on some recently fumigated plots had deformed and partially sterile ears. Harmful effects, however, are small and transient compared

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with the benefits conferred by killing nematodes, especially the free-living types that not only attack and damage many kinds of crop but also transmit several viruses that are economically important. The returns from the considerable cost of fumigating land should not be assessed by the increased yields of the succeeding crop but in its total effects over several years.

Fortunately, the free-living nematodes that cause "Docking disorder" of sugar beet, and also stunt the growth of other crops by feeding on their roots during spring, are prevalent only in light land. The unusual damage they did in 1967 was a consequence of the continuous wet weather during the early part of the growing season, for the nematodes are active only when the soil is moist, and most active when the soil is draining after rain. A dry spell stops them from moving and feeding, and gives attacked seedlings the opportunity to produce new roots and recover their vigour, but such a dry spell did not happen in 1967 until June, by when too much damage had been done for affected crops to yield well. In addition to enhancing the severity and prevalence of "Docking disorder" by allowing the nematodes greater opportunity than usual to feed, the excessive rain in May was further damaging by leaching nitrogen from the seed-bed into deeper soil. With little or no nitrate within reach of their roots, the seedlings grew only slowly, and what roots they could produce were exposed to attack by nematodes for a long period until some could reach a source of nitrogen and allow the plants to grow vigorously.

The need to improve methods of applying seed-dressings. Some insecticides that, when used as seed-dressings, have successfully controlled wheat-bulb fly in experiments have been reported not to do so when later they have been used on a large scale. A likely explanation for this discrepancy was provided by our analyses of some samples of commercially dressed seed, which showed that the amounts of insecticide adhering to individual seeds ranged widely, and the average was often much less than should have been from the amount applied. This explanation seems all the more probable now that a survey made by chemical companies and the Plant Pathology Laboratory of the Ministry of Agriculture, Fisheries and Food has shown that the samples of seed we analysed were typical rather than exceptional, for most of the cereal seeds treated commercially with dry powder dressings they analysed also carried less insecticide than they should. In the expectation that dressing seeds with liquids instead of powders would be more satisfactory, we analysed samples of seed dressed commercially with liquids. Although more of the insecticide adhered to the seeds than from powders, it was distributed very unevenly, with a few seeds carrying large amounts and many carrying very little. As there is only a limited range in which some insecticides are effective against pests and harmless to the seedlings, this means that many seedlings would be unprotected against pests and that some could be damaged by an excess of the poison. The reasons for the unsatisfactory distribution are being sought in attempts to improve the performance of machines used to dress seed.

Incorporating pesticides during the process of pelleting sugar-beet seed gave results much more satisfactory than when previously dusted seeds

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were made into pellets. The range around the intended dose was only from 95 to 116%, and the distribution was more uniform when the pesticide was incorporated in the outer than in the inner layers of the pelleting material. Incorporating an organo-mercury dust in the material used to pellet seed infected with the fungus *Phoma betae* increased the number of seedlings by 42%, but steeping the seed in ethyl mercury phosphate was more effective and doubled the number of seedlings.

Poisoning of bees. The commonest cause of bees being poisoned by insecticides is from the spraying of bean crops, especially spraying from the air. As the black bean aphis was much more plentiful in 1967 than in 1966, and its control more difficult, it is gratifying rather than surprising that we received only 22 more samples of bees suspected of being poisoned. Of the 53 samples received, 37 contained insecticide, and at least 20 of these were probably killed during the spraying of beans. However, there should not be this number, because protecting beans from black aphis need not put bees at risk. Bees are not poisoned unless the crop is sprayed when in flower. Sprayed before this, bees are unharmed, as they are also when crops in flower are treated with granular insecticides instead of with sprays.

The increased acreage of oil-seed rape, grown mainly as a break crop between cereals, might also have been expected to increase the number of poisonings, for the flowers are very attractive to bees, and the recommended way of controlling pollen beetle is to spray with malathion, which is very toxic to bees. Happily the expectation was not realised, and only one of the samples we received was possibly poisoned by the spraying of rape. In comparative tests, endosulfan, which seems to control pollen beetle adequately, killed very few foraging bees when applied to rape in flower, whereas malathion killed many.

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