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ROTHAMSTED RESEARCH

Report for 1968 - Part 1

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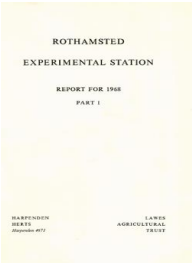
ROTHAMSTED
EXPERIMENTAL STATION
REPORT FOR 1968
PART 1

General Report

F. C. Bawden

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GENERAL REPORT

F. C. BAWDEN

An obvious item that calls for comment is the change in the Annual Report, which for the first time is published in two parts. A change was unavoidable because one volume was becoming unwieldy, and the only alternative was to stop publishing the review articles, which have long been a feature of the Report, and restrict it to an account of the past year's work. However, this was unacceptable, because the need for these articles, especially those that summarise the results of and conclusions from our long-term field experiments, is increasing rather than decreasing, and these are more appropriately published in the Report than elsewhere. Part 2 will in future cater for this need. This year, which we expect to be an exception, it deals exclusively with one subject, the wheat experiment on Broadbalk field. This is because the experiment was so greatly changed in 1968 as to mark the beginning of a new era. Not only a new variety of wheat, but new crops (potatoes and beans) were grown on parts of the field, and changes made in the manuring of some plots still maintained with wheat as the only crop. It seemed an appropriate occasion to review the work done during the history of this classical experiment on the nutrition of wheat. Few other experiments could justify a whole volume devoted to them, and in the future Part 2 will contain articles summarising work on diverse experiments and subjects.

Obituary. The Earl of Radnor, a Lawes Trustee since 1943, died on 23 November. He was chairman of the Trust Committee from 1938 to 1964, and when he retired from that post we paid tribute to his wise guidance during a period when the scope of our work and numbers of staff increased greatly. Again it is fitting we should express our gratitude. Despite his many other appointments and responsibilities, he always willingly gave his time to consider our affairs and we owe much to his unfailing support and generosity. He is succeeded as a Trustee by Sir Richard Verdin.

It is also sad to have to report the death of Constance M. Hunt, a valued member of the Statistics Department for 20 years and W. G. Jones, assistant storekeeper since 1964.

Staff changes. F. Yates, who joined the Statistics Department in 1931, has been head of it since 1933 and deputy director of the Station since 1958, retired on 31 March. This is neither the time nor place to assess his many contributions to Statistics and the Station, but it is appropriate to remark that, under his leadership, the activities and responsibilities of the department have steadily increased, and its staff grown from four to fifty-two. To follow R. A. Fisher was no mean task and would have been daunting to most young men. However, Yates not only maintained and developed the lines of work initiated by Fisher, and sustained his standards, but also pioneered many new ones, including the application of electronic computers. Happily we still benefit from his unique experience, for he

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continues to work part-time in the Computer Department, which was set up on 1 January, with D. H. Rees as its head.

D. J. Watson was appointed deputy director to succeed Yates, and J. A. Nelder head of the Statistics Department.

C. A. Thorold retired from the post of Officer-in-Charge of Woburn Experimental Station, which he had held since 1957. This post will not be filled because the laboratory work previously done at Woburn is now more conveniently done at Harpenden. Woburn will be used only for field experiments and the staff there now come under the Head of Farms.

H. Chapman, who gave notable service on the Rothamsted Farm for 35 years, and F. Hamilton, who ably filled such varied posts as head cleaner and gardener during his 22 years with us, also retired.

Honours and awards. R. Hull and R. H. Kenten were honoured by being made Officers of the Order of the British Empire in the New Year Honours. F. C. Bawden was awarded the Elvin Charles Stakman Award of the University of Minnesota for outstanding contributions to Plant Pathology. He was President of the First International Congress of Plant Pathology, and of the newly formed British Crop Protection Council. He was also elected Treasurer, and appointed Vice-President, of the Royal Society.

Visitors and visits. With the International Congress of Plant Pathology held at London in July, and the International Congress of Entomology held at Moscow in August, overseas visitors during the summer were even more numerous than usual. In addition to many individuals, we received two parties of delegates to the Plant Pathology Congress at Rothamsted and one at Broom's Barn. However, the largest party was for the Annual General Meeting of the Association of Applied Biologists at which D. J. Watson gave his Presidential Address. Visitors from the United Kingdom included Mrs. Shirley Williams, Minister of State in the Department of Education and Science, and Mr. J. J. Astor, the Chairman of the Agricultural Research Council.

Two main occasions for members of the staff travelling overseas were to attend the Entomological Congress at Moscow and the International Congress of Soil Science in Adelaide, but, as the departmental reports show, there were also many and varied other reasons. In addition to the visits reported there, 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 returned home *via* Ottawa to accept an invitation to lecture to the Research Branch of the Canada Department of Agriculture. In May he visited Berkeley to give one of the Centennial Lectures during the celebrations of the Centenary of the foundation of the University of California.

Buildings. The building to house four controlled-environment rooms for growing plants, and nine controlled-environment cabinets, was finished in June, but, regrettably, we still have had no use of them because of faults in the equipment. At the end of the year good progress had been made on the new building that will house the statisticians and the new multi-access

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computer, a System 4.70 of International Computers Limited, which is promised for delivery late in 1969.

An unhappy year for farming. It is difficult to find much cause for joy in a year that began menaced by the threat from an uncontained epidemic of foot-and-mouth disease of cattle, though we are happy to have escaped this, then produced the worst harvest of cereals for many years, and ended with some potatoes and sugar beet still in ground long water-logged. It seems typical of the year that the one bumper crop we harvested in excellent condition, hay, should have been destroyed by fire in October and that the only practical benefit from our irrigation system was to provide water enough to restrict the fire to the Dutch barn and save the main farm buildings.

For arable crops, the year was all the more disappointing because conditions during spring were favourable for field work and all crops were drilled or planted in good time. Although the weather in May prevented some cereals from being sprayed with herbicides, at the end of the month they all looked well and there seemed the promise of again achieving record yields. However, it was not to be, for the dull, wet summer and autumn (all months after April had less sunshine than average, and the total deficiency for the year was 366 hours) not only made harvest difficult but greatly diminished yields. Barley lodged badly, and all varieties except Sultan were severely attacked by mildew. Yields were small, averaging a fifth less than in 1967, and were often larger with small than with large dressings of nitrogen fertiliser. Wheat lodged less than barley, but yielded poorly, winter varieties about 25% less than in 1967 and spring ones 30% less. The quality of grain, both barley and wheat, was also poor. An unusual feature was that straw weights, which were as much as in 1967, exceeded grain weights. Beans, too, did poorly; for the first time for many years they needed hoeing because the pre-emergent weedkiller was not fully effective. Yields differed considerably between different fields, but were from a third to a half less than in 1967. Oilseed rape also yielded considerably less than in 1967.

Root crops did better than cereals, but lifting out of saturated soils was a tedious business. Except where we planted seed of Majestic imported from Northern Ireland, a third of which failed to produce plants, potato yields were as large as in 1967. Sugar beet was sown early, grew vigorously and yielded well, but the sugar content was smaller than in 1967.

The only crop the year fully favoured was grass, which after April was always more than enough for the stock.

Problems in farming light land. Against the obvious advantages light land has over heavy, such as greater ease of cultivation and of harvesting root crops, have to be set many disadvantages, not only being more liable to lose nutrients by leaching, a smaller water-holding capacity and greater likelihood of poor structure, but also more problems in deciding correct fertiliser use and from soil-borne pests and diseases. These differences show vividly in comparing results of our experiments on the heavy land at Rothamsted with those on light land at Woburn and at various places in

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eastern England. For example, at Rothamsted attempts to grow cereals without cultivation, by drilling into grass swards or stubble sprayed with herbicide, have all failed, whereas at Woburn they have succeeded and given yields equal to those obtained by drilling into seed-beds prepared by conventional cultivations. However, although crops are more difficult to get in at Rothamsted, yields are usually larger and vary less than at Woburn, where it is not only more difficult to assure that crops are adequately fed but nematodes and soil-borne fungi can be damaging, though they would not be with similar crop rotations at Rothamsted.

The use of nitrogen fertilisers allows light land to be cropped more intensively than previously, but plants do not live by nitrogen alone and the larger yields it produces initially will not be maintained indefinitely unless other nutrients are also supplied. Not only can reserves of potassium soon be depleted, but amounts of magnesium in light soils not given organic manures can also become too small for maximum yields, and we report benefits to potatoes at Woburn and sugar beet at various places from dressings of magnesium.

However, responses of potatoes at Woburn to magnesium were small compared to those from fumigation with methyl bromide, which doubled the yield on land where potatoes died prematurely in 1966 and made it equal that on land long free from potatoes, where it did not increase yield. The plants on the unfumigated plots died prematurely from *Verticillium* wilt, and also carried potato cyst-nematodes, which other experiments have shown aggravate wilt, whereas those on the unfumigated plots were free from both the fungus and nematode. But there are other reasons still to be discovered for potatoes yielding poorly at Woburn, because on another site fumigation with chloropicrin also doubled the yield of Maris Piper, which is resistant to the cyst-eelworm, although the plants in unfumigated plots were not attacked by *Verticillium* sp.

Although our problems at Woburn are many, they do not yet include severe Docking disorder, a crippling disease of sugar beet on much light land, though the free-living nematodes that cause it occur in some fields. The condition was much less prevalent and severe in eastern England than in 1967, presumably because the nematodes were less active during the drier spring, and when the soil later became wet the beet were already too well established to be greatly harmed. Nevertheless, and despite the large yields obtained this year from untreated land, soil fumigants and other chemicals that kill nematodes again increased sugar yields. On a field at Herringswell, Suffolk, where beet yielded only 15 cwt/acre in 1965 because of Docking disorder, the plants have not since suffered evidently and sugar yields on unfumigated plots in 1968 were good, 65·8 cwt/acre. However, plots fumigated with 'D-D' did even better: those fumigated in 1968 yielded 77·5 cwt, and those fumigated in 1966 yielded 75·2 cwt, good evidence that the benefits from fumigation are sometimes lasting. Violet root rot, caused by the fungus *Helicobasidium purpureum*, was prevalent on roots from unfumigated plots, but not from fumigated ones.

These plots were fumigated in total, and it is improbable that the benefits we find from injecting small amounts of 'D-D' beneath rows where sugar beet is to be planted will similarly persist. However, this

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method is much cheaper and responses in only one crop can more than repay the cost. Certainly it seems that, until soil-borne pathogens in light land can be controlled, yields will fluctuate greatly between years and the returns from using fertilisers will be unpredictable.

Leaf protein. The importance of protein deficiency in the diets of people in many parts of the world is being increasingly appreciated, and this is reflected in the growing interest, not only in our work on leaf protein, but also in other novel ways of increasing protein production. Leaf-protein production is included in the International Biological Program, and to standardise extraction procedures, so that yields recorded in different places and from different plant species can be meaningfully compared, a small pulper and press were designed. The pulper, which works with only a few pounds of leaves, extracts about the same proportion of protein as does our large-scale machine. Several of these units are already in use overseas and others are on order.

The argument for growing crops specially to extract leaf protein is that much more protein able to be eaten by people can thereby be produced than by current agricultural practices. For example, this year, with a sequence of winter wheat followed by two sowings of fodder radish or mustard, all generously fertilised, we achieved nearly a ton of protein per acre of land. However, by-product leaves are also valuable sources, and the discarded vines and pods of pea crops yielded nearly 50% more protein than was in the peas for which the crops were grown. Haulm of early potato varieties, and sugar-beet tops, were also rich sources. Nor does the yield of extracted protein represent the total potentialities; the pressed fibre still contains enough protein to be a good fodder, and its nutrient value to sheep is being measured. Also, the liquor remaining after the coagulated protein is removed from the leaf juice is a suitable substrate for growing micro-organisms that could provide still more edible protein.

Aphids and viruses. Of the many different kinds of work on aphids and viruses described in the departmental reports, only a few can be commented on here. The series of suction traps operating in various parts of Great Britain, plus one in Holland, at 40 feet above ground, is now nearly complete. The catches in them will not only greatly increase knowledge about aphid populations and movements, and allow quantitative comparisons between districts and years, but also promise to be valuable in giving earlier warning than previously that aphids are active. Thus, the peach potato aphis was caught in these traps before it was on sticky traps or was reported by inspections of sugar-beet crops by the fieldsmen of the British Sugar Corporation. However, by applying the knowledge we have gained on how hedgerows and other windbreaks affect the occurrence of aphids in crops, the chances of detecting by inspection when aphids first enter crops could probably be increased, for this knowledge predicts the most vulnerable areas and more plants could be examined in these areas than is possible during random sampling of whole fields.

As predicted from the winter weather, the peach potato aphid was scarce early in the season, and the extensive spread of potato viruses experienced

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in 1967 was not repeated. Most other aphid species were also few and arrived late and, again in striking contrast to 1967, when black bean aphids were unusually abundant and difficult to control, in 1968 they were not abundant enough to warrant spraying crops against them. The less need to spray was reflected in fewer samples of bees being sent to us as suspected of being poisoned by insecticides, for the major cause of these poisonings is the spraying of beans when in flower.

Similarly, warnings of the need to spray sugar beet to control yellows were many fewer than usual in the east of England, where the cool, wet summer did not favour aphid multiplication. Indeed, unusually, and reflecting the unusual fact that the summer was drier in the west and centre than in the east of England, the peach potato aphid was more abundant there than in eastern England. Yellows did spread during August and September, but few fields had as many as a fifth of the plants infected and most infections were too late to affect yield greatly. However, in one experiment, the insecticide 'Temik', drilled with the seed, a treatment that also controls the eelworms that cause Docking disorder, kept plants free from aphids for several weeks and increased sugar yields by about 6 cwt/acre, presumably by its effect in decreasing yellows.

Although most aphid species were few, some grass and cereal aphids were exceptionally abundant during late July and August, and briefly reached populations of 50 per ear of wheat. Some of these species, vectors of barley yellow dwarf virus, were first trapped during June, when some plants were already showing symptoms, suggesting that a few aphids were active during May before they were caught in traps. However, the large infestation was late, as was the main spread of the virus, not until the cereals were in ear, and although yields were probably slightly affected, the aphids and virus were a minor factor in the sad story of small cereal yields in 1968.

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