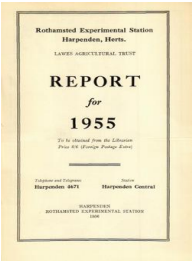
ROTHAMSTED RESEARCH

Report for 1955

Full Table of Content



Introduction

Sir William G. Ogg

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INTRODUCTION

BY THE DIRECTOR

It is with deep regret that we record the deaths of Sir Alexander Fleming, a member of the Lawes Agricultural Trust Committee since 1953, and Mr. Edwin Grey, the last remaining link with our Founder. Ted Grey, as he was affectionately called, came to Rothamsted as a " grass picker " in 1872 at the age of twelve, and was on the staff for sixty-eight years. He did a variety of increasingly responsible jobs in the laboratory and on the farm, and was finally Superintendent of the experimental plots, a post he held until his retirement from full-time work in 1922. He was a remarkable character and was known to agriculturists the world over. His *Reminiscences, tales and anecdotes* of Rothamsted (1922) and *Cottage life in a Hertfordshire village* (1934) bear witness to his affection for Rothamsted and his interest in rural life.

Professor D. D. Woods has been appointed to the vacancy on the Trust Committee as a representative of the Royal Society. In June 1955 Dr. C. B. Williams, who had been Head of the Entomology Department since 1932, retired and Dr. K. Mellanby from the London School of Hygiene was appointed in his place. Dr. Williams is continuing his work on quantitative ecology at Kincraig, Inverness-shire, with the aid of a grant from the Agricultural Research Council. Dr. B. G. Peters resigned from the Headship of the Nematology Department at the end of September 1955 to become the first Professor of Parasitology at the Imperial College of Science and Technology, London. Mr. F. G. W. Jones, Lecturer in Agricultural Zoology at Cambridge University, has been appointed to succeed him, and will take up his duties in January 1956. Dr. R. K. Schofield, who has been on the staff since 1928 and has been Head of the Chemistry Department since 1954, has been appointed Reader in Soil Science at Oxford University.

Dr. L. Broadbent was awarded a Kellogg Scholarship and spent three months visiting universities and research stations in the United States and Canada, and Dr. Mary T. Franklin also spent four months in the United States and Canada, working mainly at the Connecticut Agricultural Experiment Station, New Haven. Mr. M. V. Tracey obtained a Royal Society and Nuffield Foundation Commonwealth Bursary and will spend a year at the Wool Textile Laboratory of the Commonwealth Scientific and Industrial Research Organization at Melbourne. Dr. A. W. Taylor returned from the University of Wisconsin, where he had held a post-doctorate fellowship, and Dr. P. W. Murphy resumed his work in the Entomology Department after spending a year at the University of Vienna. Dr. T. W. Tinsley returned from the West African Cocoa Research Institute, Tafo, Gold Coast, where Miss Margaret Holden and Dr. F. Raw are still on secondment.

Sir William Ogg visited Finland at the invitation of the University of Helsinki and the British Council to give lectures and visit agricultural and forestry research organizations. He also accepted invitations to take part in a Round Table Conference at the Swedish

https://doi.org/10.23637/ERADOC-1-77

Royal Academy of Agriculture and to lecture at the Royal Agricultural College, Uppsala. Mr. F. C. Bawden went to West Africa to advise on swollen shoot disease of cocoa, and Dr. H. L. Penman visited the Gold Coast at the invitation of the Volta River Project Preparatory Commission. Dr. H. Greene, Adviser on Tropical Soils, went overseas on three occasions during the year, visiting West Africa, the United States, the High Commission territories of Swaziland and Basutoland, and the Sudan. These visits were concerned with soil surveys, field experiments, UNESCO's work on arid regions and various other problems. Dr. A. Muir was a member of the British Agricultural Delegation to the U.S.S.R.; and on behalf of the European Productivity Agency of the Organization for European Economic Co-operation Dr. G. W. Cooke visited research institutes in Denmark, Norway and Sweden. Mr. H. V. Garner spent three weeks studying field experimental methods in Holland, West Germany and Denmark, and Dr. N. Walker accepted the invitation of Professor E. B. Chain to work for six weeks at the International Centre for Research in Chemical Microbiology in Rome.

Rothamsted was represented at the 3rd International Congress of Biochemistry in Brussels, a Conference of Agricultural Physicists in Wageningen and the International Symposium on Plant Nematodes in Wageningen. Mr. F. C. Bawden attended a meeting in Paris of a study group " to consider how UNESCO might help to promote knowledge on cell growth with a view to assisting research on cancer ". Dr. G. W. Cooke contributed a paper to the meeting of the Association Internationale d'Études Phosphatières held in Blois, France, and Dr. C. G. Johnson to the German Plant Protection Conference at Kassel. Mr. N. W. Pirie attended the World Symposium on Applied Solar Energy in Arizona, and Mr. D. H. Boalch the meetings of the International Congress of Agricultural Librarians and Documentalists in Frankfurt and Ghent. Dr. R. Hull and Mr. H. V. Garner both attended meetings of the International Institute of Sugar Beet Research.

Mr. F. C. Bawden was the first recipient of the Royal Agricultural Society of England's Research Medal in recognition of his work on virus diseases of crops. Sir William Ogg retired from the Presidency of the Society of Chemical Industry in July; he delivered the 9th Dalton Lecture in Manchester on 28 October. Dr. H. G. Thornton has been appointed Foreign Secretary of the Royal Society.

Visitors

There were over 3,500 visitors to Rothamsted during the year, many from overseas. In July H.R.H. the Duke of Gloucester paid an informal visit, accompanied by Mr. F. Wycherley, his agent at Barnwell. The Marquess of Salisbury, Lord President of the Council, Mr. D. Heathcoat Amory, M.P., the Minister of Agriculture, Fisheries and Food, and Lord St. Aldwyn and Mr. G. H. R. Nugent, Joint Parliamentary Secretaries also visited the Station. Visitors from overseas included Mr. Ezra T. Benson, United States Secretary of Agriculture, and Mrs. Benson; Mr. Jens Smørum, Danish Minister of Agriculture; Mr. J. Dillon, T.D., the Irish Minister of Agriculture, and the Irish Ambassador, Mr. H. F. Boland; Mr.

https://doi.org/10.23637/ERADOC-1-77

J. E. Jantuah, Minister of Agriculture for the Gold Coast; Dr. Eric Englund, United States Agricultural Attaché, and Mrs. Englund; Mr. K. R. Damle, Vice-President of the Indian Council of Agricultural Research, and senior Indian Government officials. Visitors from the U.S.S.R. included Mr. I. Benediktov, Minister of State Farms; Academician Tsitsin, Director of the Moscow Agricultural Exhibition; Academician I. G. Petrovsky, Rector of Moscow University; and Academician A. L. Kursanov, Director of the Timiryazev Institute of Plant Physiology.

Buildings and Land

The West Building was completed in the spring, and the Entomology, Insecticides and Fungicides Departments and the mycologists of the Plant Pathology Department have moved into their new accommodation. The space vacated by the Entomology Department at Rothamsted Lodge has provided more room for the Bee Department and the Bee Advisory Service; the old Insecticides laboratories are being used by the Botany Department and the Office.

Two orchards adjoining the north boundary of the farm, together amounting to 26 acres, were purchased during the year. The trees were in very poor condition and, apart from a small area, are being grubbed up. The land, which is to be known as Whittlocks, will be used for experimental purposes.

The Work of the Station

In the **Physics** Department much attention continues to be given to the question of soil structure. This is dependent on the surface physics of the mineral components, particularly of the clays, and careful work on one clay, kaolin, has shown almost conclusively that there are charges on the edges of the kaolin crystals in addition to the isomorphous replacement charges associated with the basal surfaces. There are indications that the action of some soil conditioners such as polyacrilic acid is due to the edge-to-edge linking of the clay crystals, whereas linking of the basal surfaces in interlamellar complexes may be the dominant factor in the crumb structure built up under a grass ley. Field experiments have provided some evidence that improved crumb structure increases crop yields.

The environment of the growing plant has a direct bearing on the incidence of diseases. Studies of dew formation and persistence on potato plants (an important aspect of the blight problem) have made progress, and equipment is now almost complete for a comprehensive experiment on potatoes in which daytime transpiration and night-time condensation will be continuously measured at the same time as the energy transfer in and above the soil. Work has also been started on the micro-meteorological problems of cereals; the first year's pilot experiment has revealed significant differences between close and open stands of wheat. Little control of environment is possible except that deficiencies of rainfall may be made good by irrigation. The dry weather from mid-June onwards has indicated how much benefit may be derived from such control, for the irrigation experiment has shown a 60 per cent increase in dry

https://doi.org/10.23637/ERADOC-1-77

matter from irrigated grass, 90 per cent from main crop potatoes (from 11 tons/acre without irrigation to 20½ tons with 6 inches irrigation) and 40 per cent in sugar yield from sugar beet.

The **Chemistry** Department's work on fertilizer placement has been continued. Placing of both superphosphate and muriate of potash increased yields of peas and beans on soils where broadcasting these fertilizers had little effect. On ordinary potassium-deficient soils combine-drilling muriate of potash gave higher yields of barley than twice as much broadcast potash, confirming the results of earlier work on Chalk soils. For potatoes, placing potash beside the seed gave consistently higher yields than broadcasting. In contrast, placing and broadcasting of nitrogen fertilizers gave similar yields for both cereals and potatoes. Experiments carried out over the last three years show that there is no gain from splitting the normal nitrogen dressing used for main crop potatoes, higher yields being obtained by applying all the nitrogen before planting than by applying a portion of it before earthing-up the potatoes. In a comparison of calcium nitrate with ammonium sulphate, the two forms of nitrogen gave similar yields of cereals and of kale; for potatoes calcium nitrate was inferior, particularly when heavy dressings were used. Work on nitrogen for spring cereals emphasizes the difficulties of recommending the " best " rates, and times and methods of application, since so much depends on soil and weather conditions. For the present it seems best to suggest that nitrogen dressings for spring corn should be split, part being given to the seedbed and the remainder applied as a top-dressing in May. In ten long-term experiments on oil palms carried out in West Africa, potassium fertilizers consistently increased yields; phosphorus was effective on only one kind of soil, and there were no gains from dressings of nitrogen, calcium or magnesium. In examining these data it was necessary to take account of both climatic cycles and physiological rhythms in the crop. In the investigation on the manuring of forest nurseries copper sprays cured a deficiency-symptom described as " needle-tipburn " of Sitka spruce seedlings which had appeared on plots on a heathland soil. On plots where a hop-waste compost was used there was no deficiency, since the compost contained an appreciable amount of copper. In pot experiments the yields of oats grown on a calcareous " skirt " fen soil were increased by both complex and simple salts of manganese, although symptoms of " greyspeck " disease were not completely eliminated.

Estimates of the values of dicalcium phosphate and rock phosphate, in terms of superphosphate as standard, have been made in pot and field experiments by measuring both crop yields and phosphorus contents and also by using radio-tracer techniques. Isotopic exchange is being used to examine the phosphorus status of soils which have had varying manurial histories. Important progress has been made in defining the conditions under which denitrification occurs in soils, particular attention being given to the losses of nitrogen which are promoted by additions of organic materials. Studies on the nature of organic phosphorus compounds present in soils have continued.

In the **Pedology** Department mineralogical studies have been carried out on a wide range of soils and soil clays from this country

https://doi.org/10.23637/ERADOC-1-77

and from various parts of Africa. It would appear that the black clay soils from the Athi Plains, Kenya, show microreliefs similar to those of Australian gilgai soils. An examination of the calcareous shales of the Lower Lias formation has shown that there are high concentrations of molybdenum in the lower zones and in shales with between 10 and 50 per cent calcium carbonate. In an investigation of the trace element content of crops from the classical plots it was found that wheat shoots from Broadbalk field showed little variation from plot to plot. Where continued application of ammonium sulphate has increased soil acidity, however, the molybdenum content was strongly depressed. Determination of the inorganic constituents of cocksfoot from Park Grass field, when the plants were in flower (June), showed little variation in the Ca content of non-flowering shoots between limed and unlimed plots. Copper uptake followed the pH of the various plots with the lowest value on a limed area. Molybdenum uptake increased with pH, but the content seems to be influenced positively by the dung and guano treatment on a no-lime plot. Further studies have been made of the effect of materials leached out of leaves on the mobility of sesquioxides and clay with reference to movement in soils.

The **Soil Microbiology** Department has commenced a study of the non-symbiotic nitrogen-fixing organisms in Broadbalk field. It would appear that the anaerobic *Clostridium pasteurianum* is much more abundant than Azotobacter and may be of more importance in nitrogen fixation.

Further work has been done on the breakdown of herbicides in soil, and organisms that can decompose 2 : 4-D, MCPA and parachlorophenoxyacetic acid have been isolated and are being studied. Treatment of soil with any of these compounds accelerates the rate of decomposition of the compound added, or of the other two. As small an addition as 1 part per million of 2 : 4-D will thus adapt the soil to its decomposition. A soil adapted to decompose 2 : 4-D or MCPA will retain this adaptation for at least 6 months.

A survey has been made of the types of predominant fungi in clover rhizospheres in the surrounding soils. Preliminary results show some differences in numbers and types of fungi, both as between rhizospheres and surrounding soil and between clover-sick and healthy soil. Experiments have been carried out to test growth and survival of clover nodule organisms in soil and in media at various pH. In sterilized soil at a pH below 5·7 none grew and all died within two weeks. Work has shown that on the introduction of effective strains a ratio of 1 : 1,000 of a competitive ineffective strain was sufficient to give improved clover growth, and higher ratios gave an increased effect.

The **Botany** Department is working on certain aspects of plant nutrition, weed problems, the physiological effects of virus infection and the physiological limitations of crop yield. It has been found that molybdenum added to a complete nutrient solution delayed the precipitation of iron, possibly because it also retarded the upward drift of pH. This may account for the increased uptake of iron and the reduction of chlorosis when molybdenum is supplied to plants growing with a deficiency of iron. The interaction between molybdenum and iron may be at least partly due to chemical reaction outside the plant.

https://doi.org/10.23637/ERADOC-1-77

The application to wheat of a nitrogenous spring top-dressing in the same spray solution as 2 : 4-D has been studied, and it appears that the weed-killing effect was not interfered with, but only about half as much nitrogen was recovered in the crop as when it was applied as fertilizer to the soil.

The studies of wild oats and of certain other weeds have been continued, and it has been found possible to reduce the amount of viable seed produced by wild oats by spraying them with maleic hydrazide after the panicles emerge; but this is not a practical measure, as the crop may also be severely damaged. There are indications that the population of viable wild oat seeds rapidly decreases under temporary ley.

In the **Biochemistry** Department most attention continues to be given to the study of enzymes. Three of these, ribonuclease, metaphosphatase and phosphatase, are concerned with breaking a link between a phosphate group and some other structure, and are of particular interest because of the importance of nucleic acids and phosphate esters in the metabolism of the leaf. Leaf ribonuclease preparations can now be made in which no other enzyme activity has been recognized. Work has continued on the enzymes of bracken, particularly on thiaminase, which destroys vitamin B and is in part responsible for the toxicity of bracken; furthermore, it is found in few other plants, and an attack on it might provide the basis of a selective poison for bracken. More evidence has been accumulated about the parts that amine oxidase and peroxidase may play in alkaloid formation and in controlling the concentration of growth hormone. Chitinase and related enzymes should be useful in studying the nature of fungal mycelia and their residues in soil organic matter; some strains of bacteria are promising sources of these enzymes.

The physiological state of a leaf has a great effect on its composition and on its susceptibility to virus infection, and attempts are being made to find some correlation between them. The properties of highly purified virus preparations may differ from those of viruses in the natural state in infected leaves, and the changes which take place in tobacco mosaic virus during purification are being studied.

Further progress has been made in the large-scale preparation of leaf protein. A palatable protein curd is now being produced as a first step to a product that can be stored without refrigeration.

In the **Plant Pathology** Department virus diseases are being studied in a wide range of crops, including potatoes, sugar beet, barley, and various legumes and crucifers. Potato paracrinkle virus, which is universal in the variety King Edward, seems to be an aberrant strain of potato virus S, which occurs in many other potato varieties. By excising apical meristems from King Edward plants and culturing them on agar, a clone of this variety has been established that seems to be free from paracrinkle virus. Potato virus C, although a strain of the common aphid-transmitted potato virus Y, is not transmitted by aphids when obtained directly from infected potato plants. An isolate that has been maintained for years in tobacco plants under glass has, however, become transmissible by aphids, but when transmitted to potato and returned to tobacco this isolate usually lost its ability to be transmitted by aphids.

Further attention has been given to the possibility of checking

https://doi.org/10.23637/ERADOC-1-77

the spread of virus diseases by means of insecticides. Spraying potato crops with DDT emulsion again prevented the spread of leaf roll within crops, but only slightly decreased the spread of rugose mosaic. This insecticide was valueless against aphids on sugar beet; other insecticides decreased the incidence of yellows, but the disease was not prevalent enough for spraying to give profitable returns. A survey showed that wild beet is abundant on many parts of the east coast and is generally infected with viruses and downy mildew fungus as well as being infested with mangold fly. The plants were free from aphids in the summer, but there was evidence at a few sites that wild beet had provided sources of pests and diseases for nearby beet or mangold crops. Wild beet now occurs on waste land and in hedges far inland up to the high-water level reached by the sea floods in 1953.

Among the diseases being studied by the mycologists are foot-rots of cereals, potato blight, potato skin spot, downy mildew of sugar beet, pea wilt and apple scab. Outbreaks of apple scab in East Anglia were again correlated with spring weather that liberated ascospores from dead leaves. The liberation of ascospores was much decreased by spraying dead leaves with DNOC. Eyespot and take-all of cereals were unusually prevalent, and in an experiment where these diseases were controlled the wheat variety Capelle, grown after potatoes, yielded up to 65½ cwt./acre, a record for Rothamsted. Further work has been done on the effects of ultra-violet radiation on plant pathogens.

Work has been continued in the **Nematology** Department on various species of eelworm of economic importance. Attention is being paid to the structure and development of cyst-forming nematodes. The detailed development of the cabbage-root eel-worm appears to be very similar to that of the sugar-beet eelworm. Population studies on the cereal-root eelworm indicate that build-up appears to be more rapid on oats than on other cereals, and that in the absence of hosts there is a rapid decline in population. The study of the emergence of larvae has been extended to the cabbage-root eelworm and its responses to root diffusates investigated. The relationship of eelworms to their host plants is being studied, and a number of varieties of oats, barley and wheat have been tested for resistance to cereal-root eelworm, but no marked resistance was detected. Work on the physiology of plant nematodes has been commenced, using potato-root eelworm as material, and a start has also been made on the study of nematode parasites of insects.

In the **Insecticides** Department recent work has led to a much greater understanding of the reasons why a change in particle size of a contact insecticide produces a change in its toxicity. The effects of temperature on this change in toxicity have been studied in detail, and a theory has been put forward which may sometimes enable the effect of temperature on the relative toxicity of different-sized particles to be predicted.

The earlier work on the mode of action of organo-phosphorus compounds is being followed up. These insecticides are believed to act by inhibiting esterases, but it is not certain which of these enzymes are directly concerned with the death of the insect. Pro-gress has been made in isolating from the German cockroach those enzymes which hydrolyse acetyl choline from those that hydrolyse

https://doi.org/10.23637/ERADOC-1-77

phenyl acetate but not acetyl choline. This separation is a necessary preliminary to the identification and characterization of the particular enzyme system concerned with the death of the insect.

The study of pyrethrins and allied molecules has been continued, and various substances have been synthesized and tested biologically, but it is doubtful whether they could be produced cheaply enough to compete with the natural products or the synthetic materials already in the market. Further field studies on the control of black aphis (*Aphis fabae*) on field beans and of wheat-bulb fly have been carried out, and in conjunction with the Plant Pathology Department additional information has been obtained on the prevention of virus spread through control of the aphid vectors by insecticides.

A beginning has been made with fungicide investigations. A technique for studying fungicidal action on plant pathogens has been elaborated in which the ability of treated spores not only to germinate but also to infect is measured. Work on the action of the systemic fungicide griseofulvin on club-root of cabbage and powdery mildew of cereals has been carried out, and a considerable amount of information has been obtained about the way in which this chemical affects these diseases.

Much of the work of the **Entomology** Department has continued to deal with insect numbers. Estimations of numbers of various species, and of their activity, have been made with light traps, suction traps working at different levels up to 1,000 feet above the ground, and among vegetation. Populations have also been measured in soils of various kinds, and in different crops. The results obtained have been related to changes in the weather and to variations in the physiology of the individuals concerned. This work is fundamental to any understanding and prediction of attacks by insects of economic importance, and the significance of data collected over many years is only now becoming apparent.

While some of the work has concerned insects generally, and has not been related to pest species, most of the investigations have concentrated on insects of economic importance. Gall midges attacking wheat and other crops have been studied. On Broadbalk the wheat-blossom midge has been estimated for the twenty-ninth successive year; 1955 showed a much increased infestation over 1954, with some 27,000 larvae per 500 ears of wheat. Work on the Hessian fly and on the gall midges affecting seed production in clover has been continued. Aerial trapping work has been largely concerned with aphids, whose flight-physiology has also been investigated. Soil studies relate particularly to wireworms and other beetles which attack growing crops, as well as to the relations between earthworms and fertility. Several members of the department have worked on different aspects of the life history of the wheat-bulb fly.

In the **Bee** Department much attention continues to be given to various aspects of bee behaviour. Evidence has been obtained which supports the view that food-sharing amongst the adult bees provides the network of communication which is the basis of social life in honey-bee communities, and it has recently been shown that a most important function of food sharing is the widespread and rapid distribution of " queen substance ". This material inhibits ovary development in workers and the production of queen cells;

https://doi.org/10.23637/ERADOC-1-77

a similar ovary-inhibiting substance appears to be present in certain other arthropods. Studies of the stimuli which lead to food exchange between worker bees indicate that scent is highly important. The accuracy with which bees communicate the whereabouts of food crops to fellow members of their colonies and the practical problems involved in inducing bees to forage on selected crops requiring pollination are also being investigated. Further information has been obtained on the factors affecting the incidence of swarming. It would appear that queen-cell production is not a reliable index, particularly after midsummer.

The researches on bee behaviour, physiology and pathology are now being applied to the solution of practical problems, such as the control of various diseases, the prevention of spoilage of stored combs by wax-moths, the introduction of queen bees and other aspects of colony management. Nosema and amoeba diseases can be eliminated from colonies by transferring the bees in early summer to combs that have been sterilized with the vapour of acetic acid. Further work has been done on European Foul Brood and on the organisms responsible for this disease.

An increasing amount of work on the design and analysis of field and laboratory experiments has been undertaken by the **Statistics** Department for Rothamsted and other research stations and for the National Agricultural Advisory Service. The electronic computer is proving very useful in this connection, and about 850 analyses of sets of experimental results, mainly randomized blocks and Latin squares, were carried out on it during the year. Good progress has also been made on the application of the machine to other branches of statistical work, and arrangements have been concluded with the National Research Development Corporation for it to remain at Rothamsted for a further period of five years. Surveys of fertilizer practice were carried out in four more districts, and a summary of the manuring of cereal crops, based on information from the fertilizer surveys, has been published. More than a third of the cereal acreage in England and Wales receives no nitrogen fertilizers, and the average dressings given are only about half the calculated optimal dressing. The conclusion is reached that profitable increases in nitrogen might increase total cereal yields by about 6 per cent. Average potash dressings on cereals are about optimal, but too much phosphate is used on much of the acreage. Contrary to current advice, as much as a third of the nitrogen used on winter cereals is applied in the seedbed in autumn, and use of complete fertilizers results in the wasteful application of phosphate and potash in spring top-dressings. Other publications include a report on the results of a survey of progress under the Hill Farm and Livestock Rearing Acts, a paper on the use of weed-killers and insecticides, and a report on the results of the 1954 Survey of rabbit damage to winter cereals. In co-operation with the National Institute for Research in Dairying and the Advisory Bacteriologists of the National Agricultural Advisory Service, a series of trials has been carried out to compare the standard hypochlorite disinfectant with some new detergent sterilizers, and in another investigation an analysis has been made of a large experimental assay of new tuberculins on cattle and tests of their powers to discriminate between tuberculous and tubercle-free cattle.

https://doi.org/10.23637/ERADOC-1-77 *pp 10*

The **Field Experiments** Section and Farm staffs were responsible for 3,000 experimental plots at Rothamsted and Woburn, about 850 microplots being laid out by the scientific departments. A small area of continuous wheat has been re-established on Broadbalk; the remainder of the field will continue to have one year fallow in five. Included in this report is an account covering the 20 years 1935–54 of the effects of the fallowing system on yield, the residual effects of one year's bare fallow, the relationship of fallow to the level of fertility of the land and the effect of bare fallowing on the incidence of eyespot, take-all and wheat-bulb fly. The report also gives a condensed summary of the very large amount of detailed work carried out by the Botany Department on the effect of the fallowing system on the weed population. Much thought has recently been given to re-casting the long-term experiments which have completed their cycles. The four-course has now commenced a new period with a modified rotation and some new treatments suggested by the results of the earlier period. A new plan is under consideration for the utilization of the Agdell plots, which are meantime being cropped with nitrogen only, after the acid areas had been limed. The deep-cultivation rotation experiment will be discontinued as each block completes two entire cycles. Important modifications have been carried into the ley–arable rotation experiments to reduce eyespot disease and to equalize the status of soil potash which was being affected by differences in the management of the leys. The most notable addition to the annual experiments has been a new series of experiments at Rothamsted and Woburn to investigate the nitrogenous manuring of spring wheat, including rates of application of "Nitro-Chalk", different times of application and a study of divided dressings.

At Woburn the dry summer was favourable for cereal crops, but main crop potatoes and grass only gave full yields under irrigation. The permanent barley plots each received a dressing of ground chalk sufficient to raise the pH to 6·0. The crop was much improved by the chalking, and the land will now be intensively cleaned in 1956. The ley–arable experiment, now in its eighteenth season, has shown the value of leys on the Woburn soil, but the results are now being complicated by the potato-root eelworm, which has built up, particularly in the purely arable rotations. This will necessitate a modification in the experiment. Observations have been made to ascertain the factors involved in the increase in yield observed in spring-sown wheat and barley following the application of "Nitro-Chalk". Preliminary results indicate that the ear length of barley increases in proportion to the nitrogen applied, but the effect in increasing the numbers of ears per foot of row falls off rapidly as the dressing is increased. The effect of bulky organic manures in increasing weeds has been studied in the market-garden experiment. In general, all the organics tested increased the weeds by about one-third, whether used in single or double dressings. Work on exotic crops was continued. Maize ripened perfectly in 1955, but yields were light, two early Dutch types giving 25–30 cwt. grain/acre. The mean yields of Wisconsin and Dutch types grown for seven seasons on ordinary farm land with at most 3 cwt. sulphate of ammonia has been 35 cwt. grain/acre. The outlook for soya beans in this country is not promising, the experiments showing that only

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the dwarf types ripen and that these are uncertain and not highly productive. The " Topine " strain of Jerusalem artichoke stood up well to the drought, the tops alone in 1955 giving 2·82 tons of dry matter. A study of the rate at which added organic matter disappears from Woburn soil has been completed.

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