ROTHAMSTED RESEARCH

Report for 1977 - Part 1

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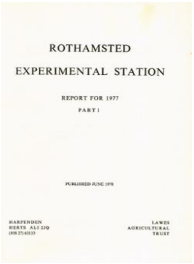

General Report

L. Fowden

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GENERAL REPORT

L. FOWDEN

Rothamsted's scientific heritage stems from John Bennet Lawes, born at Rothamsted Manor House in 1814. His ancestors had lived at the Manor for almost 200 years previously. It is then gratifying that his great grandson, Sir John Claude Bennet Lawes, has decided to donate to the Experimental Station a collection of over 140 paintings, including portraits of several of these previous owners of the Manor, and their families. The collection, which has been on loan to the Station since 1953, also includes about 50 watercolours by Lady Caroline Lawes, the wife of our founder. The Lawes Agricultural Trust on behalf of all at Rothamsted wishes to thank Sir John for his generous gesture.

Thanks to the initiative of G. V. Dyke, and the willing cooperation of Lady Bawden, the Station now has a posthumous portrait of the former Director, Sir Frederick Bawden, painted by Mr. P. Deighan. The portrait hangs in the Russell Building with those of other previous Directors.

Lawes Trust Committee. Professor C. T. Ingold, CMG, retired from the Committee after serving as a member for the past 6 years. His place as Linnean Society representative from January 1978 will be taken by Dr. R. W. J. Keay, CBE, Executive Secretary of the Royal Society.

Staff. R. Hull retired as Head of Broom's Barn Experimental Station in March. He had devoted his whole career to research on the sugar-beet crop, starting at the Hackthorn Field Station of the Midland Agricultural College in 1935. Rothamsted became responsible for the programme of the Field Station in 1947, and soon thereafter a new centre at Dunholme near Lincoln was developed under Hull's leadership. At Dunholme the sugar-beet research programme was expanded but was handicapped by shortage of land and suitable buildings. Hull moved his team to Broom's Barn at the end of 1961, and there built up a centre for laboratory and field studies that is universally respected for its work aimed at improving the yield, quality and profitability of both the root and seed crops. Hull's personal contributions to the advancement of sugar-beet research were marked in many ways, including the award of the OBE in 1968.

B. Kassanis, another long-serving staff member, retired from the Plant Pathology Department in March. He first joined Rothamsted as a British Council Scholar from Greece in 1938, and was appointed to the staff in 1943. During his career he made many outstanding contributions to fundamental knowledge of plant viruses, and developed the technique for culturing stem apices to eliminate virus from potato stock. He was elected a Fellow of the Royal Society in 1966 and awarded the OBE in 1977.

Several other members of staff retired after serving Rothamsted for many years. E. Church, Deputy Secretary, had worked within the Station's Administrative Section since 1953, providing exemplary financial control and advice. Ruth Hunt had been Secretary to the Head of Statistics Department for 30 years, and F. B. Leech had worked in the same department since 1952 with a major responsibility for the statistical analysis of animal experiments performed by members of the Agricultural Development and Advisory Service (ADAS). T. Z. Nowakowski retired after 19 years at Rothamsted studying the effects of nutrients on plant composition.

P. B. Tinker, formerly Professor of Agricultural Botany and Head of the Department of Plant Science at the University of Leeds, assumed the Headship of the Soils and Plant Nutrition Department in March, whilst R. K. Scott, previously Reader in Agronomy at the University of Nottingham's School of Agriculture, became Head of Broom's Barn in April.

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Staff of the ARC Unit of Soil Physics, Cambridge, transferred to Rothamsted at the beginning of October, becoming members of the Physics Department. Four members of the ARC Unit of Developmental Botany, Cambridge, which disbanded at the end of September, joined our Insecticides and Fungicides Department.

Honours and awards. The following staff members were included in the Queen's Silver Jubilee and Birthday Honours List: B. Kassanis received the Order of the British Empire, and T. E. Ablewhite, B. W. Avery, R. A. Dunning, Myrtle E. Hughes and G. E. G. Mattingly were awarded Silver Jubilee Medals.

L. R. Taylor received the Royal Agricultural Society of England's (RASE) Research Medal in recognition of his important contributions to insect pest monitoring and especially his work leading to the development of the Rothamsted Insect Survey. J. A. Nelder was awarded the Guy Medal in Silver of the Royal Statistical Society for his descriptions of Generalised Linear Models and his work with others resulting in the production of the GLIM Computer Programme.

M. Elliott and N. F. Janes received financial awards as inventors of the successful resmethrin and bioresmethrin insecticides: the awards were approved by the Agricultural Research Council (ARC) on the recommendation of a Government Committee and were paid from income received by the National Research Development Corporation (NRDC) from commercial users of the insecticides.

Buildings. The new laboratory building for the Departments of Entomology and Molecular Structures was completed in May and opened by the Hon. J. J. Astor, Chairman of ARC, on the occasion of the summer meeting of the Lawes Trust Committee in June. It was named the Daniel Hall Building, commemorating a former Director of Rothamsted (period 1902–12).

Planning permission was received during the year for the erection of a new Stores building and construction will begin early in 1978.

Demonstrations of research

Subject Days: The Woburn Centenary. This year the work at Woburn was featured in our Subject Days held on four days in July. The event had special significance for it marked the centenary of the first harvest at Woburn Experimental Station. A small historical exhibit told the story of the farm from the acquisition of the lease from the 9th Duke of Bedford by RASE in 1876 to Rothamsted's assumption of responsibility for the Experimental Station in 1926, and then to its present role in agricultural research. The second day provided the occasion for a Centenary Celebration when we welcomed a distinguished group of agriculturalists including the Chairman and other members of our Trust Committee, the Chairman, Secretary and many senior officers of ARC, the First Permanent Secretary and Chief Scientist of the Ministry of Agriculture, Fisheries and Food (MAFF), and their senior colleagues in ADAS. About 30 representatives of RASE, including many Council members, were present, as were representatives of the Bedford Estates.

Speaking after lunch, the Director reminded the gathering that at Rothamsted's own centenary in 1943, the then Minister of Agriculture, The Rt. Hon. R. S. Hudson, said 'It is important to remember that Rothamsted is a station concerned with scientific research. It is a scientific laboratory whose job it is to find out and test fundamental agricultural principles'. The Director continued, 'Rothamsted still believes that its programme must include basic and strategic scientific research; research of high quality and innovativeness that will underpin the agricultural advances of the 1980s and 1990s. It

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further believes that in the design of its programme of research, consisting partly of feasibility studies of new agricultural procedures, it should be outward looking and receptive of the views of advisers and farmers alike'. The occasion at Woburn was very valuable in this regard for it permitted Rothamsted to present aspects of its researches to a lively and informed audience coming from many backgrounds within agriculture. Demonstrations showed how important benefits to crop yields had followed from long-term research leading to an increased understanding of the factors influencing the organic matter content, structure and acidity of light soils and their effects on the availability of P, K and Mg. A major part of the Nematology Department's field experimentation is based on Woburn, and nematological exhibits included one showing the large benefits to potato crops that can result at Woburn following the effective control of cyst-nematodes using successfully-tested combinations of resistant varieties, cultural practices and nematicide applications. Demonstrations of newer research showed the extent to which atmospheric pollution could reduce crop growth and yield, and the possible role of nitrification inhibitors in increasing a crop's utilisation of aqueous ammonium fertiliser.

Other exhibitions. Our work to devise pheromone trapping systems for monitoring pea moth populations and predicting the most favourable times for insecticidal sprays was described in an exhibit at the British Growers Look Ahead demonstration at Harrogate in February, and again in May at the Chelsea Flower Show. The Station provided an exhibit for the Royal Society's Soirees illustrating our research on the problem of resistance in insects to insecticides. Later in the year, we mounted a demonstration of our research relating to the biology and control of potato cyst-nematodes during the annual conference of the British Crop Protection Council at Brighton.

Visits and visitors. During 1977 Rothamsted remained very popular with visitors coming from many countries, and having varied interests and fields of endeavour. Lord Selborne, a member of Council of ARC, visited us in May and had a very full day of discussions. In November we welcomed the Rt. Hon. John Peyton, MP, the Conservative Party Spokesman on Agricultural Matters in Parliament, for a general visit. Mr. P. S. Preston (now Sir Peter), Permanent Secretary at the Ministry of Overseas Development, visited in May, and was particularly interested to see Rothamsted's research relating to problems of tropical and semi-tropical agriculture. Among overseas visitors, we welcomed Ing. A. H. Bertoni, Paraguayan Minister of Agriculture and Livestock. Academician V. D. Pannikov, Vice-President of the USSR Academy of Agricultural Sciences and Professor V. G. Mineev, Director of the All-Union Research Institute of Fertilisers and Soils, Moscow, came as visitors under the terms of the agreement on Anglo-Soviet Cooperation in Agricultural Research: they had detailed discussions within the Soils and Plant Nutrition Department about long-term fertiliser experiments and nutrient residues. Several senior agricultural scientists from Brazil came at different times during the year and included Dr. K. Igue, Dr. F. Dalberto, Dr. L. C. Monaco and Dr. Lowndes Brasil. Other visitors included Dr. K. A. Badruddoza, Vice-Chairman of the Agricultural Research Council of Bangladesh. Rothamsted was host to 48 scientists from 11 countries attending a Working Party meeting devoted to 'The use of insect pheromones in integrated control' held in October under the auspices of the International Organization for Biological Control.

Visiting scientists from 25 countries, including Australia, Brazil, Iraq, Japan, Nigeria, Sri Lanka, USA and USSR, have worked in Rothamsted departments during the year. Several of them had come as students and successfully completed PhD degrees awarded by London University during their stays.

Co-operation in agricultural research with other countries has been fostered by many

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overseas visits by Rothamsted staff, who either have been engaged directly in research projects or have acted as advisers or consultants during shorter missions. F. G. W. Jones, Barbara Mosse and J. M. Day visited Brazil at different times, under the terms of an Anglo-Brazilian agreement on scientific collaboration sponsored by the British Council. Links with research in progress at various institutes administered by the Consultative Group on International Agricultural Research have been maintained through visits by P. S. Nutman, J. F. Witty, J. B. Free and Ingrid H. Williams to the International Crops Research Institute for the Semi-Arid Tropics, Hyderabad, India, by L. Fowden, R. J. Roughley and P. B. Tinker to the International Institute of Tropical Agriculture, Ibadan, Nigeria, by Barbara Mosse to the International Centre for Tropical Agriculture, Palmira, Columbia, and by F. G. W. Jones and R. W. Gibson to the International Potato Centre, Lima, Peru. D. S. Jenkinson returned after spending a year in research at the Waite Institute, Adelaide, Australia and G. G. Briggs left in July to spend a similar period working in the Department of Soil Science and Plant Nutrition of the University of Western Australia, Perth. Other staff making shorter visits to Australia were L. Bailey, M. Elliott, J. A. Nelder and G. J. S. Ross. L. Fowden visited university departments and government institutes concerned with plant science and agricultural research during a visit to Israel in June under the Royal Society – Israeli Academy of Sciences Exchange Programme.

The organisation and funding of research. Almost 5 years have passed since the funding of work within the Agricultural Research Service was placed on a dual-support basis. Now research funds managed by the ARC are derived from two sponsoring government departments, the MAFF and the Department of Education and Science (DES). The larger element of support provided by MAFF is administered on a customer-contractor basis, in which the Chief Scientist's Group (CSG) commissions and reviews programmes paid for by the Ministry. The DES vote in support of civil science is partitioned between the Research Councils on the advice of the Advisory Board for the Research Councils (ABRC). The Joint Consultative Organisation (JCO) was set up in 1973 by agreement between ARC, MAFF and the Department of Agriculture and Fisheries for Scotland (DAFS) to review the national effort in agricultural research and development supported by public funds and to identify and advise the three bodies about programmes and priorities. This overall review by JCO Boards and Committees is now almost complete. Many desirable agricultural objectives were defined and new research initiatives followed in institutes such as Rothamsted.

The determination of senior officials of ARC and the CSG to make the customer–contractor relationship operate successfully has been rewarded for we now seem to have a system of commissioning providing a generally satisfactory and stable basis for future MAFF support of research. Institutes are still concerned about the slowness with which new research projects are accepted as parts of MAFF Commissions, but action is promised to rectify this situation.

Recently, ARC have concentrated attention on proposals for new programmes in basic and strategic research to support their submissions to ABRC aimed at maintaining the relatively favoured position adopted by the Advisory Board towards agricultural research in recent years. The ARC identified itself particularly with this activity and constituted a Working Party from its members to evaluate and assign relative priorities to about a dozen proposals. The two areas of work selected initially for development fall within Rothamsted's sphere of interest. These are programmes to investigate the causes of yield variation in crops, especially winter wheat, and the opportunities to improve crops using genetic manipulation techniques. A partial redeployment of effort in some Rothamsted Departments will enable new programmes to be started on the effects of chemical,

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physical and biological factors on the soil-root relationship, on the yield losses caused by nematodes attacking cereals, on the opportunities for developing new compounds capable of downward translocation in plants and effective as fungicides, insecticides or nematicides, and on physical factors affecting soil structure and water and ion movement in soils. We rely on allocation of funds for specialised items of equipment to initiate these projects which are all expected to contribute to the better understanding of the factors limiting cereal yields. The scope of the collaborative programme on genetic manipulation is still under discussion, but it seems certain that our Biochemistry Department will participate in important ways.

Weather and crop growth. Autumn 1976 was unusually wet after the previous long summer drought. The first 3 months of 1977 were also wetter than average, February having over twice the monthly average rainfall. Consequently, much nitrogen was leached from soils during the winter period. Spring and summer were cooler than normal, the maximum mean monthly temperatures for all months from April to September being below average. July rainfall was only 9 mm, but in August 122 mm fell, mainly in the last half of the month.

These conditions made sowing of both winter and spring cereals difficult: the sowing of other spring crops was also protracted. The crops, however, generally grew well, although cereals ripened later than usual, and harvesting of many experiments was delayed further by the heavy rain of late August. Conditions in September, October and November were generally good, with less rain than normal; potatoes and sugar beet were lifted fairly easily, and autumn sowings for a large field experimental programme were completed successfully.

Cereals on our farms generally were relatively free from foliar diseases. Aphids infested winter wheat at Rothamsted and Woburn and were controlled by pirimicarb sprays. The outbreak, however, did not appear particularly damaging, for in experiments that included an aphicide test the resulting yield advantage was only 0·11 t ha^{-1} at Rothamsted and 0·21 t ha^{-1} at Woburn. Some barleys were cut in good condition before the August rain, but the warm weather and high humidity of late August caused some discolouration and germination in the ear of this and other grain crops. Yields of both wheat, and especially barley, were generally good, but none was outstanding. The benefit of early sowing of winter wheat was seen clearly in this year's experiments; a September-sown wheat yielded 7·73 t ha^{-1} whereas a similarly treated November-sowing gave only 5·94 t ha^{-1}.

In the barley variety trial at Rothamsted, Lofa Abed yielded best (5·79 t ha^{-1}) out-yielding Julia by 0·5 t ha^{-1} when crops were sprayed with tridemorph. When untreated with tridemorph, the yield of Julia, now mildew susceptible and becoming outclassed, was 0·89 t ha^{-1} less than the sprayed control. When winter wheat varieties were grown on a site infected with soil-borne pathogens, Maris Kinsman gave the best yield (6·12 t ha^{-1}), but on a healthy site, receiving lower levels of N, Maris Sportsman (5·49 t ha^{-1}) per-formed best. Yields on the healthy site were generally light because of late sowing in bad conditions following the delayed harvesting of the preceding potato crop.

Potatoes yielded well despite some problems with seed beds. This year the main field for potato experiments at Rothamsted was one of the heaviest on the farm, and bad weather in late April meant that planting was not finished until May: even then soil conditions were not good and early growth was somewhat impaired. Summer growth, however, was vigorous, and no blight was evident until very late. The variety Pentland

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Crown, given conventional treatments, yielded about 42 t ha^{-1} of total tubers. National yields have been good, resulting in prices much below those of the last two years.

Sugar beet was remarkably free from virus yellows this year. Nationally, symptoms showed on less than 1% of plants at the end of August, the lowest ever recorded. After the high incidences of yellows in the past 3 years, the sugar beet industry views this year's figures with relief, but it is still important to develop an effective strategy for future control through a major research effort seeking a better understanding of the epidemiology of the disease. The presence of the beet cyst-nematode, *Heterodera schachtii*, was confirmed for the first time on plots at Broom's Barn that had grown sugar beet each year since 1965 (see Part 2 of this Report, p. 5).

Although growers have expressed disappointment about the size of roots in relation to the tops, which remained unusually vigorous and healthy until late in the season, they have been compensated by universally high sugar concentrations. The lack of residual nitrogen in soils after the wet winter prevented luxury uptake of nitrogen, which depresses sugar concentrations, whilst the low pre-harvest rainfall of September and October reduced the water content of the storage roots. The factors controlling sugar accumulation in beet are being investigated under controlled-environment conditions at Rothamsted, and in future these studies will be complemented by physiological investigations on the field crop at Broom's Barn, in an attempt to determine how root yields and sugar concentration respond to seasonal and agronomic changes and to disease incidence.

Grain legume performance in 1977 was quite different from that in the unusually dry years of 1975 and 1976. In those two earlier years, field beans and lupins (*Lupinus albus* var. Kievsky), without irrigation, gave best results of only 2·0 t ha^{-1}, even with stringent pest control. In the wetter season of 1977, spring-sown beans given the most favourable combination of treatments yielded about 5 t ha^{-1}, but the yield of lupins was only slightly increased at 2·2 t ha^{-1}. Leafless peas, grown by us for the first time this year, gave 3·6 t ha^{-1} under similar conditions: unexpectedly, they lodged so severely that hand-harvesting was necessary. Comparison of the performances of the newer grain legumes with field beans will be continued, but at present we are satisfied that the greater emphasis we place on field-bean research is justified.

Aspects of current research.

Soils work. The start of a cooperative investigation into aspects of soil structure by members of the Departments of Physics, Soil Microbiology and Soils and Plant Nutrition, and of the Soil Survey, was reported 2 years ago (*Rothamsted Report for 1975*, Part 1, 15). First results of this work were presented in June at a seminar attended by soil scientists drawn from many sectors of agricultural research and industry. Two aims were emphasised. The first was an attempt to compare, for the first time, all the wide range of methods in use at Rothamsted for assessing soil structure and stability. The second objective was to use the results of these largely physical measurements to characterise several soils, selected as pairs having similar texture and profile descriptions but differing in that they are in series which either frequently or rarely have structure-related management problems. 'Ease of management' is difficult to define, and will be influenced by weather, which may also affect, to a greater or lesser extent, some of the measured physical properties.

The physical measurements covered many different facets of soil structure; some of them attempt to assess the soil environment for plant growth and some for ease of management. A clear correlation between all of them was therefore not expected. Where results could be compared directly there was moderate agreement. Some of the measure-

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ments, such as that of macropores > 60 μm, distinguished between the 'easy' and 'difficult' soils, but most showed no relationship. The assessment of this work is continuing.

For many years members of the Soil Survey have made measurements of water retention, porosity and density of subsoils and surface soils from many arable areas of lowland England. Their data, which usefully complements the cooperative work just described, has now been published as *Technical Monograph* No. 9. The *Monograph* provides a method for classifying structural quality (as one of four categories), based upon laboratory measurements of air capacity and available water content of undisturbed soil samples. The findings may allow profile available water and climatic data to be used in assessing drought risk for grassland and certain arable crops.

Plant physiology and biochemistry. For the past 4 years, members of the Botany Department have assessed the effects of aerial pollutants on the growth and yield of barley. At the experimental site at Woburn, crop performance has been compared in open-top chambers through which ambient field air passes, either directly or after filtration through carbon. Much effort has been devoted to the design of the chambers to ensure that the internal conditions are as close as possible to those in the field.

Aerial pollution has not caused any visible crop injury, except in 1976 when slight awn scorching was observed on plants in the unfiltered chambers and on outside plots. The summer of 1976 was exceptionally hot and dry, and total plant dry weight and grain yield were both reduced by 40–50% in the presence of aerial pollutants. In 1977, when the season was more favourable for cereals, pollutants had a smaller effect and total dry weight of plants grown in unfiltered chambers was only about 15% less than controls produced in filtered air; this smaller difference in overall plant growth did not result in any significant difference in grain yield. Therefore, the effects of pollutants on grain yield seem to be determined not only by antagonism of the primary production processes, but also by their influence upon factors controlling assimilate distribution within the plant.

Similar chambers to those used at Woburn are being installed at Great House Experimental Husbandry Farm, Rossendale, Lancashire, where the effects of aerial pollutants on the growth of ryegrass will be investigated in association with ADAS.

Research in the Biochemistry Department is concerned largely with nitrogen assimilatory mechanisms in crop plants, and considerable emphasis is placed upon the more precise characterisation of cereal seed proteins. A detailed study of methods for extracting and separating the major storage protein of barley seed (the hordein fraction) has led to highly refined electrophoretic techniques for characterising the multiplicity of polypeptides represented within the hordein complex. The pattern of individual polypeptides differs between varieties, and is unaffected by environment, nitrogen nutrition, position of seed within the ear or degree of grain ripeness. The methods used as yet do not produce a unique pattern of polypeptides from every variety, but further sub-division of varieties behaving alike on electrophoresis may be possible when additional separation procedures are applied. The method, however, has potential importance for the commercial identification of barley varieties by analysis of single or half seeds in a manner comparable with that already used to establish varietal distinctness in wheat.

Electrophoretic techniques have also been used to characterise the 'b-proteins' formed within leaves of tobacco plants after infection with tobacco mosaic virus producing localised necrotic lesions. The proteins are 'coded-for' by the host plant rather than the virus, and are present only in the inoculated leaves and their close neighbours. Since the localised virus infection induces a resistance to further virus infection, the b-proteins may be part of the resistance-conferring mechanism. This conclusion is supported by previous work in the Plant Pathology Department showing that the proteins disappeared when

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infected plants were kept in conditions where the induced resistance broke down, and also that the proteins are produced when Xanthi tobacco plants are made resistant to virus infection by injection of polyacrylic acid. The b-proteins then may have a role analogous to that of interferon produced during virus infection of animal tissues. The Biochemistry and Plant Pathology Departments are collaborating in attempts to isolate pure samples of the b-proteins to test this idea and to investigate whether the resistance-inducing system may be manipulated to protect crop plants.

Control of pests and diseases. If the crop yields now expected from modern intensive agriculture are to be maintained, adequate protection from pests and diseases must continue. For the foreseeable future this implies a major reliance on chemical protection agents, and it is then important that research aimed at maintaining the efficacy of chemical control should feature strongly in our programme.

Development of synthetic pyrethroids. This year saw further advances towards commercial exploitation of the photostable synthetic pyrethroid insecticides discovered at Rothamsted. NRDC, which holds the patent rights, has licensed the compounds to major agrochemical manufacturers throughout the world; permethrin ['NRDC 143'; 'Ambush' (ICI); 'Pounce' (FMC)], cypermethrin ['NRDC 149'; 'Ripcord' (Shell)] and decamethrin ['NRDC 161'; 'Decis' 'K-Othrine' (Roussel–Uclaf Procida)] are now available commercially for some uses in certain countries. Their outstanding activity allows them to be applied at much lower rates than most previous insecticides; for example, the levels at which practical control is achieved are respectively 100–200 (permethrin), 30–100 (cypermethrin) and 10–50 g ha^{-1} (decamethrin) compared with 500–3000 g ha^{-1} for other groups of established insecticides. The pyrethroids are especially active against lepidopterous larval pests of cotton, tobacco and other dicotyledonous crops; permethrin was given clearance for emergency use on cotton in the USA in 1977.

Low toxicity to mammals and birds combined with low vapour pressures, relatively small application rates and rapid degradation by soil micro-organisms indicate that contamination of the environment will not be a problem with these synthetic pyrethroids. These properties are helping to establish the photostable pyrethroids as a major additional class of contact insecticides which should provide a new weapon for practical control of pests in a wide range of circumstances.

Resistance to insecticides and fungicides. The efficacy of commonly used insecticides and fungicides may be diminished seriously by the development of resistance within pest and pathogen populations. If this risk is to be minimised, we need to understand better the mechanisms of resistance and the ways in which resistance becomes established in populations.

Our survey has shown that low levels of resistance are now universal in populations of the peach potato aphid (*Myzus persicae*) on sugar beet in Britain. Indications that much more resistant strains, although still rare, are becoming more widespread engender concern for the future. We are investigating the significance of this greater resistance in relation to both aphid and virus control, realising that it will be important to manage aphicide use to prevent, or at least markedly retard, the proliferation of these more resistant strains.

Our programme on resistance also includes studies on the mechanisms and genetics of pyrethroid resistance for we must do everything possible to ensure that the enormous potential of the photostable pyrethroids is not eroded by the development of resistance arising from injudicious use.

Problems with fungicides are in many ways similar. Surveys have revealed that con-

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siderable variation in the response to systemic fungicides can exist within barley mildew populations. Widespread use of at least one of these fungicides has led to some decline in the overall sensitivity of mildew, but to what extent this has adversely affected yield improvements is not clear. Nevertheless, our aim must be to ensure that the most resistant strains do not become abundant within the natural mildew population.

Computing developments. The ICL System 4-72 was commissioned during the year. New software links it to the 4-70 and so flexible control is possible over the whole computing service. A basic service can be maintained if either of the two main systems ceases to function temporarily.

Users are already exploiting the dual system and demand exceeds the anticipated growth rate. Now over 100 devices are linked in the computer network, and the increased complexity places extra demand on telecommunications. For this reason, new techniques are being developed to provide improved control of demand by local management.

A special project undertaken by the Computer Department has been the design of a stock control system on behalf of the Plant Breeding Institute, Cambridge, who have recently completed a new seed store to house material in ideal conditions. The computerised system, now managed by the Department, will ensure the effective use of storage space, and the monitoring and control of seed movement. A catalogue will be prepared regularly to give warnings about expiry of normal storage life and reserve weight. Initially, there will be about 40 000 deposits, but this number could increase ten-fold in about 5 years.

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