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Report for 1978 - Part 1

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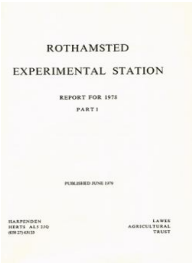
ROTHAMSTED
EXPERIMENTAL STATION
REPORT FOR 1978
PART I

General Report

L. Fowden

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GENERAL REPORT

L. FOWDEN

Lawes Trust Committee. Members of the Trust Committee and staff of Rothamsted learned with deep regret of the death of Lt.-Col. Sir Richard Verdin in August after a long period of illness. He had joined the Committee as a representative of the Royal Agricultural Society of England (RASE) and been elected its Chairman in 1964, in succession to Lord Radnor. Sir Richard was active in public life, especially in agricultural matters. The Committee and the Station benefited from his wise counsel, particularly in the early 1970s when the organisation and policies of agricultural research were subjected to an intensive government enquiry. Sir Edward Salisbury, who had been a Trustee of the Lawes Agricultural Trust since 1947, died in November aged 92.

Lord De Ramsey, a member of the Trust Committee since 1964 and Treasurer since 1970, succeeded Sir Richard as Chairman and as a Trustee, and Dr. L. E. Sutton became Treasurer. The Earl of Selborne has joined the Committee in the vacancy created by Sir Richard's death.

It is a pleasure to record that two members of the Trust Committee received awards in the New Year Honours List: a Knighthood was conferred on Professor Kenneth Mather, and Professor J. L. Harley became a Commander of the Order of the British Empire.

Staff. K. E. Clare retired as Head of the Soil Survey of England and Wales in March. He had assumed the Headship in 1966, coming to Rothamsted from the Road Research Laboratory. During his office Clare strengthened the organisational methods of the Survey, ensured the timely adoption of new techniques in the practice of soil surveying, and developed the present strong regional character of the organisation. He was succeeded as Head by D. Mackney, a member of the Soil Survey since 1950 and Regional Officer for the South-East Region since 1969.

I. J. Graham-Bryce, Deputy Director, was designated as Director of East Malling Research Station and will take up the post in August 1979. Several other members of staff have retired or resigned after long periods at Rothamsted. M. Roberts had spent 33 years at Rothamsted and had worked latterly on specialised analyses of soils and plant materials. J. Simpson retired after 31 years' devotion to bee research, and Mary G. Hills after 23 years' association with statistical survey work. J. Bolton, who had worked as a soil scientist since 1964, left to take up a senior post with the International Agricultural Development Service, and Audrey Gathergood retired from the Insecticides and Fungicides Department after 19 years' service.

During the year, Rothamsted welcomed two members of staff transferred from Wye College following the closure of the Agricultural Research Council (ARC) Unit of Plant Growth Substances and Systemic Fungicides.

It is with sadness that we report the deaths of I. M. Wright (Computer Department), A. Duffus (Nematology Department) and H. W. Vince (Instrument Workshops).

Honours and awards. The UNESCO Science Prize was awarded to a group of scientists in the Insecticides and Fungicides Department for their development of synthetic pyrethroids, a new class of highly active, safer insecticides. This biennial prize, created in 1968, is awarded to mark an outstanding scientific or technological achievement contributing to the development of a Member State or Region, and this recognition of Rothamsted work, gained in competition with proposals from many other countries, is very gratifying. The annual Tate & Lyle Award of the Phytochemical Society of Europe

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recognising outstanding contributions to phytochemistry by European scientists was received by B. J. Miflin in April. M. Elliott was nominated as Holroyd Memorial Lecturer and Medallist by the Society of Chemical Industry, and the John Jeyes Lecturer and Medallist of the Chemical Society/Royal Institute of Chemistry for his work on synthetic pyrethroids. L. Fowden was elected a Foreign Member of the Lenin All-Union Academy of Agricultural Sciences of the USSR.

Buildings. The construction of the new Central Stores has progressed throughout most of the year; completion is expected in early 1979.

Funding and planning permission have been obtained for additional laboratory space for the Biochemistry Department to accommodate new work forming part of the joint ARC programme on genetic manipulation for the improvement of crop plants.

Planning permission for a southern extension to the Computer Department was refused by the local authority. Rothamsted's appeal against this decision was considered at a Public Inquiry in December, and was upheld by the Secretary of State for the Environment.

Demonstrations of research

Subject days. The theme of the 1978 Subject Days was 'Chemical and metabolic processes that might be exploited to improve agriculture'. Emphasis lay largely on fundamental and strategic research likely to provide the knowledge leading to the development of new and important agricultural products and practices during the next 20 years. Some 60 exhibition panels, illustrating work from several departments, formed the basis of the presentation, but this year the programme was augmented by short lectures outlining the objectives of major areas of research and the experimental approaches adopted. The topic was very popular and more visitors than ever before asked to attend the Subject Days, which proved to be an occasion when members of the Trust Committee could mingle with senior officials of the ARC, including the Chairman and Secretary, and the Chief Scientist of MAFF, as well as many scientists from sister institutes within the public sector of research, the universities and industrial research laboratories.

Open days. A week-end in early July was devoted to Open Days for local residents. About 5000 visitors took an opportunity to see demonstrations of laboratory work, to tour the farm and field experiments, and to learn about the early connection between Rothamsted Manor House and the Experimental Station.

Outside exhibits. Staff from the Plant Pathology Department mounted an exhibit at the 1978 Royal Society Soirées on the theme 'Image analysis in agricultural research'. The demonstration showed how an automatic image analysing computer (the Quantimet 720) may be used in such diverse agricultural investigations as the measurement of size distribution of spray droplets on leaf surfaces or the better definition of selected parameters of soil structure.

Three exhibits were included in the Royal Show at the National Agricultural Centre (NAC), Stoneleigh. Two dealt with biological factors influencing cereal yields (leaf diseases, including brown rust and powdery mildew, and aphids as vectors of barley yellow dwarf virus). The third, an exhibit portraying the history of Woburn Experimental Station, in which the RASE had an interest from 1876 to 1921, was displayed in the Members' Pavilion.

Exhibits illustrating aspects of the Station's work on potatoes formed part of an ARC presentation at the National Spring Potato Demonstration at the NAC, and at the

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Potato Marketing Board's autumn demonstration at Dinnington. Our exhibit described the main types of tuber disease, the importance of effective disease control, and the methods by which healthier seed may be obtained. A demonstration on the identification, distribution and control of potato cyst-nematodes, including effective techniques for applying granular nematicides, was included in the Arthur Rickwood Experimental Husbandry Farm's Open Day programme.

Management practices designed to minimise the effects of pests on ryegrass swards, especially those caused by the mite vector transmitting ryegrass mosaic virus, were outlined in the National Grassland Demonstration at Stoneleigh in May, and again in September at the NAC Dairy Farming Event.

Visits and visitors. Rothamsted has remained a popular venue for visitors from Britain and overseas. Early in the year, the Soil and Water Management Association held their Annual General Meeting at Rothamsted and members were able to learn about the research on soils conducted in the Physics and Soils and Plant Nutrition Departments, and about the mapping programme of the Soil Survey of England and Wales. In November, Members of the Water Panel of the Advisory Council for Agriculture and Horticulture, chaired by Sir Nigel Strutt, visited the Station to collect evidence and views on present and future uses of water in agriculture. We were pleased to welcome members of Council of the European and Mediterranean Plant Protection Organisation at the end of their tour of Southern England in September and to describe briefly our work on the biology and control of crop pests and diseases. A group of senior plant protection specialists from the USSR visited the Entomology and Insecticides and Fungicides Departments in April, being particularly interested in the work on synthetic pyrethroids. Another group visit provided the Scientific Attachés of the London Diplomatic Corps with an introduction to Rothamsted's role in agricultural research.

In the past year, we again welcomed numerous overseas visiting scientists and students for periods of research collaboration and training: altogether, 40 visitors from 22 different countries worked in our laboratories.

Many Rothamsted staff spent periods abroad. The Station was well represented at major international congresses devoted to soil science (Canada), pesticide chemistry (Switzerland), plant pathology and nematology (W. Germany) and statistics (Netherlands). Collaboration in research formed the basis of visits made by R. W. Gibson to the International Potato Centre in Peru, by G. G. Briggs, A. W. Farnham, R. W. Payne and R. T. Plumb to different laboratories in Australia, by K. A. Lord and R. H. Bromilow to Brazil, and by K. Evans to Cornell University, USA. Barbara Mosse and D. S. Hayman organised and taught in Brazil a 4-week course on the biology and agricultural applications of mycorrhiza under the terms of a British Council administered agreement for enhanced Anglo-Brazilian co-operation in scientific research. P. B. Tinker visited Brazil under the same scheme for discussions with soil scientists, especially of ways for extending the use of rock phosphates as fertilisers under Brazilian conditions. Four members of the Soil Survey made extended overseas visits. S. J. Staines and R. C. Palmer each spent 4 months in Saudi Arabia mapping potentially irrigable arable and grazing land as part of a survey of land and water resources of the country. M. J. Reeve spent a year attached to the Soil Bureau of the New Zealand Department of Scientific and Industrial Research, this being the first leg of an agreement for exchange of Soil Surveyors between Britain and New Zealand. R. A. Jarvis collaborated in soil survey projects in Argentina and Colombia during a 10-week period in South America. L. Fowden visited India in September at the invitation of the Ministry of Overseas Development to assess possibilities for increased collaboration in agricultural research under a new Anglo-Indian government agreement, whilst J. Bowden spent 10 weeks at the

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University of Agricultural Sciences in Bangalore, where he organised a specialist course on insect pest monitoring and forecasting.

Weather and crops. At Rothamsted, average monthly temperatures were below the long-term means for each month in the period January to August, with the exception of March (warmer) and May (average). Total sunshine was also less than normal between January and August; only in March and May did sunshine hours exceed long-term means. Rainfall was above average, often markedly, for each month from January to June, and far below average for the months of August, September, October and November; total rainfall measured in the latter 4 months was only 96 mm compared with the long period mean of 270 mm. In summary, weather conditions during the growing season were atypical; a cold spring and cool early summer, wetter and duller than average, preceded a long and unusually mild, dry autumn. The incidence of many pest insects and disease organisms remained low in the cool weather and so the health of crops was generally good, enabling them to benefit fully in growth and yield in the clement late season.

Cereals. The 1978 programme of field experiments contained an increased number of cereal plots, and it was then fortunate that autumn 1977 generally provided good conditions for sowing winter wheat and some barley. By contrast, spring sowings were difficult and prolonged, especially on the heavy land at Rothamsted. Both winter and spring cereals initially looked poor, but recovered well during May. Grain ripened slowly and the harvest, beginning with barleys cut in the second week of August, was unusually late and extended.

Wheat yields were generally good, Maris Huntsman, Flanders and Atou being the main varieties. On the Broadbalk Classical Wheat experiment, Cappelle was grown for the last time—and gave the best ever single plot yield of 8·05 t ha^{-1} (FYM + 96 kg N ha^{-1}). Generally, Cappelle is now outclassed by newer varieties, and Flanders has replaced it on Broadbalk for the 1979 crop: changes in the rotations on the Broadbalk experiment will be made in 1979 and are described in the report of the Field Experiments Section (p. 116). The experiment comparing the performance of winter wheat varieties on a healthy site at Rothamsted was affected by excessive rain and data was derived from only one block on which Mardler performed best (mean yield of all treatments 6·32 t ha^{-1}). When grown on a site infected with soil-borne pathogens (but otherwise with better soil conditions), Maris Huntsman gave the highest yield (mean of all treatments 6·74 t ha^{-1}).

Yields of barley, mainly spring sown in poor conditions, were average. The principal variety grown was Porthos, but Julia will be kept on the Hoos Permanent Barley experiment for one more season. Yields recorded from well-manured plots this year averaged about 0·5 t ha^{-1} less than in 1977. In the variety experiment, Athos gave the best mean yield (6·49 t ha^{-1}) at Rothamsted, and Minak at Woburn (4·72 t ha^{-1}). Athene and Sonja, grown as winter varieties, yielded well.

The national cereal harvest was the largest on record, and the generally good autumn weather produced few problems for drilling winter cereals. We, like some other farmers in S.E. England, irrigated cereals in October or November to encourage germination, because the soil was so much drier than is normal for late autumn.

Potatoes. Prolonged wet weather in spring delayed the planting of some potato experiments, and since some tilths were cloddy considerable numbers of misshapen tubers were produced. Adequate rain until mid-August permitted good growth, but the subsequent prolonged dry period made the ground unusually hard at lifting and there was more mechanical damage to tubers than usual. Yields were about average or a little

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better, 45 t ha^{-1} being typical for well-treated plots. Haulms showed slightly more blight than in recent years but this was well controlled by fungicide sprays.

Field beans. The year was particularly favourable for field beans and yields of 5 t ha^{-1} or more were common from conventionally-treated crops. Our multi-disciplinary experiment on spring-sown field beans completed the third season, the most favourable combination of treatments giving yields of 6·5 t ha^{-1}. In two ancillary experiments which included factors not yet introduced into the main experiment, even heavier yields were obtained—7·1 t ha^{-1} in one experiment and 8·3 t ha^{-1} in the other: these are the largest yields of field beans ever recorded at Rothamsted. In our experiments field beans again yielded considerably better than leafless peas and lupins.

Sugar beet. Generally, plant establishment and final populations were satisfactory, but exceptions occurred especially with early March sowings. These suffered some frost damage and, in the slow growing conditions, damage due to soil pests, mainly symphylids and millipedes, was evident in some areas. The leaf canopy was slow to close, but aphids infested the crop late to give the most virus-free crop on record. Free from disease, the beet at Broom's Barn, and the national crop, responded to the bright late season. The crop's deep root system apparently was able to satisfy its water requirement during the dry autumn because irrigation given at the end of August produced no yield response. Conditions favoured high sugar concentrations and, until frosts affected the beet, extraction rates at the factories approached record levels.

The 1978 crop again developed many bolters. This situation was not unexpected since the 1977 seed crop ripened unusually late under conditions leading to partial vernalisation of seed while on the straw. With the exception of certain varieties, however, the general level of bolting was not so pronounced as in 1977, and a great effort was made by staff of Broom's Barn and fieldmen of the British Sugar Corporation to alert growers to the dangers of weed beet infestation if seeds were allowed to set.

Selected research activities

Major collaborative programmes with other institutes. Last year (*Rothamsted Report for 1977*, Part 1, 12) reference was made to new programmes of joint research to be initiated within the Agricultural Research Service (ARS) following a review of research priorities by a Council Working Party. During the past year, inter-institute discussions have identified research objectives and strategies more clearly and experimental work has begun in two principal programmes, namely, yield variation in cereals and genetic manipulation for the improvement of crop plants.

Yield variation programme. Initially, this programme will concentrate on winter wheat. The national average yield in 1977 was 5·0 t ha^{-1} and in 1978 a little more, yet individual fields have given more than 11 t ha^{-1}. The reasons underlying this wide spectrum of yields are not fully known, and with the current highest field yields not far below the predicted biological maximum for our climate, the most immediate way of increasing average yields is to attempt to reduce variation by lifting the lower values.

Present agricultural research techniques mainly compare the effects of treatments applied to a single field, but the fuller examination of the causes of yield variation between fields will require a broader approach. ARC, therefore, have asked four institutes (the Plant Breeding Institute, Letcombe Laboratory, Long Ashton Research Station and Rothamsted) to collaborate on this topic. It will be important to establish the extent of field yield variation and to obtain better information on its relationship to weather, soil and agronomic variables. It is intended to develop a whole-crop wheat simulation model,

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which should help to define better the problems and to identify areas of ignorance requiring concentration of future effort. It is expected that the soil/plant root relationship will be such an area, and the new non-destructive technique for observing the manner in which roots develop in soils (described on pp. 197–198 of this report) should prove useful in this context. The Rothamsted mobile rain shelter is also likely to be of value in formulating the model because it is providing detailed information on the effects of water stress on cereals grown in the field.

A large multifactorial wheat experiment, just begun at Rothamsted, seeks to determine the maximum yield obtainable on our soil when given the best combination of available inputs, and to decide which inputs are critical. A detailed comparison is also being made with a wheat crop at Woburn, using a greater range of measurements than in a previous experiment comparing wheat growth at Rothamsted and Broom's Barn: later we also hope to mount new experiments on some very high-yielding sites, and so obtain a complete comparison of the growth of normal and bounteous crops.

Genetic manipulation programme. The main objective of this programme is the development of techniques permitting the transfer of genetic information, consisting of pieces of DNA, pieces of chromosomes or complete genomes, into crop plants by means other than sexual reproduction: it is a corollary that the information so transferred should be stably incorporated and transmitted to future generations. The John Innes Institute, the Plant Breeding Institute, the Welsh Plant Breeding Station and Rothamsted will collaborate in work to isolate and study the nuclear and organellar genes of plants, to examine various systems as potential vectors for effecting transfer of genetic information into plants, and to develop suitable recipient systems.

During 3 years beginning summer 1978, additional staff will be appointed to our Biochemistry Department to enable us to develop parts of the joint programme. Our contribution will involve the isolation of the genes for storage proteins of cereal grains, and cooperative work has begun with the Plant Breeding Institute to characterise the messenger RNA molecules for selected components of the hordein fraction of barley, to produce DNA copies by reverse transcription, and to clone the DNA so formed. A second major activity will be concerned with protoplast biology. Isolated protoplasts are seen as the most likely acceptor system for transferred genetic information but, for this information to be transmitted, whole plants must be regenerated from protoplasts. For many major crop species, including cereals and legumes, such regeneration has not been achieved. We shall evaluate current techniques and attempt to develop new or modified methods for isolating protoplasts exhibiting minimal structural and metabolic damage, a likely prerequisite for the later success of regeneration procedures

Water and crop growth. Some years ago a comprehensive study of crop responses to irrigation was completed on the light loamy sand soil at Woburn Experimental Station. A similar series of careful irrigation experiments has now been completed on the heavier Rothamsted silty clay loam. The two sets of data give rise to concepts that can be applied usefully in farm irrigation. For example, for those crops included in either the Rothamsted or the Woburn experiments it should be possible to predict for any soil by extrapolation the moisture deficit that must be exceeded before a growth response will result from irrigation, provided the available water holding capacity of that soil is known or measured.

Members of the Botany and Physics Departments continued their joint study of the physiological effects of water stress on crop growth, whilst new work was started within the Molecular Structures Department on the effects of crown ether compounds on stomatal behaviour and transpiration processes. The crown ether chosen for the initial

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study specifically complexes potassium ions. It reduced transpiration from the leaves of certain test plants to which it was supplied through their root systems, and brought about a partial closure of stomata in leaf epidermal layers floated on its solutions. These effects accord with the knowledge that the sizes of stomatal apertures are related to the potassium ion concentration of their guard cells.

Soil surveying. The Soil Survey and MAFF have agreed on a new project that will map the soil of the whole of England and Wales at a scale of 1:250 000. The project will begin in 1979 and is expected to take 5 years to complete. Field sampling will be supplemented by air photography to better predict soil variability, both in the uplands and lowlands. The soil map legend will be designed to give the maximum useful information to a wide range of potential users.

A land use capability map for England and Wales has been published using a scale of 1:1 000 000. It distinguishes land of different qualities, and indicates reasons for the differences using a letter and number code. The map symbols are linked to descriptive comments in the legend which emphasise management characteristics and physical limitations. These comments reflect the properties and constraints of whole map units and refer to soil type, soil water regime, permeability, texture and structural stability, profile available water and drought risk, shallowness, stoniness, gradient, soil distribution patterns, flooding and erosion risks, and irrigation need. The map then should provide general information about land capability useful at many levels of interest.

Photorespiration and ammonia assimilation. Photorespiration is recognised as a potentially wasteful process occurring in most temperate crop plants. This process, in which CO_2 is produced as a result of a series of reactions occurring in the light, is counter-productive to photosynthesis: in practice, it may reduce net photosynthesis to a level far below that of true photosynthesis. Although the adverse effect of photorespiration on net carbon assimilation is widely recognised, the production of ammonia, equal in amount to the CO_2 released, usually goes unnoticed. Both compounds are formed, together with an equimolar quantity of serine, from two molecules of glycine during the photorespiratory process. The ammonia production is important, firstly because the compound in low concentrations is toxic to plants, and secondly because the rate of release during glycine dissimilation is far greater than the rate at which ammonia originating from external sources is assimilated by the plant. Members of the Botany and Biochemistry Departments have investigated jointly how the 'photorespiratory' ammonia is reincorporated into organic nitrogenous compounds, as part of a continuing attempt to understand the paradoxes of the photorespiratory process and to ascertain whether it constitutes a barrier to yield improvement of temperate crops. The study has indicated that the ammonia is first introduced into glutamine, probably in the cytoplasm of leaf cells, before a subsequent transfer of the nitrogen atom to form glutamate in the chloroplasts. Thus, ammonia is cycled into and out of organic combination. Whilst it remains uncertain whether these photorespiratory processes confer any benefit on the plant, it is fortunate that the most energy-demanding reaction of ammonia reassimilation occurs in the chloroplast and therefore can be driven by light energy.

Crop pests and diseases. Our studies of how external and intrinsic factors influence pest populations and the incidence of disease organisms have continued over a broad front in attempts to devise better control strategies. The topics cited below represent examples of this type of study.

Nematode populations and pathotypes. A population model has been devised for

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cyst-nematodes having one main generation a year. The model simulates changes in nematode populations when host and non-host crops are grown in any sequence or rotation. It also can depict the effects on populations of two types of nematicide, of weeds, of attacks by pathogenic fungi on females, of competition between sibling species (e.g. the two species of potato cyst-nematode) and of the selective influence of resistant cultivars on pathotypes within species.

Several years of exacting work has shown beyond doubt that major genes for resistance to attack by nematodes in potatoes are matched by genes in nematode pathotypes able to overcome this resistance. This ability was linked with a double recessive condition in the two instances studied. The gene-for-gene relationship now identified for nematodes is similar to that documented in certain tolerant strains of rust fungi, and provides another example supporting the view that such relationships may be common in parasitic situations throughout the animal and plant kingdoms. The implications of these findings in relation to mating between pathotypes of potato cyst-nematodes are being assessed experimentally.

Pest monitoring using pheromones. It is very gratifying to report that work on the sex pheromone of the female pea moth, begun at Rothamsted just a few years ago, has now been developed to provide a successful monitoring system for field crops. The research conducted jointly by members of the Entomology and the Insecticides and Fungicides Departments established the way in which pheromones could be used to bait specially designed traps to lure male moths. Subsequent work showed how trap catches could be used to monitor damaging populations of moths and permitted the design of more effective insecticide regimes. The system was field tested in collaboration with the Agricultural Development and Advisory Service of MAFF and the Processors & Growers Research Organisation, and finally marketed by Oecos Ltd. for commercial use. It was adopted enthusiastically by a large proportion of pea growers, and has now largely superseded crop inspection as a means of monitoring this pest.

Resistance of insects to insecticides. Last year's report (Part 1, p. 16) drew attention to the concern surrounding the build-up of resistance in insects to commonly used insecticides. The detection of resistance to organophosphorus and pyrethroid insecticides in houseflies in Britain provides a further reminder of the increasing seriousness of this problem. Monitoring also indicates that resistance in aphids in the field is proliferating. New biochemical studies with aphids have given useful information about the substrate specificity of the esterase responsible for resistance to organophosphates, carbamates and pyrethroids, and suggested that certain organophosphorus structures may be less susceptible to this enzymic degradation mechanism. Other studies have provided an explanation for the very interesting spontaneous loss of resistance encountered occasionally in some highly resistant strains of aphids: it appears that high levels of resistance are caused by gene duplication which can be unstable. Good progress has then been made in understanding the causes of resistance and in seeking ways of overcoming it.

Induced resistance to virus infection. An earlier report (*Rothamsted Report for 1974*, Part 1, 117) described how leaves of tobacco (cv. Xanthi-nc) acquire resistance to infection by tobacco mosaic virus (TMV) after treatment with polyacrylic acid. Recent studies have demonstrated that 0·02% acetylsalicylic acid (pH 6·5) injected into tobacco leaves induces resistance to TMV infection 4–7 days later. Leaves acquiring resistance produced three new proteins, apparently identical to those formed after polyacrylic acid treatment. Resistance is also induced when the compounds are sprayed onto leaves or applied to soil. Acetylsalicyclic acid is effective at lower concentrations (w/v) than polyacrylic acid,

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and induces resistance in two tobacco varieties (Samsun NN and White Burley) for which polyacrylic acid is ineffective. Salicylic acid (0·01%) and benzoic acid (0·1%) produce effects similar to acetylsalicylic acid.

Computing activities. During the year the Advisory Committee on Computing of ARC set up a small Study Group to examine the future needs for computing in support of agricultural research, and the various opportunities existing for further development of computing. Modern technology would permit a wide range of independent computing facilities to be installed in the institutes of the ARS, and these could be linked into a unified, shared resource through a telecommunications network. Further development of telecommunications practice would enable this principle to be extended to include other national and international computing facilities. A unified service could be expected to use staff and equipment more efficiently provided institutes accepted some loss of individual responsibility for computing matters. These issues were considered by the Study Group and its recommendations will be presented in 1979.

The Computer Department has been associated closely with the development and management of data base systems for plant breeding gene banks and seed store data, and for other important collections of data relating to virology, agrometeorology, mass spectrometry, soil surveying and general bibliography. The requirements for both storage and retrieval of data will influence the future style of the computing service provided by Rothamsted.

The Genstat program developed by the Statistics Department now accounts for about 35% of the total workload on the Rothamsted computer. The program is becoming widely used outside the ARS. During the year 36 new licences were agreed, and 30 of present total of 70 licensees are overseas subscribers. Other programs including MLP, GENKEY and CLASP are also available under licence.

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