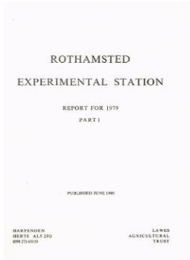
ROTHAMSTED RESEARCH

Report for 1979 - Part 1

Full Table of Content


ROTHAMSTED
EXPERIMENTAL STATION
REPORT FOR 1979
PART 1

Plant Pathology Department

E. Lester

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Introduction

The very dry autumn of 1978 restricted the development of splash-borne diseases and delayed the appearance of volunteer cereals so that the carry-over of obligate foliage pathogens from harvest to the newly-sown crop was decreased. Likewise, emergence of sown crops was delayed by lack of moisture to the extent that experiments designed to study interactions between sowing date and disease were partially thwarted because different sowings emerged coincidentally. The very severe winter was very damaging to stands of some grain legumes. Winter beans survived well, even though above-ground parts were completely killed; chocolate spot was not much in evidence and chemical control failed to give a yield increase. Emergence of autumn-sown lupins benefitted from fungicidal seed treatment but they failed entirely to survive the winter so that we were unable to assess the effects of some newer fungicides on root diseases.

Potato planting was delayed by adverse soil conditions until mid-May but growth

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subsequently was rapid, resulting in less stem canker than in recent years. Blackleg, conversely, was more prevalent than usual, especially on poorly drained soils. A change to drier weather in June, coinciding with the beginning of tuber formation, resulted in the worst levels of scab on un-irrigated potatoes for several years. Although weather conditions in August favoured blight, progress of the disease was arrested by a dry September which may also have accounted for the lower incidence of *Phoma exigua*, the gangrene pathogen, on desiccated haulm.

Those concerned with the epidemiology of diseases affecting the crops in which they have special interest have come to recognise the need for expanded study of splash-borne diseases generally, so that our epidemiologists now have the active support and collaboration of pathologists concerned with diseases of potato and oil seed rape as well as with cereals, where the need was first recognised. The commissioning of the 'open' configuration of the raintower/wind tunnel complex during the year will enable more progress in the collaborative spore dispersal studies on which a useful start has been made. An unexpected result from preliminary experiments has been the similar behaviour of the very dissimilar spores of *Pseudocercosporella herpotrichoides* and *Pyrenopeziza brassicae* in splash droplets. In addition, useful progress has been made in the development of techniques and equipment for monitoring splash-dispersed spores, using *P. herpotrichoides*-infected straw in field conditions as a model. These studies are complemented by measurements of splash-dispersal in a field crop of barley with *Rhynchosporium secalis*.

Preliminary investigations have been made on the effects of some newer systemic fungicides, for which downward movement in plants has been claimed, on root diseases of field beans and cereals. Useful effects of some compounds were clearly demonstrated in pot experiments with *Phytophthora megasperma* on beans and there is no doubt that these chemicals will prove to be valuable research tools whether they achieve commercial acceptance or not.

Earlier investigations on the effects of glandular hairs present on the leaves of some *Solanum* spp. in controlling potato pests have led to experiments to determine whether the effect extends to the spread of important potato viruses. Preliminary results show that removal of the glandular exudate from *Solanum berthaultii* leaves increased transmission of potato virus Y by aphids to tobacco test plants four-fold.

Our knowledge of the *Gaeumannomyces–Phialophora* group of root-infecting fungi, in respect both of their taxonomy and their interrelationships as pathogens is increasing. However, much remains to be done, especially with regard to the possibilities for biological control. The need to continue research on take-all disease with renewed vigour has been underlined by the widespread occurrence of serious attacks this season.

Other aspects of the research programme reported in earlier years have continued.

Diseases spread by rainsplash

Evaluation of spore samplers. Field evaluation of samplers for splash-dispersed spores continued on a fallow area spread with straw infected by the eyespot fungus, *Pseudocercosporella herpotrichoides*. More spores were recovered from both beaker and liquid impinger samples between October 1978 and June 1979 than last season (*Rothamsted Report for 1978*, Part 1, 216) because methods of handling the samples had been improved. Before counting, samples were concentrated by sieving and centrifugation and they were processed immediately rather than after a period of storage. Beaker samples contained spores each week except during January and February when the ground was snow-covered. The 1979 spring was cold and wet and most spores were collected in the week 22-29 May (750 000) with other peaks from 7–14 November (110 000) and 20–27 March (40 000). Although the seasonal pattern was similar, fewer spores were recovered

https://doi.org/10.23637/ERADOC-1-136

from impinger samples which suggests that most spores were carried by large ballistic rather than small airborne droplets.

There was no relationship between spore numbers and the proportion of plants exposed for 1 week periods which subsequently developed eyespot symptoms when incubated in a cool glasshouse. In 24 out of 32 weeks over 50% of exposed plants developed eyespot (average for season 62%).

Only 30% of plants exposed 2·5 m outside the area of infected straw at cardinal points developed symptoms and there was no difference between sites, which suggests that the spore dispersal gradient was steep and supports the view that most spores are carried by large ballistic drops. (Fitt and Bainbridge)

Separation of spores from soil particles. Large numbers of soil particles sometimes made it difficult to count the spores in samples. Therefore attempts were made to separate the spores from soil particles by a combination of sieving, flotation and centrifugation. The largest particles were removed by sieving (sieve aperture 63 μm). A flotation method using 90% glycerol (density 1·4) gave 15% recovery of *P. herpotrichoides* spores from pure suspensions but, when field samples were tested, many spores adhered to soil particles. About 50% of the spores were recovered by bubbling air through suspensions to which surfactants ('Triton X-100', 'Agral', 'Teepol' or 'Decon 75') had been added. However, it was difficult to disperse the foam and the method did not give reproducible results. The most promising method tested used paraffin oil. After vigorous shaking of spore suspensions to which a few drops of oil had been added the spores collected at the oil/water interface. Accurate counts of spores depend upon developing a method of dispersing the emulsion. (Bainbridge and Fitt)

Comparison of two rain-activated switches. Rainswitches are useful tools in the study of splash-dispersed diseases. They improve the efficiency of electrically-operated spore samplers by limiting sampling to periods of rainfall and thereby excluding large numbers of dry-dispersed spores. Between October 1978 and February 1979 the performance of two rainswitches was monitored at a site on the Rothamsted Farm adjacent to a weather station. The sensor of the moisture-activated switch (Stedman, *Annals of Applied Biology*, in press) was a matrix of electrical contacts fixed into a panel. The sound-activated switch was a modification of the one described by Faulkner and Colhoun (*Phytopathologische Zeitschrift* (1977) **89,** 50–59) with a microphone sensor suspended under a polyethylene diaphragm.

All types of precipitation triggered the moisture-activated switch whereas only moderate or heavy rain triggered the sound-activated switch; during periods of light rain and snow in February they were activated for 62·7 h and 5·9 h respectively. It was less clear why the sound-activated switch was activated for longer than the moisture-activated switch during moderate and heavy rain in November (84 h and 38·2 h respectively) and December (108·8 h and 89 h). Since splash dispersal is unlikely to occur during snow and very light rain these results suggest that the sound-activated switch is generally more suitable for use in the study of splash-dispersed diseases. However use of the moisture-activated switch may sometimes be preferable because it is more robust and not activated by extraneous noises. (Fitt, Rawlinson and Smith)

Mechanisms of splash dispersal. If splash-dispersed spores are carried only by large ballistic droplets, wind is unlikely to be important in their dispersal and they would travel only short distances. However, if they are also carried by small airborne droplets they should travel farther. To investigate which sizes of splash droplet carry most spores, drops (diameter 5 mm) were allowed to fall in still air from a height of 13 m on to spore

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suspensions of *P. herpotrichoides* and *Pyrenopeziza brassicae* (depth 0·5 mm, concentration 120 000 spores ml^{-1}). The resulting splash droplets were collected on pieces of fixed photographic film.

Although spores of these two fungi differed in size and shape (2×50 μm and 4×11 μm respectively) the distribution of spores in splash droplets was similar for both. Over 60% of the spores were carried in droplets larger than 1000 μm (less than 10% of the droplets), although the number of smaller spore-carrying droplets was far greater. For both fungi plots of log spore number against log droplet diameter gave straight lines, with slopes of 2·56 and 2·71 respectively.

It was estimated that one splash produced over 2500 splash droplets of which at least 25% carried spores. Most of the smaller droplets were collected near the target, whereas larger ones travelled farther, a situation which would probably be reversed in wind. (Fitt and Fatemi)

Collection and measurement of splash droplets in a barley crop. Pairs of glass slides (35×25 mm), one facing upwind (u.f.s.), one downwind (d.f.s.), were held vertically on sticky tape and exposed on steel rods at 20, 40, 60, 80 and 100 cm above ground level in winter barley (cv. Maris Otter). The slides were coated with 2% naphthol green B solution and each pair was protected from direct raindrop impaction by 24 cm diameter discs supported 5 cm above their upper edge. Exposures were brief to prevent superimposition of droplet stains. Droplet diameters were derived from measured stain diameters by reference to a calibration curve obtained from known droplet sizes. In early June (crop height 35 cm) during 20 min light rain only two droplets were trapped on u.f.s. at 20 cm compared with 27, 59, 105 and 85 at 40, 60, 80 and 100 cm respectively with the largest droplets (mean diameter 0·2 mm) at 40 cm immediately above the crop. Mean droplet size decreased with height to 0·08 mm at 100 cm. The mean number of droplets trapped on d.f.s. was *c.* 80% fewer but except at 100 cm diameters were greater. There were many *Rhynchosporium secalis* lesions low within the crop but no spores were seen in any droplets. In a test in late June (crop height 80 cm) droplets containing generally less than ten spores were trapped at 60 and 80 cm. However, one large droplet, 0·45 mm diameter, contained 220 spores. (Stedman)

Dispersal of *Rhynchosporium secalis* spores from dry leaves by waterdrops. In laboratory tests 4·4 mm diameter drops falling at near-terminal velocity were aimed on to each of several batches of dry barley leaves bearing *R. secalis* lesions. Samples of droplets generated were trapped on naphthol green B-coated slides. The stains of some droplets contained *R. secalis* spores but generally less than ten. Other droplets were trapped on slides coated with silicone fluid (M.S. 200/1000), into which droplets sink but maintain their spherical shape. Many of these droplets apparently had dry *R. secalis* spores upon their surfaces. Single water drops (4·0 mm diameter) run over dry infected leaves also collected apparently dry spores on their surfaces. Few spores were collected in this way (mean of five drops 87), but single drops run over the same five leaves after brief immersion in water collected a mean of 53×10^3 spores which were suspended within the drops.

Single (4·0 mm diameter) water drops, run over 3 cm long infected dry leaf sections were trapped in the angle between leaf blade and stem of pot grown Maris Otter barley seedlings. Five specimen drops carried a mean of 30 spores each. The seedlings were examined after 21 days when 54% of 200 inoculations showed lesions. By contrast 89% of single drops of spore suspension (30 spores per drop), tested similarly but using healthy leaf sections, produced infections and of single drops of the same suspension carefully placed at 200 sites 82% produced infections. (Stedman)

https://doi.org/10.23637/ERADOC-1-136

Biodeterioration

Fungicidal control of the microflora of ripening grain. Application of benomyl, captafol or a mixture of carbendazim and maneb ('Delsene M') to wheat crops between ear emergence and harvest failed to prevent infection of more than 90% of grains by *Alternaria* spp. *In vitro* tests showed that mycelial growth of *Alternaria* isolates was generally inhibited less than that of *Fusarium* or *Cladosporium*. *Alternaria* growth in the presence of 1000 ppm benomyl was still about 25% of that of untreated colonies while *Fusarium* and *Cladosporium* were completely inhibited by 10 ppm. However, 10 ppm of captafol or 100 ppm of the carbendazim + maneb formulation allowed little or no growth of *Alternaria*. Tests of other fungicides showed that growth of *Alternaria* was completely inhibited by 3 ppm prochloraz or imazalil but 300 ppm rovral failed to prevent growth longer than 3 days. (Mais, Kanapathipillai and Lacey)

Isolation and taxonomy of *Actinomadura*-like isolates from stored products. Large numbers of actinomycetes morphologically resembling *Actinomadura* can be isolated from stored hay and cereal grains, from grain dust and from the air of grain stores and cotton mills. Isolates from these sources, cultures of *Actinomadura* spp. from clinical and saprophytic sources and cultures of closely allied actinomycete taxa were included in a numerical taxonomic study. All were screened for 122 biochemical and morphological characters and the results analysed using the CLASP package of programs (*Rothamsted Report for 1976*, Part 1, 334). The analysis showed that one group of isolates, all from cotton mills, clustered with *Nocardiopsis* (*Actinomadura*) *dassonvillei*. Isolates from stored products mostly fell into three groups which all showed similarity to cultures of *Actinomadura*, *Micropolyspora* and *Nocardia*. Group A (Goodfellow *et al.*, *Journal of General Microbiology* (1975), **112,** 95–111) was most closely related to *Micropolyspora rectivirgula* cultures, including the type of the species but further work is necessary to determine whether they constitute a new centre of variation within the genus.

To establish the role that *Actinomadura*-like actinomycetes play in the deterioration of natural products and in possible health risks requires selective media that can reliably isolate these organisms when faster-growing or antagonistic species are present. The insensitivity of these actinomycetes to certain antibiotics and to heating was utilised in developing a method for their preferential isolation. Heat was applied to 1 g of the dry material in an open petri dish or to 2 ml of a 10% w/v suspension in 1/4-strength Ringer's Solution in a sterile, pre-heated McCartney bottle. Antibiotics were incorporated in nutrient or yeast extract agars containing actidione. Best results were obtained by heating suspensions at 55° for 6 min and then plating them on nutrient/actidione agar containing 5 μg neomycin ml^{-1}. On yeast extract agar and with other antibiotics, bacterial growth made isolation and identification difficult. (Athalye and Lacey, with White, Statistics Department, and Dr. M. Goodfellow, Newcastle University)

Chemical preservation of damp hay. Successful preservation of damp hay with propionic acid and its ammonium salts is limited by our inability to distribute the chemical uniformly on the hay. This allows the development of insensitive organisms which can metabolise the preservative. Work on the tolerance and metabolism of propionic and other fatty acids by members of the *Aspergillus glaucus* group is described in the report of the Chemical Liaison Unit. (Lacey, with Lord and Cayley)

Diseases of tropical crops

A disease of hybrid and Malayan dwarf coconuts in North Sumatra and peninsular Malaya. In early 1976 deaths began to occur in 18-month-old hybrid coconut palms in an estate

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in Sumatra and continued until the palms were about 3 years old. In nurseries and during early months in the field serious losses of Malayan Dwarf material also have occurred. The internal stem and rachis tissues of both seedlings and older palms become necrotic and by the time external symptoms appear the disease is far advanced. Electron microscopic examination of vascular tissue from diseased and healthy palms revealed mycoplasma-like organisms in the sieve tubes of diseased palms only. (Jones and Kenten, with Mr. P. D. Turner, Harrisons Fleming Advisory Services, Great Tower St., London)

Sumatra disease of cloves. Since 1968 a die-back and wilt disease has destroyed about 70% of the clove trees in West Sumatra. A small gram-negative bacterium with rickettsia-like structure (RLB) is consistently found in the xylem vessels of roots, trunks and branches of diseased trees. An RLB has been isolated from diseased trees but attempts to transmit the disease experimentally have been unsuccessful. Further evidence for the implication of an RLB has been obtained from the response to trunk-injected antibiotics. Trees given doses of tetracyclines and streptomycin have remained symptomless while neighbouring untreated control trees have developed typical die-back and wilt symptoms. Chemical control with antibiotics may provide a temporary solution until sources of natural resistance can be found and exploited. (Jones, with Messrs. C. P. A. Bennett and P. Hunt, ODA, London/LPTI Sub-Station, Solok, Sumatra Barat, Indonesia)

Cereal diseases

Effects of new fungicides on infection of barley roots by minor pathogens. An attempt to control root-infecting Phycomycetes on spring barley cv. Porthos at Rothamsted and Woburn on sites free from major pathogens was unsuccessful. 'Aliette' (fosetyl-al) or 'Ridomil' (Ciba-Geigy CGA 48988) was applied to the seed bed at respectively 15 and 1·5 kg ha^{-1} in 1000 litre ha^{-1} water or as foliar sprays at respectively 0·7 and 0·07 kg ha^{-1}, but the incidence of infection by minor pathogens was too small to give a definite result. There was no indication that infection by *Pythium* spp. or by *Olpidium*, *Polymyxa*, *Phialophora radicicola graminicola* or *Endogone* had been decreased and there were no increases in yield. (Salt)

Antifungal activity of Neem against cereal pathogens. At the request of Dr. S. A. Radwanski, we did some simple experiments on the antifungal activity of neem (*Azadirachta indica* A. Juss) cake and oil, supplied from India by Mr. C. M. Ketkar. In experiments using potato dextrose agar, emulsions of the oil (up to a maximum concentration of 10%), applied to wells cut in the agar, had no effect on the growth of *Fusarium culmorum*, *Rhizoctonia solani*, *Cephalosporium graminearum* or *Pseudocercosporella herpotrichoides*. Extension of *Gaeumannomyces graminis* was also unaffected but the oil caused the mycelium to darken much sooner than normal.

An emulsion containing 5% neem oil was phytotoxic to wheat leaves (cv. Kador) but one containing 1% oil caused little or no damage, whether or not wetter (Manoxol O.T.) was added. Application of a 1% emulsion of the oil, as a spray, to barley seedlings (cv. Zephyr) prior to inoculation with powdery mildew (*Erysiphe graminis*), gave some protection against the pathogen, decreasing the average amount on the three youngest leaves from 13·4% on unsprayed seedlings to 8·6% on sprayed. Development of take-all (*Gaeumannomyces graminis*) on the roots of wheat (cv. Cappelle-Desprez) grown in infected soil was unaffected by a 1% spray. Application of a drench containing 1% oil, at 10 ml 230 g^{-1} air-dried soil, decreased the number of infected seminal roots by *c.* 50% (from an average of 1·0 per plant to 0·5 per plant). Incorporation of neem cake in the soil at 1% w/w apparently decreased infection even more (to 0·3 seminal roots per plant)

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but interpretation is difficult because the roots were severely stunted and distorted, with much brown discolouration. There was no evidence that this browning was caused by a pathogen. (Read, Jenkyn and Prew)

Take-all disease. In these reports the following abbreviations are used for simplicity:

Gaeumannomyces graminis var. *tritici* = Ggt;
G. graminis var. *graminis* = Ggg;
Phialophora radicicola var. *radicicola* = Prr;
P. radicicola var. *graminicola* = Prg.

Gaeumannomyces-Phialophora *complex*. Knowledge of this group of important pathogens and possible biocontrol agents continues to increase. Isolates of *G. cylindrosporus* Hornby, Slope, Gutteridge & Sivanesan (Gc), indistinguishable from Prg in culture, have been obtained from asci and have reproduced Gc perithecia on rotted wheat-seedling roots, confirming that the anamorph of Gc is Prg. All fungi currently identified as Prg may not have Gc as the teleomorph. (Hornby)

The possibility of Prr being the anamorph of Ggg (variety with lobed hyphopodia) has been discussed often, although there were no records of Ggg in the UK. However two recent collections sent to us by Dr. M. B. Ellis have provided *Gaeumannomyces* spp. with lobed hyphopodia. One, from *Carex rostrata* Stokes in Powys, differs from Prr and Ggg in culture and in pathogenicity tests. The other, from *Deschampsia caespitosa* (L.) Beauv. in Suffolk, resembles Prr in culture and constitutes the first firm evidence of a Ggg teleomorph of Prr in the UK. Attempts to develop a teleomorph from isolates of Prr from cereals have mostly failed; one produced a few atypical *Gaeumannomyces* perithecia on sprouted maize-seed agar, but the significance of this is still unclear. (Hornby, with Holden, Biochemistry Department)

Effects of added inoculum and soil sterilisation on take-all in continuous spring barley. Between 1972–78 the 'Effects of Breaks on Take-all' experiment at Woburn (*Rothamsted Report for 1977*, Part 1, 216) apparently did not generate contrasting soils with and without take-all decline. With never more than 4% of roots infected in the field, even in barley sequences following a 2-year break, the site seemed to have become unfavourable to take-all and in 1979 the experiment was modified to try to identify the reasons. The modifications comprised three treatments, each testing a different hypothesis of how significant take-all could be reintroduced: breaks from susceptible crops extended to

TABLE 1

Reintroducing severe take-all after 9 years of little disease in spring barley on Butt Furlong, Woburn

Treatment	Previous crop	Barley yields t ha^{-1}	Take-all on 16 July 1979: % plants infected	Take-all on 16 July 1979: % roots infected
Continuation of existing sequences	3rd barley[1]	2·31	7·9	2·7
	4th barley	2·45	0	0
	11th barley	1·98	15·2	3·8
Soil sterilant[2]	5th barley	2·37	1·7	0·1
Added inoculum[3]	1st barley	1·59	97·0	53·2
Soil sterilant + added inoculum	2nd barley	1·27	99·0	67·2
SED (rep)		0·257(2)		

1. All barley sequences followed a 2-year break of fallow then beans
2. Formaldehyde solution (37–40% w/v), 300 ml m^{-2} applied in 54 litres water
3. Colonised whole oats

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3 years (fallow, beans, oats), soil sterilisation (the reason for late sowing on 8 May) and added inoculum. There was a trace of take-all (0·4% of oat plants infected) in the third year of the extended break. The results of the other treatments (Table 1) were dramatic and show that where virulent artificial inoculum was provided close to the barley grain at sowing, severe infection ensued and that the soil's ability to suppress disease arising in this way was limited. (Hornby and Henden)

Effect of phosphate fertiliser on take-all. The final results from the 'PK and Take-all' experiment, West Barnfield, and the 'Residual Phosphate' experiment are summarised in the report of the Soils and Plant Nutrition Department. (Slope and Gutteridge, with Mattingly, Soils and Plant Nutrition Department)

Take-all decline. During 1969–72 results from the 'Wheat after Intensive Barley' experiment, Little Knott field, showed that take-all increased during three or four successive wheat crops and then declined (*Rothamsted Report for 1972*, Part 1, 138). Part of this experiment was retained to provide a source of soils for studies attempting to identify the cause of this decline. However, observations on this and other experiments suggested that 1- or 2-year breaks from wheat and barley might not eliminate fully the decline factor once it had been established, so a 3-year break (fallow, beans, beans) was introduced in 1973. The effects of this have now been tested in 2 years, both generally favourable to take-all. Table 2 shows that a peak and decline of take-all occurred in both years. The proportion of plants infected and the disease ratings of the most infected crops were only a little less than during 1969–72 but the area of crop obviously stunted was less than usually observed in crops in the 'non-decline' phase. This suggests that our method of assessing disease severity by the proportion of roots blackened may not relate consistently to damage to growth. The experiment is now ended. (Gutteridge)

TABLE 2

Effect of previous cropping on the take-all disease rating (maximum 300) of winter wheat

Year	No. of wheat crops after a 3-year break				Continuous wheat or barley since 1961
	1	2	3	4	
1978	6	155	130	—	114
1979	9	60	114	109	72

All crops were given 100 kg N ha^{-1} in spring

Mildew on winter barley. Six dates of sowing (5, 12 and 19 October and 1, 15 and 29 November), triforine seed treatment (2·7 g a.i. kg^{-1}) and tridemorph sprays (0·7 litres a.i. ha^{-1}) on 27 April and 1 June were tested in a factorial experiment for their effects on yield of winter barley (cv. Hoppel, sown at 176 kg ha^{-1}). Dry soil conditions in the autumn of 1978 prevented emergence until November in most plots sown on the first four dates. In the very cold winter crop growth was slow and by early March plants in the most advanced plots had only reached GS 23 while those sown on 29 November were still at GS 10. No mildew was seen until early summer; on 2 July plants in late-sown plots without fungicide had only *c.* 10% of the area of the 3rd leaf affected. This late development of mildew was reflected in the response to fungicide; only the spray on 1 June increased yield, from 7·32 to 7·61 t ha^{-1}. As in previous years yields were much affected by sowing date averaging 7·85, 8·03, 7·87, 8·07, 7·29 and 5·68 t ha^{-1} respectively. The first four sowings gave yields which did not differ significantly presumably because the crops emerged together. (Bainbridge, Jenkyn and Finney)

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Effects of defoliating spring barley. Identifying those growth stages at which the yield of plants is most affected by damage to their leaves or roots can provide a useful basis for developing models relating the incidence or severity of pests and diseases to the losses they cause. Cereal leaf diseases are generally considered most damaging during grain filling although earlier attacks, by powdery mildew at least, can certainly cause damage. In an unreplicated experiment reported by White (*Scientific Agriculture* (1946) **26,** 225–229) total defoliation on single occasions, intended to simulate grasshopper damage, most affected yield of wheat when done between the heading and dough stages. Defoliation of young seedlings also decreased yield, in part at least by decreasing numbers of ears, but defoliation between then and ear emergence had relatively little effect on yield. In 1979 we did a similar but replicated experiment with spring barley to see whether a modern variety grown under modern conditions would respond similarly. Small plots were totally defoliated on one of seven dates between 22 May and 2 July. Partial and progressive defoliation treatments, which would more accurately simulate damage by diseases, were planned but later abandoned because they required so much labour, so that there were seven untreated plots in each of the four blocks. None of the defoliation treatments significantly affected either number of ears m^{-1} of row or number of grains per ear. Defoliation at growth stage (GS) 21 decreased yield by 18% but 1000 grain weight by only 6%, implying some effect on ear number or number of grains per ear whereas defoliation at GS 24 or GS 30 had no significant effect on yield or 1000 grain weight. The smallest yield (31% less than untreated) was given by plots defoliated at GS 37. (Anilkumar, Jenkyn and Finney)

Agropyron mosaic virus in wheat. Agropyron mosaic virus (AgMV) is transmitted by the mite *Abacarus hystrix* (Nal.) and is widespread in *Agropyron repens* (couch grass) in Britain. Although most, if not all, British wheat cultivars are known to be susceptible and the virus has been reported from wheat crops in N. America and Europe (Slykhuis, *Annual Review of Phytopathology* (1976) **14,** 189), natural infection of wheat has not previously been reported from Britain.

In early June a rather diffuse, stripy chlorosis was seen on the youngest fully expanded leaf of winter wheat cv. Maris Huntsman growing along the edge of West Barnfield where couch with slight yellow flecking on the leaves was common. Long (685 ± 25·8 nm) slightly flexuous virus particles were present in both wheat and couch. The properties and host range of the virus show it to be AgMV: serological tests remain to be done.

Several hundred wheat plants were infected and all were adjacent to infected couch grass. Fertile shoots showing symptoms were slightly shorter, gave slightly smaller 1000 grain weights, but had 25% fewer grains per ear than symptomless shoots.

It seems likely that infection occurred in the autumn as a result of large mite populations on infected couch invading the emerging wheat. The localisation of infection around couch suggests that AgMV, although a potentially damaging pathogen, is likely to be confined to couch-infested areas of wheat crops. (Plumb and Lennon)

Barley yellow dwarf virus (BYDV) and enzyme-linked immunosorbent assay (ELISA). Antisera were prepared to the two isolates B and F of BYDV that are most widespread in Britain. Isolate F is most efficiently transmitted by the aphid *Macrosiphum* (*Sitobion*) *avenae* and causes slight symptoms and yield loss, while isolate B is most efficiently transmitted by *Rhopalosiphum padi* and causes severe symptoms and considerable yield loss.

In both glasshouse- and field-infected wheat, oats and barley the antisera readily detected their homologous virus in ELISA tests. The antiserum to F also detected the presence of isolate B, but less efficiently, whereas the antiserum to B did not detect F. ELISA tests using both antisera can now detect the presence and strain of BYDV and

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identify the most likely aphid vectors in UK cereal crops. (Plumb and Lennon, with Dr. M. F. Clark, East Malling Research Station)

Diseases of grasses and forage legumes

Short-distance spread of ryegrass mosaic virus (RMV) by its mite vector *Abacarus hystrix*. Once long distance wind-borne transport of *Abacarus hystrix* carrying ryegrass mosaic virus has introduced infection and produced foci in newly-sown fields, most subsequent spread may be achieved by transmission amongst neighbouring plants. Such short-distance spread could also be important in fields renovated by reseeding without completely destroying the old sward.

In June, 1979, newly-sown plots (2·5 × 3 m) of Italian ryegrass cv. RvP had the central row replaced with perennial ryegrass transplants from an old sward infested with mites and infected with RMV; control plots were either RvP alone or also contained a central row seeded with perennial ryegrass. By mid-July, there were no virus-infected tillers and only an average of 0·2 mites per tiller in control plots, but on treated plots about 12% of tillers were RMV-infected and there were about 10 mites per tiller. Both mites and virus were concentrated around the transplants and, 1 month later, when RMV-infected tillers could still not be found in control plots, 60% of tillers were RMV-infected in the first rows adjacent to the transplants in treated plots, 30% in second, and 4% in fourth rows (15 cm between rows). There were then about 220 mites per tiller on first, 50 on second and 10 on fourth rows, but only 2 mites per tiller on control plots. By mid-October, there was on average 97% of tillers with RMV in first rows adjacent to the central strip in treated plots, 67% in second, 40% in fourth and 18% in seventh rows, compared with an average of 2% infected tillers in control plots.

Thus, in this experiment, short-distance spread of RMV by mites within plots greatly exceeded spread from outside, suggesting that once initial foci of infection are established in a field, these are the sources of most subsequent infection and that the destruction of only part of an established sward containing perennial ryegrass during the process of renovation by reseeding could leave many such foci of infection from which spread into the new grass would be rapid. (R. W. Gibson)

Chemical control of *Sclerotinia* rot of clover. Initial work on the chemical control of clover rot (*Sclerotinia trifoliorum*) which mostly tested benomyl applied to red clover, has been extended to include white clover and to compare iprodione with benomyl. Results from two harvest years (1978 and 1979) show that programmes of five iprodione sprays, applied monthly from September to January each year, are less effective than similar programmes using benomyl (average increases in total dry matter yield over the 2 years being 7 and 14% respectively). In the first harvest year (1978), resistant varieties of red and white clover (Hungaropoly and Blanca, respectively) responded to the programme of benomyl sprays at least as well as susceptible varieties of the two species (Sabtoron and Sabeda, respectively). However, in the following year the average responses of the susceptible varieties were much greater than those of the resistant ones. (Jenkyn)

Crimson clover latent virus (CCLV). This previously undescribed virus, first isolated in 1978 (*Rothamsted Report for 1978*, Part 1, 221), has been identified in each of the six seed lots of crimson clover (*Trifolium incarnatum*) so far examined; five of the seed lots were from European countries and one was from the USA. All plants grown from each seed lot were infected but were without symptoms. The virus was not transmitted by *Myzus persicae*, but was transmitted by inoculation of sap to *Chenopodium album*, *C. amaranticolor* and *C. quinoa*. Plants of 24 other species from seven families were not infected. CCLV was best propagated in *C. quinoa* in which it caused stunting and systemic

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chlorosis. Sap from infected *C. quinoa* was infective after dilution to 10^{-2} but not 10^{-3}, after 10 min at 60°C but not 65°C, and after 20 days at 20°C.

In neutral phosphotungstate, CCLV has isometric particles *c.* 26 nm in diameter with a hexagonal profile. From 20–80 $A_{260}^{1\,cm}$ units of purified virus were obtained from 1 kg of infected *C. quinoa* or *C. amaranticolor* leaf. Purified virus sedimented as three components with sedimentation coefficients ($S_{20,w}$) of 52S, 101S and 122S. At equilibrium in CsCl gradients, buoyant densities of the 101S and 122S components were 1·438 and 1·495 g cm^{-3} respectively. From the sedimentation coefficients and buoyant densities, the nucleic acid contents of the 101S and 122S components were estimated to be 32–35% and 40–41% respectively. The virus contained a single protein with a molecular weight of 52 000. CCLV was not serologically related to any of 29 other morphologically similar viruses. Although its vector is unknown it seems to have affinities with nepoviruses. (Kenten, Cockbain and Woods)

Diseases of grain legumes

Effect of fungicides on survival of lupins, *Lupinus albus* cv. Kievsky. The hard winter confirmed the frost-susceptibility of this crop, a weakness that was suspected even after the mild winter of 1978 (*Rothamsted Report for 1978*, Part 1, 219). Emergence from seed sown in October was 44% from untreated and 63% from seed treated with a benomyl-thiram mixture ('Benlate T') at the rate of 0·6 g to 100 g seed. Smaller increases in emergence were obtained from 'Aliette' and 'Ridomil' applied respectively at 1·0 g and 0·6 g. Similar improvements in emergence were obtained from the same fungicides applied as drenches to the furrow at planting time. Most plants survived until the first hard frosts in December but by mid-February there were no survivors from the October sowing and no emergence from a sowing in November. A spring sowing delayed until 9 May by wet soil resulted in emergences of 27, 37, 38 and 53% respectively from untreated seed and from seed treated with 'Aliette', 'Benlate T' and 'Ridomil'. This sowing was too late to enable the crop to ripen and it was cut green in October. This work has shown that fungicidal seed treatment improves emergence and that lupin cv. Kievsky is unsuitable for autumn sowing and presents problems with late harvesting if spring sowing is delayed. (Salt)

Phytophthora root rot of *Vicia faba*. Field beans grown in pots of soil from Barnfield, which had been fallowed for 3 years after successive crops of field beans, developed severe root rot and wilt. *Phytophthora megasperma* was the main pathogen but *Pythium* spp. and *Fusarium* spp. were also present. Soil drenches of 'Aliette' (2·0 g l^{-1}), 'Benlate T' (2·0 g l^{-1}) and 'Ridomil' (0·2 g l^{-1}) were applied at emergence at 100 ml per pot and plants were harvested 3 weeks later. 'Aliette' decreased root rot spectacularly and almost doubled the weight of roots whereas 'Benlate T' and 'Ridomil' had no effect. Foliar sprays of 'Aliette' and 'Ridomil' were applied to untreated plants 3 weeks after emergence when they were already severely diseased. Two weeks later there was no effect on the weight or health of tap roots or on the total weight of lateral roots, but 'Aliette' had increased the percentage by weight of healthy lateral roots to 44% of the total compared with 25% (no treatment) and 26% ('Ridomil'). As foliar sprays were prevented from contaminating the soil it seems that 'Aliette' must have been translocated downwards to protect newly developed roots. (Salt)

Hosts of *Phytophthora megasperma* isolated from *Vicia faba*. *P. megasperma* has been reported causing disease in a range of crop plants including field beans, brassicas, sugar beet and potatoes. An isolate from field bean was tested on a range of species grown in potting compost in the glasshouse. Ten ml of a suspension containing *c.* 100 zoospores ml^{-1} were poured around the bases of seedlings of field bean, pea, white lupin, navy

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bean, lucerne, red and white clover, sugar beet, turnip, cabbage and rape on 5 consecutive days and root systems examined 12 days after the first inoculation. Only the roots of field bean were diseased. (Salt)

Bean yellow mosaic virus. Host range studies and serological tests showed that 13 mottled broad bean samples from S.E. Turkey were all infected with bean yellow mosaic virus but no other virus was detected. Three Turkish isolates selected for more detailed study closely resembled four British isolates in host range and in several physical characters but showed small serological differences. (Govier and Yilmaz)

Vicia cryptic virus (VCV). Further attempts to transmit this seed-borne virus of field beans and broad beans (*Rothamsted Report for 1978*, Part 1, 220–221) by mechanical inoculation and grafting failed. No virus was detected in pea, French bean and *Vicia narbonensis* plants 4–10 weeks after union with VCV-infected field bean stocks, nor in field bean and broad bean plants (grown from healthy seed) 12–28 weeks after union with infected stocks. However, studies done in collaboration with Miss G. Toynbee-Clarke of the Plant Breeding Institute, Cambridge, showed that VCV is transmitted through pollen as well as through seed. The virus was transmitted through 50% of seeds from healthy field bean plants pollinated with pollen from infected plants, and through 88% of seeds from infected plants pollinated with pollen from healthy plants. All seeds obtained by crossing infected plants were infected, and all seeds obtained by self-pollinating healthy plants were healthy.

The results of a small plot experiment suggest that VCV has little or no effect on the growth and yield of field bean cv. Minden. Yields of four inbred infected lines (*c.* 87% plants infected) ranged from 51·7 to 76·5 g per plant (mean, 66·7 g); yields of four inbred healthy lines ranged from 57·3 to 72·4 per plant (mean, 65·1 g). (Kenten, Cockbain and Woods)

Chocolate spot on winter beans. In a replicated experiment of split plot design, irrigation and benomyl fungicide were assessed for their effects on chocolate spot and crop growth. The crop (cv. Throws MS) was sown on 9 October 1978 and emerged in early November. Most aerial growth was killed during the winter but the majority of plants produced new stems from below ground during March and April. By early May stems had 3–5 nodes, flowering began in late May and continued till early July. Irrigation of 12·5 mm was applied on four occasions in July, when weekly rainfall was less than 15 mm. Benomyl (0·6 kg a.i. ha^{-1}) was applied once (24 May), twice (24 May and 27 June) or not at all. Chocolate spot was slight but sprays decreased disease. By mid-June lower leaves on unsprayed plots had 5·67% leaf area diseased compared with 2·13% on sprayed plots. In early August lowest green leaves, i.e. at about one-third stem height, in unsprayed plots had 2·33% disease whereas two sprays had almost prevented disease development.

Effects on yield were the opposite of the previous year: benomyl did not affect yield, whereas irrigation significantly increased the number of pods per stem from 9·1 to 11·3, 1000-seed weight from 726 g to 756 g, and yield from 3·29 to 4·26 t ha^{-1}. It is not known why the effect of irrigation differed in 2 years with similar total summer rainfall. Perhaps the much more severe winter of 1978–79 had so restricted root development that un-irrigated plants were unable to exploit soil water reserves to the same extent as in the previous year. (Bainbridge and Finney)

Diseases of Brassica crops

Pyrenopeziza brassicae. Seed infection by this fungus has been confirmed. Previous studies on oilseed rape (*Rothamsted Report for 1977*, Part 1, 222) had traced infection from floral

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organs through to funicula and immature seeds within pods, but not to mature seeds. In 1979 cauliflower plants with severe natural infection were grown to maturity and yielded mature seeds of which <5% carried sporing acervuli beneath the seed coat.

Current oilseed rape breeding programmes aim, among other objectives, at a low concentration of glucosinolates in seed. Some glucosinolate derivatives, such as the isothiocyanates, are known to be fungitoxic. In an investigation of the possible pathological consequences of this trend one derivative, allyl isothiocyanate, was found to be toxic to *P. brassicae*. Solutions containing >0·5 ppm allyl isothiocyanate decreased mycelial growth in liquid culture and in the vapour phase inhibited spore germination. (Rawlinson, Emmenegger and Fovargue)

Photosynthesis by clubroot-diseased plants. In cabbages affected by clubroot (*Plasmodiophora brassicae*), dry matter is diverted to the clubroot tumour at the expense of tops and fibrous roots, leading to diminishing increases in capacity for assimilation and absorption. The altered distribution of assimilates was strikingly shown by measurements of ^{14}C in different organs 48 h after feeding $^{14}CO_2$ to one leaf. The fed leaf of a healthy plant retained 27% of the ^{14}C originally fixed, 46% had moved to the shoot, 7% to the root and 20% was lost. Of a like amount fixed by a diseased plant, 18% was retained in the fed leaf, 20% had moved to the shoot, and 21% to the root (3% to the fibrous root and 18% to the clubs). 41% had been lost probably because of enhanced respiration by infected and tumorous tissues.

Infected plants have few fibrous roots in relation even to their decreased leaf area—a major cause of their frequent wilting. Porometry showed that their stomata behaved similarly to those of healthy plants and closed when leaves were under water stress. Thus, when photosynthesis was measured in a growth room in the later part of the light period infected plants, which were wilting slightly, fixed 14% less $^{14}CO_2$ than healthy plants. In further experiments to find how photosynthesis of infected plants compared with that of healthy plants at comparable stomatal apertures, nearly simultaneous measurements were made of stomatal resistance of and photosynthetic $^{14}CO_2$ fixation by healthy plants either untreated or artificially wilted by adding a solution of polyethylene glycol (−3 bar) to the soil, and by infected plants. There was, generally, a negative correlation of rate of photosynthesis with stomatal resistance. Values for infected plants differed little from those for the other two groups. We conclude that, under the conditions used so far, the rate of photosynthesis by clubroot-diseased plants seems determined principally by water relations. (Finney and Macfarlane)

Potato diseases

Planting was delayed until mid-May when there was a brief improvement in weather and soil conditions. Seed was well sprouted when planted and most crops had emerged by early June. *Rhizoctonia* was less severe than in the past 2 years but blackleg was prevalent on Ulster Sceptre and on the heavy, poorly-drained land of Delharding had a particularly devastating effect on emergence and early development of about 40% plants. On the better drained soils of Long Hoos symptoms appeared later on only about 20% of plants and had less effect on plant growth, typically only affecting one of the stems of a plant. However dry weather from mid-June dried out the stem lesion. The change in weather coincided with the onset of tuber formation and Maris Piper at Woburn (as in much of East Anglia) was so badly affected by common scab that it was unsaleable as table potatoes. Following a dry and relatively warm July, August was wet and cool. Late blight was found first on 29 August on Desiree and Pentland Crown on Great Knott and 2 days later on King Edward on Highfield on sites of groundkeeper experiments. The

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number and size of lesions suggested first infections in early August. Fungicide sprays and a dry September prevented development of the disease and none was found on farm crops until early October following late September rain, but by then the haulm of most crops had been burned off. Pycnidia of *Phoma exigua* were less prevalent on desiccated stems than for a number of years.

Diseases caused by bacteria

Spread of* Erwinia carotovora *varieties. The experiment (*Rothamsted Report for 1978*, Part 1, 222) in which seed tubers placed in the crop were rotting with one *Erwinia carotovora* variety (e.g. var. *atroseptica*—blackleg) and stems of the same plants were inoculated with the other (var. *carotovora*—tuber soft rot), or *vice-versa*, was repeated with some modification in 1979. Presence of the inoculated strains in the inoculated organs, in soil and in induced progeny tuber rots was monitored serologically (*Rothamsted Report for 1976*, Part 1, 271).

This series of experiments, now completed, has shown that spread of var. *atroseptica* is favoured by cool wet weather and that of var. *carotovora* by warmer weather, that inoculum of either variety from stems is more effective in contaminating progeny than from inoculated seed tubers and that less rainfall is needed for this to be achieved from stems. Changes in weather rapidly affect soil populations and the ease and speed with which progeny tubers can be induced to rot. This may account for the safe storage of crops when lifted under ideal conditions, despite a high incidence of blackleg stems and large soil and tuber populations earlier in the season. (Lapwood and Read)

Potential bactericides. Dichlorophen has shown good antibacterial activity *in vitro* against *Erwinia carotovora* but *in vivo* it has increased bacterial soft rotting over water-treated controls. When damaged tubers treated either with chemical or water were incubated under anaerobic conditions neither showed evidence of wound healing but under aerobic conditions a distinct wound barrier was evident in the water- but not dichlorophen-dipped tubers. The intensity of fluorescence under ultraviolet light (brightness factor) of the outer walls of the first layer of undamaged cells of wounds was measured as an indication of the extent of wound healing, using an Image Analysing Computer (Quantimet). After a standard healing period water-dipped controls had a brightness factor (the mean of 20 brightness levels measured by the computer) of 2·9 whereas those for different formulations of dichlorophen were 0·8 ('Pro-phen', Geest Industries), 0·6 ('Elbadyne', Winton Laboratories) and 0·3 ('Panacide', B.D.H. Chemicals), showing inhibition of the first stages of wound healing. (Harris)

Seed treatment. The use of a chemical seed treatment to prevent or reduce the rotting of the seed (mother) tuber, a major source of the *Erwinia* bacteria, could decrease the level of contamination of progeny tubers and thereby the risk of rotting in store. Tubers from a seed crop were treated either immediately after harvest in 1978 or prior to traying up for chitting in 1979 with chlorine dioxide, 8-hydroxyquinoline, 5-nitro-8-hydroxyquinoline or dichlorophen, applied as dusts or dips to washed or 'as harvested' tubers. 5-nitro-8-hydroxyquinoline delayed the onset of bacterial degeneration of seed tubers early in the season but no treatment significantly affected the ease with which *Erwinia* spp. could be isolated from mother tuber rots. (Harris, Lapwood and Read)

The use of fungicides against tuber-borne pathogens

Effects of seed treatments on diseases in stored crops. In experiments at Sutton Bridge Experimental Station treating King Edward seed with thiabendazole in March decreased

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incidence of skin spot in the stored ware crop from 23 to 1% and of black scurf from 37 to 18%. Silver scurf was less affected and, although we previously suggested that infection might spread from tuber to tuber during storage, few spores of *Helminthosporium solani* were caught in a Burkard spore trap operated in the store throughout the storage period. In other experiments with thiabendazole comparing treatment of seed before sprouting with treatment of ware before storage, skin spot was decreased most by seed treatment and silver scurf most by ware treatment. At Sutton Bridge black dot (*Colletotrichum coccodes*) was prevalent on experimental tubers after storage, causing superficial blemish very similar to silver scurf. This caused difficulty in assessing silver scurf and initially microscopic examination was required to distinguish the two diseases. Black dot was not controlled by seed or ware treatment with thiabendazole.

Effects of ware treatment before storage. During loading into store ware tubers were sprayed with a suspension of thiabendazole (40 g a.i. t^{-1}) or imazalil (1, 4 or 10 g a.i. t^{-1}) in experiments at Sutton Bridge (cv. Maris Piper), Catterick (Pentland Dell) and Thame (Pentland Crown). Skin spot was decreased equally by imazalil at 10 g a.i. t^{-1} and by thiabendazole; and silver scurf by imazalil at 1 g a.i. t^{-1} and by thiabendazole. In two experiments gangrene was decreased more by imazalil at 10 g a.i. t^{-1} than thiabendazole at 40 g a.i. t^{-1}. Incidence of black dot was not affected by fungicide treatment. (Hide, Cayley and Read)

Laboratory tests. Of 16 materials tested for control of gangrene on wounded and stored tubers, prochloraz, imazalil, 'Sisthane' and nuarimol were the most effective. Dry rot (*Fusarium solani* var. *caeruleum*) was controlled best by prochloraz, thiabendazole and carbendazim and these materials together with imazalil and 'Sisthane' also controlled dry rot caused by *F. sulphureum*.

In tests of fungicides for controlling stem canker, tubers with black scurf were treated and germination of *Rhizoctonia solani* sclerotia assessed after incubation for 24 h. The most effective materials were thiabendazole, iprodione and benodanil. Imazalil was usually less effective although on treated tubers stored in daylight for up to 1 week before incubation germination of sclerotia was almost completely prevented. (Hide and Cayley).

Gangrene (*Phoma exigua* var. *foveata*)

Infection of stems and stolons. Pycnidia of the pathogen develop on potato stems after desiccation and can contribute to inoculum levels around tubers at harvest but the origin of stem infections is still uncertain. In a field experiment, undamaged internodes were inoculated in August by binding on cotton wool soaked in one of a range of concentrations of pycnidiospores in suspension, using wax film. After 2 weeks, the inoculum had dried but no symptoms had appeared. Stems were cut at ground level and stored in trays at 7°C in the light with inoculum pads *in situ*. After a further 5 weeks, about half the sites inoculated at 10^5 spores ml^{-1}, 10% of sites at 10^4 spores ml^{-1} and no sites at smaller concentrations had developed lesions with pycnidia.

In laboratory experiments, excised stems, etiolated sprouts and stolons were inoculated using filter paper discs soaked in pycnidiospore suspension (5×10^5 ml^{-1}) and incubated in high humidity at 15°C. After 1–2 weeks some inoculation sites showed tiny necrotic areas. Microscopic examination of stained sections showed that the fungus had apparently penetrated between epidermal cells, a few of which had died. Earlier experiments (*Rothamsted Report for 1978*, Part 1, 224) showed that the pathogen could sometimes be recovered from within green stems growing from contaminated seed tubers, although

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extensive lesion development is usually delayed until haulm senescence. These results suggest that such stem infection might arise from direct penetration of the epidermis. (Adams)

Disease development in store. Inoculum concentration in soil and the type and incidence of tuber damage influence amounts of gangrene in store. To determine the importance of each of these factors in practice, crops of cv. Pentland Dell were surveyed during 2 years on arrival at a commercial bulk store and assessments were made of damage incidence, inoculum in tuber-borne soil and inoculum potential of the tubers. Nets of tubers buried in the tuber bulk were recovered after storage and gangrene incidence compared with damage and inoculum assessments. Regression analysis indicated that both inoculum potential and the incidence of severe damage influenced amounts of disease but that damage incidence was of greater importance. (Adams)

Effects of seed affected by silver scurf. Tubers with slight or severe silver scurf (<20 or >80% surface affected) were selected from seed stocks of cvs Ulster Sceptre and King Edward and sprouted on trays at 10°C before planting. During sprouting severely affected seed shrivelled, Ulster Sceptre losing 18% wt in 8 weeks and King Edward 14% wt in 13 weeks, compared with less shrivelling and 11 and 10% weight loss respectively for the slight category. Severely affected tubers produced more but smaller sprouts.

One month after planting, plant size, measured as ground cover, was almost twice that from slightly as from severely affected seed and in samples taken fortnightly during growth severely affected seed produced less weight of haulm and fewer and smaller tubers and up to 10% less weight of tubers than slightly affected seed. Stem numbers were not affected. By September there were no differences in tuber yields. (Read)

How glandular hairs may affect the spread of potato viruses. The droplet secreted by the sticky-tipped hairs, one of the two types of aphid-trapping glandular hairs found on the wild potato *Solanum berthaultii*, can be dissolved away in absolute ethanol, a treatment which has no observed effect on the type with the four-lobed head. Quickly washing off the ethanol with water prevents damage.

In a glasshouse experiment, about 85% of winged *Myzus persicae* remained on untreated *S. berthaultii* 3 days after being placed on the plants, and these were mostly trapped by the hairs. Washing off the sticky droplets with ethanol followed by water decreased the numbers of aphids remaining to about 50% and these were trapped by the four-lobed hairs alone. By comparison, only 15% remained on cv. King Edward plants and none of these was trapped.

In a second series of experiments, starved apterous adult *M. persicae* were allowed access for 5 min to PVY-infected *S. berthaultii* leaves untreated or treated with ethanol. When tested on tobacco plants, aphids allowed access to treated *S. berthaultii* infected relatively four times as many *Nicotiana tabacum* test plants as those allowed access to untreated *S. berthaultii:* the former group behaved similarly to aphids allowed access to PVY-infected Arran Banner leaves. However, preliminary results suggest that washing off the sticky droplets did not make *S. berthaultii* easier for *M. persicae* to inoculate with PVY.

In Britain most potato viruses including PVY overwinter in potatoes. Any treatment or mechanism that restricts virus acquisition by vectors or that hinders aphid movement should limit virus spread. Our experiments have shown that glandular hairs of *S. berthaultii* combine these effects and show considerable promise for control of PVY spread if they can be introduced into commercial cultivars. (Gunenc and Gibson)

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Potato virus diseases at Rothamsted. When counts were made at the end of June, plots planted with King Edward seed grown at Rothamsted in 1978 contained 0·3% potato virus Y (PVY) and 0·1% potato leaf roll virus (LR). Pentland Crown had no PVY but 0·2% LR. Few *Myzus persicae* were caught in the Rothamsted trap, and these not until the end of July. No current season virus spread was detected in the 1979 seed crop in inspections at the end of July, although experimental plots of King Edward interplanted with infected plots had contracted 2% PVY infection. (Govier)

Staff and Visiting Workers

September marked a unique occasion for Rothamsted, when George King, head of our glasshouse staff for more than 20 years, was ordained a deacon at St. Albans Abbey. We offer him our sincere congratulations.

Following a period of study at the John Innes Institute, S. J. Eden-Green returned to Jamaica in April, to rejoin the ODA team working on coconut lethal yellowing disease. D. Hornby has accepted an invitation to initiate and to chair an international Committee on Soil-borne Pathogens under the auspices of the International Society for Plant Pathology.

During the year, Miss H. Davies, M. E. Finney, Miss L. Hadnutt, R. J. Harris, J. Mayne, Mrs. J. M. O'Sullivan, Mrs. P. Parkins, J. Payne and S. Prior left and Mrs. S. Nabb, Mrs. P. M. Roberts and Mrs. J. Sandison were appointed. Mrs. C. Leather (née Bates) was appointed in March and left in September. P. J. Read was awarded an upper second class Honours Degree in Applied Biology, following part-time studies at Hatfield Polytechnic. M. R. Almond was awarded the Ph.D. degree of London University for his work, as a CASE student, on viruses of *Gaeumannomyces graminis*. Other CASE students who studied in the Department during the year included Miss M. Athalye (University of Newcastle-upon-Tyne), J. J. McFadden and Miss R. M. McGinty (Imperial College) and Miss S. Marriott (with the Potato Marketing Board as industrial partner). N. White completed and K. Delaney continued their studies, supported by ARC studentships and Miss F. Fatemi and Mrs. M. A. Mais spent 5 months in the Department as part of their studies for the MSc. degree of Reading University. N. Magan, a United Nations Research Fellow and Miss Y. Gunenc, supported by the Turkish Ministry of Agriculture, commenced studies for a higher degree.

P. H. Gregory continued to work in the Department at the invitation of the Lawes Agricultural Trust. Visiting workers, who spent between 1 and 4 months in the Department, included Dr. El-Desouky Ammar (Saudi Arabia), Dr. T. B. Anilkumar (India), Mr. J. Emmenegger (Switzerland), Mr. D. Fargette (France), Dr. V. S. Kanapathipillai (Malaya) and Dr. M. Yilmaz (Turkey): Miss J. Clarke, P. Dutton, J. Kelly, Miss E. Machin, S. Warry and Miss B. Woods were sandwich course students.

R. W. Gibson lectured in Tunisia and Turkey on control of potato pests and virus vectors as part of a course on potato production, for African and Middle East students.

J. F. Jenkyn attended the IX International Congress of Plant Protection in Washington D.C.

P. Jones attended a 3-week training course in Mycoplasma Techniques, organised in Bordeaux in September by the International Organisation for Mycoplasmology.

J. Lacey attended a meeting of the International Agency for Research on Cancer in Lyon, the 4th IUPAC Mycotoxin Symposium in Lausanne and the International Symposium on Actinomycete Biology in Cologne, in August/September. In November he visited the Kuopio Regional Institute of Occupational Health, Finland and in December the Department of Pulmonary Diseases, University of Siena, by invitation as adviser.

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E. Lester spent a week in Kenya in February as a member of a three-man team reviewing the Crop Virology Research Project at Muguga, on behalf of ODA.

R. T. Plumb gave an invited paper at a meeting of the West German working group on diseases of cereals and legumes at Fulda in December and visited research workers at Braunschweig.

C. J. Rawlinson visited France, Germany and Sweden in May to discuss oilseed rape problems with research workers.

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Book

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3 HORNBY, D. (1979) Take-all decline: a theorist's paradise. In: *Soil-borne plant pathogens.* Ed. B. Schippers & W. Gams. London: Academic Press, pp. 133–156.

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