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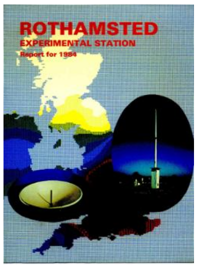

Multidisciplinary Agronomy

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MULTIDISCIPLINARY AGRONOMY

The series of multidisciplinary experiments on winter wheat and spring beans continued with little change for a final year. The series on winter barley started a new phase designed to gain new information on the effects of previous cropping. Those on winter beans, peas and intensive potato growing were also continued.

The close proximity within one field of the wheat and barley experiments and the similarity of some of the treatments invited comparisons between the crops. Although such comparisons lack statistical validity opportunity has been taken to report on the more striking differences.

The results of the first series of experiments on winter barley were displayed by members of the multidisciplinary team at the Royal Agricultural Society of England 'Barley '84' event at Northallerton, North Yorkshire. Three of the factors were tested in a field experiment adjacent to the display and we report briefly on these results also.

Factors limiting yield of winter wheat

The multifactorial experiment at Rothamsted, continued on a new site with little change to the treatments (Table 1).

Yield at maturity. Grain yields were larger than in the two previous years with a best 16-plot mean of 11·1 t ha^{-1}. On average wheat after oats yielded over 2 t ha^{-1} more than wheat after barley. The difference was greater when the wheat was sown early or given pesticide (Table 1). Wheat after oats had more ears with larger grains than wheat after barley. Early sowing had no effect on yield of wheat after oats, although it increased ear number and grain size. Yield after barley was decreased by early sowing because amounts of take-all were increased resulting in smaller grains and fewer grains per ear. Pesticide increased yield after oats, but not after barley, by increasing weight per grain.

TABLE 1

Factors tested and their effects on grain yield (t ha^{-1}) of Avalon winter wheat grown after oats (O) or after barley (B): Means over all other factors

Level 1		Yield	Level 2		Yield
(1) Sown early (E) 20 September	O B	10·43 7·52	Sown later (L) 18 October	O B	10·43 8·88
(2) Nitrogen rate 1, 160 kg ha^{-1}	O B	10·08 7·80	Nitrogen rate 2, 230 kg ha^{-1}	O B	10·78 8·61
(3) Timing of main nitrogen application at ear initiation of early-sown (7 March)	O B	10·36 8·12	Timing of main nitrogen application at ear initiation of later-sown (4 April)	O B	10·49 8·28
(4) Growth regulator. Chlormequat ('New 5C Cycocel' at 1·75 l ha^{-1}, E3 April, L27 April)	O B	10·52 8·36	None	O B	10·34 8·04
(5) Spring fungicide. Benomyl ('Benlate' at 0·5 kg ha^{-1}, 10 April)	O B	10·53 8·50	None	O B	10·33 7·90
(6) Summer fungicides. Propiconazole ('Tilt' at 0·5 l ha^{-1}, 30 May and 26 June)+carbendazim+maneb ('Delsene M' at 2·5 kg ha^{-1}, 26 June)	O B	10·47 8·21	None	O B	10·39 8·20
(7) Pesticide. Aldicarb ('Temik' at 50 kg ha^{-1}) to seedbed+omethoate ('Folimat' at 1·12 l ha^{-1}, 10 February)+pirimicarb ('Aphox' at 0·28 kg ha^{-1}, 21 June)	O B	10·74 8·11	None	O B	10·12 8·29

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Spring fungicide increased yield slightly. Summer fungicide failed to increase yield for the first time in this six-year series of experiments. The 70 kg extra N ha^{-1} increased yield by increasing ear number without the compensating decrease in grain size observed previously. Timing of nitrogen had negligible effect on yield but early nitrogen increased ear number and decreased the number of grains per ear. Growth regulator increased yield slightly.

Larger yields than in the two previous years were accounted for by larger grains. Mean dry weight per grain of the best yielding crops was 48 mg compared with 36–39 mg previously.

Two extra plots that were included, following fallow in 1983 and not given nitrogen, growth regulator, fungicides or pesticides, gave remarkable yields: sown early 7·3, sown later 8·6 t ha^{-1}. (Thorne, Physiology and Environmental Physics; Carter, Entomology; Prew, Field Experiments; Webb, Nematology; Lacey and Plumb, Plant Pathology; Penny, Soils and Plant Nutrition; Church and Todd, Statistics)

Growth and development. The experiment was sampled seven times (Table 2). The number of plants established from both sowings was 304 m^{-2}. The differences in growth and development between crops sown early (E) and late (L) decreased progressively during the season. The two crops reached comparable stages of development on the following dates: double ridges E 23 February, L 27 March; terminal spikelet E 16 April, L 27 April; 50% anthesis E 14 June, L 18 June. Zero leaf area and ripeness came four days earlier with the earlier sowing. Growth of wheat after barley was always less than that of wheat after oats. Complete leaf senescence and ripeness came three to five days earlier after barley than after oats.

Applying nitrogen early consistently increased total dry weight, leaf area and shoot number, although effects were small from anthesis onwards. Using the larger amount of nitrogen increased all aspects of growth from May onwards by as much as 14%. An extra 40 kg N ha^{-1} at sowing, tested on eight extra plots, gave better growth in the winter and spring. At maturity wheat after barley given autumn N had larger weights of grain than comparably treated wheat without autumn N, especially when sown late. (This test was

TABLE 2

Avalon winter wheat. Change with time in total dry weight (g m^{-2}), leaf area index, number of shoots m^{-2} and Zadoks growth stage of winter wheat grown after oats (O) or after barley (B) and sown on 20 September (E) or 18 October (L). Means over all other treatments

		6 Dec	27 Feb	3 Apr	2 May (E) 14 May (L)	18 June (E) 25 June (L)	23 July (B) 30 July (O)	15 Aug
Total dry weight	OE	61	126	244	567	1429	2119	1930
	L	8	32	49	493	1293	1992	1790
	BE	52	113	214	523	1348	1713	1500
	L	9	31	42	473	1226	1647	1520
Leaf area index	OE	1·0	1·5	2·9	6·8	10·8	0·2	—
	L	0·1	0·4	0·9	5·8	8·4	0·4	—
	BE	0·8	1·3	2·4	6·0	8·6	0·4	—
	L	0·1	0·4	0·8	5·3	7·1	1·7	—
Number of shoots	OE	1364	1538	1362	994	626	556	569
	L	275	922	1374	980	522	511	516
	BE	1157	1346	1221	930	551	481	474
	L	309	904	1216	854	474	449	470
Growth stage (O and B)	E	15/23	17/24	19/23	33	65	85	92
	L	11	14/22	15/23	33	69	87	92

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on irrigated plots.) Sufficient irrigation to keep the deficit between 12 and 37 mm (138 mm applied between 1 May and 10 July) was tested on 16 extra plots. Although irrigation delayed leaf senescence and increased ear number, it did not affect the weight of grain or straw. The growth regulator decreased final stem height by 2 cm and had negligible effects earlier in the season. (Thorne, Mullen and Wood, Physiology and Environmental Physics)

Nitrogen contents. Data are so far available only for the first four samplings (December–May). Percentages of N were usually slightly larger after oats. Mean values in December, April and May were 4·29, 4·36 and 2·36 respectively. Uptake of N was little affected by previous cropping until May when wheat after oats contained 129 kg N ha^{-1}, after barley 116 kg.

Percentage of N in the crop in December was unaffected by sowing date but was much larger in the later-sown in February (4·74 *vs* 3·84) and in March (5·04 *vs* 3·68); by May it was slightly larger in the early-sown. Uptakes of N until May were always larger in the early- than in the later-sown (24 *vs* 4 kg ha^{-1} in December, 137 *vs* 180 kg in May). Applying 40 kg N ha^{-1} on 3 February significantly increased %N and N uptake on 27 February, but much more in the early-sown crop. The last part of the N was not applied until May so effects of amounts and timings of N were not comparable until anthesis. (Penny, Widdowson, Darby and Hewitt, Soils and Plant Nutrition)

Nitrate-N in wheat shoots. On 5 December, 3 February and 6 March the sap of the wheat shoots on plots given no fertilizer N contained more NO_3-N in the later-sown crop (920 ppm *vs* 850 ppm, 810 *vs* 550, 690 *vs* 140 respectively). Amounts were almost none by 3 April in the early-sown, by 18 April in the later-sown. Although fertilizer-N increased the NO_3-N contents of the early- and later-sown to 390 and 750 ppm respectively on 3 April, they both then fell rapidly to less than 100 ppm by 1 May and to almost none by 14 May. The final part of each N dressing increased amounts again during late May and early June, but by much less than the earlier dressings, and they had returned to nil by 29 June. (Penny and Bird, Soils and Plant Nutrition)

Nematodes. Nematodes were sampled on three occasions, in August 1983 before sowing, on 21 May and after harvest in August 1984; counts are given in Table 3. The cereal cyst nematode *Heterodera avenae* was found for the first time in these experiments

TABLE 3

Avalon winter wheat. Effects of previous crops and pesticide on plant-parasitic nematodes (numbers $litre^{-1}$ soil). Means over all other treatments

	Pratylenchus	*Tylenchus*	*Tylenchorhynchus*	*Helicotylenchus/Rotylenchus*	Totals
18 August 1983					
After oats	300	1200	450	3275	5225
After barley	1125	900	400	2800	5225
21 May 1984					
With pesticide	109	216	244	1088	1657
Without pesticide	166	421	497	1400	2494
After oats	113	313	409	1128	1963
After barley	163	334	331	1359	2187
20 August 1984					
With pesticide	1047	472	597	2125	4241
Without pesticide	2091	863	1159	2978	7091
After oats	1681	713	963	2947	6304
After barley	1456	622	794	2156	5028

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in the pre-crop samples but numbers were few and none were found in subsequent root or soil samples. In May pesticide significantly reduced *Pratylenchus* spp. in roots from 33 g^{-1} untreated to 5 g^{-1} treated, but had little effect on nematodes on the soil although all genera were fewer with pesticide. Numbers in May were less than in the previous August because of the very dry conditions. In the post-harvest samples all genera had increased over those found in May and were greater than the pre-crop samples except for *Tylenchus* spp. Pesticide reduced the number of all genera. There were more *Pratylenchus* after barley but previous cropping had little effect on final populations of other genera. It is unlikely that any of these populations was large enough to affect yield. (Beane and Webb, Nematology)

Barley yellow dwarf virus (BYDV). In autumn 1983 populations of potential aphid vectors of BYDV at Rothamsted were smaller than usual and few were infective. Consequently our forecast based on the Infectivity Index (*Rothamsted Report for 1983*, 122) was that there would be little infection by BYDV and no benefit was expected from the autumn treatment with aldicarb. This forecast was supported by observations which showed that only a few scattered plants were infected. However, combined treatment of aldicarb and the summer treatment with pirimicarb did increase yield. Because early-sown crops, which are exposed to autumn infection by BYDV for longer than crops sown later, did not differ from the later-sown crops in their yield response to pesticides it seems likely that this response resulted from control of the aphid population in summer.

Aphids. The autumn migrations of *Sitobion avenae* and *Rhopalosiphum padi* continued into November and all plots without aldicarb were colonized. The population of *R. padi* increased to 30 m^{-2} in November (early-sown) and 0·4 m^{-2} in December (late-sown) and then both declined to almost none. The density of *S. avenae* was almost constant during the winter (range in early-sown plots; 0·4 to 8·5 m^{-2} and late-sown plots; 0 to 0·9 m^{-2}); *Metopolophium festucae* was uncommon during the winter and spring. Aldicarb significantly diminished the winter aphid populations.

TABLE 4

The population development of Sitobion avenae *(numbers per shoot) on Avalon winter wheat sown on 20 September and receiving no pesticide*

30 May	8 June	15 June	22 June	29 June	6 July	16 July	20 July
0·07	0·19	0·92	6·3	14·5	29·7	22·4	13·0

The spring migration of *S. avenae* started at the end of May and by mid-June aphid traps indicated the risk of an outbreak. The density of *S. avenae* increased to a peak in early July (Table 4). The pesticide treatment controlled this outbreak but yields were increased only after oats. This may have been because pesticide increased the take-all present after barley. Previous crop did not affect aphid population development nor did the amount and timing of application of nitrogen. Other aphid species were uncommon. Natural enemies had little impact on early aphid population development although they probably diminished the peak density. (Carter and Dewar, Entomology)

Fungal diseases. Take-all was again the most damaging disease; there was almost none after oats but infection was severe after barley particularly with early sowing. By December most early-sown plants were infected but only few from the later sowing. Although spring infection was considerable, take-all severity remained less on the later sowing. The pesticide treatment, probably the aldicarb component, significantly in-

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TABLE 5

The effects of previous crops, sowing dates, pesticide and fungicide treatments on the incidence of foot and root rots in Avalon winter wheat. Means over all other treatments.

	% straw infected on 2 July		Take-all infection		
			% plants		Rating
	Eyespot	Sharp eyespot	6 Dec	3 April	2 July
After oats	34	26	2	2	2
After barley	49	20	48	61	182
Sown 20 September	47	33	42	45	124
Sown 18 October	36	13	8	17	60
None	44	18	25	31	82
Pesticide	38	27	25	31	103
None	62	18	—	—	92
Spring fungicide	21	27	—	—	92

creased the severity of take-all; a similar but smaller effect had been observed in the two previous years. None of the other treatments affected take-all infection. Eyespot and sharp eyespot were prevalent and increased by early sowing. Amounts of eyespot were less following oats and with benomyl but these increased sharp eyespot (Table 5). There was little foliar disease, the mean infected area of the topmost leaf never exceeded 0·5%. (Prew and Yeoman, Field Experiments)

The microflora of ripening ears. As hitherto, bacteria dominated the microflora when fungicide was applied at Zadoks growth stage 67 and filamentous fungi were few. Dry weather during the following month caused a decline in bacteria until rain on the ripe grain in early August prompted an unusual late increase (Table 6). There was no effect of fungicide on bacterial numbers. Yeasts dominated the fungal flora during grain development, sometimes exceeding bacteria in abundance and only decreasing in number on the fully ripe grain. Often *Sporobolomyces* were sufficiently numerous to discolour the grain and were only slightly decreased by fungicide. Yeast-like fungi (*Aureobasidium pullulans, Hyalodendron* spp.) were more numerous than filamentous fungi on untreated plots but were decreased more by the fungicide. Among the filamentous fungi there was little effect of fungicide on *Alternaria* but populations of *Cladosporium* and *Verticillium* were both halved for six and four weeks respectively. The most common *Fusarium* species during grain development were *F. poeae* and *F. tricinctum* and these were unaffected by fungicide.

TABLE 6

Avalon winter wheat. The effect of fungicide on the microflora of ripening ears assessed by dilution plating (means of eight plots)

Date	27 June	11 July	25 July	8 August	20 August
Growth stage (Zadoks)	67	77	85	92	93
Untreated	(No. of colony-forming units$\times 10^{-6}$ g^{-1} of ears)				
Yeasts	0·52	23·21	13·75	23·20	3·53
Yeast-like fungi	0·91	2·33	2·21	4·48	3·81
Filamentous fungi	0·04	0·90	1·68	4·18	2·75
Bacteria	61·30	17·21	17·67	47·83	270·83
Fungicide-treated					
Yeasts	0·45	21·24	11·96	23·32	6·54
Yeast-like fungi	0·74	1·39	0·84	3·18	3·68
Filamentous fungi	0·01	0·51	0·86	2·81	3·09
Bacteria	60·55	23·68	8·96	62·63	241·67

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At harvest nearly every grain carried *Alternaria* and *Cladosporium* and about 20% carried *Fusarium* species. Over half the *Fusarium* isolates were *F. culmorum. F. poae, F. tricinctum* and *F. avenaceum* were each present, but on no more than 3% of the grains. There was a little more *Fusarium* on grain from fungicide-treated plots. (Lacey, Plant Pathology)

Water use. From the end of March to the end of July there were two dry periods separated by a period of 21 days from 15 May, during which 108 mm of rain were recorded. The soil moisture deficit following oats reached 95 mm, fell to 35 mm and increased again to 136 mm. Water was extracted from a 90 cm depth of soil in the first dry spell and from 130 cm in the second. Following barley, the average deficits were 65 mm, 0 and 90 mm and water was generally extracted from the same depths.

Water use on the early-sown crop, without irrigation, after barley and oats was 233 *vs* 286 mm, increased to 301 *vs* 364 with irrigation. Thus irrigation allowed the take-all infected crop to use slightly more water than the unirrigated crop after oats.

The dry weather caused only small interruptions to growth without loss of yield following oats. Extra water use from irrigation when following barley did not compensate for the loss of active roots caused by take-all with increased growth. (Weir and Smith, Soils and Plant Nutrition)

Factors limiting yield of winter barley

The previous experiments, made from 1981–83 on Igri winter barley all followed potatoes (*Rothamsted Report for 1983,* 27–31). A new series of experiments was begun on a previously prepared site, which allowed comparisons between three crop sequences, (1) barley–barley–barley, (2) barley–oats–barley, and (3) barley–fallow–barley. The first cropping sequence is the most typical for winter barley and in this the seven factors shown in Table 7 were tested on the two-row cultivar Panda in factorial combination (2^7), using a half replicate design. Additional plots, also with Panda, but with a restricted set of treatments allowed the three crop sequences to be compared. Further additional plots, sown with the six-row cultivar Pirate allowed comparisons with Panda grown in sequences (1) and (2). These 80 plots were arranged in two blocks of 40 plots; additionally four plots not given nitrogen fertilizer, were placed at one end of the experiment.

Nitrogen in the soil. Because most of the barley followed two previous winter cereals, the soil was expected to contain little NO_3-N in autumn. However, on 4 October, shortly after emergence there were 83 kg NO_3-N ha^{-1} to 90 cm, with 46 kg NO_3-N ha^{-1} in the top 30 cm. By 23 November the total amount of NO_3-N had diminished to 46 kg ha^{-1}, with only 13 kg ha^{-1} in the top 30 cm. Thereafter amounts of NO_3-N diminished in the deeper layers also and by 1 February only 16 kg NO_3-N remained. Because barley sown in mid-September was expected to remove all the NO_3-N from the soil quickly and because farmers frequently top-dress winter barley in autumn, we tested 'winter' N (30 kg N ha^{-1} as urea on 9 November, repeated on 1 February). Effects were monitored by measuring NO_3-N concentration in stem sap at fortnightly intervals. On 2 November there were only 250 ppm of NO_3-N in the sap, but then values increased until by 21 December there were 875 ppm NO_3-N whether or not N had been given. Afterwards concentration declined rapidly where no N had been given, but slowly where it had, so that by 26 January relative values were 400 *vs* 750 respectively, on 6 March 40 *vs* 200 and on 2 April 10 *vs* 70 ppm NO_3-N. (Widdowson, Bird and Darby, Soils and Plant Nutrition)

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TABLE 7

The effects of seven factors on the numbers of ears on 21 May and on the grain yield (t ha^{-1}) of Panda winter barley

	Ears m^{-2}	Grain yield
(1) Seeds sown m^{-2}		
300	989	9·09
450	1077	9·07
(2) Seed treatment ('Baytan')*		
Without	1067	8·96
With	1000	9·21
(3) 'Winter' nitrogen (60 kg N ha^{-1} as urea)		
Without	1016	8·97
With	1051	9·20
(4) Early growth regulator (CCC)†		
Without	1025	9·04
With	1041	9·13
(5) Fungicide sprays in spring and summer‡		
Without	1034	8·79
With	1032	9·38
(6) Spring nitrogen (kg N ha^{-1}) on 2 April		
90	1012	8·88
150	1054	9·29
(7) Insecticide ('Cymbush')§		
Without	1035	9·06
With	1032	9·11
SED	22·6	0·065

* 'Baytan' a.i. triadimenol+fuberidazole.
† 'New 5C Cycocel' on 21 October, 29 November and 21 March (0·8 l ha^{-1} on each occasion).
‡ Tridemorph on 10 February; prochloraz+carbendazim on 27 March; 'Cosmic' a.i. maneb+tridemorph+carbendazim on 1 May and 21 May.
§ 'Cymbush', a.i. cypermethrin on 28 October.

Development, tillering and leaf areas. The experiment was sown on 19 September. From 300 seeds sown about 260 plants m^{-2} were established and from 450 seeds, 380 plants. Seed treatment with 'Baytan' decreased mean plant number from 345 to 301 m^{-2}. Plants of Panda developed rapidly and by 16 December the apices were at double ridges, similar to September-sown Igri in 1982/83. As before 'Baytan' seed treatment delayed development; in the early vegetative stages fewer primordia were formed on the apex, but the effect was lost by early November. The awn primordium stage and maximum spikelet number were reached on 10 April; neither leaf number (13.4) nor maximum spikelet number (48.2) were affected by treatment. On 10 April plants of Pirate were at a similar stage, with 13.5 leaves and 44.8 spikelet-bearing nodes on the ear. Anthesis of Panda was on 23 May. Crops of both varieties grown after barley had lost all green area by 10 July, but leaves of Panda after fallow and Pirate after oats stayed green for two to three days longer. Crops were mature (Zadoks growth stage 92) by 19 July.

Most tillers were produced in the autumn. Shoot number was greatest in mid-February and then gradually declined. At anthesis about 17% of shoots were still green, but did not produce a fertile ear. The higher seed rate produced more tillers per unit area in the early stages, but fewer tillers per plant (4·02 *vs* 5·70); maximum shoot number was not affected. The 'Baytan' seed treatment prevented extension of the coleoptile internode and it was the internode above leaf one which elongated to bring the crown near the surface. Tiller one did not appear on many of these plants and those which emerged were small. Consequently tillering was slower, but maximum shoot number and ear number were unaffected. 'Winter' nitrogen greatly increased growth and tiller numbers during the autumn but did not affect final ear number.

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'Winter' nitrogen increased leaf areas throughout the year (leaf area index on 28 March: 2·54 *vs* 1·80; at anthesis: 12·1 *vs* 9·8). To a lesser extent 'Baytan' seed treatment also increased leaf area during the winter, presumably because mildew was controlled, but this advantage was lost by anthesis. Other treatments did not significantly affect leaf area. (Wood and Lawlor, Physiology and Environmental Physics)

Growth and yield in the first crop sequence. Samples were taken on three occasions for dry weight, shoot number and leaf area index. On 28 February, only 'winter' nitrogen significantly increased all three and the 'Baytan' seed treatment the leaf area. Chlormequat, tested as an early growth regulator, significantly decreased dry weight but not shoot number or leaf area. On 28 March shoot number, dry weight and leaf area had been significantly increased by 'winter' nitrogen but not by any of the other factors. On 21 May the number of ears m^{-2} was significantly increased by the larger seedrate (1077 *vs* 989) but dry weight was unchanged. By contrast 'winter' N significantly increased dry weight but not ear numbers. The larger amount of N in spring also only increased dry weight but the increase was less. None of the other factors significantly changed dry weight or number of ears at this date.

Measurements on the relatively small numbers of plants sampled for disease assessments showed that by mid-December differences in plant growth had only partly compensated for the difference imposed by seed rate; mean dry weights per plant were 0·37 *vs* 0·49 for the larger and normal seed rates respectively. By mid-March compensation was complete; seedlings from plots sown at the normal seed rate were 59% heavier than those from plots sown at the larger seed rate (1·03 *vs* 0·65 g dry weight per plant respectively) and had 50% more shoots (5·7 *vs* 3·8 shoots per plant). On both dates, plants from plots sown with 'Baytan'-treated seed were larger than those from plots sown with untreated seed and in March larger with 'winter' N.

At harvest (26 July) grain yields (Table 7) were significantly increased by fungicides, both to the seed and as sprays but more by the sprays. Similarly 'winter' N significantly increased yields, but by less than the same amount of N given in April. By contrast straw yields were increased far more by 'winter' N. Grain size was diminished by the larger seed rate and by nitrogen fertilizer whenever it was applied, but was increased by the fungicides, especially by the spring and summer applications which increased the weight of 1000 dry grains from 37·1 to 38·8 g.

Yield components were also examined on small samples taken at maturity. The larger seed rate gave more ears, but the grains were smaller and yield therefore unaffected. Although 'winter' nitrogen increased pre-anthesis growth this did not lead to an equivalent increase in grain yield because even though more grains per ear formed, there were few more ears. The larger rate of nitrogen applied in the spring increased yield mainly by increasing grains per ear. Both fungicide treatments increased yield by increasing grains per ear and also, particularly by the summer fungicide, grain size. Growth regulator had little effect.

Growth and yield in all three crop sequences. Neither previous crop nor variety had any effect on the number of plants established but after the fallow seedlings of Panda were 66% larger in December, 58% larger in March, than those after oats or barley respectively. By 28 February the number of shoots was greater with Pirate than with Panda (although dry weights were the same) and was greatly increased by previous fallow. By 28 March the number of shoots was still greater with Pirate but was unaffected by previous cropping. By 21 May the contrast between the cultivars was reversed, Panda having the larger number of ears (1002 *vs* 804). At this stage the yield of dry matter was larger after fallow than after oats or barley. At harvest (Table 8) Pirate, despite fewer

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TABLE 8

The effects of previous cropping and cultivar on the number of ears on 21 May and on the grain yield ($t\,ha^{-1}$) of winter barley

	Ears m^{-2}	Grain yield
Two-row, Panda		
Previous crop		
Fallow	992	8·55
Barley	980	9·33
Oats	1024	9.59
Six-row, Pirate		
Previous crop		
Barley	876	10·56
Oats	733	10·82
SED	50·6	0·19

ears and smaller grain, consistently outyielded Panda (10·69 *vs* 9·46 $t\,ha^{-1}$) because it had about two-thirds more grains per ear and hence many more grains m^{-2} (25·9 *vs* 20·4 thousand). Growing oats rather than barley beforehand slightly increased the grain yield of both cultivars (both by 0·26 $t\,ha^{-1}$) whereas fallowing the site rather than growing barley beforehand decreased the grain yield of Panda by 0·78 $t\,ha^{-1}$. By contrast fallowing beforehand produced by far the largest yield of straw, suggesting that the benefit from it occurred before ear emergence and thus to the detriment of grain production. The numbers of grains per ear were little affected by previous cropping. Numbers of infertile spikelets were most affected by amounts of N applied in spring and of the total potential grain sites 13·3 and 12·6% failed to produce grain in plots given 90 and 150 $kg\,N\,ha^{-1}$ respectively. (Widdowson and Darby, Soils and Plant Nutrition; Scott, Insecticides and Fungicides; Jenkyn and Plumb, Plant Pathology; Lawlor and Wood, Physiology and Environmental Physics; Ross, Statistics)

Fungal diseases. The only disease that occurred in significant amounts on the leaves was powdery mildew (*Erysiphe graminis* f. sp. *hordei*). In late October areas affected on first seedling leaves from comparable plots of Panda and Pirate averaged 0·8 and 0·3% respectively; then the disease was completely controlled by the 'Baytan' seed treatment. By mid-December mildew was evident in the 'Baytan'-treated plots also, but less so than in the untreated (0·7 *vs* 2·2% on second youngest leaves of Panda, 0·3 *vs* 1·1% on Pirate). On Panda there was less mildew at the larger seed rate (1·6 *vs* 2·8% in plots without 'Baytan'); most occurred following the fallow (4·6%). By mid-March mildew incidence was slight, it was decreased by the tridemorph (0·9 *vs* 0·6% on second youngest leaves of Panda) but increased by 'winter' nitrogen. The fungicide spray was applied to all of the extra plots but mildew continued to be significantly more severe after a fallow than after barley or oats. 'Baytan' was, by then, having no effect on mildew but did decrease the very small amounts of leaf blotch (*Rhynchosporium secalis*) that occurred then and later. In mid-May mildew was very slight but was decreased by the fungicide sprays (0·5 *vs* 0·2% on third youngest leaves) and increased by N applied in spring (0·3% with 90 $kg\,N\,ha^{-1}$ *vs* 0·7% with 150 $kg\,N\,ha^{-1}$ where no fungicides were given). In June (Zadoks growth stage 75), mildew was common but still not severe. On Panda, average areas affected on second youngest leaves were decreased by the fungicide sprays from 3·2 to 1·5%. The disease was greatly increased by extra N from 1·5% on second youngest leaves from plots given 90 $kg\,N\,ha^{-1}$ in spring to 3·1% on those given 60 $kg\,N\,ha^{-1}$ in winter plus 150 $kg\,N\,ha^{-1}$ in spring. Mildew was more abundant on plots given 150 $kg\,N\,ha^{-1}$ in spring than on those given the same total amount of N divided between winter and spring (2·5 *vs* 2·0%).

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'Baytan' completely controlled loose smut (*Ustilago nuda*) which, in the untreated plots, affected about 10 ears m^{-2}.

Root and stem base diseases were assessed on selected plots in late October, mid-December and late February and from all plots in mid-March and mid-June (Zadoks growth stage 73). Predictably take-all (*Gaeumannomyces graminis* var. *tritici*) was always more prevalent following barley than following oats or fallow; at the final assessment in mid-June comparable take-all ratings for Panda were 61, 10 and 20, respectively. On all but one of the five occasions take-all was less severe in plots sown with 'Baytan'-treated seed. In October, February and March both the proportion of plants showing symptoms and the average number of infected roots per plant were decreased by the 'Baytan' but only the effects on root numbers were significant (average numbers of infected roots per plant without and with 'Baytan' on the three dates were, respectively, 0·2 *vs* 0·1; 2·4 *vs* 1·1; 1·3 *vs* 0·8). In mid-June, take-all ratings were significantly decreased by 'Baytan' from 90 to 60. Symptoms on the roots were mostly slight but numbers of plants with moderate and severe symptoms were decreased from 12·5 to 5·7% and from 3·3 to 0·9%, respectively by the fungicide. In plots sown at the larger seed rate there was more take-all, and a larger effect of 'Baytan' on the disease, than in plots sown at the normal seed rate; the latter effect presumably reflecting the correspondingly larger amounts of fungicide applied per unit area.

Eyespot (*Pseudocercosporella herpotrichoides*) was common but the fungicide sprays decreased numbers of straws affected by the disease (24·2 *vs* 1·5%) and the numbers with moderate or severe symptoms (9·9 *vs* 0·4%). Brown foot rot (*Fusarium* spp.) was very slight but was also controlled by the fungicide sprays. (Jenkyn, Gutteridge and Feekins, Plant Pathology)

Aphids. Vacuum samples were taken from October to April. Initially *Rhopalosiphum padi* was the commonest species but, as before numbers declined from a peak of 16·6 m^{-2} in November to less than 1 m^{-2} in April. The density of *Sitobion avenae* changed little through the winter (range 1·6 to 8·4 m^{-2}) and the species was the commonest from January onwards. *Metopolophium festucae* was absent from the late-winter and spring samples in contrast to previous years when populations have increased rapidly from April onwards. Cypermethrin significantly diminished aphid populations (0·4 *vs* 15·3 total aphids m^{-2} in December). Aphids were few on the crop in summer in contrast to the situation on winter wheat. (Carter, Entomology)

Barley yellow dwarf virus (BYDV). As predicted (*Rothamsted Report for 1983,* 122) there was less infection by BYDV than last year. However, the mild conditions did favour symptom expression and a few scattered plants and one or two small infected patches (less than 0·5 m diameter) were visible in January but this infection did not spread and the absence of significant effect from the autumn insecticide was therefore expected. (Plumb, Plant Pathology)

Pests other than aphids. There were no symptoms of damage by stem-boring Diptera in late October and less than 1% of shoots were damaged by larvae of *Opomyza florum* and *Delia coarctata* (wheat bulb fly) in early April. (Scott, Insecticides and Fungicides)

Comparisons between winter wheat and winter barley

Visual differences between the wheat and the barley in the adjacent multidisciplinary experiments were often striking and were related to differences in soil-nitrogen use and to the severity of take-all attack. Thus the leaves of barley without nitrogen fertilizer were bright yellow in early March whereas comparable leaves of wheat were still green.

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By this time the barley had used more of the soil-N residues, as shown by its greater total N uptake (51 *vs* 38 kg ha^{-1}), and consequently had much less nitrate-N in its stem sap (40 *vs* 140 ppm).

Take-all symptoms on roots were always much less severe in the barley than in the wheat. In December 26 *vs* 48% plants were infected and by June comparable take-all ratings were 85 *vs* 133. In July the wheat had a take-all rating of 265 and had then reached the growth stage of the barley in June, so that even if the differences detected until June were a consequence of differences in initial inoculum rather than susceptibilities, the massive increase in take-all on wheat between June and July led to it being much more severely damaged during the critical grain-filling period. This was confirmed by the much smaller yield benefit of the oats break for barley than for wheat (0·26 t *vs* 2·91 t ha^{-1}). (Prew, Field Experiments; Gutteridge, Plant Pathology and Widdowson and Penny, Soils and Plant Nutrition)

'Barley '84' at Northallerton, North Yorkshire

Many of the 5000 visitors to this event inspected our field experiment adjacent to the display boards detailing results at Rothamsted from 1981 to 1983. The experiment (managed jointly by Rothamsted and ADAS) tested three factors (Table 9) and the data produced were in close agreement with those previously obtained at Rothamsted.

TABLE 9

The effects of three factors on yield, and its components, of Igri winter barley at Northallerton

	No. of ears m^{-2}	Grain t ha^{-1}	1000 grain wt (g)	Grains m^{-2} $\times 10^{-3}$
(1) Sowing date				
13 September	1258	9·06	41·8	18·4
13 October	936	8·69	44·8	16·5
(2) Fungicides/insecticides*				
Without	1152	8·03	41·3	16·6
With	1042	9·72	45·4	18·3
(3) Nitrogen timing†				
6 March	1043	8·81	43·4	17·2
4 April	1151	8·94	43·3	17·6

* 'Baytan' to seed, 'Tilt'+'Ambush' in autumn, 'Corbel'+'Ambush' in spring, followed by 'Sportak Alpha'+ 'Corbel' and then 'Tilt'.

† Applied at 120 kg N ha^{-1} in addition to 30 kg N ha^{-1} on 16 November and on 3 February.

Growth and yield. In late February dry matter production was much greater from the earlier sowing (99 *vs* 26 g m^{-2}). In late May this difference persisted (1029 *vs* 681 g m^{-2}) but, perhaps because of take-all, only led to 4% greater grain yield.

Diseases. The principal foliar disease was powdery mildew. It was well controlled by the fungicides used and it is probable that this was the main cause of the yield response from the insecticides/fungicides treatment.

The barley was a fourth cereal therefore take-all was prevalent, particularly on the earlier sowing, but was not affected by the fungicides, which included 'Baytan' seed treatment. Eyespot was common, on the earlier sowing only, in late February but by late May was slight, similar on both sowings and unaffected by fungicides. The incidence of BYDV was negligible. (Jenkyn, Plant Pathology and Widdowson, Soils and Plant Nutrition)

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Field beans *(Vicia faba)*: effects of pests and pathogens

The multidisciplinary experiment on winter beans gave a mean grain yield of 4·2 t ha^{-1} and there were no effects of treatments. We are not reporting further on this experiment this year pending further investigation of the suggestion in a companion experiment (p. 58) that the seed rates used in the winter bean multidisciplinary series have been inappropriate for the sowing dates and that this may have masked benefits from our treatments.

The spring bean experiment completed a fifth and final year comparing the three sets of crop protection treatments: current standard practice, economically enhanced practice (with additional treatments likely to give economic responses) and full control (with all treatments likely to give the healthiest crop irrespective of cost).

Standard practice allows for aphicide sprays against black aphids but these were few this year and no crop protection chemicals were applied to this treatment. 'Economic' received phorate (2·2 kg ha^{-1}) combine-drilled with the seed and foliar sprays of pirimicarb (0·14 kg ha^{-1}) on 4 June, maneb+mancozeb (each at 0·8 kg ha^{-1}) on 1 August and benomyl (0·5 kg ha^{-1}) on 16 August. Full control included all these treatments plus aldicarb (10 kg ha^{-1}) worked into the seedbed and foliar sprays of fosetyl-Al (2·0 kg ha^{-1}) on 16 May, benomyl (0·5 kg ha^{-1}) on 6 July and maneb+mancozeb (each at 0·8 kg ha^{-1}) on 16 August. A test of irrigation was also included, to lessen a soil moisture deficit of 50 to 25 mm before pods were set, 80 to 55 mm thereafter, a total of 150 mm was applied. The treatments were arranged in four blocks of two plots, for irrigation, split into three sub-plots for chemical treatments.

Grain yields (Table 10) were increased from 3·5 to 5·6 t ha^{-1} by the combination of irrigation and 'full' pathogen control. 'Full' pathogen control alone gave a yield increase of 1·1 t ha^{-1}, similar to the increase from irrigation alone. (Bardner, Entomology; McEwen and Yeoman, Field Experiments; Beane and Webb, Nematology and Cockbain and Lapwood, Plant Pathology)

TABLE 10

Effects of pest and pathogen control on grain yield (t ha^{-1}) of Minden spring beans

	Pest and pathogen control		
	'Standard'	'Economic'	'Full'
Unirrigated	3·5	4·1	4·6
Irrigated	4·7	5·4	5·6
SED 0·26 (12 d.f.)			

Plant growth. The experiment was sown at Rothamsted on 20 March and established well with a mean population of 51 plants m^{-2}, unaffected by treatments. The soil moisture deficit on unirrigated plots increased from none at the beginning of April to 100 mm by mid-May, fell to 40 mm by the beginning of June and then increased steadily to 200 mm by mid-August. The irrigation treatment was applied at 25 mm on six occasions, 3 May, 16 May, 15 June, 25 July, 1 August, 15 August. All plots were harvested on 31 August.

Total above-ground dry matter, measured on 7 August, was increased from 7·9 to 9·8 t ha^{-1} by irrigation but was unaffected by the other treatments. (McEwen and Yeoman, Field Experiments)

Weevils *(Sitona lineatus)*. Untreated plots had five larvae per plant on the roots on 28 June, lessened to three by irrigation and eliminated by both 'economic' and 'full' treatments. (Bardner, Entomology)

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Viruses and vectors. The pea aphid, *Acyrthosiphon pisum,* was rare in May and early June and consequently the incidence of aphid-borne viruses was low. In mid-June the numbers of adult *A. pisum* (alatae and apterae) ranged from 0·3 to 1·4 m^{-1} row in 'standard' and 0 to 0·8 m^{-1} in 'economic'; none was found in 'full'. Early in July bean leaf roll virus affected 7% of plants in 'standard', 1·5% in 'economic' and 0·4% in 'full'; corresponding results for bean yellow mosaic and pea enation mosaic viruses were, respectively, 1·1, 0·5 and 0·4% and 0·4, 0 and 0·1%.

No seed-borne viruses were found at the seedling stage but a trace of infection (0·08%) with broad bean true mosaic virus was found at the end of flowering. Probably this was spread by the bean flower weevil, *Apion vorax,* from a crop with seed-borne infection 250 m away. (Cockbain, Plant Pathology)

Foliar fungi. Chocolate spot *(Botrytis fabae)* was first assessed on 11 June when about 1% leaf area of the mid and lower canopy was affected, mainly by the spot symptom. By the end of July the upper canopy was affected, with more disease in irrigated (1·3% leaf area) than unirrigated (0·7%) plots and with most (2·6%) in the irrigated 'full' treatment in which more spots had become 'aggressive' lesions.

Rust *(Uromyces viciae-fabae)* was first found on 30 July but despite irrigation it rarely exceeded 1% leaf area affected (average of eight pustules per leaflet) and at the end of August was least (0·5%) in the irrigated 'full' treatment.

The predominantly dry weather hastened senescence of the unirrigated plots and by 23 August most leaves had fallen and many plants, especially in the 'standard' treatment, were already dead. On irrigated plots most leaves in the 'standard' and 'economic' treatments had been lost by 30 August but in the 'full' treatment plants were still green retaining at least a third of the leaf area although the pods were mature. (Yeoman, Field Experiments and Lapwood, Plant Pathology)

Root fungi. Root blackening, which affected mostly the lateral rather than the tap roots increased from 19% of the root area affected in mid June to 49% by late July. Damage was less in irrigated (47%), especially with 'economic' (44%) and 'full' (43%), than in unirrigated plots (51%) where the worst affected was the 'standard' treatment (56%). (Yeoman, Field Experiments and Lapwood, Plant Pathology)

Nematodes. The most numerous plant parasitic nematodes were the root lesion nematodes, *Pratylenchus* spp. present in roots at 19 g^{-1} fresh weight (FW) in May and 1850 $litre^{-1}$ of soil. 'Full' treatment lessened these to 0 g^{-1} and 238 $litre^{-1}$ respectively. The phorate component of the 'economic' treatment lessened the root population in May to 3 g^{-1} FW, but did not affect the soil population. In June numbers in roots reached 65 g^{-1} FW in 'standard' and 6 g^{-1} FW in 'full' but by then numbers in 'economic' were the same as in 'standard'.

The *Pratylenchus* population was potentially more damaging than in previous years with only 38% of the less damaging species *P. neglectus* but 62% of more pathogenic species *P. pinguicaudatus* (36%) and *P. thornei* (26%). (Beane and Webb, Nematology)

Conclusions. 'Economic' control cost £35 ha^{-1} and gave 0·6 t ha^{-1} more grain worth at least £110. This increase is attributed to control of weevils and perhaps also to early control of nematodes and some improvement in foliar health. A further increase, on unirrigated plots, of 0·5 t ha^{-1} by 'full' control may be attributable to better nematode control and better leaf persistence, the increase was much smaller (0·2 t) on irrigated plots on which root feeding by nematodes would be expected to be less damaging. The 'full' treatment cost an additional £670 ha^{-1}.

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This was the last of five annual experiments of this type. They have consistently shown substantial yield gains from improving the health of spring beans. 'Standard' unirrigated plots averaged 3·6 t ha^{-1}, 'economic' gave an average gain of 0·5 t ha^{-1} whether irrigated or not and 'full' a further 0·5 t without irrigation, 0·3 t with. Irrigation alone increased yield by 0·7 t ha^{-1}, this was 0·3 t less than 'full' alone.

The results have shown the importance of a range of pests and diseases on spring beans and that a measure of control may be profitably undertaken. A research challenge remains to improve the gains from 'economic' control to those of 'full' without undue cost.

Peas: effects of pests and pathogens

The experiment concerned primarily with the control of pests and pathogens on the roots of peas was repeated on a fresh site. It tested all combinations of with and without aldicarb at 5 kg ha^{-1} combine drilled with the seed, with and without tolclofos-methyl at 50 kg ha^{-1} worked into the seedbed and with and without permethrin at 0·15 kg ha^{-1} applied to the foliage on 4 May and on 31 May. Seed was cv. Progreta treated with metalaxyl and thiram, sown on 9 March. Establishment counts on 4 May showed a mean population of 82 plants m^{-2}. The whole site was sprayed with pirimicarb at 0·14 kg ha^{-1} on 6 June to control pea aphids.

The experiment was harvested on 10 August and gave 5·5 t ha^{-1} of grain from untreated plots (Table 11). Permethrin alone gave an increase of 0·5 t ha^{-1} and aldicarb alone 0·8 t ha^{-1} but these responses were not additive. There was no response to tolclofos-methyl. (Bardner, Entomology; McEwen and Yeoman, Field Experiments; Green, Webb and Whitehead, Nematology; Cockbain and Lapwood, Plant Pathology)

TABLE 11

Effects of pest and pathogen control on grain yield (t ha^{-1}) of peas cv. Progreta

	None		Aldicarb	
	None	Permethrin	None	Permethrin
None	5·5	6·0	6·3	6·2
Tolclofos-methyl	5·6	6·0	6·0	6·4

SED 0·31 (14 d.f.)

Weevils *(Sitona lineatus)*. Untreated plots had an average of three larvae per root when assessed on 27 June. The average was lessened to two by permethrin alone, to none by aldicarb. (Bardner, Entomology)

Viruses. Virus incidence was low. In mid-July 1·1% of untreated plants had bean yellow mosaic virus and 1·1% pea enation mosaic virus; corresponding results for aldicarb-treated plants were 2·3 and 1·1%. (Cockbain, Plant Pathology)

Nematodes. The lesion nematodes *Pratylenchus thornei* and *P. neglectus* were the most commonly found nematodes in roots and nodules but were rarely present in stem tissue. Numbers were greatly decreased by aldicarb but were increased by tolclofos-methyl if aldicarb was not given. (Green, Nematology)

Fungi. *Fusarium solani* was the commonest fungus identified in roots and stems, in nodules *F. tabacinum* was equally common. In all situations the prevalence of *Fusarium* invasion was increased by aldicarb, without increasing necrosis of roots, but was not affected by other treatments. (Green, Nematology)

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Nodulation. Nodulation was increased by aldicarb, more so if tolclofos-methyl was also applied, but tolclofos-methyl without aldicarb decreased nodulation. Aldicarb increased the weight of nodules five-fold and more were pink and on, or near, the tap root. On all other plots, there were damaged and hollow nodules, some containing mites, bacteriophagic nematodes or weevil larvae. Many of these were on, or near, the tap root. Pink nodules were smaller and a greater proportion were distributed on the lateral roots further from the tap root. Roots from tolclofos-methyl treated plots had fewer pink nodules. (Green, Nematology)

Conclusions. Because permethrin affected mainly weevils the yield increase from permethrin alone might be ascribed to their control but its efficacy appeared insufficient to explain the size of the increase. Aphids were not counted because a basal pirimicarb spray was planned and used. It is possible that earlier aphid control given by the permethrin contributed to the yield increase.

Larger increases in yield from aldicarb are related to greatly improved nodulation with this treatment. This may in part be caused by good control of weevils, in part by control of *Pratylenchus*. Lesion nematodes have been shown in pot experiments to decrease nodulation or inactivate nodules on pea roots while some fungi growing on or in the root epidermis can inhibit nematode invasion. It is therefore likely that the increase in nematode invasion and decrease in nodulation when tolclofos-methyl was applied were related.

Intensive potato production

The experiment described in 1982 (*Rothamsted Report for 1982,* 39–41) continued for its third year on the same sandy loam site at Woburn. Treatments were all combinations of three two-level factors: with and without the nematicide oxamyl at 5 kg ha^{-1} worked into the seedbed, with and without a combined fungicide treatment to the seed of imazalil at 10 g and tolclofos-methyl at 250 g t^{-1} of tubers, with and without the molluscicide methiocarb at 0·22 kg ha^{-1} on each of six occasions from July to September. In addition there was the first test of cultivar and cropping frequency—Maris Piper after Désirée in 1982 (barley in 1983), Désirée after Désirée in 1982 and Désirée this year only (all sequences follow Pentland Crown in 1979). (Whitehead and Webb, Nematology; Hide, Lapwood and Govier, Plant Pathology; Henderson, Entomology; Scott and Etheridge, Insecticides and Fungicides; Addiscott, Soils and Plant Nutrition)

Potato cyst nematodes and tuber yields. As before, numbers of potato cyst nematode eggs varied greatly between sub-plots (0·2 to 278 eggs g^{-1} dry soil before planting in 1984). In untreated sub-plots yields of total Désirée tubers decreased with increase in nematode numbers from about 47 t ha^{-1} in the least-infested to about 12 t ha^{-1} in the most heavily-infested sub-plots. In untreated sub-plots, numbers of potato cyst nematodes increased greatly in lightly-infested soil but little or not at all in heavily-infested soil. Oxamyl prevented nematode injury to both roots and tubers, greatly increased yield

TABLE 12

Effects of previous cropping, cultivar and nematicide on yield of tubers t ha^{-1}

	Oxamyl	
Previous cropping and cultivar*	None	5 kg ha^{-1}
Désirée (1984)	43·1	56·8
Désirée (1984 and 1982)	15·7	41·9
Maris Piper (1984 after Désirée 1982)	23·9	50·3

* All potatoes Pentland Crown in 1979, all spring barley in other years.

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(Table 12) and lessened nematode increase on Désirée potatoes by as much as 95% in lightly-infested sub-plots. Despite good control of the nematodes, yields of Désirée potatoes were 15 t ha^{-1} more in sub-plots growing Désirée for the first time than in those growing Désirée for the second time.

Maris Piper prevented increase of the potato cyst nematode *Globodera rostochiensis* Ro1, present on this site, because it is resistant but nevertheless yielded twice as much in oxamyl-treated as in untreated soil and did not appear tolerant of potato cyst nematode attack on this site.

Seed tuber treatment did not affect yields of Désirée or Maris Piper potatoes but the molluscicide methiocarb reduced yields on average by 10%. (Whitehead and Webb, Nematology)

Aphids. Phorate to the seedbed and pirimicarb to the foliage almost eliminated aphids. No adult apterous aphids were found and on only one occasion were alates found in any number. (Etheridge, Insecticides and Fungicides)

Slugs. No slugs were found in slug traps between July and September and no slug damage was observed on harvested tubers. (Scott, Insecticides and Fungicides; Henderson, Entomology)

Virus diseases. In late June about 0·7% of the Maris Piper plants were infected with potato virus Y but none was seen in the Désirée plants. (Govier, Plant Pathology)

Fungus diseases. Tubers of the 1983 crop, from plots which had been treated with oxamyl, had a lower dry matter content at harvest in 1983 (21·8%) than from untreated plots (23·2%). After storage, black scurf *(Rhizoctonia solani)* and silver scurf *(Helminthosporium solani)* were less common than in the previous year but the incidence of both was halved by seed tuber treatment. Oxamyl also decreased black scurf from 43 to 22% of tubers affected.

About 95% of tubers on all plots were affected by black dot (*Colletotrichum coccodes*), a minor blemishing disease.

In 1984, more stems of Maris Piper than Désirée were affected with stem canker *(R. solani)* but with both cultivars seed tuber treatment halved the incidence of disease. On Désirée, stem canker was more common in plots that had grown potatoes in 1982 than in plots growing potatoes for the first time since 1979. On all plots, the incidence of brown lesions on stem bases caused by *Polyscytalum pustulans* was halved by seed tuber treatments. Common scab *(Streptomyces scabies)* was not a problem because of the basal irrigation used. (Hide and Lapwood, Plant Pathology)

Conclusions. As in 1982 and 1983, the principal pests in the experiment were potato cyst nematodes, which again reduced yield and quality of harvested tubers. For the third successive year, oxamyl controlled the nematodes well and greatly increased tuber yield and quality. However, yields of Désirée tubers were significantly less where grown for the second time than where grown for the first time. Virus diseases, late blight, aphids and slugs were rare or well controlled by basal applications. Seed tuber treatment halved the incidence of stem canker and *Polyscytalum* lesions on the stems without affecting tuber yields.

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