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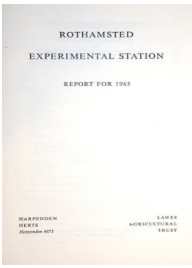
Rothamsted Experimental Station Report for 1965

Full Table of Content



Field Experiments

G. V. Dyke

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FIELD EXPERIMENTS SECTION

G. V. DYKE

The field experiments at Rothamsted, Woburn and Saxmundham are controlled by the Field Plots Committee: F. Yates (Chairman), G. V. Dyke (Secretary), F. C. Bawden, G. W. Cooke, P. H. Gregory, F. G. W. Jones, J. R. Moffatt, H. D. Patterson, C. A. Thorold and D. J. Watson.

F. G. W. Jones was appointed to the Committee to fill the vacancy caused by the retirement of R. G. Warren, who had been a member for 11 years.

The Section continued to provide sketches, plans and instructions for the field experiments on the three farms. In 1965, excluding many rough sketches, 74 plans were prepared for offset printing and about 70 copies of each were distributed. Work on the *White Books* and *Numerical Results of the Field Experiments* also continued; in addition, the *Details of the Classical and Long-Term Experiments up to 1962* (prepared by the Statistics Department and Field Experiments Section) was sent for printing. This publication deals with all existing long-term experiments at Rothamsted and Woburn and those ended in recent years; it gives the treatments applied, the varieties and seed-rates of the crops and, for most of the experiments, summaries of the yields recorded. For the classical experiments mean yields of successive periods are given (the length of the period varies: e.g. for Broadbalk 5 years, equal to the fallow cycle, for Park Grass 8 years, two liming cycles) as well as the long-term means. For most rotation

TABLE 1

Number of full-scale plots harvested 1965

	Grain	Roots	Hay	Grazed	Total
Classical experiments:					
Rothamsted	193	—	200	—	393
Woburn	—	—	—	—	—
Saxmundham	36	10	—	—	46
Long-period rotation experiments:					
Rothamsted	582	312	268	—	1,162
Woburn	90	286	112	12	500
Crop-sequence experiments:					
Rothamsted	621	9	141	—	771
Woburn	454	136	—	—	590
Annual experiments:					
Rothamsted	288	274	—	—	562
Woburn	192	40	—	—	232
Totals:					
Rothamsted	1,684	595	609	—	2,888
Woburn	736	462	112	12	1,322
Saxmundham	36	10	—	—	46
Total	2,456	1,067	721	12	4,256
Full-scale plots (no yields taken):					355
Microplots:					1,987
				Grand total	6,598

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experiments it has been possible to take tables of mean yields from published papers. It is hoped to publish supplements to the *Details* at intervals of five years.

Table 1 shows the number of full-scale plots harvested on the three stations in 1965, classified according to crops and types of experiments. The increase in the number of harvested units on Park Grass caused by the new liming scheme was more than balanced by the fallowing of Barnfield. The harvested units of potatoes on the Rothamsted Ley–Arable were fewer than before (yields were taken by quarter-plots instead of by $\frac{1}{16}$-plots), although the experimental area was unchanged. The number of plots in crop-sequence experiments again increased, but the number in annual experiments dropped.

Crop rotations at Rothamsted and Woburn. After McEwen stressed the increasing demands by sponsors of experiments for land with certain specified sequences of crops in the near past, the need was recognised for a more rigid rotation of crops than has been practised recently.

Past experiments show that the effects of several factors on winter wheat (e.g., date of sowing, amount of fertiliser N) are greatly influenced, sometimes even reversed, by the incidence of soil-borne diseases. On Rothamsted fields where neither wheat nor barley has been grown for two years or more such diseases can be expected to be unimportant, but after a shorter break (or no break) their incidence varies widely. Unless soil-borne diseases are being studied, therefore, an experiment sited after a two-year break will give more consistent results than an experiment sited after a shorter (or no) break. A one-year break cannot be relied upon to eliminate the couch grass (mainly *Agropyron repens*), which is sometimes abundant after a sequence of cereal crops. Spraying with aminotriazole (against *Agropyron*) or dalapon (against *Agrostis* spp.) has given a useful control, but has never been completely successful. Where infestations are severe, a fallow, using a rotary cultivator three or four times during the summer, is a more effective control.

For cereal experiments we need sites with three types of cropping history:

(i) no wheat or barley for at least two years;

(ii) intensive cropping with cereals to give a great incidence of soil-borne diseases, contrasting with (i); and

(iii) after one cereal (wheat or barley) to give intermediate conditions corresponding to a great proportion of the land under cereals in England.

At Rothamsted beans are a convenient crop to break a sequence of cereals, but there has been some concern recently about residual effects in the succeeding crop of the persistent chemicals used to control weeds in the beans. (This point is under study in the Cultivation Weedkiller Rotation Experiment summarised on p. 221)

Potatoes are the only other tillage crop that can be conveniently grown on a large acreage at Rothamsted, but where they are grown often potato cyst-nematodes may increase; in the past it was thought safe to plant potatoes every 3rd year, but now, with yields much greater, nematode populations may increase faster and we try to limit potatoes to 1 year in

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5 or more. The acreage of potatoes on the farm is also limited by the demands for men and machines at planting and lifting; also a prolonged potato-harvest delays autumn work for crops of the following season.

Short leys provide a possible break in the cereal rotation. Only a limited area of conserved leys can be handled, and grazing by sheep and cattle sometimes makes the nutrient content of the soil so uneven as to harm a following experiment. Couch grass sometimes spreads seriously in leys at Rothamsted.

These and other considerations led the Field Plots Committee to the following decisions for Rothamsted Farm:

(i) An area to be allocated to intensive cereals; wheat or barley each year except for a break crop (or fallow) every 6th year, with the break in different years on parts of the area.

(ii) Specified fields are kept deficient in P and K; no dung or fertiliser containing P or K is used. Only a restricted range of crops mainly cereals and grass can usefully be grown on such land and there are occasional fallows.

(iii) Some fields to be kept in permanent grass or long leys, grazed or cut.

(iv) The remaining area of tillage to follow a seven-course rotation:

Year 1. Beans or 1-year ley.
2. Winter wheat (spring cereal if necessary for experiments).
3. Cereal (winter or spring).
4. Potatoes, ley, beans or fallow.
5. Potatoes, 2nd-year ley, beans or fallow.
6. Cereal (winter or spring).
7. Spring cereal.

The leys will usually be cut, but the aftermath may be grazed. The alternative crops listed allow for the need for sites for winter and spring cereal experiments on land of different types and give some room to manoeuvre in fitting in crops such as potatoes. It must be emphasised that this rotation is planned entirely for the sake of field experiments and is in no way recommended for commercial farming.

The fields have been allocated to the seven phases of the rotation, taking into account their recent cropping and their acreages, to provide the required variety of sites as soon as possible. Fields in which the rotation is broken to accommodate crop-sequence experiments will revert to the rotation as soon as possible. Some rotation fields may be put down to long leys.

On the light soil at Woburn the problem is more difficult; the demand for experimental sites is greater in proportion to the area of useful land, and there is an additional risk of damage by cereal cyst-nematode. Also the potato cyst-nematode is more dangerous, for populations under potato crops of susceptible varieties increase faster than at Rothamsted: hence "resistant" varieties (on which nematodes feed but very few can reproduce) are introduced:

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Year 1. Sugar beet, 1-year ley or potatoes (resistant variety).
2. Winter wheat.
3. Cereal (winter or spring).
4. 1-year ley or fallow.
5. Potatoes (susceptible variety).
6. Cereal (winter or spring).

In year 5 susceptible potatoes will be grown to lessen the chances that populations of nematodes able to multiply on the resistant varieties will develop.

On the few fields of heavy soil at Woburn the following rotation is intended:

Year 1. Beans, 1-year ley or resistant potatoes.
2. Winter wheat.
3. Cereal (winter or spring).
4. 1-year ley or fallow.
5. Potatoes (susceptible variety) or spring beans.
6. Cereal (winter or spring).

Permanent barley, Hoosfield. Maris Badger (introduced in 1964, see *Rothamsted Report* for 1964, p. 214) was grown again on the same sub-plots. The pattern of yields was much as in 1964, Badger with N, P and K yielding over 35 cwt grain/acre, and 45 cwt with FYM.

Rothamsted ley–arable rotation experiments. Wheat sown on plots of the Ln (all-grass ley) treatment in Fosters was badly attacked by stem-boring larvae in March. The cocksfoot originally sown on these plots had failed, and Italian ryegrass was sown in spring 1964. This may have led to the attack by insects, for wheat in the corresponding plots on Highfield, where the cocksfoot was left down for the full 3 years, was not damaged. Although the affected plots looked almost bare at the end of March, the thin plant remaining tillered well and yielded 43 cwt grain/acre, against 46–50 from other treatments. On Highfield the wheat after Ln yielded 49 cwt, more than any other treatment except "reseeded" (15 years grass mainly grazed).

One of the two plots of 3rd-year lucerne on each field was ploughed up in spring because patches were infested with stem eelworm.

Tests of N in rotation and crop-sequence experiments. When comparing the yields of test-crops, such as wheat, barley or sugar beet grown in different rotations or after different sequences of crops, it is usually necessary to apply several amounts of fertiliser N to the test crop. In the Rothamsted Ley–Arable, for example, without N fertiliser wheat in the "arable" rotation gave smaller yields than the lucerne rotation, but with plenty of N the difference was decreased or reversed (*Rothamsted Report* for 1963, p. 177). The sub-plot comparisons of four levels of N revealed the differences between the response curves and gave us reasonably good estimates of the levels of N required for maximum yield after the different sequences. Fewer than four levels would have been inadequate.

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In several other experiments, both at Rothamsted and Woburn, four levels of N have been applied to sub-plots of each crop-sequence. Often different levels have been applied to different main treatments. The details have varied and a summary is shown below.

Rothamsted Ley–Arable

			N cwt/acre			
Wheat	1961–63	Highfield	0	0·3	0·6	0·9
		Fosters	0	0·4	0·8	1·2
	1964	Highfield "arable"	0	0·4	0·8	1·2
		Highfield remainder	0	0·3	0·6	0·9
		Fosters "arable"	0	0·53	1·07	1·6
		Fosters remainder	0	0·4	0·8	1·2
	1965 as 1964 but with additional factor: 0 v 0·6 cwt N applied in winter					
Barley	1962–65	Highfield	0	0·1	0·2	0·3
		Fosters "arable"	0	0·4	0·6	0·8
		Fosters remainder	0	0·2	0·4	0·6

Woburn Long-term Green Manuring Experiment

Barley	1963		0	0·3	0·6	0·9
	1964–65	(*a*)	0·3	0·6	0·9	1·2
		(*b*)	0	0·3	0·6	0·9

(*a*) Plots without green manures throughout experiment.
(*b*) Remainder.

Woburn Ley–Arable

		N cwt/acre (two levels only)			
Sugar beet 1964:	Arable and arable with hay		1·40	1·75	
	Lucerne and ley		1·05	1·40	
	(With factorial tests of dung, P and K)				
Sugar beet 1965:	Arable with hay	1·05	1·40	1·75	2·10
	Arable	0·70	1·05	1·40	1·75
	Lucerne and ley	0·35	0·70	1·05	1·40
	(With uniform P, tests of dung and K)				

Usually each whole plot of a given cropping treatment has sub-plots allocated to each level of N assigned to that sequence, sometimes in duplicate, sometimes with an extra factor included. In the Woburn Green Manuring, however, each main plot is divided into two sub-plots only; some plots compare the first and third levels, others the second and fourth. In the Rothamsted Ley–Arable the arrangement of sub-plot treatment allows the examination of the effects on barley of the levels of N applied 2 years earlier to the wheat, but in other experiments residual effects of N are not allowed for.

Note that the N applied is often not the same for all cropping treatments. To explore the important part of the response curve, the appropriate dressings are usually larger after arable cropping than after leys. In cereal crops zero N has been retained; this makes it almost certain that a valid comparison between cropping treatments can be made even in a year of severe lodging, when any N dressing may decrease yield. Given that zero is included, two ways of varying the range of levels were used—scaling up all levels in proportion, or omitting the first non-zero one and adding a larger one. In the Green Manuring Experiment zero N on plots that have had no organic manuring for over 10 years and are now in continuous barley

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