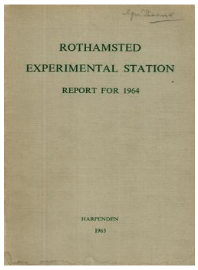
ROTHAMSTED RESEARCH

Report for 1964



Woburn Experimental Station

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WOBURN EXPERIMENTAL STATION

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Irrigation, ley-farming and organic manuring experiments on the light land at Woburn were particularly interesting in a year of contrasting wet and dry periods.

TABLE 1

Monthly mean temperatures (means of maximum and minimum), total rainfall and daily means of bright sunshine (departures from long-period means in brackets)

Month	Mean temperature (° C)	Rainfall (in.)	Bright sunshine (daily mean) (hours)
March	3·7 (−1·8)	3·19 (+1·61)	1·85 (−2·06)
April	8·4 (+0·2)	2·53 (+0·60)	3·58 (−1·33)
May	13·1 (+1·9)	1·12 (−1·08)	6·51 (+0·47)
June	13·9 (−0·5)	3·34 (+1·64)	4·79 (−1·82)
July	16·3 (0·0)	0·92 (−1·52)	5·95 (−0·09)
August	15·5 (−0·5)	0·82 (−1·51)	6·54 (+1·32)
September	13·9 (+0·2)	1·10 (−0·93)	6·55 (+1·92)
October	8·4 (−1·3)	0·91 (−1·39)	4·11 (+0·72)

Winter wheat and rye were drilled during a dry period in late October and early November. The rest of November was wet, but December 1963 to February 1964 was unusually dry (2·03 in.) and allowed seedbeds to be prepared. Barley drilling started on 14 February and finished on 11 March, when snow fell and lay for a few days, causing waterlogging later. Conditions improved in May, but the first half of June was unusually wet; a dry spell then started and lasted until the end of the year.

Winter wheat did exceptionally well compared with spring barley. Cappelle yielded 50 cwt grain/acre and did not respond to nitrogen in an experiment on newly ploughed land. On lighter land, which had recently carried cereal crops, the largest yield (54 cwt grain/acre) was with 1·34 cwt N/acre broadcast in April, compared with 17 cwt grain/acre without nitrogen and 38 cwt grain/acre with 0·67 cwt N/acre given in spring.

Barley yields varied widely on land where cereal crops have been grown frequently. Varieties reacted differently to adverse conditions. Europa and Impala came into ear prematurely in June, whereas Plumage Archer did not. The varietal test was abandoned because of weeds that grew where plants died from take-all and probably other soil-borne infections. A nearby experiment with Maris Badger drilled in March was less affected. The mean yields from three rates of nitrogen applied in February (0·4, 0·7, 1·0 cwt N/acre) were 21·0, 30·3, 38·3 cwt grain/acre. Much nitrogen was probably leached during the wet spring, and nitrogen deficiency early in the season probably caused the barley to grow poorly, rather than lack of water later. Applying "Nitro-Chalk" in May improved the colour of barley leaves, with or without water, and in the Irrigation Experiment barley drilled on 14 February responded more to nitrogen than to watering.

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In an experiment with spring wheat sited where cereals previously suffered from "scorch", formalin lessened the percentage of stems with take-all from 60 to 1%, and considerably diminished the number of cereal eelworms (*Heterodera avenae*) and doubled the mean yield. The largest yield (37 cwt grain/acre) was with formalin combined with irrigation and 1·2 cwt N/acre (see pp. 66–65).

Many fewer aphids were caught on sticky traps than in 1963. Neither *Aphis fabae* nor *Myzus persicae* was caught until July, but the flight period extended into October. Virus diseases in sugar beet and potato crops were negligible. *Cavariella* spp. constituted a large proportion of the aphids caught in July and carrots were affected by motley dwarf virus. Spraying five times from May to July with menazon increased yields of marketable carrots from 14 to 19 tons roots/acre.

Potato experiments were mostly planted at the end of April, with seed grown and chitted at Rothamsted. Chitted seed of Majestic and King Edward yielded about 1 ton/acre more total tubers than unchitted and gave a greater proportion of ware potatoes. With the late date of planting and the dry weather after June, the chitted seed benefited by growing earlier when soil moisture was adequate. Scab, more prevalent on Majestic than on King Edward, was also less on the crop from chitted seed.

Continuous wheat and barley land. When cropping was resumed on the continuous wheat and barley plots after 3 years of fallow yields (cwt grain/acre) decreased from 1959 (wheat 19·2, barley 20·6) to 1961 (wheat 11·4, barley 14·4), with take-all becoming prevalent and making the plots uneven. The manurial treatments maintained from 1876 to 1927 were not replicated but duplicated by single similar plots on the wheat and barley land. As take-all invalidated comparison of fertility of the two sites, spring oats were grown in 1962. Yields suggested that the barley land was the more fertile, but oats yielded better after barley than after wheat on both (*Rothamsted Report* for 1962, p. 210). The whole area had cereal-root eelworm, which may have affected treatment comparisons. Both lands were fallowed in 1963 and spring beans were sown in 1964.

TABLE 2

Mean yields of beans (cwt grain/acre) comparing: Nil (unmanured: plots 1 and 7) and FYM (farmyard manure: plot 11b) and NPK (N *as* $NaNO_3$ + PK*: plot 6) of "continuous wheat" and "continuous barley" land in 1964*

	"Continuous wheat" land				"Continuous barley" land			
	Nil	FYM	NPK	Mean	Nil	FYM	NPK	Mean
After wheat	19·0	28·5	16·4	21·3	20·6	29·2	27·5	25·8
After barley	17·3	20·0	18·4	18·6	21·8	25·4	24·8	24·0
Mean	18·2	24·3	17·4	20·0	21·2	27·3	26·2	24·9

Table 2 shows that the mean yield of beans on the barley land (24·9 cwt grain/acre) exceeded the mean yield on the wheat land (20·0 cwt grain/acre), as with oats in 1962. However, contrary to the oats, beans yielded more after wheat on both lands. Another indication of a fertility difference was that the beans on the barley land ripened more slowly and were not

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harvested until 1 September, whereas on the wheat land harvest was on 26 August.

Market-garden experiment. The results of the experiment, started in 1942 to study the effects of annual dressings of organic manures on market-garden crops, were summarised up to 1960 by Mann and Patterson (*Rothamsted Report* for 1962, pp. 186–193), who commented on the much less P and K given to the fertiliser plots than given in the organic manures. The experiment was redesigned in 1961 and dressings of fertilisers increased.

From 1951 to 1960, 20 tons/acre FYM produced 1·5 tons more leeks/acre than did the largest dressing of fertiliser (0·9 cwt N; 0·3 cwt P_2O_5; 0·3 cwt K_2O/acre). Since the fertilisers were increased to 1·8 cwt N; 1·5 cwt P_2O_5; 3·0 cwt K_2O/acre, the difference has averaged only 0·5 ton/acre.

Globe beetroot in the experiment have often germinated unevenly, and differences in plant numbers and spacings have affected comparisons of manurial treatments; the organic manure plots have usually borne many more plants than the fertiliser plots. With improved methods of drilling, and using seed treated with fungicide and insecticide, the stand of plants is much improved and much more uniform. Although the plots given FYM again produced more seedlings than the others, the difference (90,000 seedlings/acre) was less than previously, and after singling the plots had similar numbers.

From 1951 to 1960 the mean yield of total produce on plots given FYM (12·5 tons/acre) was 5 tons more than with fertiliser only. Since 1961, the difference in yield has diminished, and from 1961 to 1963 yield with FYM at 10 tons/acre (8·0 tons total produce/acre) was only 0·2 tons more than with fertiliser only; yield with 20 tons FYM/acre was 11·6 tons total produce/acre. In 1964 (Table 3) yield with fertiliser only exceeded the

TABLE 3

Mean yields of globe beet roots and tops (tons/acre) at two harvests

	First harvest (22 July)		Second harvest (10 August)		Mean of two harvests		
	Roots (tons)	Tops (tons)	Roots (tons)	Tops (tons)	Roots (tons)	Tops (tons)	Total Produce (tons)
NPK* without FYM	4·7	4·5	8·6	3·8	6·6	4·1	10·7
FYM 10 tons/acre	3·2	3·0	6·9	3·1	5·0	3·0	8·0
FYM 20 tons/acre	7·0	5·9	11·3	4·7	9·2	5·3	14·5
FYM 10 tons/acre + NPK†	7·2	6·3	12·4	4·6	9·8	5·5	15·3
FYM 20 tons/acre + NPK†	7·4	6·4	13·8	5·7	10·6	6·0	16·6

NPK*, 0·9 or 1·8 N/acre; 1·5 cwt P_2O_5/acre; 1·5 or 3·0 cwt K_2O/acre.
NPK†, 0·9 N/acre; 1·5 cwt P_2O_5/acre; 1·5 cwt K_2O/acre.

yield with 10 tons FYM, although it was less than with 20 tons FYM. Yield with FYM was increased by also giving fertiliser. In July and August beet plants on plots given only fertiliser wilted more than those on plots given FYM.

Early potatoes and carrots. From 1956 to 1960 potato crops given only fertiliser yielded less than those given FYM. With more fertiliser given since 1961, the mean yield with fertiliser only (6·6 tons tubers/acre) ex-

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ceeded the mean yield with FYM at 10 tons/acre by a ton and was only 0·1 ton less than the mean yield with 20 tons/acre FYM. In 1962 attack by eelworm (*Heterodera rostochiensis*) vitiated manurial comparisons; the mean yield with fertiliser was 3·2 tons tubers/acre and with FYM was 5 tons. Because of the eelworm, carrots replaced early potatoes in 1963 and 1964. Carrots were chosen because they had consistently responded to FYM in the Ley–arable rotation experiment. Seedlings were counted about 1 month after drilling, and there were two harvests at intervals of about 2 weeks. The yields in Table 4 are means of the two harvests and record only plants with marketable roots (exceeding 1¼ in. diameter).

TABLE 4

Numbers of carrot seedlings (thousands/acre) and yields of marketable roots and tops as means of two harvests (tons/acre) in 1963 and 1964

	1963			1964		
	Seedlings (No.)	Roots (tons)	Tops (tons)	Seedlings (No.)	Roots (tons)	Tops (tons)
NPK*	639	3·8	3·2	1,582	13·4	8·6
FYM	734	6·0	6·0	1,510	13·9	10·3
FYM + NPK†	529	5·2	5·6	1,554	14·5	12·7

NPK*, NPK†, as in Table 3; FYM mean of 10 and 20 tons/acre.

In 1964, when the plant populations and yields were 2–3 times greater than in 1963, yields of roots were not much increased by FYM. However, in both years FYM increased the ratio of weight of tops to weight of roots, a feature that seems peculiar to carrots and does not happen with globe beet.

Irrigation experiment

Sugar beet. Seed drilled on 10 April germinated well and singling finished on 23 May. Irrigation started on 26 May with 0·5 in. given to "full" (C) and "early" (A) treatments, but there was ample rain in June (3·3 in.) for the crop. However, from July to October only 3·75 in. of rain fell, whereas the average is 9·10 in. Leaves on unirrigated plots flagged in July–September, especially on those given extra nitrogen. All leaves of some plants collapsed, and many died, exposing much bare ground. Although the plant population was satisfactory (29,000/acre), only on plots irrigated after July and given 1·5 cwt N/acre was the ground well covered.

TABLE 5

Effects of irrigation (O, A, B, C) and two rates of nitrogen* (N1, N2)† *on sugar-beet roots and tops (tons/acre)*

	N1		N2		Mean	
	Roots (tons)	Tops (tons)	Roots (tons)	Tops (tons)	Roots (tons)	Tops (tons)
Not irrigated (O)	13·4	5·9	13·8	7·2	13·6	6·6
Early irrigation (A)	13·3	7·1	16·8	9·5	15·1	8·3
Late irrigation (B)	17·5	8·1	19·9	11·9	18·7	10·0
Full irrigation (C)	16·6	7·9	20·2	13·9	18·4	10·9
Mean	15·2	7·3	17·7	10·6	16·5	9·0

* O, no watering: A, 1·5 in. May–July; B, 3·0 in. July–September; C, 2·5 in. May–July, 2·0 in. August–September.
† N1, 0·75 cwt N/acre; N2, 1·5 cwt N/acre.

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Without irrigation, less than half the ground between the rows was covered. Soil moisture determinations in July and August agreed with appearances of the plots. Unirrigated plots given 1·5 cwt N/acre had less moisture at 9–18 in. (3·2%) than plots given 0·75 N/acre (4·0%). In irrigated plots given 0·75 cwt N/acre soil moisture was 6·0% and with 1·5 cwt N/acre 4·8%.

The mean response to the extra 0·75 cwt N/acre was 2·5 tons roots/acre, and to "full" irrigation was nearly 5 tons roots/acre, equivalent to 1 ton sugar/acre. On unirrigated plots response to the extra nitrogen was only 0·4 ton roots/acre, but the weight of tops increased from 5·9 to 7·2 tons tops/acre, and this was associated with severe wilting.

Plants with signs of magnesium deficiency occurred among others with nitrogen deficiency. A few plants became infected with virus yellows at end of August.

Barley. Maris Badger was drilled on 14 February with either 0·3 or 0·6 cwt N/acre, and unwatered or given two lots of 0·5 in. in May and two of 0·5 in. in July. There were obvious benefits in growth from extra nitrogen, but none from watering. Table 6 shows an increase of 7·6 cwt grain/acre from the extra 0·3 cwt N/acre, and of 1·2 cwt grain/acre from the irrigation.

TABLE 6

Effects of irrigation and two rates of nitrogen (0·3 cwt N/acre: 0·6 cwt N/acre) on barley yields (cwt grain/acre)

cwt N/acre	0·3	0·6	Mean
Without irrigation	28·8	37·4	33·1
With irrigation	31·0	37·6	34·3
Mean	29·9	37·5	33·7

Clover. Dorset Marl Red Clover undersown in barley in 1963 started as a satisfactorily uniform crop in 1964, but without irrigation or with only the two "early" applications of 0·5 in., it suffered severely from lack of water and many plants died. On the "late" and "fully" irrigated plots ground cover was still nearly complete in September. Table 7 shows yields from three cuts. Fresh produce from recently watered plots contained 80% moisture in September, 10% more than the produce of the drier plots.

TABLE 7

Effects of irrigation on yields of clover (cwt dry matter/acre) at three cutting dates

Irrigation	O	A	B	C	Mean
First cut (11 June)	28·5	29·5	27·8	34·0	30·0
Second cut (27 July)	17·8	16·3	28·9	24·5	21·9
Third cut (29 September)	2·3	3·9	11·1	11·6	7·2
Total, three cuts	48·6	49·7	67·8	70·1	59·1

O, no watering; A, 1·0 in. May; B, 3·5 in. June–September; C, 4·5 in. May–September.

Lucerne. Some plots developed poorly in the spring and were abandoned, and the others had patches infected with stem eelworm (*Ditylenchus dipsaci*). Despite this, four cuts gave a mean total of 77 cwt dry matter/acre

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(Table 8), and even in this dry year the full irrigation increased yield by only 11%.

TABLE 8

Effects of irrigation on yields of lucerne (cwt dry matter/acre) at four cutting dates

Irrigation	O	A	B	C	Mean
First cut (9 June)	31·0	32·5	33·1	30·7	31·8
Second cut (16 July)	20·0	19·5	20·3	19·5	19·8
Third cut (2 September)	15·8	17·2	17·1	21·7	18·0
Fourth cut (30 October)	7·0	6·0	7·5	10·5	7·8
Total, four cuts	73·8	75·2	78·0	82·4	77·4

O, no watering; A, 0·5 in. May; B, 1·5 in. July–September; C, 3·5 in. May–September.

Soil moisture at 9–18 in. decreased from 10·8% in April to 3·2% in September in the unirrigated plots and to 8·0% in those given "full" irrigation.

Ley–arable rotations experiment

Sugar beet. A test of extra phosphate at 1·5 cwt P_2O_5/acre was introduced in 1964, additional to the changes introduced in 1962 to test magnesium sulphate and additional potash given to plots without FYM (*Rothamsted Report* for 1962, pp. 211–212). The mean difference between treatments with and without FYM from 1956 to 1961 was 3·3 tons roots/acre. In 1963 it was 2·4 tons roots/acre, in 1962 1·7 tons, and in 1964 it diminished further to 0·5 ton roots/acre. Without FYM, but with the extra potash and phosphate, the mean yield was 16·1 tons roots/acre, equal to that with FYM. Thus the magnesium and extra potash and phosphate have abolished the large differences between plots with and without FYM in the earlier years.

Barley. Maris Badger was drilled on 10 March and harvested on 21 August, when there was some lodging of the FYM plots, which gave less grain (42 cwt/acre) but more straw (34 cwt/acre) than plots without FYM (44 cwt grain and 31 cwt straw/acre).

Rye. In contrast to the barley, the autumn-sown rye yielded rather better on the FYM plots, about 3 cwt grain/straw/acre more than on the others.

Potatoes. The mean yield of Majestic was 11 tons tubers/acre, despite attack by eelworm (*Heterodera rostochiensis*), which was uneven, for some plots carried potatoes in 1959 but others not since 1954.

Carrots. The variety Autumn King was grown and sprayed three times with menazon, which prevented aphid infestation. Yields averaged 15·3 tons roots and 4·3 tons tops/acre. In contrast to results with the variety Scarlet Intermediate between 1956 and 1963 when larger yields were obtained on the FYM plots, yields in 1964 did not respond to the FYM. Plots that carried carrots in 1959 yielded less (12·9 tons roots/acre) than plots that were grazed leys in 1957–59 (17·7 tons roots/acre).

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Sainfoin. Lucerne was replaced by sainfoin as the treatment crop in 1964 to avoid possible attack by stem eelworm (*Ditylenchus dipsaci*). It was drilled at 56 lb/acre on 8 April and cut twice (Table 9). Total yield

TABLE 9

Effects of farmyard manure applied at 15 tons/acre in 1962 on sainfoin yields (cwt dry matter/acre) at two cutting dates

	First cut (23 July)	Second cut (26 October)	Total (two cuts)
Without farmyard manure	22·2	10·4	32·6
With farmyard manure	24·6	8·6	33·2
Mean	23·4	9·5	32·9

(33 cwt dry matter/acre) was 2 cwt more than the average for first-year lucerne between 1958 and 1963. Chemical analysis showed that the sainfoin took up similar amounts of nutrients to lucerne but less calcium.

Lucerne. Stem eelworm affected the second-year lucerne, particularly on plots that carried lucerne in 1958–60, which yielded 15 cwt dry matter less per acre than plots that had not carried lucerne since 1945. The third-year lucerne was poor, because of eelworm, and the third cut from plots that carried lucerne in 1957 and 1958 yielded only 4 cwt dry matter/acre.

Grazed leys. There was less grazing than usual, particularly on the plots in the third year of the ley rotation, with only 1,012 sheep days/acre, compared with the average of 1,580 in the previous 10 years. First-year (1,253 sheep days/acre) and second-year (1,512) leys provided more grazing, but none was grazed during 7 weeks from August to October.

Dairy farm. Field experiments started on the Dairy Farm, where 228 plots occupied about 3 acres of Horsepool Field, and winter wheat yielded 50 cwt grain/acre and potatoes 13 tons tubers/acre.

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