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### Woburn Experimental Station

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# WOBURN EXPERIMENTAL STATION

C. A. THOROLD

The total rain for the year was 33.14 inches, which has been exceeded only twice since 1880, in 1903 (34.45 inches) and in 1924 (33.52 inches). However, 1960 excelled these years in the number of rain-days (0.01 inches or more), of which there were 210, compared with 179 in 1903 and 176 in 1924.

In spite of the rain at harvest, field experiment plots were reaped satisfactorily. The pattern of excess rain shown in Table 1 for mid-summer and autumn continued to the end of the year. Several of

TABLE 1

*Monthly mean temperatures (means of maximum and minimum), total rainfall and daily means of bright sunshine for April to October 1960, with departures from long-period means in brackets*

Month	Mean temperature (° F)	Rainfall (inches)	Bright sunshine (daily mean) (hours)
April ... ..	47.5 (+1.1)	0.40 (-1.53)	4.91 ( 0.00)
May ... ..	54.5 (+2.5)	1.19 (-1.01)	6.13 (+0.09)
June ... ..	60.1 (+2.6)	3.73 (+2.03)	8.69 (+2.08)
July ... ..	59.1 (-2.3)	3.15 (+0.71)	4.58 (-1.46)
August ... ..	58.9 (-1.8)	3.19 (+0.86)	4.90 (-0.96)
September ... ..	55.5 (-1.2)	3.51 (+1.48)	4.28 (-0.35)
October ... ..	50.4 (+0.9)	4.48 (+2.18)	2.07 (-1.32)

the experiment sites remained too wet to prepare seedbeds, and customary sowings of winter wheat and rye were not achieved. In this respect also, 1960 was exceptional, for even in 1903 and 1924 winter wheat was sown in November. However, yields in 1960 were affected less. In 1924 winter wheat gave one of the smallest yields since 1877, and in 1903 it was considerably below the average. The mean yield of wheat in certain plots of the "continuous wheat and barley" areas (Table 2) was 23.3 cwt./acre in 1959 and 22.6 cwt./acre in 1960, more than twice the mean for the period 1951-55 (9.3 cwt./acre).

Although the total rain for 1960 exceeded the long-period mean (24.78 inches) by more than 8 inches, there was a period in April, May and early June when there was rainfall deficiency. Table 4 shows that the first three cuts (10 and 31 May, and 22 June) of ryegrass benefited from an application of water equivalent to 3 inches of rain, but later the plots which had not been irrigated yielded more.

## FIELD EXPERIMENTS

*Continuous wheat and barley*

The strips of winter wheat and spring barley were drilled across the "continuous wheat and barley" areas, in the same positions as these two crops occupied in 1959. However, the total area of cereal cropping has been decreased by two new developments initiated by the Chemistry Department (*Rep. Rothamst. exp. Sta. for 1959*, pp. 39 and 54). Two strips of grass, each 30 links wide, have been planted across the wheat and barley areas, to check soil erosion. One is on the boundary between plots 1, 2, 3 and 4, 5, 6, the other between plots 4, 5, 6 and 7, 8, 9. To measure the residual effects of potash and phosphate fertilisers applied between 1876 and 1926, microplot experiments with potatoes and barley were started. These plots occupied the strip which would otherwise have been drilled with barley on plots 7, 8, 9, 11a, 11b.

The *Report for 1959* (p. 184) considered the yields of wheat and barley for plots 1, 7 and 11b, in the "continuous wheat and barley" areas, in relation to mean yields between 1951 and 1955. Table 2 compares wheat and barley yields in 1959 with those in 1960; to do this it was necessary to provide new means, omitting areas which were not cropped in 1960.

TABLE 2

*Mean yields of grain (cwt./acre) in plots 1, 7 and 11b of "continuous wheat" and "continuous barley" areas in 1959 and 1960*

	Continuous wheat area		Continuous barley area	
	Wheat	Barley	Wheat	Barley
1959	20.5	23.2	26.1	22.5
1960	19.6	21.9	25.6	19.9

The table shows some decline in wheat and barley yields in both the "continuous wheat" and "continuous barley" areas. The unmanured plots 1, which are included in Table 2, were among the plots sampled by the Plant Pathology Department in July 1960, when take-all (*Ophiobolus graminis*) was found on wheat and barley straws. This disease is probably causing some of the loss in yield.

*Six-course rotation experiment*

This experiment ended in 1960; it started in 1930 on a part of Stackyard Field where a four-course rotation experiment ran from 1877 to 1910. There were temporary pastures in the period 1913-16, but arable crops were grown for over 10 years before the start of the six-course experiment. The full range of crops was not achieved in 1930, but all phases of the rotation were represented each year from 1931 onwards. Therefore, it is convenient now to consider the experiment as beginning in that year.

The rotation was sugar beet, barley, clover, wheat, potatoes, rye. These crops rotated on six areas, so that each crop of the rotation was present every year. The main object of the experiment was to provide information on the effects on yields of varying amounts of

the three standard fertilisers, nitrogen, potash and phosphate, in relation to the different weather of successive years. The arrangement of the plots was described and the results discussed up to 1948 in the *Rothamsted Report* for 1948, pp. 90-94. Consideration was then given to the possibility of detecting any soil exhaustion caused by using only mineral fertilisers, by examining the mean yield of each crop taken over successive periods of 6 years. Table 3 gives the mean yields of sugar beet, potatoes, wheat and barley for the first (1931-36) and the last (1955-60) of such periods, together with the means for the duration of the experiment (1931-60). It seems desirable for present purposes to exclude results for clover, because this crop failed in several years, including the last two. Rye results are omitted, because between 1931 and 1933 it was cut green and afterwards harvested when ripe.

TABLE 3

*Mean yields per acre for two six-year periods (1931-36 and 1955-60) and for the duration of the six-course rotation experiment (1931-60)*

	Sugar beet			Potatoes (tons)	Wheat		Barley	
	Roots (tons)	Tops (tons)	Total sugar (cwt.)		Grain (cwt.)	Straw (cwt.)	Grain (cwt.)	Straw (cwt.)
1931-1936	7.88	6.67	26.8	8.13	12.2	26.0	23.9	39.5
1955-1960	10.66	7.01	37.9	8.80	17.0	21.5	29.1	27.0
1931-1960	8.42	5.68	31.2	8.00	14.7	24.7	24.0	28.9

Table 3 indicates that, except for wheat and barley straw, yields were greater in the last six-year period (1955-60) than in the first (1931-36). Some of the improvement may reflect changes in the varieties grown; sugar beet has been Kleinwanzleben since 1943, when it replaced Kühn; Majestic potatoes replaced Ally in 1942; the winter wheat variety was Yeoman from 1931 to 1946 and from 1956 to 1960, Squareheads Master from 1947 to 1951 and from 1953 to 1955, and Red Standard in 1952. Plumage Archer has been the barley variety from 1930 to 1955, but from 1956 to 1960 the variety was Herta.

Crops have benefited in recent years from higher dressings of ammonium sulphate. The levels of nitrogen applications were doubled in 1956 for all crops except clover. This change was prompted by the high responses to nitrogen in this experiment. The responses to nitrogen, potash and phosphate, in relation to weather conditions, have been discussed by Yates and Patterson (*J. agric. Sci.* 1958, 50, 102).

#### *Green-manuring experiments*

The experiment started in 1936 to observe the fertilising effects of various green manures, was changed in 1954 to compare the effects from ryegrass and from trefoil sown after early potatoes on barley; the effects from ryegrass and from trefoil undersown in the barley are tested in the succeeding crop of early potatoes. The mean yield of early potatoes on plots which have not had green manures was 10.3 tons/acre, compared with about 11 tons/acre after

trefoil and after ryegrass. An increase of  $\frac{1}{2}$  ton/acre is attributable to the residual effect of green manures from the old scheme.

Barley yields have been increased by green manures ploughed in either in autumn or spring; ploughing green manures in spring gave 3 cwt. extra grain/acre in 1960.

To avoid residual effects, and to extend the investigation of trefoil and ryegrass as green manures, new experiments were started. Unfortunately, the trefoil did not establish satisfactorily, apparently because nodulation failed (see p. 86). Trefoil similarly failed in the irrigation experiment.

#### *Ley and arable rotations experiment*

Lucerne plots in their 3rd year were so seriously infested with lucerne-stem eelworm (*Ditylenchus dipsaci*) as to constitute dangerous sources of infestation. Acting on the recommendations of the Nematology Department, the crop was not harvested, but destroyed and ploughed in. Parts of the plots were also fumigated with a soil sterilant.

Lucerne plots in their 2nd year were not seriously infested. The crop was cut three times (7 June, 28 July, 26 September), and then these plots were treated with an experimental nematicide.

#### *Irrigation experiment*

Italian ryegrass was established in the autumn of 1959, replacing Cocksfoot, which had deteriorated after 6 years cropping. The ryegrass was cut eight times, and Table 4 gives the mean yields.

TABLE 4  
*Mean weights of dry grass (cwt./acre) at each cutting,  
with and without irrigation*

Date of cut:	Without irrigation	With irrigation
10 May ... ..	6.1	9.6
31 May ... ..	10.9	15.5
22 June ... ..	9.6	19.8
Total (3 cuts) ... ..	26.6	44.9
18 July ... ..	22.4	18.3
8 August ... ..	9.2	9.6
30 August ... ..	11.1	11.6
23 September ... ..	11.1	10.6
8 November ... ..	8.5	7.5
Total (5 cuts) ... ..	62.3	57.6

The ryegrass was first irrigated on 28 April; additional waterings in May and June brought the total given to an equivalent of about 3 inches rain, and these increased the yield of dry grass at the first three cuts from 27 to 45 cwt./acre. In the course of the subsequent five cuts, water (0.5 inch) was given only once in August; from July to November the unirrigated plots yielded 62 cwt./acre and the irrigated 58 cwt./acre.

In its 1st year the ryegrass has produced over 4 tons/acre of dry matter, compared with a mean yield of about 3 tons/acre from the preceding Cocksfoot sward.

Potatoes, which were grown from 1951 to 1956, replaced sugar beet in 1960. They were not grown from 1957 to 1959 because root eelworm (*Heterodera rostochiensis*) was present on all plots. After 3 years without potatoes, it was thought that early potatoes would escape serious eelworm damage, at least for one 3-year cycle. However, there was some yellowing shortly before harvesting, and many cysts were present on the roots.

Results from other trials with a triazine weed-killer, "Simazine", suggested a particular use in the irrigation experiment (*Rep. Rothamst. exp. Sta.* for 1959, p. 179). Potatoes grown on low, rounded ridges, maintained by minimum cultivations, might use water more efficiently than in tall, pointed ridges maintained by normal cultivations, so "Simazine" was tested to see whether it would replace cultivations as a method of controlling weeds.

Table 5 shows that the yields of tubers lifted on 15 July were increased by irrigation, but, with or without irrigation, yields were greater on the plots that received "normal" cultivations than on those treated with "Simazine" at 2 lb. in 40 gallons/acre on 15 April, after planting on 7 April.

TABLE 5

*Mean yields of early potatoes (tons/acre) grown with normal cultivations, and with minimum cultivations plus weed-killer ("Simazine") application, with and without irrigation*

	Normal cultivation	Minimum cultivation	Mean
Without irrigation ...	9.73	7.88	8.81
With irrigation ...	11.97	9.56	10.76
Mean ...	10.85	8.72	9.79

However, because of the dry weather after planting, few weeds developed on any of the plots, and conditions did not favour testing the efficacy of the weed-killer.

It was intended to establish trefoil on some plots after lifting the potatoes, to be ploughed in during the spring of 1961 before drilling a cereal crop. Unfortunately, the trefoil did not establish satisfactorily. On some plots it was adversely affected by residual toxicity from the "Simazine" applied in April 1960, but the failure was more general, apparently because of poor nodulation.

The mean yield of winter beans without irrigation was 22.6 cwt. grain/acre, and 34.4 cwt. grain/acre with irrigation equivalent to 3.3 inches rain given in May and June. Irrigation prolonged the period of growth; the unirrigated plots were combine-harvested on 10 August and the others on 26 August.

#### *Market-garden experiment*

Leeks harvested between 4 March and 26 April yielded 7 tons/acre, and the early potatoes also yielded well, at 9 tons/acre.

Globe beet was sown on 16 May, during the dry period which lasted until early June. Germination was irregular, and plant populations varied from plot to plot. Such differences commonly occur in this experiment, but the variability this year was greater than usual. The largest mean number of plants (thousands/acre)

was 133.1, and the smallest was 82.8. These differences were not consistently related to particular manurial treatments. The mean yield of "bulbs" was 6.85 tons/acre, slightly less than the mean yield for the period 1954-59 (7.09 tons/acre).

*Jerusalem artichoke*

The *Report* for 1959 (p. 187) referred to an experiment in which the tops of some of the Topine and artichoke plants were cut in July, and the tops of the others in November. Early removal of tops greatly decreased the yield of tubers; the mean yield was 1 ton/acre compared with 7 tons/acre of tubers when the tops were left until November. This experiment is being repeated, to see whether early removal of tops affects yield of tubers differently in different years. In 1959, a dry year, the plants did not grow again after cutting in July. In 1960, a wet year, the tops grew well after cutting in July. (Mann and Barnes.)