ROTHAMSTED RESEARCH

Report for 1950

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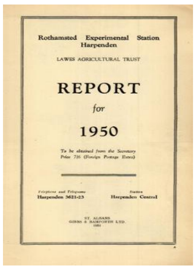
Rothamsted Experimental Station
Harpenden

LAWES AGRICULTURAL TRUST

REPORT
for
1950

Field Experiments Section

Anon

Anon (1951) *Field Experiments Section ;* Report For 1950, pp 112 - 120 **- DOI: https://doi.org/10.23637/ERADOC-1-72**

FIELD EXPERIMENTS SECTION

The following members of the staff, who constitute the Field Plots Committee, are responsible for planning and carrying out the programme of field experiments: E. M. Crowther (Chairman), H. V. Garner (Secretary), H. H. Mann, J. R. Moffatt, D. J. Watson and F. Yates.

The number of plots handled by the Field Staff at Rothamsted and Woburn were:

	Grain	Roots	Hay	Grazing	Total
Classical					
Rothamsted	115	72	50	—	237
Woburn	12	—	—	—	12
Modern Long-Term Experiments					
Rothamsted	279	264	160	64	767
Woburn	149	242	31	12	434
Annual Experiments					
Rothamsted	277	232	54	—	563
Woburn	—	40	—	—	40
Grand total ..	832	850	295	76	2,053

Note. Grain includes cereals, beans, peas, linseed. Roots includes potatoes, sugar beet, mangolds, cabbage, kale, leeks. Hay includes meadow and seeds hay, lucerne, cut grass.

The programme laid down for 1950 was successfully carried through with the exception of the classical barley plots at Woburn which had to be ploughed up owing to an exceptionally severe infestation of spurrey (*Spergula arvensis*). There was a serious attack of wheat bulb fly on the section of Broadbalk immediately following the fallow of 1949. This thinned the plant badly and a heavy infestation of corn buttercup (*Ranunculus arvensis*) occurred particularly on plots 9, 10 and plots that carried a poor plant of wheat. The Wheat after Fallow plots on Hoos field were also attacked by wheat bulb fly and were resown with spring wheat.

The characteristics of the season have been dealt with in the farm report. From the experimental point of view 1950 was a year of abundant growth of grass and fodder crops, heavy potato crops, and lodged cereals. Weeds grew fast and were difficult to control in crops such as beans and kale that could not be sprayed.

The classical and long-period experiments on both farms were continued with the exception of the 2-Course Rotation testing repeated dressings of agricultural salt which was terminated after the barley crop of 1950. Several of these experiments have been summarized in recent reports*. A few notes on the new ley arable rotation experiments at Rothamsted follow:

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* 4-Course Rotation. Residual effect of various straw manures. Summary of 14 seasons. Station Report 1946, p. 81.

3-Course Rotation. Effect of raw straw and straw composts. Summary of 14 seasons. Station Report 1947, p. 79.

6-Course Rotations, Rothamsted and Woburn. Effect of levels of nitrogen, phosphate and potash. Summary of 19 seasons. Station Report 1948, p. 90.

Ley Arable experiment, Woburn. Rotations with and without leys and legumes. Summary of 8 seasons. Station Report 1948, p. 94.

2-Course Rotation. Cumulative effect of salt on sugar beet and barley. Summary of 8 seasons. Station Report 1949, p. 101.

Ley Arable Rotation

The second preliminary year of this experiment was very different from the first in regard to the produce of the plots under grass and forage crops. There was a very marked contrast in summer rainfall. In 1949 during the period April-September inclusive, there was only 8·0 inches, in 1950 over the same period 17·9 inches. The results for the two experimental fields were :

Production of dry matter, cwt. per acre, 1949, 1950

	Highfield		Fosters	
	1949	1950	1949	1950
1st year blocks :				
Permanent Grass	16·6	41·8	—	—
Reseeded Grass and Ley ..	23·3	35·6	14·7	35·3
Cut Grass	7·8	64·6	3·4	44·2
Lucerne	18·6	51·3	12·7	46·2
2nd year blocks :				
Permanent Grass..	—	49·4	—	—
Reseeded Grass and Ley ..	—	51·9	—	36·5
Cut Grass	—	72·4	—	47·4
Lucerne	—	94·2	—	83·0

The level of production was much higher in 1950 than in 1949, cut grass in its first year, for example, gave about ten times as much in the wet summer than in the dry one. Lucerne was on the whole the biggest producer of dry matter, and the second year lucerne was much more productive than the first. In Highfield after old turf none of the grazing plots responded to extra nitrogen, but on Fosters on a poor arable soil there was evidence of nitrogen responses in first year grazing. In the wet season cut grass was very responsive to heavy nitrogenous treatment in both fields. One-year leys were poor in both fields and showed a response to extra nitrogen only on Fosters.

Test-crop wheat yielded 30 cwt. per acre in Highfield, and gave no response when the top dressing was increased from 2 to 4 cwt. " Nitrochalk " per acre. The yield was only 16 cwt. in Fosters, for there the plant wintered very badly. There was, however, a small nitrogen response on this field. Potatoes, the second-year test-crop, was excellent on both fields. The yield was 14 tons per acre for the basal dressing with no appreciable response on either field to dung or extra nitrogen. A further year's experience with sheep grazing on the grass plots showed that there are still improvements to be made in technique before the herbage is fully utilized by the animals. The wheeled hurdles used for the first time in 1950 were quite satisfactory.

The Annual Experiments

Several of the annual experiments were carried out on behalf of various departments who will themselves report results. They were :

Eyespot experiment on wheat—Little Knott and Little Hoos : Dr. M. D. Glynne.

Wireworm experiment on wheat—Little Hoos : Dr. C. Potter.

Fertilizer Placement experiments : winter and spring beans—West Barnfield ; lucerne—Long Hoos ; kale—Stackyard ; old grass—Highfield : Dr. G. W. Cooke.

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The remaining annual experiments were concerned with general fertilizer problems and were mostly the continuation of schemes begun in previous years.

Residuals in wheat of dung applied to potatoes

The main potato experiment testing various dung applications is usually followed up in a cereal crop to measure dung residues. The wheat of 1950, which received a top dressing of 2 cwt. sulphate of ammonia per acre promised well early in the season, but lodged in the wet summer; it yielded 27 cwt. grain per acre. The extent of the lodging followed the quantity of dung applied to potatoes the year before, the plots having 15 tons per acre were badly lodged and those receiving only 5 tons were standing. The differences in yield of grain due to residual dung were negligible, but there was more straw with the highest level of dung.

Dung applications to potatoes

This was a repetition of the 1949 experiment testing levels of dung and methods of applying it to potatoes and also the effect of the three standard nutrients. There was a heavy crop averaging nearly 14 tons per acre, with a big response to dung. The light dressing of only 5 tons per acre gave an increase of 2½ tons of potatoes, the second 5 tons gave a further increase of 1½ tons, but the heaviest application of 15 tons of dung gave no further improvement in 1950. The response to sulphate of ammonia was large and practically independent of the amount of dung applied. The potash response was over 4 tons in the absence of dung, 2 tons with light dunging, but negligible with the higher rates of application of dung. In 1950 the response to superphosphate increased with the amount of dung applied, thus in the absence of dung superphosphate gave a depression on yield, but in the presence of 15 tons of dung superphosphate gave a considerable increase in yield. Of these interactions with dung those involving nitrogen and potash have frequently been recorded before and are regarded as the normal behaviour. The positive dung-phosphate interaction, although statistically significant in this particular experiment, should be accepted with reserve, for usually dung slightly reduces the phosphate effect.

Methods of planting potatoes

An experiment which was begun in 1949 at Rothamsted to test methods of applying fertilizer when potatoes were planted by dropper, was repeated in 1950 at Rothamsted and Woburn. The following methods were compared with the ordinary method of hand planting in ridges:

(1) Broadcast fertilizer on the flat, ridge up, and plant in ridges with dropper.

(2) Broadcast fertilizer on the flat and plant on the flat with dropper.

(3) Ridge, apply fertilizer in ridges, split back ridges and plant in ridges with dropper.

A potato fertilizer was used at 8 and 16 cwt. per acre.

The first season, 1949, was exceedingly dry and the average yield was only 5·3 tons per acre. Even the single dressing of fertilizer had a barely significant effect and there was no further gain from the double dressing. The standard method of planting gave significantly less yield than the others, but this could not be attributed entirely to the effect of fertilizer location since it happened even in the absence of fertilizer.

In 1950 the Rothamsted experiment which received a basal dressing of 12 tons of dung per acre yielded no less than 15·1 tons without fertilizer. There was no improvement from a light dressing of fertilizer applied in the standard method, and the double dose of fertilizer was harmful no matter what system of planting and application was adopted. At both levels of fertilizer the standard method was inferior to all the dropper plantings. In both years at Rothamsted the dropper put in about 6 per cent more seed tubers than were planted by hand. This did not entirely account for the superiority of machine planting, but this point will be remedied in future experiments.

At Woburn where no dung was given fertilizer responses were extraordinary. The yield without fertilizer was 7·8 tons per acre. The first 8 cwt. of fertilizer raised the yield by 6·1 tons per acre and the additional 8 cwt. gave a further significant increase of 1·8 tons. At the lower level of fertilization the standard method gave much the same result as the others, but at the 16 cwt. level the standard method gave the smallest yield.

These experiments open up an important question and suggest that under certain conditions potatoes planted by dropper can make good use of broadcast fertilizer, and that the normal method of planting and manuring potatoes is not necessarily the most efficient under all circumstances. Further trials on these points are in progress.

Late nitrogenous top dressings for cereals

A start was made in 1950 to investigate the effect of very late nitrogenous top dressings on corn crops, applied when the plants were beginning to come into ear. It was claimed that in certain circumstances these dressings might increase both yield and nitrogen content of the grain. Three small preliminary trials were put down to test these points. The crops chosen had already received top dressings of sulphate of ammonia in spring: wheat, Squareheads Master, had 1¾ cwt. per acre; barley, Plumage Archer, 1½ cwt. per acre; oats, Sun II, 2 cwt. per acre. The late top dressings of "Nitrochalk" were applied on June 27th and 28th. In the wet summer all the wheat was lodged and there was no obvious difference in the degree of lodging due to the late dressing. All the oats were lodged, and plots receiving extra nitrogen late in the season were flatter than the rest. All the barley plots were standing but those receiving the heavier dressings of "Nitrochalk," in June, were leaning but not lodged.

The yields are given below together with nitrogen determinations made by R. G. Warren :

"Nitrochalk"	Wheat		Barley		Oats	
cwt. per acre	Grain	Straw	Grain	Straw	Grain	Straw
			Yield, cwt. per acre			
0	24·5	49·0	22·7	28·2	31·4	53·9
1·5	25·9	51·3	22·7	29·6	30·0	54·1
3	25·5	50·6	23·1	29·5	28·8	53·0
S.E. ±	1·30	4·12	0·76	1·08	1·08	1·03
			Mean dry matter per cent			
	86·2	86·4	84·5	79·7	85·8	81·3
			Nitrogen per cent of dry matter			
0	2·38	0·54	1·55	0·84	2·37	0·49
1·5	2·46	0·58	1·81	0·95	2·50	0·72
3	2·58	0·70	2·03	1·11	2·64	0·87
			Increase in crude protein, cwt. per acre			
1·5	0·30	0·17	0·31	0·19	0·06	0·66
3	0·42	0·48	0·61	0·39	0·11	1·01
			Percentage uptake of added nitrogen			
1·5	20	12	22	13	4	45
3	14	18	21	13	4	35

In spite of a very favourable season for the action of late nitrogen there were no appreciable effects of late nitrogen on the yields of grain and straw.

There were, however, large effects on the nitrogen percentage or crude protein content for each crop. The crops responded in different ways. Wheat and barley both took up about one-third of the nitrogen added late whilst oats took up about one half. For each of the crops the heavy dressing of late nitrogen gave about one cwt. additional crude protein per acre. The additional nitrogen in the wheat and barley was distributed between the grain and the straw, the increase in the nitrogen percentage of the barley grain being relatively large since the barley without late nitrogen had a low percentage of nitrogen. In the oats nearly all the extra nitrogen was contained in the straw.

Where feeding barley or oat straw are fed on the farm, the use of very late top dressings of soluble nitrogen fertilizer may provide a useful method for obtaining additional crude proteins very cheaply. If further work confirms these results it will be necessary to devise machinery to apply these late dressings to corn crops with the minimum of damage.

Time of Planting Potatoes

In 1945 the Plant Pathology department began a field study of the influence of certain cultivation and manurial treatments on the spread of virus disease in potatoes, and the series of experiments devised for this purpose lasted for six seasons occupying a fresh site every year. The experiments have now terminated and the virus aspects will be reported by the Plant Pathology department. The agricultural treatments chosen, however, have considerable practical interest and are summarized here.

https://doi.org/10.23637/ERADOC-1-72

The standard form of the experiment consisted of four dates of planting spaced at intervals of about three weeks, each of these testing dung, nitrogen, phosphate, and potash in all combinations. There were consequently 64 treatments which were confounded into blocks of 16 without replication. This plan was followed in four years. In 1945 and 1947 certain of the factors were omitted so the main agricultural results of these two experiments will be recorded separately.

The sowing dates, which varied somewhat year by year according to the season may be classified as follows :—Early : end of March to early April ; Normal : third or last week April ; Late : second or third week May ; Very late : late May to early June. The actual dates in the four groupings do not overlap. The rates of fertilizer application per acre were : dung 15 tons at each date of planting, sulphate of ammonia 0·6 cwt. N, superphosphate 0·6 cwt. P_2O_5, muriate of potash 1·0 cwt. K_2O. Fertilizers were always put in the ridges shortly before planting, but dung was applied in this way only in 1946 and 1948, in the last two years the dung was ploughed in on all its appropriate plots before the first planting. The following table gives the planting dates and mean yields for each year, and the mean of these values over the four seasons. The main effects of dung and each of the fertilizers are recorded for each planting date, also the first order interactions of dung and fertilizers. Actual yields are given for the four combinations of dung and potash.

Time of planting potatoes, Rothamsted 1946-1950

	Dates of planting					*Mean*
1946	April 10	April 30	May 20	June 7		—
1948	April 10	April 24	May 8	May 22		—
1949	Mar. 29	April 20	May 10	May 30		—
1950	Mar. 31	April 21	May 11	May 31		—
Mean	April 4	April 24	May 12	May 30		—
	Mean yields : tons per acre				±	
1946	11·56	10·64	10·35	9·43	0·27	10·49
1948	12·15	9·22	9·42	6·91	0·50	9·42
1949	5·38	5·02	5·07	4·48	0·14	4·99
1950	12·14	11·00	10·55	9·18	0·36	10·72
Mean	10·31	8·97	8·85	7·50		8·90
Mean effects :						
Dung	3·35	2·81	2·40	1·92		2·62
Nitrogen	1·59	0·73	1·17	0·95		1·11
Phosphate	0·80	0·78	0·44	0·42		0·61
Potash	2·29	0·83	1·08	0·49		1·17
Interactions :						
Nitrogen × Dung..	0·00	0·16	−0·06	−0·09		0·00
Phosphate × Dung	−0·38	0·27	−0·15	−0·64		−0·23
Potash × Dung ..	−0·70	−1·26	−1·58	−0·54		−1·02
Mean yields with :						
No Dung, No Potash	7·1	6·5	6·3	6·0		6·5
Dung, No Potash ..	11·2	10·6	10·3	8·5		10·1
No Dung, Potash ..	10·1	8·6	9·0	7·0		8·7
Dung, Potash ..	12·8	10·2	9·8	8·4		10·3

Yields were good except in the very dry deason of 1949. The yields, especially in well manured crops, fall off with delayed planting. Averaging over all manuring, potatoes planted near the beginning of April yielded over one ton per acre more than those planted towards the end of April or in the first half of May, but there was a large drop in the yield of potatoes planted at the end of May. The benefits from dung, nitrogen and potash were much greater for the earliest planting than for all later ones. The average gain from superphosphate was much smaller than from the other fertilizers and also varied considerably from year to year.

As in many other experiments the use of dung had no effect on the gain from nitrogen fertilizer, but the returns for phosphate and potash were much reduced on plots which had received dung. The interaction of potash with dung varied with the date of planting. This is illustrated by the mean yields at the foot of the table.

The gain from dung used without potash was about 4·0 tons per acre at each of the first three planting dates, but it fell to 2·5 tons at the fourth planting date. Dung and potash fertilizer together gave a marked improvement over dung alone at the first planting date but there was no gain from using potash as well as dung on any other planting date. The earliest planting allowed the crop to respond well to heavy manuring but potatoes planted later could make no use of additional potassium beyond that supplied in dung. On land receiving both dung and potash the earliest planting gave 4·4 tons of potatoes per acre more than the latest planting.

The 1945 experiment which fell out of line with the main series brought out an interesting point. Chitted and unchitted seed was planted at each of the four dates. The figures were :

Potatoes, tons per acre

	March 30	April 20	May 11	June 1	Mean
Ordinary seed	10·02	10·85	8·96	6·63	9·12
Chitted seed	10·27	10·90	10·11	7·99	9·82
Effect of chitting	0·25	0·05	1·15	1·36	0·70

There was the usual reduction in yield with delayed sowing, but the gain from using chitted seed was much greater on the later sowings than on the earlier ones. Chitting therefore slightly reduced the adverse effect of late planting. In this experiment the effect of dung and of nitrogen fell off rapidly with late planting, these effects being similar to those summarized above for the main series, but in a more pronounced degree.

In 1947, owing to the very late spring, only two plantings were possible, one on 5th May and the next on 24th May. There was only a small crop due to the very dry summer and all effects were small, but the results were in the general direction shown by the complete set of experiments.

Irrigation of Sugar Beet

The irrigation experiment of 1950 was carried out on the farm of Messrs. W. O. & P. O. Jolly, at Kesgrave, near Ipswich. It was a continuation of the experiment of the previous year on a somewhat larger scale, testing four levels of watering in combination with four levels of nitrogenous manuring :

On main plots :	*On sub-plots :*
O = No irrigation	0 = Basal manuring only (P, K, Salt)
A = Irrigation on farmer's system	1 = Basal + 0·4 cwt. N
B = Severely restricted irrigation	2 = Basal + 0·8 cwt. N
C = Restricted irrigation	3 = Basal + 1·2 cwt. N

The season will long be remembered for its showery summer which provided three inches more rain in the four summer months than the previous year. The figures recorded on the plots were :

	Inches per month				
	May	June	July	August	Total
1950	1·35	1·47	2·37	2·32	7·51
1949	1·99	0·42	0·72	1·54	4·67

The soil was a sandy gravel, the basal dressing 6 cwt. granular mixture providing 13·8 per cent P_2O_5, 13·8 per cent K_2O, and 4 cwt. agricultural salt per acre. Nitrogen treatments were applied as " Nitrochalk " before drilling. The seed was drilled on March 28th.

Watering began in mid-June and continued on certain plots until mid-September. The details were :

		Irrigation, inches		
		2A	2B	4C
June	13–16	—	1½	2
July	1–2	2	—	—
July	12	—	½	1
August ..	15	—	—	¼
September ..	13–14	—	—	¾
	Total	2	2	4

Since watering and nitrogen acted almost independently in 1950 the results are adequately brought out in the table below which gives the effect of water and of nitrogen separately for all attributes of the crop.

Mean yields with increasing levels of irrigation and with increasing quantities of nitrogen

Roots and tops tons per acre, sugar cwt. per acre, plant number thousands per acre, sugar per cent, noxious N mg per cent.

	Irrigation, inches				S.E.
	0	2A	2B	4C	±
Roots, tons	14.64	17.71	16.30	17.58	0.30
Tops, tons	6.42	6.92	6.88	7.13	0.20
Sugar, %	18.07	18.20	18.14	18.07	0.11
Sugar, cwt.	52.8	64.4	59.1	63.5	1.13
Plant No.	32.6	32.6	32.4	33.1	0.44
Noxious N., mg.% ..	32.8	30.0	31.6	23.8	3.94
	" Nitrochalk," cwt. per acre				S.E.
	0	2½	5	7½	±
Roots, tons	15.76	16.60	16.73	17.13	0.21
Tops, tons	5.74	6.44	7.35	7.81	0.15
Sugar, %	18.72	18.41	18.04	17.31	0.12
Sugar, cwt.	59.0	61.1	60.4	59.3	0.88
Plant No.	32.6	32.7	33.0	32.3	0.37
Noxious N., mg.% ..	20.2	25.4	32.4	40.1	1.84

There was an excellent crop with an average yield of 3 tons of sugar per acre. Every irrigation treatment produced a significant improvement over the dry plots. A single watering of 2 inches in early July (treatment A) gave an increase of no less than 11·6 cwt. of sugar per acre. Two inches applied, 1½ inches in mid-June and the remaining ½ inch in mid-July (treatment B), gave 6·3 cwt. sugar. While 4 inches of water, of which 2 inches were applied in mid-June and the remainder distributed from mid-July onwards (treatment C), gave 10·7 cwt. of sugar. The first method was significantly better than the second ($+5{\cdot}3 \pm 1{\cdot}8$ cwt. sugar). Whereas the effect of water has frequently been proved in these experiments this is the first occasion in this series where a substantial difference has been revealed between the irrigation treatments themselves. Since treatments A and C produced practically the same yields, and treatment B was intermediate, it appears probably that in this showery season where there was well distributed rainfall during July, August and September the outcome of irrigation treatments was largely decided by the amount of water applied on or before the first days of July.

The net effects of nitrogen on sugar production were small in 1950, the gains in root weights being largely offset by the reduction in sugar percentage. The tops and noxious nitrogen showed the usual increases.

https://doi.org/10.23637/ERADOC-1-72