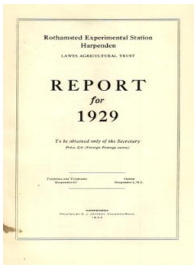
ROTHAMSTED RESEARCH

Report for 1929

Full Table of Content



Potatoes

Rothamsted Research

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The relationship of the nodule organisms to the plant has been further studied; Dr. Thornton has shown that they do not normally enter the plant until the true leaves begin to form: then there is extruded from the root a substance which facilitates or even determines their entry. The nature of this substance is not yet determined, but it does not appear to be made in the leaf. When the organisms are in the root they increase greatly in number, and they stimulate the plant cells to multiply, forming the well-known nodules. Around the colony of bacteria a network of conducting vessels develops as an offshoot from the main circulating system of the plant, and, this close connection being established, the bacteria take sugar from the plant, causing an increase in growth. If the supply of sugar is cut off by keeping the plants in the dark, or by stopping the development of the conducting vessels (which can be done by withholding the trace of boron needed for this purpose) the bacteria turn to the root tissue for food and begin to consume it: they thus change from being beneficial into harmful parasites. If the supply of air is restricted the bacteria fix less nitrogen, but they do not become parasitic.

POTATOES.

The potato experiments were conducted on much the same general lines as last year. The yields, however, were low, as the result of the very dry March and April: the plants were not able to start growing till May.

The increases given by fertilisers were, in cwt. per acre :—*

	1929			Average 1925–28 †		
Sulphate of Ammonia cwt. per acre	0	1.5	3	0	2	4
Sulphate of Potash cwt. per acre 0	–	12	15	–	20	24
,, ,, ,, 1	7	15	18			
,, ,, ,, 2	2	16	21	15	49	71
,, ,, ,, 4				16	55	75
	Basal crop 4.52 tons per acre.			Average Basal crop 6.62 tons per acre.		

* In all years except 1925 farmyard manure was also applied.
† In 1928, the weights of fertilisers used were as in 1929.

The increases are thus less than usual, nevertheless they cost less than £2 per ton. Taking the four years 1925-28, the expenditure in pence on manure per cwt. of additional crop has been :—

	1925–28		
Sulphate of Ammonia	0	2	4
Sulphate of Potash 0	0	13	21
,, ,, ... 2	21	12	12
,, ,, ... 4	39	16	15

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The results show, as before, that neither sulphate of ammonia nor sulphate of potash acts best by itself : the gain in crop is small and the cost is high. The best results are obtained when both act together: these fertilisers are closely linked. Further, the total effect is more than the sum of the separate effects: 2cwt. of sulphate of ammonia increased the yield by 20cwt., and 2cwt. of sulphate of potash increased it by 15cwt., but when the sulphate of ammonia and sulphate of potash acted together the increased yield was 49cwt. per acre: 4cwt. sulphate of ammonia alone gave additional crop at a cost of 21 pence per cwt., and 4cwt. sulphate of potash alone at a cost of 39 pence per cwt., but the two together gave it at a cost of 15 pence, while 4cwt. sulphate of ammonia and 2cwt. sulphate of potash gave it a cost of 12 pence per cwt. As a rule at Rothamsted our best results are obtained by a combination of 3 or 4cwt. sulphate of ammonia with about 2cwt. sulphate of potash: this corresponds to a ratio of 3 or 4N : 5 K_2O, a larger amount of potash than is usually provided in compound fertilisers.

The effects of the fertilisers are modified by the season. The responses in cwt. per acre to sulphate of ammonia in increasing dressings in presence of sufficient sulphate of potash, super. and dung have been :—

	Yield tons per acre. No Nitrogen.	Increase for 1st dose Sulphate of Ammonia cwt.	Further increase 2nd dose Sulphate of Ammonia cwt.	Further increase 3rd dose Sulphate of Ammonia cwt.	Quantity of Sulphate of Ammonia in single dose.	Basal dressing. cwt. per acre.
1925	7.92	52	8	–9 (a)	2 cwt.	No dung, 3 super. 4 Sulphate of Potash
1926	7.79	24	29	38 (b)	1 cwt.	Dung, do. do.
1927	6.90	16	–5	— (c)	2 cwt.	,, ,, ,,
1928	7.06	35	37	— (c)	1½ cwt.	,, ,, and 2 Sulphate of Potash
1929	5.18	7	19	— (c)	1½ cwt.	Dung, 3 super. 2 Sulphate of Potash

(a) Basal potash was 6 cwt. sulphate of potash.
(b) Treble dose was 4 cwt. sulphate of ammonia.
(c) No experiment.

Except in 1927 and 1929, the average response per cwt. sulphate of ammonia is of the order of 20cwt. potatoes, as usual in the earlier experiments. The second cwt. has in some years done better than the first.

The response to potash has been more variable, but the bad years were also 1927 and 1929: in 1927 the potatoes were planted late (May 24th) and 1929 was a dry and sunny season.

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The responses to sulphate of potash* in presence of sufficient sulphate of ammonia, super. and dung have been :—

Year	No Potash Yield. Tons per acre.	Increase for 1st dose. Potash cwt.	Further increase for 2nd dose. cwt.	Further increase for 3rd dose. cwt.	Quantity of Sul. Potash in single dose.	Basal dressings. cwt. per acre
1925	6.45	75	7	0	2 cwt.	No dung, 3 super, 4 Sulphate of Ammonia
1926	9.53	32	9	14	1 ,, †	Dung do. do. do.
1927	7.16	14	–8	—	2 ,,	do. do. do. do.
1928	8.26	56	–8	—	1 ,,	do. do. 3 Sulphate of Ammonia
						(Mean of all potassic fertilisers)
1929	5.94	–1	11	—	1 ,,	Dung, 3 super, 3 Sulphate of Ammonia

* Except 1928 when there were very few plots owing to frost damage.
† The 3rd. dose was 4 cwt. Sulphate of Potash.

The highest yields in each year and the manurings given were :

	Yield given by best manurial treatment.	
Year.	Tons.	Manuring (cwt. per acre) : Super +
1925	10.96	4 Sulphate of Ammonia : 4 Sulphate of Potash
1926	12.34	4 Sulphate of Ammonia : 4 Sulphate of Potash
1927	7.96	4 Sulphate of Ammonia : 4 Muriate of Potash
1928	11.05	3 Sulphate of Ammonia : 1 Sulphate of Potash
1929	6.82	3 Sulphate of Ammonia : 1 Potash Salts

The three potassic fertilisers, sulphate, muriate and potash manure salts, all gave similar increases in 1929; the differences recorded in 1927 did not appear.

The effect of phosphate has again been clearly marked, and again it has depended on the other fertilisers given : superphosphate at the rate of 3 cwt. per acre (0.4 cwt. P_2O_5) gave the following increases in cwt. per acre :—

		1929			1928		
Sulphate of ammonia : cwt. per acre ..		0	1.5	3	0	1.5	3
Sulphate of potash : cwt. per acre ..	0	5	8	11	10	7	5
	1	3	13	17	1	Nil.	26
	2	5	9	19	10	13	18
Basal yields tons per acre		.. 4.5 to 5.6			..	.. 6.1 to 9.7	

The superphosphate acted best when combined with the most effective mixtures of sulphate of ammonia and sulphate of potash. In these conditions it gave its extra yield at an expenditure of :—

1929 1928
8 ... 6 pence per cwt. of potatoes obtained.

The effect of superphosphate, however, depends very much on the soil. At Woburn, no response was obtained in 1927 or on the average in 1929 when yields were low (4 to 5 tons per acre), but there was a good response in 1928 when the crop grew better : a yield of 12.25 tons per acre was raised by 3 cwt. of super to 13.4 tons and by 9 cwt. to 14.7 tons per acre, the gains thus being 23 cwt. and 50 cwt. respectively, at an expenditure of 7 pence and 9½ pence respectively per cwt. of potatoes obtained.

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The 1929 experiment was on a more elaborate scale than in 1927, and brought out a curious result: the superphosphate increased the crop so long as no nitrogen was given, but it apparently decreased the crop in presence of nitrogen and potash. At the outside centres the effects of superphosphate have varied, again mainly as the result of soil variations. There was a gain at Wisbech of 6.6 cwt. potatoes per cwt. of superphosphate used as compared with 4 cwt. potatoes per cwt. of super. at Rothamsted, but no gains at Bangor, Sutton Bonington or Owmby Cliff.

The work this year has been extended to include a full examination of the influence of manuring on the cooking and keeping qualities of the crop. Nearly four hundred samples were examined by Dr. Lampitt, of Messrs. Lyons' laboratories, and the very extensive data are being worked up. Certain results are already emerging: chipped potatoes were not affected in any uniform or definite way either in colour, flavour or consistency, but boiled potatoes were improved by potassic fertilisers in colour both "outside" and "mashed." Muriate of potash gave the best results, sulphate came second, and potash manure salts third: at times, indeed, the latter was somewhat harmful. For flavour the potassic fertilisers came out in the same order, but only the best of the samples were equal to those grown without potash, and the others were inferior.

Number of Plants per acre. The potatoes are planted 15 inches apart in rows which are 27 inches apart. The total possible number of plants per acre is 15,490. Actually the numbers found per acre in 1929 at Rothamsted were:—

Number found per acre, no artificials ...	14,480
,, ,, ,, complete artificials..	14,870
Average of all plots	14,593
Total possible	15,490

There is thus very little variation in number on the plots, though the numbers were all less than was expected. At Woburn, the numbers were smaller owing to depredations of pheasants.

SUGAR BEET.

The sugar beet experiments again emphasised the need for new varieties better suited to English conditions than those now grown. With no scheme of manuring is it possible to obtain the impressive yield increases given by mangolds or potatoes; the leaves respond but the roots do not, and it is not yet possible to control the leaves so as to make them send more material into the root. One ton of leaf may give from a few hundredweights up to about 3 tons of root, but rarely more, and the factors determining this are not in our control. Certain consistent features stand out. Nothing is gained by the large dressings of farmyard manure or of artificials sometimes given on the Continent,* the fertiliser must

* As an example: The Bernburg investigators find that the best manuring for sugar beet gives 400 dz. per hectare or 16 tons per acre. This manuring is:—

	Kgm per ha.	lb. per acre	Fertiliser per acre
N	160	143	9 cwt. nitrate of soda
P_2O_5 ..	60	54	3 cwt. superphosphate
K_2O ..	180	160	320 lb. sulphate of potash

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