

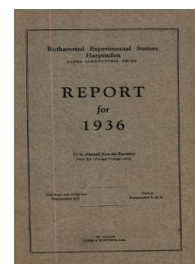
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FERTILISER REQUIREMENTS OF SUGAR BEET

Modern fertiliser trials on sugar beet were commenced at Rothamsted and Woburn in 1926 and during the following six years were extended to the outside centres. With the limited resources available it was possible to carry out only some six or seven trials each year. Nitrogen appeared to be the most consistent of the common nutrients in its effects, potash and common salt were frequently beneficial, but there were few clear-cut results from phosphate. These results did not accord with the views generally held by Factory Agriculturists, many of whom believed that when the crop was handled well on suitable land generous fertiliser treatment was essential and profitable. The Rothamsted trials were consequently greatly extended in 1933 under the Scheme of the Committee on Sugar Beet Education and Research. The purpose was to ascertain the response of the sugar beet crop to fertilisers and to relate the responses to the laboratory analyses of soil samples from the experimental areas. The Factory Staffs accepted responsibility for supervising the growing of the crop, each factory having one or more centres in its area, while the conduct of the experiment in the field and the work on soils were in charge of the Rothamsted Staff. The arrangements have worked admirably and there are now four years' results on record. The figures are published annually in the Station Report but since the work is still in the preliminary stages it is not intended to use them at present as a basis for recommendations. It happens, however, that in the short period covered by the experiments very marked seasonal differences have been observed and a note on this aspect of the case is here given.

The experiments tested the three common nutrients—nitrogen, phosphoric acid and potash (in the forms of sulphate of ammonia, superphosphate and muriate of potash)—alone and in all combinations. In 1933 the manures were used at two levels only, nil and single dressing, giving 8 treatments. In 1934 and subsequently, three levels of each nutrient have been employed, to give 27 treatments. A summary of the seasonal weather conditions (at Rothamsted) and the mean yields of roots of the experiments is given below for each year.

Rothamsted, May—Aug. incl.			Mean yield of Experiments		
Year	Rainfall, ins.	Sunshine, hrs.	No. of Centres	Actual tons p. a.	Per cent. of English average
1933	4.70	898	13	11.5	128
1934	5.69	841	15	13.5	134
1935	7.51	873	23	9.5	104
1936	12.16	800	26	10.4	106

The first three years were characterised by hot dry bright summers, whereas 1936 was one of the wettest seasons since the introduction of sugar beet into this country. In the first two years the centres chosen were distinctly above the average in fertility, but in subsequent years there were more soils of lower fertility and the mean yield was close to the country's mean.

A general view of the nature of the fertiliser responses year by year, taken as an average over all soils and also grouped by soil types for 1936, is presented in the following table, the yields being expressed as cwt. of sugar per acre.

	1933	1934	1935	1936	1936 Coarse sands	1936 Fine sands	1936 Light loams	1936 Heavy loams	1936 Clay loams	1936 Fens
No. of centres	13	15	23	26	6	5	6	4	3	2
Mean Yield	37.5	47.6	32.4	36.6	35.3	30.8	41.4	36.1	36.9	41.1
MEAN RESPONSE TO										
<i>Sulphate of Ammonia</i>										
2 cwt.	+0.37	+1.8	+1.8	+5.5	+8.3	+4.4	+4.0	+4.9	+7.0	+3.1
4 cwt.	—	+3.0	+2.7	+7.7	+11.6	+5.9	+5.6	+9.2	+9.9	+0.8
<i>Superphosphate</i>										
3 cwt.	+0.34	+0.4	+0.1	+1.9	+2.3	+1.3	+3.0	+0.6	+2.5	+1.2
6 cwt.	—	+1.0	+0.4	+3.0	+4.2	+2.7	+3.7	+1.2	+4.3	+0.2
<i>Muriate of Potash</i>										
1½ cwt.	+0.75	+1.4	+0.8	+1.2	+1.8	+2.6	+0.3	+0.2	+0.0	+2.1
2½ cwt.	—	+0.4	+0.9	+1.9	+3.3	+4.4	+1.5	-1.2	-1.4	+4.2

In 1936 the single application of nitrogen (2 cwt. sulphate of ammonia per acre) gave on the average almost four times the increase in sugar that resulted in the three previous seasons; the double dressing gave about three times as much. This was mainly due to a larger increase in weight of washed roots, but also to the fact that the addition of nitrogen had a much smaller depressing effect on the sugar percentage in 1936 than in previous years. Thus, in the three dry years 1933-35 the single dressing of sulphate of ammonia reduced the sugar percentage by 0.25 per cent.; in 1936 the reduction was only 0.06 per cent. For the double dressings the corresponding figures were 0.52 per cent in 1934-5 and 0.18 in 1936. In yield of tops the effects of sulphate of ammonia in the wet season were, contrary to expectation, not much greater than in the dry years.

The responses in total sugar following the use of superphosphate were quite small in the three dry years but considerable in 1936, being statistically significant at 10 of the 26 centres. Phosphate also had a marked effect on tops in 1936, the average increase being 0.72 tons for the 6 cwts. of superphosphate. At several centres in 1936 the effect of superphosphate in hastening the early development of the plant was very marked, especially on the heavier soils.

The single application of muriate of potash, 1½ cwt. per acre, gave much the same increase in 1936 as in previous years, but the double dressing was distinctly more effective. When the results are examined on the basis of soil type it is seen that potash was highly effective on the lighter soils but not on the heavier types. Although 1936 provided so many contrasts with the previous years, the well-known effect of potash in increasing the sugar percentage of the roots was much the same in all years, the figures being :

Muriate of Potash	Increase in sugar percentage			
	1933	1934	1935	1936
1½ cwt.	+0.15	+0.23	+0.16	+0.14
2½ " "	—	+0.22	+0.24	+0.24

In addition to the average over-all effects of the nutrients given above, the experiments were designed to test the extent to which the response to any fertiliser depended on the presence of another fertiliser. The only general effect was between nitrogen and potash. In each of the years 1934 to 1936 the response in sugar to either fertiliser was about 2 cwt. per acre greater when the other was present than when it was absent. This positive interaction, which appears to be independent of seasonal effects, emphasises the importance of preserving a proper balance between nitrogen and potash in fertiliser mixtures for sugar beet.

In view of the low proportion of clear-cut responses to phosphoric acid and potash in the three dry summers it was not possible to make satisfactory tests on the practical value of the chemical analyses conducted on each of the experimental soils, but in 1936 there was a reasonably satisfactory measure of agreement between the size of the actual phosphate responses and the amounts of readily soluble phosphoric acid in the soils, as estimated in several alternative ways. It was also possible by incubation experiments in the laboratory to differentiate between the soils which gave large or comparatively small responses to sulphate of ammonia. The soil analyses for the so-called "available potash" were less successful. The following table illustrates the extent of the agreement for a group of light soils, which were divided into three classes by their responses to fertilisers. For phosphoric acid and sulphate of ammonia very large responses in the field were obtained only on soils with low analyses. There were no large responses on soils rich in the available nutrient.

Distribution of Fertiliser Responses of Sugar Beet and Soil Analyses for Light Soils, 1936

Inorganic N after incubation mgs. per kg. soil	Response in sugar to 4 cwt. Sulphate/Amm.		
	Below 5	5 to 10	Over 10 cwt. p.a.
0—40	1	3	5
40—60	4	3	1
Over 60	1	0	0
P ₂ O ₅ extracted by M/2 acetic acid mgs. per 100 g. soil	Response in sugar to 6 cwt. superphosphate		
	Below 2	2 to 4	Over 4 cwt. p.a.
0— 8	1	5	8
8—16	3	2	0
Over 16	3	0	0
K ₂ O extracted by M/2 acetic acid mgs. per 100 g. soil	Response in sugar to 2.5 cwt. muriate of potash		
	Below 2	2 to 4	Over 4 cwt. p.a.
0— 8	1	1	4
8—16	4	3	4
Over 16	3	1	0