ROTHAMSTED RESEARCH

Report for 1927-28

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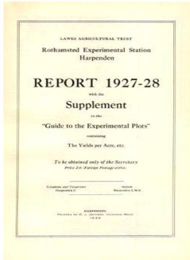

Detailed Laboratory and Pot Culture Investigations on Fertilisers

Rothamsted Research

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PLANT GROWTH AND QUANTITY OF FERTILISERS.

Of the many attempts to find the relationship between the amount of plant growth and the quantity of fertiliser applied, the most widely discussed is the attractive one of E. A. Mitscherlich, which, however, is open to some criticism. Professor Balmukand, working in Dr. Fisher's laboratory, has shown that the results may be expressed in terms of two constants, one representing the importance of the nutrient to the crop, while the other represents the amount of nutrient the crop can extract from the unmanured soil. The first of these constants is presumably a crop and even a varietal factor, and the second is a soil factor: the constants promise to afford a means of estimating both, and so of expressing numerically both the crop need and the amount of available plant food in the soil.

DETAILED LABORATORY AND POT CULTURE INVESTIGATIONS ON FERTILISERS.

The laboratory work is carried out in the Chemical Department by Mr. R. G. Warren and Dr. H. L. Richardson, under Dr. E. M. Crowther, and the pot culture work by Dr. W. E. Brenchley and Miss K. Warington.

Cyanamide. No experiments had been made at Rothamsted with this substance since 1920 and, as the method of manufacture has considerably altered, an extended series of investigations was begun in 1927 and is being continued. The modern material is practically free from the dicyanodiamide which used to cause much trouble, and it is also easier to handle than the old samples: it still needs, however, to be applied a few days before sowing. In our experiments, it has been as effective as sulphate of ammonia on barley at Rothamsted, but less on potatoes at Woburn and sugar beet at Colchester. The increments in crops for 1 and 2 doses of cyanamide and of sulphate of ammonia have been:—

	No Nitrogen.	One dose.			Two doses.			Cyanamide value when Sulphate of ammonia = 100	Urea value when Sulphate of ammonia = 100
	bushels	Sulphate of ammonia	Cyanamide	Urea	Sulphate of ammonia	Cyanamide	Urea		
Rothamsted.									
Barley, bushels.									
1927	23.6	10.4	12.4	9.2	14.2	12.3	20.2		
1928	28.6	7.0	4.8	6.4	6.0	8.9	7.2		
Additional bushels per lb. nitrogen.									
1927	—	0.45	0.54	0.40	0.31	0.27	0.44	106	110
1928	—	0.31	0.21	0.28	0.13	0.19	0.16	94	100
Woburn.									
Potatoes	tons.	cwt.	cwt.		cwt.	cwt.			
1926	6.50	17.6	15.2	—	27.2	25.0	—		
1927	6.53	12.8	7.2	11.0	−2.0	4.0	8.0		
1928	11.9	44.4	16.6	—	—	—	—		
Additional cwts. per lb. nitrogen.									
1926	—	0.76	0.66	—	0.59	0.54	—	89	—
1927	—	0.37	0.21	0.32	−0.03	0.06	0.12	79[1]	129
1928	—	1.29	0.48	—	—	—	—	37	—
Colchester.									
Sugar beet.	tons.				tons.	tons.			
1928	6.09	—	—	—	1.32	0.70	—		
Additional cwts. per lb. nitrogen ...	—	—	—	—	0.44	0.23	—	52	—

[1] Single dressing.

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The comparison is made on the basis of the increments and not of the yield figures: it therefore carries all the errors of the experiments and acquires validity only as data accumulate. The very low value at Woburn in 1928 is probably fictitious and arises from the circumstances that the increment for sulphate of ammonia was abnormally high, being indeed the highest we have ever obtained.

Much work has been done in the Chemical Department by Dr. E. M. Crowther and Dr. H. L. Richardson on the decomposition of cyanamide in soil. The first reaction giving urea is brought about by some chemical change not understood: the urea then changes rapidly to ammonia and this, through the action of micro-organisms, is oxidised to nitrate.

While the general course of the decomposition is probably the same in all soils, the rate at which it proceeds varies in different soils. The most striking result is the delay in the formation of nitrate even after all the cyanamide has decomposed: the ammonia remains unnitrified for some long time. In spite of this, however, plants make good growth, suggesting that they are using the ammonia.

Ammonium Chloride.—The experiments described in the preceding pages and the earlier reports, show that ammonium chloride is, in general, superior to ammonium sulphate in equivalent amounts for cereals and, so far as the experiments have gone, for sugar beet but not for potatoes. Further information is being accumulated.

Urea. This substance compares very favourably with sulphate of ammonia in equivalent quantities; it has the advantage of high concentration, containing 46 per cent. of nitrogen against only 20.6 in sulphate of ammonia. Further, it has less tendency to make soil acid.

Basic Slag. Mr. R. G. Warren has shown that a solution of sodium chloride affords a better means of assessing the agricultural value of basic slag than the official 2 per cent. citric acid. Basic slag increased the amount of manganese in the barley grown in pot experiments: if it did the same for oats it might be expected to cure the "grey fleck" disease, which is attributed to deficiency of manganese. The manganese in the slag, however, did not appear to increase the yield of barley.

Superphosphate. In spite of much experimental work by the staff of the Chemical Department, no indication can be found that superphosphate ever makes a soil acid. Farmers in the west country and in the north maintain that it increases the liability to finger and toe in swedes: on this we have hitherto been unable to make experiments.

Dr. Brenchley has shown (in confirmation of Gericke's earlier work) that barley utilises phosphate for increased growth only in its early stages of growth, although absorption of phosphate continues almost throughout the whole life of the plant. Early sown barley can utilise phosphate for at least 12 weeks (varying with different varieties) while later sown barley cannot, its period of utilisation being shorter. Further, the period during which phosphate can be withheld without injury is longer for early sown than for late sown barley. These advantages in favour of early sowing have not previously been recognised.

Sodium Silicate. Sodium silicate has long been shown to benefit the barley crop at Rothamsted: evidence is now obtained that this is due to an action in the soil enabling the plant to take up more phosphate, rather than an action in the plant enabling it to use phosphate better, as was previously supposed.

Elements needed only in small amounts. The necessity of boron and of manganese in small amounts has already been demonstrated in earlier reports. Recently, R. V. Allison, in Florida, obtained striking crop increases by the use of copper sulphate on certain Florida " muck " soils, which apparently resemble some of our fen and peat soils. Dr. Brenchley has made trials on a number of crops on these soils, but found no response to copper sulphate: there seems, therefore, no likelihood of it proving useful here.

SOIL CULTIVATION.

The experiments on soil cultivation follow three general lines. Measurements are taken in the field of the draught or drawbar pull of the implement and of the effect it has had on the soil. Laboratory experiments are made to study the physical properties of the soil, including stickiness, tilth, its relations to water, air and temperature, and so to explain the field observations. Finally, field experiments are made to test other and simpler methods of achieving the same results as present-day cultivation methods.

Earlier work had shown that heavy dressings of chalk, such as were formerly given in Hertfordshire, markedly reduced the drawbar pull necessary to get a plough through the soil. The smaller dressings now customary have been tried during the past three years: five tons per acre of finely divided chalk and 30 cwt. per acre burnt lime; but at Rothamsted neither caused any appreciable reduction in drawbar pull, though another property was affected, as shown later.

Among the attempts to simplify cultivation, the rotary cultivator is one of the more promising: it achieves in one operation what the usual implements do in two or three, and thus offers the possibility of reduction in cost. It proved better in 1926 than either the ordinary ridge or flat cultivation for swedes during the first part of their growth, but not afterwards; the rotary cultivated plots then "capped " or hardened considerably; ordinary cultivation methods were used for the succeeding barley in 1927, but the effect of the 1926 rotary cultivation was still visible and was entirely beneficial—a residual effect that was not expected and cannot yet be explained. The values for yields were:—

Barley, 1927.	Former rotary-Cultivation.	Horse Cultivated.	Horse Ploughed.	General Mean.	Standard Error.
Grain.					
Per cent. ...	117.0	91.0	92.0	100.0	4.89
Bushels ...	27.8	21.6	21.9	23.8	1.16
Straw.					
Per cent. ...	111.1	95.3	93.6	100.0	2.35
Bushels ...	21.7	18.6	18.3	19.5	0.46