Report for 1948

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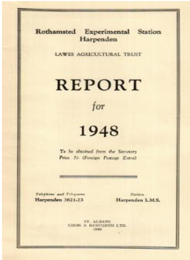
Rothamsted Experimental Station
Harpenden
LAWES AGRICULTURAL TRUST
REPORT
for
1948

Chemistry Department

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E. M. Crowther (1949) *Chemistry Department ;* Report For 1948, pp 27 - 32 **- DOI: https://doi.org/10.23637/ERADOC-1-70**

CHEMISTRY DEPARTMENT

By E. M. Crowther

Fertilizer Practice

A number of papers were published on various aspects of fertilizer practice in the United Kingdom during the last ten years and in relation to the agricultural expansion programme.

Fertilizer Placement for Row Crops

A special three-row drill for experimental work on fertilizer placement was built by the National Institute of Agricultural Engineering in 1946 and suitably modified after the first year's experience in the field. In 1948 it could be used to place fertilizer in any desired position near the seed in experiments of the normal pattern and with rapid adjustments of coulter settings and delivery rates.

In the very dry season of 1947 No. 2 National Compound Fertilizer (9% N, 7·5% P_2O_5, 4·5% K_2O) placed with or directly below sugar beet seed seriously damaged germination. Plant establishment was also reduced when the fertilizer was placed one inch to the side of the seed. For root crops side-band fertilizers containing nitrogen or potassium should therefore be kept more than one inch from the seed. There was, however, no advantage from any form of placement over broadcasting sugar beet fertilizers. For swedes placement in contact with the seed seriously depressed plant establishment but placement below the seed, either immediately below or to the side, gave higher yields than broadcasting. With peas a fertilizer containing 10% P_2O_5 and 20% K_2O injured germination when placed in contact with the seed but gave better yields when placed below the seed or in side-bands than when broadcast.

In five experiments in 1948 peas again showed considerable advantages from placing the fertilizer in side-bands below the seed. There was also a small gain from broadcasting on rough land several weeks before sowing over broadcasting immediately before sowing. In thirteen experiments on sugar beet and three on mangolds in 1948 there was no benefit in final yield from placing an NPK fertilizer in sidebands over broadcasting, though the placed fertilizer sometimes gave more vigorous early growth. Bands one inch to the side of the seed caused slow and irregular germination at most centres.

Sugar Beet Manuring

Two series of sugar beet manurial experiments were continued in 1948 in collaboration with the British Sugar Corporation. One series, at about twenty centres, annually tested N,P,K,Na and B fertilizers. Another, at a smaller number of centres, compared ammonium sulphate and sodium nitrate at two rates and in the presence and absence of sodium chloride; all plots received 0·6 cwt. P_2O_5 per acre as superphosphate and 0·3 cwt. K_2O per acre as chloride. The sodium chloride at 3·5 cwt. per acre contained as much sodium as the double dressing of sodium nitrate. The average results of 17 experiments in 1945 to 1947 are summarized

https://doi.org/10.23637/ERADOC-1-70

below (one experiment on an irregular site was omitted because very acid raw subsoil was brought up by deep ploughing shortly before sowing the beet).

Mean yields of Sugar in cwt. per acre

	No sodium chloride	With sodium chloride	Difference
No nitrogen ...	36·4	39·1	2·7
Ammonium sulphate			
0·4 cwt. N per acre	42·1	45·2	3·1
0·8 cwt. N per acre	43·4	47·5	4·1
Sodium nitrate			
0·4 cwt. N per acre	45·9	46·9	1·0
0·8 cwt. N per acre	48·9	48·3	–0·6

Sodium nitrate was much better than ammonium sulphate where no sodium chloride was given; ammonium sulphate and sodium chloride gave results approaching those from sodium nitrate alone. Sodium nitrate should be regarded as supplying two plant nutrients for sugar beet. Where it is used at fairly heavy rates there is no need to provide additional sodium chloride.

As would be expected the superiority of sodium nitrate over ammonium sulphate showed more markedly on the lighter soils which are commonly deficient in sodium and potassium.

Manuring of Peas

In collaboration with the staff of the Home Grown Threshed Peas Joint Committee and the National Agricultural Advisory Services field experiments have been carried out on a uniform plan each season since 1946. Ammonium sulphate, superphosphate and potassium chloride, each at three rates (0, 1, 2), were tested in all 27 combinations. The average results of 18 experiments in three seasons 1946 to 1948 are given below for the principal treatments.

Mean yield of threshed Peas in cwt. per acre

Fertilizer dressings in cwt. plant-food per acre

No N	16·2	No P_2O_5	16·0	No K_2O	15·6
0·2 N	16·1	0·5 P_2O_5	16·2	0·6 K_2O	16·3
0·4 N	16·3	1·0 P_2O_5	16·4	1·2 K_2O	16·6

Nitrogen had no effect. There was a large response to phosphate in one experiment but significant depressions in three others; the average benefit was very small. The double dressing of potassium fertilizer increased the yield in 14 out of 17 trials and the average gain was highly profitable. In the six centres classed as "very low" in readily soluble potassium by a rapid method of soil analysis the average response to the higher dressing was 2·4 cwt. threshed peas per acre, as compared with only 0·3 cwt. per acre in the eleven centres with more readily soluble potassium. The main manurial requirement of peas is potassium fertilizer, especially on soils deficient in available potassium. Phosphate fertilizers are needed only in a few acutely deficient soils, but a potassic superphosphate high in potash could supply potassium in a drillable form and also

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cover any risk of phosphate deficiency. Suitable mixtures are not at present offered by manufacturers; their introduction, especially in a granular form, is urgently needed for peas and for winter cereals to be combine-drilled on soils deficient in readily soluble potassium.

Bulky Organic Manures

The Agricultural Research Council Conference on Sewage Sludge and Composts has published a memorandum (Ministry of Agriculture Technical Communication No. 7) which summarizes the results of a series of over a hundred field experiments carried out by the Chemistry Department in different parts of England in recent years. The report also includes average analyses of a large number of samples of different kinds of sewage sludge.

Sewage sludge has a moderate manurial value as a source of slowly available nitrogen and phosphate with very little potash. In general the crop-producing power of sludges taken from drying beds is much less than that of equal weight of farmyard manure. The physical effects of sewage sludge on the soil are less pronounced and of a different kind from those of farmyard manure because sewage sludge lacks the coarse fibrous ingredients derived from straw and other plant residues.

Digestion improves the physical condition of sludge and the availability of its nitrogen. Certain sludges from sewages of industrial origin contain iron and other heavy metals which may render the phosphate unavailable and may even be toxic to crops.

Composts prepared with one-and-a-half parts of sludge dry matter to one part of straw proved better than sewage sludge alone but were somewhat inferior to equal quantities of farmyard manure.

Field trials at Rothamsted and elsewhere have shown that composts from straw and inorganic nitrogen have only low manurial value. Recent laboratory investigations have shown that the total amount of nitrogen immobilized by straw is much the same whether the straw and inorganic nitrogen are added directly to the soil or previously subjected to composting. Where inorganic nitrogen is added at the rate of one part per hundred of straw little, if any, of the nitrogen immobilized is subsequently liberated in the soil as ammonia or nitrate, at least in experiments with composting for two months at 30°C. and subsequent decomposition in soil for three months at 23°C. (About one-half of the organic matter of the straw was lost in the composting process.) These laboratory experiments suggest that previous rotting of straw has little effect on the amount of nitrogen which ultimately becomes available in the soil from a given amount of straw and nitrogen fertilizer. They also emphasize the low availability to plants of the nitrogen locked up during the rotting of straw. Earlier field and pot experiments had shown that amounts of inorganic nitrogen, readily nitrifiable nitrogen or the nitrogen per cent. of organic matter often gave reasonable guides to the immediate availability of the nitrogen in a wide variety of rotted manures and composts.

Analysis on a number of experimental composts prepared under practical conditions revealed a possible source of error in attempts to draw up nutrient balance sheets. Repeated turning of the heaps had led to considerable admixture of nutrient-rich soil from the floor of the compost-shed.

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A number of experiments were carried out in forest nurseries to test how far the manurial effects of composts depended on factors other than their contents of readily available nutrients.

Nutrition Problems in Forest Nurseries

Work in collaboration with the Research Branch of the Forestry Commission was continued on conifer seedlings in several nurseries in 1948.

A sharp distinction must be drawn between problems encountered in nurseries on very acid soils cleared from heath or forest and those on less acid or neutral soils in many of the "established" nurseries on what was previously agricultural land. On the very acid soils good first-year seedlings and second-year transplants can be grown provided nitrogen, phosphorus and potassium are supplied either in fertilizers or composts. Good results have been obtained with inorganic fertilizers alone, though the best times and methods of applying inorganic nitrogen to transplants have still to be found. In one experiment on very acid light soil at Wareham, Dorset, transplants top-dressed with ammonium sulphate were scorched during spells of hot weather; those with other soluble nitrogen fertilizers grew well.

On neutral or moderately acid soils in "established" nurseries Sitka spruce seedlings often grow very poorly indeed, even with composts or fertilizers. Although the precise cause of the failure has not yet been determined, marked improvements have been obtained by using steam, formalin and several methods of acidifying the soil. Ammonium sulphate at the rate of one ton per acre, applied during the winter, proved to be a convenient and effective method of acidifying the soils.

At three nurseries pH range experiments were laid out in 1948, the adjustments of soil reactions being made by graded dressings of aluminium sulphate and calcium carbonate. In preliminary first-year tests several species of tree seedlings showed pronounced pH optima. When the disturbing effects of surplus salts wear off, it may become possible to determine the pH optima more precisely and to study a number of nutritional factors related to soil reaction.

First-year seedlings and second-year transplants raised with fertilizers or composts grew well in planting experiments in several forests. The first-year seedlings gave relatively large increases in height and diameter from fertilizers applied near the time of planting. It is proposed to follow the effect of manurial treatments in the nursery and the forest on the subsequent growth of the trees over many years.

Some of the characteristic features of conifer seedlings in various nurseries were shown in Sitka spruce grown on soil samples in small scale pot experiments at Rothamsted.

Soil Organic Matter

Investigations on the extraction and fractionation of soil organic matter have often been limited by the difficulties of determining organic carbon in soil extracts. It has recently been found that the Van Slyke-Neil manometric apparatus can be used for determining both organic and inorganic carbon in soils and organic carbon in soil extracts. The organic carbon is determined by the

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method of Van Slyke and Fulch and inorganic carbon by a modification of the same method. Both methods are as accurate as established procedures and can deal with micro-quantities of material. They are rapid and simple and seem well suited for the routine analysis of soils and soil extracts.

By using these new methods it was possible to extend earlier work on the extraction of soil organic matter by alkali, sodium pyrophosphate or other salts forming insoluble calcium compounds or soluble complexes with heavy metals. The ratio of carbon to nitrogen in the extract was constant for any given extractant but sodium hydroxide gave lower carbon-nitrogen ratios in the extracts than the salts. The difference was particularly great with fen soils for which the carbon-nitrogen ratio with sodium hydroxide was about half of that with the salts.

The fact that alkaline extracts of soils are appreciably oxidized in air is objectionable for some purposes. It has, however, been found that the amount of organic matter extracted from soil by alkali does not depend on such oxidation, the same quantities being extracted in nitrogen and in air.

Earlier work on the extraction of soil organic matter and on the nature of the organic nitrogen of soils has been continued and papers prepared for publication.

Soil Manganese

Earlier work in collaboration with the Biochemistry Department on the various forms of manganese in soils was written up for publication. In continuing the investigation it was found that the proportion of the total manganese extracted by ammonium acetate containing 0·2 per cent. hydroquinone decreased rapidly with increasing soil carbon over a range of soils. Although hydroquinone and sodium hydrosulphite in ammonium acetate extract similar amounts of manganese from mineral soils, they behave quite differently with organic soils. The uptake by organic soils of manganese added in ammonium acetate is not much affected by the presence of hydroquinone but is greatly diminished by the presence of hydrosulphite. Ammonium acetate containing hydrosulphite extracts relatively large amounts of manganese and iron from organic soils. Low values for readily reducible manganese as determined by hydroquinone do not necessarily imply that the soils have low contents of higher oxides of manganese. Manganese ions formed by the hydroquinone may be taken up again by the soil organic matter.

The reducing powers of neutral pyrophosphate extracts of organic soils were estimated from the amounts of manganese dissolved after adding manganese dioxide. The values obtained were little altered by storing or aerating the extracts in more alkaline conditions, but were very sensitive to the amounts of pyrophosphate used to dilute the extracts before adding the manganese dioxide. They were also altered by adding manganese or copper salts. The equilibria in systems containing manganese in complexes with either inorganic or organic materials need elucidation before suitable extractants can be employed to determine the forms of the more active manganese in organic soils.

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Fluorine in Soils

The analytical determination of small amounts of fluorine in soil has been improved, and an account prepared for publication. The method has been used to follow the fate of fluorine added in superphosphate in long-continued manurial experiments at Rothamsted and Saxmundham. It appears that a considerable proportion of this fluorine is lost from the soil by leaching. The fluorine contents of the soils studied, including those without fertilizers containing fluorine, are frequently greater than the amounts added in superphosphate in annual dressings over long periods. The native soil fluorine is, in fact, more than would be required to convert all the soil phosphate to fluorapatite, though there is some evidence that neither the fluorine nor the phosphorus is present in the soil mainly as fluorapatite.

https://doi.org/10.23637/ERADOC-1-70