ROTHAMSTED RESEARCH

Rothamsted Report for 1938

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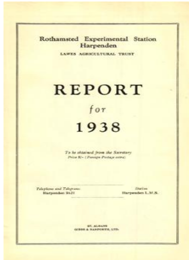

Organic Manures

Rothamsted Research

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latter value was based on only one centre in 1938. The marked effect of muriate of potash appeared in this season in three soil groups, coarse sands, fens, and clay loams, although the good results in the last group were largely due to one particularly responsive centre on a gravelly clay. The weights of tops are given in Table XVIII.

TABLE XVIII

Tops, tons per acre

Year	No. of experiments	Mean Yield	Increase for sulphate of ammonia 2 cwt.	4 cwt.
1934-37	73	9.2	+1.4	+3.0
1938	28	9.6	+1.5	+2.8

Although the yield of roots was low in 1938 the average production of tops was normal. Nitrogen had the biggest effect on tops, the yields and increases being close to the four year average : the increase produced by the double dressing was as usual almost twice that produced by the single dressing.

The sugar content of the roots was little affected by phosphate, somewhat lowered by nitrogen and slightly increased by potash, as in previous years (Table XIX).

TABLE XIX

Sugar in roots, per cent.

Year	Mean	Increase (+) or decrease (—) for: Sulphate of ammonia 2 cwt.	4 cwt.	Muriate of potash 1½ cwt.	2½ cwt.
1934-37 ..	17.4	−0.15	−0.38	+0.15	+0.22
1938	16.2	−0.1	−0.4	+0.2	+0.3

The sugar percentage in 1938 was exceptionally low, no less than 1.2 per cent. below the average of the past four years.

The poor seed bed conditions were reflected in a plant number somewhat lower than usual, on the clay loams the population was only 18.8 thousands. Fertilizers had but little effect except that potash significantly increased plant number at four of the thirty-two centres.

TABLE XX

Plants. Thousands per acre

Year	Mean	Increase (+) or decrease (—) due to:— Sulphate of Ammonia 2 cwt.	4 cwt.	Superphosphate 3 cwt.	6 cwt.	Muriate of Potash 1½ cwt.	2½ cwt.
1934-37 ..	27.8	+0.28	+0.25	+0.28	+0.25	+0.22	+0.32
1938 ..	26.1	0.0	−0.2	+0.2	+0.1	+0.2	+0.4

ORGANIC MANURES

The importance of maintaining the supply of organic matter in the soil is well recognised, but nothing is gained by the exaggerated claims sometimes put forward on the subject.

The standard organic manure, and the one which would suffice for all needs if it were available in sufficient quantity, is farmyard manure. Unfortunately the shrinking acreage of straw crops, and the reduction in number of yard-fed cattle have reduced the amounts of farmyard manure available and substitutes have to be found.

A very tempting source of organic manure is furnished by some of the waste materials of the towns, which at present are not fully utilised or even are only a source of embarrassment. Chief of these is town refuse which is available in enormous quantities and which along with much useless material contains substances of undoubted fertilizer value. In its crude form it is not readily taken by farmers and large amounts have annually to be dumped either in the sea or in the country where a complaisant land-owner or council will give the necessary permission.

Town Refuse.—The older Rothamsted experiments on town refuse indicated that the sorted and pulverised materials from Hampstead and from Walworth had fertilizing value, and they were at least as effective as dung in the one experiment in which the comparison was made.

1923 *Mangolds, tons per acre*		*1924* *Oats, bushels per acre*	
No manure	9.6	No refuse	31.1
15 tons dung	13.2	5 tons	35.4
15 tons Hampstead refuse	14.0	10 tons	36.8
15 tons Walworth refuse	13.9		

No great certainty attached to these results, since standard errors could not be calculated ; all the same the 1938 results suggest that they were probably not far wrong.

In 1938 a prepared town refuse was compared with (1) sulphate of ammonia and (2) dung or rape dust, each given in single and double dressing, the nitrogen content being taken as the basis for comparison. The sulphate of ammonia dressing provided only one half of the nitrogen of the corresponding organic manure. At Rothamsted and Woburn dung was the organic manure chosen ; at the outside centres it was rape dust. The town refuse varied somewhat in composition and was applied on the basis of its analysis ; its mean composition as used was N=0.82 per cent ; moisture=30.3 per cent.

The rates of application were :—

Single dressing of Town Refuse (about 5 tons per acre), Rape Cake, Dung 0.8 cwt. N. per acre.

Single dressing of Sulphate of Ammonia 0.4 cwt. N. per acre.

The double dressings were at twice the above rates. Town refuse significantly increased the yield of kale at Rothamsted, sugar per acre at Woburn, and of potatoes at Tunstall. It increased the number of " bolters " in the sugar beet at Woburn, and the percentage of diseased potatoes at Tunstall. It gave higher yields than farmyard manure providing equal nitrogen in three out of four comparisons at Rothamsted and at Woburn, and in one of these comparisons, the double dose of refuse against the double dose of dung at Woburn, the difference was statistically significant. Table XXI gives the yields and Table XXII shows whether the refuse did better or worse than sulphate of ammonia providing one quarter, one half, or the whole of the nitrogen.

TABLE XXI

Comparison of treated town refuse with other nitrogenous manures

Increase over no nitrogen

	Mean Yield	Single Dressing: Sulph. amm.	Single Dressing: Town refuse	Single Dressing: Dung	Single Dressing: Rape dust	Double Dressing: Sulph. amm.	Double Dressing: Town refuse	Double Dressing: Dung	Double Dressing: Rape dust	S.E.
N. cwt. per acre		0.4	0.8	0.8	0.8	0.8	1.6	1.6	1.6	
Rothamsted: Kale tons per acre ..	10.39	+1.21	+1.49	+0.97		+2.81	+2.80	+1.39		±0.465
Woburn: Sugar beet Total sugar: cwt. per acre	34.5	+6.3	+4.8	+5.8		+7.2	+7.5	+4.4		±1.71
Tops: tons per acre	7.85	+2.30	+1.02	+1.36		+4.76	+3.20	+1.23		±0.398
Plant No. thous. per acre	35.0	−1.2	−1.6	−0.4		−1.8	−2.4	−1.2		
Bolters percentage ..	3.95	+0.02	+2.62	−0.51		+2.42	+3.26	+1.52		±0.984
Rochester: Mangolds Roots: tons per acre	24.30	+0.95	+0.78		+4.92	+7.33	+2.13		+5.25	±1.63
Plant No.: thous. per acre	24.6	+0.6	+0.7		+2.5	−0.3	+0.5		+2.9	±0.826
Siddlesham: Potatoes Total produce: tons per acre	10.01	+0.89	−0.44		+1.98	+2.18	+1.61		+1.02	±0.960
Percentage ware ..	90.8	−0.3	−0.6		+1.5	+0.7	+1.1		−2.1	±1.63
Tunstall: Potatoes Total produce: tons per acre	11.39	+2.08	+1.09		+2.66	+3.18	+1.08		+4.44	±0.433
Percentage ware ..	88.6	+1.3	+0.4		+2.9	+3.2	+1.5		+5.8	±0.933
Percentage diseased ware	7.8	−0.3	+0.3		+4.7	+4.7	+2.8		+5.8	±1.201

TABLE XXII

Comparison of treated town refuse with sulphate of ammonia
Town refuse superior (+) or inferior (—)

Nitrogen in refuse	Crop	When sulphate of ammonia provides nitrogen: Equal to the N. of refuse	½ the N. of refuse	¼ the N. of refuse
0.8 cwt. per acre	Kale	—*	+	
	Beet	—	—	
	Potatoes (1)	—*	—	
	Potatoes (2)	—*	—	
	Mangolds	—*	—	
1.6 cwt. per acre	Kale		—	+*
	Beet		+	+
	Potatoes (1)		—	+
	Potatoes (2)		—*	—
	Mangolds		—*	+

(1) Siddlesham. (2) Tunstall.

* Difference between refuse and sulphate of ammonia statistically significant.

Treated town refuse did almost as well as sulphate of ammonia providing half as much nitrogen, and was distinctly superior to sulphate of ammonia providing one quarter of the nitrogen, though it was much inferior to sulphate of ammonia supplying the same amount of nitrogen.

These estimates are derived only from the yields in the year of application, and it is possible that the refuse might build up residual effects if used in heavy dressings. Further experiments should be instituted to test residual and cumulative effects. The similarity in effectiveness to dung emphasises the desirability of adequately investigating the possibility of utilising town refuse in agriculture.

There is also some hope that another waste product, now a source of embarrassment to the towns, may become of value to farmers. Much of the sewage sludge at present made is of so little value that farmers wisely do not buy it. There is, however, at least one type of sludge that would have considerable fertilizer value if it could be dried and powdered for distribution. Hitherto no suitable method has been available, and instead the sludge has been destroyed by digestion. We understand that there is now the possibility that this difficult drying problem may be solved.

The experiments with dried poultry manure were also continued ; in these the nitrogen had about two-thirds the value of that of nitrogen in sulphate of ammonia.

The fertilizer value of all these organic waste substances is determined by the nature of their carbon and nitrogen compounds and by the ratio of the carbon to the nitrogen. The work of the Fermentation Department consists in finding out exactly what part these various factors play so that the probable fertilizer value of any particular waste material may be forecasted from analysis and, more important, improvements in fertilizer value may be suggested.

USE OF STRAW AS MANURE

On July 15th, 1938, an informal conference of farmers and technical experts was held at Rothamsted on the use of Straw as a Soil Improver. Most speakers had observed that the ploughing in of raw straw had a depressing effect on the crop immediately following. The most favourable result was that the straw used in this manner did no harm. The bad effect was probably mitigated if the straw was ploughed in when the land was still warm, i.e. immediately after harvest, so that some decomposition could take place before winter. If a bare fallow followed straw ploughed in, most of the straw disappeared during the course of the fallowing operations.

In practice some form of nitrogen was usually added to straw. This was done either by direct additions of calcium cyanamide or sulphate of ammonia to the straw before turning under, or alternatively by giving a nitrogenous dressing to the following cereal crop. The rate of application was approximately 1 cwt. of nitrogenous manure per ton of straw.

No one advocated the burning of straw on the land ; ploughing under with the addition of cyanamide was said to have given noticeably better results.

It is possible to assist the decomposition of straw by growing red clover under the corn crop and turning it in with the cereal straw.

Composting the straw in heaps with the addition of cyanamide or dung had been tried, but succeeded only when a water supply was available.

Another use of straw was for the improvement of glass house soils that had lost their texture through surface watering, but were richly supplied with dung and artificials. Walls of straw let vertically into the soil improved aeration, drainage, and root action.

One complication of special importance to mechanical cereal growers is the incidence of Take-all Disease (*Ophiobolus graminis*). The fungus survives in the stubble, and control methods centre round the hastening of decomposition of the fungus after the stubble has been ploughed under. Carbohydrate additions facilitate the decomposition of the fungus, but additions of nitrogenous fertilizers tend to protect it. Furthermore although straw provides carbohydrate it also tends to aerate the soil, and aeration, while facilitating the decomposition of the fungus in the autumn and winter, assists in spreading it when the following crop has been sown. When Take-all is prevalent the stubble should be ploughed at the earliest possible opportunity together with additional straw if available. No nitrogen should be given and ploughing should be shallow to facilitate aeration which at this stage is beneficial. In the following spring the seed bed should be heavily rolled to restrict aeration and nitrogen may then be applied to the crop that follows.

GREEN MANURE

Another possible source of organic manure is to grow and plough in a green crop.

The effects of mustard, tares and lupins as green manures preceding kale were studied in a number of experiments at Woburn. In 1934, lupins were grown on all plots, the treatments compared being : removing the whole plant ; removing the tops and burying the roots ; burying the whole plant ; and burying the whole plant and extra tops. The lupins were followed by two years of kale.

Woburn : Kale (tons per acre)

	Yield with whole plants removed	Increase in yield with			S.E. of increase
		Roots buried	Whole plants buried	Whole plants and extra tops buried	
1934	3.54	−0.38	+3.15	+4.93	±0.287
1935	4.01	−0.07	+1.06	+2.16	±0.489
Nitrogen buried in 1934 (lb. per acre) ..	0	11	133	256	

The burial of the roots produced no beneficial effect on the yields of kale. There were substantial responses in 1934 where the whole plants were buried, the response per 10 lb. of nitrogen buried being about 0.3 tons with the single dressing of tops and somewhat less with the double dressing. The residual effects in 1935 were similar, except that the double dressing was as effective per unit of nitrogen as the single dressing.

The experiment was extended in 1935, the green manures being mustard, tares and lupins ; there were also some plots which lay fallow preceding kale. As the 1935 kale crop was eaten by pigeons the green manures were grown again in 1936 ; the yield of kale then was :—

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TABLE XXIII

Woburn : Kale (tons per acre), 1936

Crop	Yield after fallow	Increase in yield after green manure: Whole plant removed	Roots buried	Whole plant buried	Whole plant and extra tops buried	S.E. of increase
Mustard	6.62	−1.12	−1.68	−0.70	+0.79	±0.538
Lupins		+0.13	−0.18	+2.40	+3.61	
Tares		+0.53	+0.54	+3.66	+6.20	
		Nitrogen buried (lb. per acre)				
Mustard		0	2	37	66	
Lupins		0	6	41	77	
Tares		0	6	53	106	

With whole plants or tops removed, the growing of a green manure crop of mustard reduced the yield of kale significantly by over a ton per acre, while lupins and tares had little effect. Burial of the tops increased the yields significantly with lupins and tares. The increases to the double dressings per 10 lb. nitrogen buried were 0.39 tons for mustard, 0.53 tons for lupins and 0.57 tons for tares, the last two being significantly greater than the first. Even with the addition of extra tops, however, mustard proved little if at all better than fallow, though lupins and tares were markedly better than fallow.

The experiment was continued on the same site in 1937, but the kale was badly eaten by birds. Notwithstanding this, the buried tops of lupins gave substantial increases over fallow. In 1938, on a different site, the tares crop failed. The results for lupins and mustard were similar to those described above.

Woburn : Kale (tons per acre), 1938

Crop	Yield after fallow	Increase in yield after green manure: Whole plant removed	Roots buried	Whole plant buried	Whole plant and extra tops buried
Mustard	9.04	−1.86	−2.42	−1.54	−0.48
Lupins		−0.36	+0.60	+1.13	— *

*Plots severely affected by a snowstorm.

A comparison of the manurial values of buried tares and mustard is made each year in the Woburn green manuring experiment on Stackyard, started in 1936. The 1937 and 1938 yields of kale were exceedingly poor and showed no significant effects of the green manures. The 1936 results were :—

Woburn (Stackyard) Kale : tons per acre, 1936
Green Manure

None	Mustard	Tares
12.52	12.62	13.90

Mustard was again ineffective, but tares gave a significant increase of 1.4 tons per acre. The kale crop was followed by barley, which gave a significant residual response to tares of 2.2 cwt. per acre.

THE SOIL

One of the oldest problems in agricultural chemistry is to attempt a forecast of the effects of fertilizers on crops, this being done on the basis of chemical analysis. It was at one time thought that the problem was quite simple, and that a chemical analysis of the soil would readily show its response to fertilizers. Actual trial has proved that this view is wrong ; no method of analysis yet tested accurately forecasts the effects of fertilizers : the soil is too complex to allow the problem to be solved in an easy way. Fortunately the liming problem is less difficult. Various methods are in use for estimating chemically how much lime is needed, and one of the most popular was devised at Rothamsted, but results are by no means clear cut and much further investigation is needed before they can be regarded as satisfactory.

The whole subject is under investigation in the Chemical Department.

The field experiments furnish numerous samples of soils which vary in their responses to potassic and phosphatic fertilizers, and these soils are examined chemically to find out how their composition is related to the fertilizer results.

Certain rapid methods for approximate analysis of soil have been examined and their possibilities noted, and a rapid pot culture method of soil analysis is also being studied in the hope of evolving something that will combine the advantages of the Neubauer and the Mitscherlich methods with certain other advantages. Now that the new chemical wing is built it is hoped to set up a spectrograph which would, of course, greatly facilitate the whole of this work and make possible rapid surveys that might prove of the utmost value.

Phosphorus compounds in soil.—The phosphorus compounds of the soil have also been studied in the Chemical Department. This subject is of particular importance at the present time because our field experiments indicate that, of the phosphate added as fertilizer, only about 25 per cent. is recovered in the crop in ordinary circumstances : the rest remains in the soil, but it is, so far as we can discover, in a form in which plants cannot easily take it up. On our present evidence the soil is a poor store house for fertilizers.

In the Rothamsted soils much of the phosphorus is present as iron phosphate even in neutral soils and those heavily dunged. Fenland soils are remarkable in their phosphate relationships and these are being studied in detail. A large part of their phosphate seems to be there in combination with iron and aluminium. The organic phosphorus compounds in soil appear to be relatively inert.

Manganese deficiencies in soils.—Three main types of soil are liable to manganese deficiency as shown by characteristic crop troubles.

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