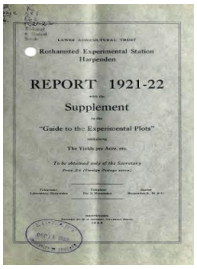
Report 1921-22 With the Supplement to the Guide to the Experimental Plots Containing the Yields per Acre Etc.



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Fertiliser Investigations

Rothamsted Research

Rothamsted Research (1923) *Fertiliser Investigations ;* Report 1921-22 With The Supplement To The Guide To The Experimental Plots Containing The Yields Per Acre Etc., pp 16 - 20 **- DOI: https://doi.org/10.23637/ERADOC-1-110**

It is hoped as a result of this work that they may become calculable and therefore insurable, just as is the risk of death. We want to be able to say to farmers, "If your soil and weather conditions are of a certain kind, the chances are so many to one that a specified fertiliser mixture will give an increased crop of so many tons or bushels per acre." The difficulties of the work are very great, but they are being steadily overcome.

Meanwhile, however, the farmer urgently needs precise information about fertilisers, and it becomes necessary to adopt a third method which, though not as accurate as the single factor or the statistical methods already described, nevertheless gives some of the information desired. This consists in repeating a field experiment as exactly as possible at a number of centres carefully chosen to represent important soil and climatic conditions. For example, a Wold farmer sees our experiments, and asks if he could get the same results on his own farm. At present we cannot say, because we do not know the effect of differences in soil type and climatic conditions; but this can be ascertained by repeating one of our typical experiments on a typical Wold farm and then comparing the results with our own. This is being done on some 20 carefully selected farms in different parts of the country.

FERTILISER INVESTIGATIONS.

In addition to field and pot tests these necessitate a considerable amount of chemical work, which is carried out in the Chemical Department under Mr. Page.

THE NEW NITROGENOUS MANURES.—UREA.

Our experiments indicate that this substance has a value between that of nitrate of soda and sulphate of ammonia. In addition it has two attractive features—it is highly concentrated and it exerts no harmful influence on the soil (p. 93, p. 101).

AMMONIUM CHLORIDE.

Experiments made in the past two seasons at Rothamsted and the outside centres show that the yields from ammonium chloride, when those from ammonium sulphate containing an equal amount of nitrogen are put at 100, are:—

	1921		1922	
	Rothamsted	Average of all outside centres	Rothamsted	Average of all outside centres
Cereals . .	104	117 91 *	103	99
Potatoes .	112	112 85 *	110†	98
Mangolds .	95	95		98

* Two groups of results in each case. † With dung. The value without dung was 99.

https://doi.org/10.23637/ERADOC-1-110

Examined in detail the results appear to fall into two groups. In both years the larger number of the values fall between 90 and 100, but a second group of values falls distinctly above 100. The indications are that ammonium chloride would generally be about 5 to 10% less effective than ammonium sulphate containing the same amount of nitrogen, but in some circumstances, which we cannot yet define, it may be somewhat more effective.

THE NEW BASIC SLAGS AND MINERAL PHOSPHATES.

The object of these experiments is to compare the respective fertiliser values of the old Bessemer slags, the more modern open-hearth slags, some of which are of high and some of low solubility in the official citric acid solution, and the mineral phosphates.

The general result up to the present is that the high soluble slags are quicker in action and more effective than those of low solubility, but the low soluble slags are more effective than their solubility indicates. These effects are seen in their simplest form in pot experiments where all conditions of growth are carefully controlled. In the field, however, the effects may be masked by various factors, such as water supply, temperature, etc.

A comparison made in 1922 gave the following results :—

	Pot Experiments	Field Experiments			
		Turnips		Barley	
	All crops 1922	Tons per acre	Per cent.	Bushels per acre	Per cent.
Open hearth slags					
90% soluble	114	24.3	108	27	80
30% soluble	106	23.3	104	29	85
Mineral phosphates: Gafsa	109	23.2	103	27.6	81
Nauru	101	22.3	99	—	—
Control	100	22.5	100	34	100

The turnip results in the field fall into line with those of the pot experiments, although the differences are probably within the experimental error, but the barley results fall out altogether. Inspection of the growing crops, however, showed that up to the end of June the appearance of the barley plants accorded with the pot experiments, but all this was lost before harvest.

In the grass experiments two distinct cases arise :—

1. If the herbage is poor, and the growth poor, the slags may increase the yield of hay ;
2. If the grass is better and gives larger crops of hay, the slags may not increase the yield, though they may increase the amount of clover and thus improve the quality.

This is seen on inspection or on botanical analysis, or, better still, by a grazing test. The following results were obtained in the last two seasons :—

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I. POOR GRASS LAND: 11 CWT. HAY ONLY PER ACRE.

	1922 *Cwt. per Acre.*
Control	10.9
Open hearth slag, 90% soluble	16.5
,, ,, ,, 30% soluble	18.7
Gafsa phosphate	18.8

II. BETTER GRASS LAND: 1-1½ TONS HAY PER ACRE.*

	Yield of Hay cwt. per acre		Live weight increase in Sheep, lb. per acre	
	1921	1922	1921	1922
Bessemer slag	24.3	17.3	59	143
Open hearth, high sol.	23.9	16.6	43.3	112
Control			59	116
Open hearth, low sol.	26.5	21.1	67.3	123
Gafsa	25.4	22.5	88	107
Control	26.4	20.1	90	115

* The slags used on the grazing land were not identical with those used on the hay land, but they were of similar types.

Inspection shows that the amount of clover is highest on Bessemer slag plots. There is less on the high soluble open hearth slag, still less on the low soluble slag and Gafsa plots, and least of all on the unmanured. The effects are beginning to show in the live weight increases.

THE POTASSIC FERTILISERS.

A beginning has been made with a test of the new potassic fertilisers, especially on the potato crop.

In 1921 the crop yields were very poor, owing to the drought; the advantage of potash showed, however, in keeping the plants alive some time after those on the "no potash" plots had died. In 1922 the yields were much better; the chloride gave practically the same yield as the sulphate. When, however, salt was present in addition to the chloride there was a drop in yield, especially where no dung was supplied. Taking the yields with potassium sulphate as the standard, the results were, for the potato crop:—

	Rothamsted		Other Centres	
	Dung	No Dung	Dung	No Dung
Potassium sulphate	100	100	100	100
Potassium chloride alone	98	106	99	104
Pot/chlor. plus salt: pure	100	96	—	—
Pot/manure salts (20% K_2O)	—	—	94	—
Sylvinite	—	—	93	82
Kainit	—	—	92	88

The experiments are being continued.

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MAGNESIUM SALTS AS FERTILISERS.

Field experiments made in 1922 with magnesium sulphate indicate that while apparently ineffective in ordinary conditions (apart from the potash-starved plots at Rothamsted), it has, in certain farming conditions, a considerable fertilising value :—

EFFECT OF MAGNESIUM SULPHATE ON THE YIELD OF POTATOES RECEIVING POTASSIUM SULPHATE.

	Rothamsted	Armstrong College Centres			
		Blaydon		Walbottle	
		Dung	No Dung	Dung	No Dung
Complete manure and—					
No magnesium sulphate .	100	100	100	100	100
Magnesium sulphate (a) .	102	114	108	129	118
(b) .	97	—	—	—	—

(a) Sulphate of potash used in complete manure.
(b) Muriate of potash used in complete manure.

We cannot at present explain this result, but the experiment is being repeated.

ARTIFICIAL FARMYARD MANURE.

This material is now being made at a number of centres and on a large scale. Some 2,000 tons of straw, in lots varying up to 80 tons in quantity, have now been treated under the direction of Messrs. E. H. Richards and R. L. Amoore on different farms in the country—mostly in the Eastern Counties. The material has been considerably improved by the introduction of phosphates, but there remain difficulties connected with the wetting of the straw. The product is not yet up to a good sample of true farmyard manure, but it is being steadily improved, and the 1922 results are distinctly promising. The following is a large scale test made by the Chelmsford Institute with potatoes on an Essex farm :—

	No Manure			Artificials only			Artificials plus Cow Manure			Artificials plus Straw Manure		
	Tons	Cwts.	Qrs.	Tons	Cwts.	Qrs.	Tons	Cwts.	Qrs.	Tons	Cwts.	Qrs.
Ware .	3	11	0	7	14	0	10	13	0	9	5	3
Seed .		18	0		17	2		15	1		18	0
Chats .		6	1		4	3		8	3		7	1
Total .	4	15	1	8	16	1	11	17	0	10	11	0

It is also shown that this artificial farmyard manure does not lose nitrogen on exposure to weather, while heaps of natural farmyard manure under similar conditions lost as much as 10% to 30%.

The development of practical applications of this kind involves an immense amount of detailed work and a business organisation differing entirely from that of an experimental station. Artificial

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farmyard manure has therefore been handed over to a non-profit-making syndicate — the Agricultural Development Company (Pyrford) Ltd., the Chairman of which is Viscount Elveden, M.P., and under these auspices the work is progressing favourably. The results indicate that this is the best method of bringing a new discovery into practical use.

The nature of the gas given off in the fermentation of straw and Nile Sudd (papyrus stems) was studied in the Chemical Department at the request of the Air Ministry. So long as air was present, the gas obtained was carbon dioxide, but when the air supply was cut off methane and hydrogen were obtained in addition. The relative proportions of these two gases depended on the reaction of the medium; if it was kept neutral by means of calcium carbonate there was a considerable quantity of methane along with a certain amount of higher hydrocarbons; if it became acid the total evolution of gas was much diminished and the methane largely disappeared, hydrogen being the chief constituent.

The maximum production of methane was obtained at a temperature of 35°-40° C. and in presence of some nitrogen compound to serve as nutrient to the organisms. In these conditions a yield of 4,400 cubic ft. of gas was obtained per ton of wheat straw, and 9,400 cubic ft. per ton of Nile Sudd; of this gas 38% was carbon dioxide and 62% combustible gas made up of 56 parts of methane and 6 of hydrogen.

The maximum production of hydrogen was obtained when the medium was allowed to become acid, but the total yield of gas was then only 1/30th that given under neutral conditions.

EFFECTS OF MANURES ON THE COMPOSITION AND QUALITY OF CROPS.

Fertilisers affect the habit of growth and the quality of the crop, but the changes, though recognisable by the practical expert, are often so subtle that the chemist is as yet unable to characterise them or to connect them up in any definite way with the chemical composition. In the Rothamsted experiments the practical expert is asked to grade the produce, and his reports are used by the chemist in seeking to trace the chemical relationships. Malting barley and potatoes are being studied in some detail.

MALTING BARLEY.

The experiments are carried out at 13 different centres as part of the Research Scheme of the Institute of Brewing, and full details are given in their Journal. The same seed and the same manurial treatment are adopted at each centre. The yields are given on p. 104. The samples of grain are valued by a committee of expert buyers and are analysed by an experienced brewers' chemist; certain typical samples are separately malted by a maltster. The results will show how quality is affected by manurial treatment, soil and season; in addition, it is hoped from the data thus obtained to deduce chemical relationships which will enable us to express better than at present the value or quality of barley in chemical terms. The experiment began in 1922, one of

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