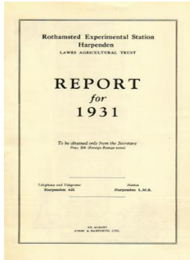
ROTHAMSTED RESEARCH

Report for 1931


Rothamsted Experimental Station
Harpenden
REPORT
for
1931

Soil Fertility and Mechanisation

Rothamsted Research

Rothamsted Research (1932) *Soil Fertility and Mechanisation ;* Report For 1931, pp 35 - 38 **- DOI: https://doi.org/10.23637/ERADOC-1-65**

It has great power of utilising added nitrogen. An experiment made at the Midland Agricultural College with marrowstem kale gave marked responses even to 4 cwt. Nitrate of Soda.

	Nitrate of Soda, Cwt.				*Standard*
	0	1	2	4	*Error.*
Kale, tons ..	15.31	18.20	19.06	22.42	0.677

HAY. *Nitrogenous manures.* The average increased production of hay this year has been 6 cwt. for 1 cwt. Sulphate of Ammonia.

SOIL FERTILITY AND MECHANISATION.

The systematic use of large scale machinery on the farm, called for convenience "mechanisation," is usually combined with a reduction in the number of live stock kept, and hence causes certain modifications in the fertility relationships of the soil. Four important groups of problems are being investigated.

(1) Can fertility be sufficiently maintained by artificial fertilisers alone or is it necessary to return the straw to the land in the form of manure? If the straw must be returned, what is the best way of doing it?

(2) Is it possible to produce, by any cultural process, the same good effects on light land as are obtained by sheep folding?

(3) Green manuring.

(4) Fallowing.

The classical experiments at Rothamsted have shown that soil fertility can be kept at a certain moderate level by the use of artificial fertilisers alone without the use of farmyard manure. In general, however, the growth of the crop has not been enough to keep down weeds, and much expense has been entailed in cleaning. A combination of artificial fertilisers with occasional fallows, however, has proved effective in maintaining yields at low expenditure in labour but with a loss of one year in four or five.

The return of the straw to the land can be effected in several ways; three are under investigation:

(1) It may be converted into farmyard manure in the usual way. In our experiments, about 25 per cent. of the nitrogen in farmyard manure is recovered by the plant as against about 50 per cent from artificial fertilisers.

(2) It may be decomposed by the method developed in these laboratories by H. B. Hutchinson and E. H. Richards and put on a commercial basis by the Adco Syndicate; the straw is treated with the necessary nitrogen compound, phosphate and limestone, to encourage the activity of micro-organisms effecting the decomposition.

(3) It may be ploughed under, and the necessary nitrogen and phosphate given in the form of artificial fertilisers. In the autumn a smaller addition is necessary than in the spring, because the soil already contains some nitrate, which if it were not used by the organisms would probably be washed away in the winter.

If this method proves feasible in practice it has the advantage of economy in labour, for the corn could simply be stripped and the straw ploughed under while the soil was still warm.

These problems are being studied in the four-course rotation experiment (p. 129).

https://doi.org/10.23637/ERADOC-1-65

Green Manuring.

This affords a simple method of manuring both heavy and light soils and it requires no live stock ; it can be practised on completely mechanised farms. Its advantage in certain conditions has long been recognised, but of late years a number of instances have been recorded where it proved ineffective. The most striking is at Woburn, where, over a series of years, green manuring with tares and with mustard has failed to increase the yield of wheat or of barley. Experiments carried out a few years ago on several other farms with the help of a grant from the Royal Agricultural Society of England also yielded negative results.

There are, however, undoubted successes, and investigations have been made and still are in progress to find the conditions under which green manuring is likely to give useful results. Two of the most important factors are the composition of the plant at the time of ploughing in and the time at which the ploughing is done. If the ratio of carbon to nitrogen in the crop is more than 20, the organisms effecting the decomposition may require more nitrogen then is supplied by the crop, in which case they draw on the soil nitrates that would otherwise either be washed out or taken by the plant. If, however, the ratio is less than 20, the organisms may not need the whole of the nitrogen, they then leave the excess in the soil in the form of nitrate, which as before, is either washed out or taken by the plant. Investigations have shown that at Woburn the tares crop failed to increase the growth of wheat because it was ploughed under in autumn, and rapidly gave rise to nitrate, which was washed out because the wheat plant, being insufficiently developed, could not assimilate it, and in the following spring the wheat suffered from nitrogen starvation. The mustard during its active growth assimilated nitrate and so saved it from loss, but some nitrate escaped assimilation and was washed out because the crop was too small or the soil was bare. Also after the mustard was ploughed in, some of it probably decomposed too slowly to supply useful quantities of nitrogen to the wheat. The value of nitrogen depends on the time when it is given ; when given late to barley it reduced the ear tillers and the number of fertile grains and increased the vegetative tillers. It seems clear that the process of green manuring needs to be clearly adapted to the soil and the crop so as to ensure liberation of nitrate only when the plant is in a position to take it up.

Fallowing.

Since the Broadbalk field was divided into five sections in 1925 to permit of rotational fallowing* it has been possible to accumulate considerable information about the effects produced.

The effect on the weed population is being studied by W. E. Brenchley and K. Warington.

The census of buried weed seeds on Broadbalk field which they began in 1925 is still being continued by the examination of samples taken yearly, in order to determine the rate at which recolonisation occurs after fallowing. The rapidity with which some of the worst seeds reassert themselves is alarmingly great, and indicates the

* See 1930 Report, p. 27, for particulars

necessity for diligent cultivation immediately the land returns under crop. After a single year under crop the soil may be re-stocked with as many weed seeds of some species (as thyme-leaved sandwort) as were present before fallowing, or even more. After three years in crop the numbers may far exceed the original stock ; black bent and chickweed are notable instances. (Table VIII).

TABLE VIII.

Broadbalk Wheat Plots.

Effect of 2 years' fallowing.

		Buried Weed Seeds Millions per acre*.			
		Before Fallowing (1925)	After 2 years Fallow. (1927)	After 1 year in Crop. (1928)	After 3 years in Crop.† (1930)
Alchemilla arvensis	Lady's Mantle	11.4	3.7	10.0	16.5
Alopecurus agrestis	Black Bent	11.3	0.5	4.8	36.5
Arenaria serpyllifolia	Thyme-leaved Sandwort	0.8	0.75	4.5	3.3
Myosotis arvensis	Forget-me-not	2.1	0.4	0.7	1.4
Papaver spp.	Poppy	82.6	38.0	34.9	34.4
Stellaria media	Chickweed	0.2	0.03	0.5	1.8
Veronica arvensis	Field Speedwell	6.8	1.5	7.3	22.8
,, *hederaefolia*	Ivy-leaved Speedwell	2.0	0.8	1.1	2.4
,, *buxbaumii*	Large Field Speedwell	0.2	0.2	2.0	0.3

Effect of 4 years' fallowing.

		Buried Weed Seeds, Millions per acre*.		
		Before Fallowing (1925)	After† 4 years Fallow. (1929)	After† 1 year in Crop (1930)
Alchemilla arvensis	Lady's Mantle	12.3	1.6	5.3
Alopecurus agrestis	Black Bent	11.3	0.2	3.7
Arenaria serpyllifolia	Thyme-leaved Sandwort	0.9	0.7	0.9
Myosotis arvensis	Forget-me-not	0.6	0.04	0.1
Papaver spp.	Poppy	112.0	23.3	26.9
Stellaria media	Chickweed	0.3	0.4	1.4
Veronica arvensis	Field Speedwell	6.5	0.6	1.6
,, *hederaefolia*	Ivy-leaved Speedwell	1.7	0.2	0.4
,, *buxbaumii*	Large Field Speedwell	0.3	0.3	0.3

Soil improvement due to fallowing is as advantageous to the weeds as to the crop, and those weed seeds which survive the fallow are able to produce very strong plants which form large supplies of seed to restock the soil. If the number of weeds could be kept down for a year or two after fallow, till the soil conditions became more normal, the growth might perhaps be less and the rate of seeding less prolific. Even after a bare fallow lasting for four years, the increase in the buried seeds of some species, such as black bent (*Alopecurus*

* Each figure gives the mean of 28 determinations, the aggregate area examined being 7 square feet. One million per acre corresponds with 160 per 7 square feet.

† Figures incomplete. Will be higher.

agrestis) and lady's mantle (*Alchemilla arvensis*) is very rapid, but others appear to be more easily controlled by cultivation methods.

One point of great practical importance is that fallowing operations may be worse than useless if they are not thorough. After the autumn ploughing the practice is to have the ground untouched till early spring, but during this period a few weeds, as shepherd's purse (*Capsella bursa-pastoria*), thyme-leaved sandwort and large flowered speedwell are able, in favourable seasons, to flower and seed so that there may be more seed present in the soil after fallowing than before. To make fallowing effective, cultivation needs to be frequent, and to be carried out during the winter months as well as during the normal growing season.

TABLE IX.

Ineffectiveness of fallowing, as a means of destroying certain weeds.

Arenaria serpyllifolia.	Millions per acre.
Before fallowing	0.9
After 1 year's fallow	1.0
,, 2 ,, ,,	0.7
,, 3 ,, ,,	1.0
,, 4 ,, ,,	0.7 *

ELEMENTS NEEDED BY PLANTS ONLY IN SMALL QUANTITIES

Plants are made up of some nine or ten elements in rather large amounts ; of these carbon, hydrogen and oxygen come from the air and water, and are not usually under control in this country ; nitrogen, potassium, calcium and phosphorus come from the soil and are regularly controlled by the use of artificial fertilisers ; magnesium, sulphur and iron occur in some of the fertilisers, and are therefore supplied incidentally ; in any case they are usually present in sufficient amount in the soil.

Besides these, however, there are other elements needed only in very small amounts. How many of these there may be is not yet known. The most detailed studies have been with boron, the necessity for which has been demonstrated by K. Warington in these laboratories.

Plants without boron neither grow nor flower normally—special symptoms are produced, including death of the apices and breakdown of conducting tissues. These effects appear much more rapidly in summer than in spring or autumn. The difference is not in the temperature but in the hours of daylight, since plants grown without boron in summer but allowed only 9 hours of daylight are also slow to develop the symptoms, and behave, indeed, like plants grown in spring.

There is some superficial resemblance between the effects of light and of boron. Plants supplied with boron but allowed only a short period of light every day fail to develop flowers just as if they were deprived of boron ; but they will produce flowers when they are given more light, while those without boron will not.

The amount of boron needed by plants is exceedingly small.

* Figures incomplete. Will be higher.