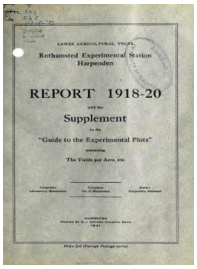
Report 1918-20 With the Supplement to the Guide to the Experimental Plots Containing the Yields per Acre Etc.



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Soil Population

Rothamsted Research

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1—By improvements in the method of sowing so as to give the seedling a good chance of establishing itself;
2—By dressings of chalk;
3—By application of phosphates, and where necessary, potash before sowing;
4—By the use of farmyard manure (p. 55).

In some of our experiments the weights of the young plants at the time of cutting the barley were:—

	Weight of young Clover plants. Cwts. per Acre	Weight of Barley. Cwts. per Acre
Control	4.8	21.2
Slag and Lime	6.7	31.7
Super and Sulphate of Potash	11.2	26.1
Farmyard Manure	10.3	28.2
Super and Farmyard Manure	15.0	26.5

We are not at present able to explain altogether this action of farmyard manure, but experiments in the bacteriological laboratory by Mr. Thornton indicate a special action of some of its constituents on the nodule organism, and seem to foreshadow interesting possibilities in the culture of the leguminous crops.

4—*Green manuring.*—The difficulty of making sufficient farmyard manure brings into prominence the need for green manuring. A field experiment has been started and the necessary laboratory work is being initiated by Mr. H. J. Page.

Although the beneficial action of a plentiful supply of organic matter in the soil is well known, precise knowledge of its mode of action is lacking. Laboratory work on humus, commenced in 1919 by Mr. V. A. Beckley (p. 37), is being extended by Messrs. H. J. Page and R. M. Winter. Refined methods for the determination of ammonia and nitrates in soils have been devised by Mr. D. J. Matthews, and are being used to study the changes occurring in the nitrogenous substances in the soil, especially after the application of green manures.

THE POPULATION OF THE SOIL. FAUNA AND FLORA.

Every farmer knows the importance of organic manure in the soil, but it is less generally realised that the effectiveness of the organic manure depends on the activity of the soil organisms, without which it would be quite useless, and in some cases harmful. Although the organisms cannot be seen by the naked eye, they are present in all fertile soils in vast numbers and in extraordinary variety. An extended survey is therefore being made on definite systematic lines with the view of learning as much as possible about the soil population. No less than 10 workers are engaged on this survey. Mr. D. W. Cutler, Miss L. M. Crump and Mr. H. Sandon study the protozoa; Mr. H. G. Thornton and Mr. P. H. H. Gray

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the bacteria; Dr. B. Muriel Bristol the algae; Dr. W. B. Brierley and Miss S. T. Jewson the fungi, Mr. H. M. Morris the insects, while till recently Dr. T. Goodey studied the nematodes and Mrs. Matthews the more general relationships. The ultimate aim of the agriculturist is to control this soil population in just the same way as the animal breeder has controlled and developed the original wild animals. But control is not possible without full knowledge of what the organisms are, what they do and how they live. It is this knowledge which the scientific workers are endeavouring to gain.

The first thing is to ascertain the numbers of each kind of organism present in the soil under different natural conditions. That is being done for bacteria and protozoa, and some striking relationships are observed. A new technique has been devised for counting protozoa and a new medium for use in bacterial estimations. As the organisms multiply much more rapidly than larger animals it is necessary to make the determinations frequently and regularly: counts of bacteria and 19 species of protozoa—4 ciliates, 6 amœbæ and 9 flagellates—are now made daily at Rothamsted, and it is intended to continue these for 365 consecutive days and then to look for correlations with temperature, soil moisture, rainfall, etc. Two interesting features are clearly brought out; the numbers of bacteria vary inversely with the numbers of active amœbæ, and one of the flagellates (*Oicomonas termo* Martin) shows a remarkable two days' periodicity, its numbers being high one day and low the next without any apparent external reason (p. 39).

Further, an examination of the drain gauge results has indicated the existence of soil organisms capable of absorbing nitrates, and thus competing with plants (p. 35). Algæ have been found which can do this, and Dr. Bristol is investigating their mode of life and their function in the soil. Bacteria can also take up nitrates. Large numbers of fungi have been found in the soil, and are being studied by Dr. Brierley and Miss Jewson.

The insect and other invertebrate fauna has been studied by Mr. H. M. Morris, who has taken samples each alternate week from the unmanured and the dunged plots on Broadbalk field. Each sample contained 729 cubic inches of soil: the whole was thoroughly sifted and the animals identified and counted. The average results were:—

TOTAL NUMBERS PER ACRE.

	No Manure.	Farmyard Manure.
Insects	2,475,000	7,727,000
Acari	215,000	532,000
Earthworms	458,000	1,010,000
Myriapods	879,000	1,781,000
Dominant Insects 1st	Collembola (693,600)	Ants (2,946,000)
2nd	Ants (690,000)	Collembola (2,391,000)
3rd	Wireworms (165,000)	Chironomid Larvæ (515,000)

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The distribution at the various depths is shown in the following table of percentages of the total in each group :—

	0-1"	1"-3"	3"-5"	5"-7"	7"-9"
INSECTS :					
Manured Plot . .	51.5	27.2	10.9	6.4	3.8
Untreated Plot . .	25.3	25.0	33.0	11.1	5.5
ACARI :					
Manured Plot . .	48.3	25.3	20.2	5.0	1.2
Untreated Plot . .	59.3	23.4	14.0	3.1	--
EARTHWORMS : . .					
Manured Plot . .	23.3	37.0	22.0	10.6	7.0
Untreated Plot . .	23.5	41.0	18.3	11.0	5.8

The vast majority of soil organisms were found at a depth not exceeding 3 inches. Wireworms are exceptional in that they attain their maximum numbers at a depth of 5 inches to 7 inches. Manuring increases the total number of soil organisms to the extent of about 200%, but exercises no very appreciable influence upon the number of wireworms present.

THE POSSIBILITY OF THE CONTROL OF THE SOIL POPULATION.

Previous investigations have shown that heating the soil or treatment with certain poisons not only rids it of pests but actually improves its productiveness, increasing the amount of bacterial activity. This has been applied in glasshouse practice in the Lea Valley. Steaming has proved effective and so have certain chemicals, but their action is complicated by the fact that some poisons such as phenol, cresol, naphthalene, etc., are destroyed in the soil before they have been able to kill those organisms to which they are fatal. It is found that certain soil bacteria have the power of attacking or feeding on these particular poisons : they are being further studied in the bacteriological laboratory. The introduction of a chlorine atom stabilises the poison and the further introduction of a nitro-group adds considerably to its toxicity (p. 58). Much work has been done to find a suitable agent for the control of wireworms (p. 43).

INVESTIGATIONS ON THE WEED FLORA.

The accumulated data on the weed flora of arable and grass land has been worked up by Dr. Brenchley and published in book form. Connections have been traced between various groups of weeds on the one hand and soils and crops on the other, and in some cases slight changes in manurial or cultural treatment may prove efficacious in the reduction of bad weed pests. Arrangements are being made for gathering together more information from different parts of the country in order to extend the practical application of the work.

THE PHYSICAL CONDITIONS OF THE SOIL.

Much of the agricultural value of the soil depends on physical conditions, such as the ease of cultivation, the supply of air and moisture, temperature, etc. These factors, which largely determine its suitability for the growth of crops and micro-organisms,

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