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ROTHAMSTED RESEARCH

Report for 1933

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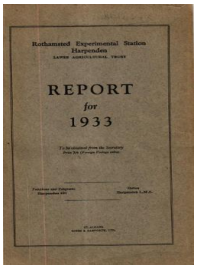

Lucerne and the Nodules Organisms

Rothamsted Research

Rothamsted Research (1934) *Lucerne and the Nodules Organisms ;* Report For 1933, pp 36 - 37 **-**
DOI: https://doi.org/10.23637/ERADOC-1-3

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being made, one of our former workers being out there for the purpose ; based on this survey is an extensive series of manurial trials. A comparison is being made of certain tropical and sub-tropical soils by some of these new methods to see how far the relations already found are likely to hold true generally.

This work will be facilitated by the investigations on the inorganic soil colloids now proceeding under E. M. Crowther. A new method has been worked out for the direct determination of aluminium in soil clays, and Sir William Bragg has kindly given facilities for using X-ray methods in the investigation of the clay structure.

Rare elements in plant nutrition. As for human beings and animals, so for plants, there are certain food substances which must be supplied, or normal growth does not take place. In one of the first investigations made by Miss Brenchley, at Rothamsted, small quantities of manganese were shown to be advantageous to cereals ; later work by Samuel and Piper at the Waite Institute, Adelaide, showed that in its absence the oat plant is specially liable to " grey speck " disease. The Chemical Department is now engaged in a study of availability of manganese in deficient soils liable to this disease.

Miss Warington showed that small quantities of boron are needed, and from various parts of the world there have since come accounts of plant diseases associated with boron deficiency. The appearance of this deficiency is less rapid in spring and autumn than in summer, but plants require boron whatever the season. Some of the effects of reduced hours of daylight superficially resemble those of boron deficiency, e.g. both may prevent flowering, but the characteristic effects are entirely distinct. One result of lack of boron is to reduce the uptake of nutrients, calcium being more affected than either nitrogen or potash.

Fertiliser from waste coal. In recent years various humic substances have been prepared from waste coal for which fertiliser value might reasonably be expected. Careful tests of materials supplied by well-known experts in coal chemistry have, however, failed to reveal anything of value to the farmer. Claims of better success have been put forward in Germany, but so far we have no evidence that these are justified.

LUCERNE AND THE NODULE ORGANISMS

The demand for cultures of the nodule organism still continues satisfactorily, and we are informed by Messrs. Allen and Hanbury that enough were sold last year to treat seed for 4,200 acres.

Meantime, H. G. Thornton is continuing the study of the relations between the nodule bacteria and the plant. He finds that the infection of the host legume increases very greatly at the time when the true leaves open. At that stage the root hairs exude something which apparently causes the nodule bacteria in the soil to multiply ; and, in turn, to produce something which causes the root hairs to curl ; and at the bend thus made they enter. H. G. Thornton has now isolated from the bacterial products a gum which causes the root hairs to curl and also to grow, so that it is either itself a growth stimulating substance or it is associated with one. Its action, however, is neutralised by a small quantity of nitrate in the presence

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of which the root hairs remain straight so that the bacteria cannot enter, hence the well-known effect of nitrate in reducing the number of nodules or inhibiting their formation. This neutralising effect, however, is overcome by addition of a little sugar, suggesting that the carbon/nitrogen ratio, known to be important in other aspects of micro-organic life, is important here also.

SOIL MICRO-ORGANISMS

Some years ago it was shown that the number of bacteria in the soil is not constant, but varies from day to day, and even from hour to hour. Improved and more rapid methods of counting have now enabled this work to be extended by C. B. Taylor, and it is shown that the fluctuations still take place even when the temperature and moisture content of the soil remain constant : this confirms an older observation by D. W. Cutler. The fluctuations of the total number revealed by the direct staining method are of the same kind as those of the special groups that grow on the culture medium used in the plate method ; this is being further examined.

The respiration of different soil micro-organisms, as measured by oxygen uptake, is being studied in the Microbiology Department. The results are unsuitable for brief summary, but an interesting point brought out is that in young cultures the respiratory quotient (CO_2/O_2) is greater than 1, while in older cultures it is less than 1. The rate of oxygen uptake per 1,000 million cells reaches a maximum value about 60 hours after inoculation, whereas the rate of carbon dioxide output per 1,000 million cells is at its maximum in the first 24 hours after inoculation, and falls off as the culture ages.

An interesting survey was made by Miss Dixon of the protozoan faunas in the tobacco soils of South Russia. All the soil samples contained protozoa, even those taken at some depth below the surface, while the upper layers of the soil contained them in considerable numbers. There was, however, no relation between the protozoan fauna and the soil type. Variations in acidity have but little effect on the fauna, though the optimum pH value varies somewhat for the different species.

Perhaps the two most important actions of micro-organisms in the soil are the breakdown of the nitrogen compounds with production of nitrate and sometimes loss of nitrogen ; and the decomposition of the non-nitrogenous compounds to carbon dioxide and water, a change which either involves their complete disappearance or leaves a residue of humus. Both have been studied in detail in the Chemical, Microbiological and Fermentation Departments.

Both changes are much influenced by the ratio of carbon to nitrogen in the substances present. The amounts of nitrite and of nitrate formed are both less when the ratio is high than when it is low. The rate of decomposition of sugar is greater when the ratio is low, but as S. H. Jenkins shows, the rate of decomposition of cellulose is less affected, though it varies in the same way.

The changes depend on the nature of the nitrogen compound. In the decomposit on of straw, ammonia is taken up by the organisms rather than nitrate in the early stages of decomposition, but not in the later stages ; in the end both are equally utilised, though nitrate causes a greater loss of nitrogen. In the decomposition of

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