ROTHAMSTED RESEARCH

Report for 1933

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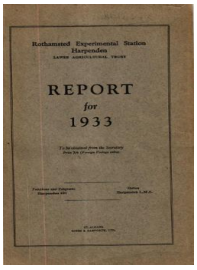

Soil Microorganisms

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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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sugar there is no evidence of any preference for ammonia over nitrate. The loss in presence of ammonia was about 14 per cent. with a C/N ratio of 8, but was nil, or even replaced by a slight gain, when the ratio was 84. Evidence is given that the loss of gaseous nitrogen takes place within the cell of the micro-organism and is not a simple decomposition of ammonium nitrate. There is also evidence that in presence of nitrate the loss is still greater, though no definite figures can yet be given.

Fungal tissue is fully available to micro-organisms as a source of nitrogen ; it is as easily and as completely nitrified as ammonia and it left no resistant unnitrifiable residue.

In all these decompositions brought about by micro-organisms there is also much resynthesis, the organisms building up their body tissues out of the decomposition products.

The sticky part of the humic residue left in the decomposition of farmyard manure is supposed to have considerable physical effect in the soil ; its formation has been studied in detail. It is most easily formed when the decomposition is begun by fungi and then carried further by bacteria ; the optimum pH is about 9.5 or 10. Nitrate and fungal tissue are better sources of nitrogen than ammonia, and the action proceeds better when the mineral bases are sodium or potassium than when they are calcium or magnesium.

PURIFICATION OF EFFLUENTS

D. W. Cutler and E. H. Richards, and their staffs, are applying these results with considerable success to the purification of effluents from sugar beet factories and from milk factories. In both cases organic matter has to be decomposed and in both cases micro-organisms are far the cheapest agencies for doing the work. The conditions required are a ready supply of oxygen, suitable reaction and suitable carbon/nitrogen ratio. The requirements may vary at different stages in the decomposition : thus the decomposition of complex substances like proteins and fats proceeds most rapidly when the first stages are done under anaerobic, and the later stages under aerobic conditions.

For sugar beet factory effluents appropriate conditions have been worked out, and the results are embodied in a report issued by the Department of Scientific and Industrial Research, under whose aegis all this work has been done. For milk factory effluents the problem is proving more difficult because of the presence of fat ; this is an old trouble long familiar to sewage experts, called upon to deal with the soap in domestic sewage. In view of its importance a special investigation of the decomposition of fat has been started. Conditions have been found under which both the fat and the casein can be precipitated from the effluent, leaving a liquid that can be run over biological filters without fear of clogging them.

PLANT PATHOLOGY

A new stage in the history of the Plant Pathology Department is opened with the appointment of J. Henderson Smith as Head and of G. Samuel as Mycologist in place of W. B. Brierley, and R. H. Stoughton respectively. Professor Brierley is writing his results for publication. Professor Stoughton's have been published, thus bringing to a close the work on Black Arm of cotton, the bacterial