ROTHAMSTED RESEARCH

Report for 1939-45

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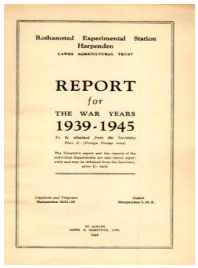

Soil-moisture and Cultivation Studies

Rothamsted Research

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composts. Stacked young bracken gave excellent results. Sewage sludges proved much less effective than good farmyard manure or bracken compost and supplied little beyond nitrogen and phosphate. Promising results were obtained from composts of straw and sewage sludge. An investigation on waste leather showed that it can be converted into an active nitrogen fertiliser by de-tanning, but the process has not yet reached a commercial scale.

Another major project has been the study of phosphatic fertilisers and particular attention has been given to questions of availability and to the problem of phosphate fixation. It is perhaps not generally realised that of the phosphate applied as fertiliser not more than 20 per cent. as a rule is recovered in the crops. A new phosphate fertiliser—silico phosphate—was developed in collaboration with the Building Research Station, and was found to compare very favourably with superphosphate for swedes and for re-seeding in wetter areas.

Fertiliser placement provides an obvious economy, particularly in the use of phosphate, and the process is now well established for cereals and is being tested for other crops.

Work on trace elements has been carried out in the departments of botany, chemistry and biochemistry and considerable progress has been made in the study of manganese deficiency. Deficiencies of manganese, boron, magnesium and potassium can now be recognised and distinguished from each other and from chlorosis due to virus and fungus diseases. The trace elements contained in Chilean nitrate were studied for several years by Dr. Brenchley and Dr. Warington, boron being the most important. Iodine gave negative results, but there were indications that molybdenum improved the growth of lettuces, and this element is being studied more intensively with various crops. The toxic effects of larger amounts of molybdenum and other trace elements are also being investigated.

Soil-moisture and cultivation studies

An examination of the daily readings of the Rothamsted drain gauges for the period 1871 to 1940 and of the continuous records taken since 1925 has yielded important information about the rate of evaporation from bare soil, and laboratory experiments have helped to elucidate the physics of the process. The transpiration of short grass continuously supplied with water from a controlled water table has been measured during two summers and its dependence on the supply of energy from solar radiation established. It is proposed to make the same measurements for tall crops. This technique should provide more precise indications of the optimum quantities of water to be supplied in irrigation work.

The study of the manner in which water is retained in soil has been continued, and progress made in devising means for measuring *in situ* the suction (or pF) of the soil moisture. A method has also been devised for obtaining the volumes occupied by solids, water and air in soil clods. Measurements have been made of the fraction of soil particles of effective diameter less than 0.1μ, and a physico-chemical study of the buffer action of a number of pure polysaccharides has paved the way for an attack on the complex chemistry of the organic matter of the soil.

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The results of soil-cultivation experiments on different soils and in different seasons are consistent with the laboratory and drain-gauge work and with comparable experiments in the United States and elsewhere. They demonstrate the depression of crop yield due to weed competition, but show that inter-row cultivation does not reduce direct evaporation from the soil.

Nodule bacteria and other soil micro-organisms

Some strains of nodule bacteria, particularly on clover, produce nodules practically ineffective in fixing nitrogen. These appear to be characteristic of poor pastures in hilly districts in the west and north of Britain, and the possibility is being investigated of improving the clover content of such pastures by inoculation with effective strains of nodule bacteria. The problem is by no means simple, however, for effective strains are liable to mutate and become ineffective on certain soils : moreover, acute competition has been found to take place between the nodule bacteria introduced by inoculation and those already present in the soil. The cause of ineffectiveness appears to be the inability of certain strains to grow strongly on the host-plant tissues or to survive therein long enough to fix appreciable amounts of nitrogen. The behaviour of the nodule bacteria is controlled by genes in the host plant as well as by the nature of the bacterial strain.

A study of the chemical nature of the bacterial secretions which cause deformation of root hairs by nodule organisms eventually led to the discovery of the high toxicity to many dicotyledonous plants of 2 : 4 dichlorphenoxyacetic acid. This and a closely related compound are now in practical use in this country and in America as differential weed killers for use in cereal crops.

Studies on the general micropopulation of field soils have been facilitated by the development of a new direct method of counting bacterial cells and of estimating the quantity of mycelium in soil by direct microscopical observation. A greatly improved technique for estimating numbers of protozoa in soil has also been devised. By the use of these improved techniques several groups of micro-organisms, formerly thought to be very rare or even adventitious in soil, have been found to be true and widely distributed soil inhabitants. These include giant rhizopods, acrasieae and myxobacteria. Of special interest are the myxobacteria which secrete compounds that destroy and dissolve gram-negative as well as gram-positive bacteria. Most of the former group are not attacked by penicillin. Soil protozoa and acrasieae have been found to be very selective in their bacterial food so that they are capable of altering the quality as well as the total size of the soil bacterial flora.

Virus diseases of plants

Plant-pathological work has increased greatly since 1939 and particular attention has been given to the diseases of potatoes, sugar beet and cereals. As far as possible all the lines of work both with viruses and fungi that were being studied in 1939 have been continued, and a good deal of advisory work has also been undertaken.

The study of viruses has been facilitated by the acquisition of an ultra-centrifuge and an electron microscope. New viruses have been

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