ROTHAMSTED RESEARCH

Rothamsted Report for 1936

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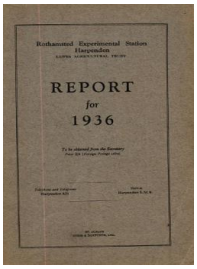

The Soil

Rothamsted Research

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(*c*) Sampling

xxxvi. F. Yates. "*The Place of Quantitative Measurements on Plant Growth in Agricultural Meteorology and Crop Forecasting.*" Conference of Empire Meteorologists, 1935, Memorandum No. 36.

An account is given of the reasons that have led to the introduction of the "Precision Records" on Wheat in the Crop-Weather Scheme of the Ministry of Agriculture and Fisheries. The purpose of these measurements, and the directions in which they are likely to be useful, are briefly described, and a plea is entered for their extension to other crops. A complementary scheme, recently introduced, of sampling commercial fields in order to test the feasibility of providing objective estimates of wheat yields throughout the country, is also described.

xxxvii. F. Yates. "*Applications of the Sampling Technique to Crop Estimation and Forecasting.*" Manchester Statistical Society. Collected Papers. Session 1936-7.

This address (read before the Manchester Statistical Society) gives an account of the methods that are likely to be of use in the estimation and forecasting of agricultural crops, and describes the results already obtained with wheat. The general principles underlying a sound sampling technique are also discussed and illustrated by actual examples of defective sampling.

THE SOIL

(Departments of Chemistry and Physics)

(*a*) Cultivation and Drainage

xxxviii. B. A. Keen. "*The Scientific Basis of the Art of Cultivation.*" Programme and Papers of the Second Conference on Mechanized Farming. Oxford, 1937, pp. 27-35.

The capillary-tube theory of water movement in soil, which has long been used to explain the control of soil moisture by cultivation operations, is shown to be erroneous. The pore-space of the soil must be regarded as a series of cells communicating with one another through relatively narrow necks. The boundaries of these cells and necks are formed by the soil aggregates or crumbs, which can be likened to small sponges. The crumbs imbibe water from the rain that percolates down the pore-space, and water is held at the points of contact of the crumbs and also partially fills the pore-spaces. Any surplus drains away and eventually reaches a water-table. When drying conditions occur at the surface, evaporation proceeds by the progressive downward drying of the top layers of crumbs rather than by the upward movement of water from below to the surface. In other words, most soils are naturally "self-mulching." Similarly, when root hairs absorb water, inward movement to the region of absorption will be very slow and over very limited distances. The water held by the soil is to be regarded as relatively static; modern theory shows, in fact, that it resists movement.

The effects on soil water content and movement attributed to operations such as harrowing and rolling are therefore much less than the old capillary theory asserted. The main function of cultivation is not to exercise a delicate and precise control of soil moisture, but to remove the competition of weeds, to obtain a seed-bed of suitable consistency, and to prevent crusts or "caps" forming on certain classes of soil.

xxxix. B. A. Keen and G. H. Cashen. "*Some Aspects of Cultivation and Other Power Operations on the Farm.*" Journal and Transactions of the Society of Engineers (Inc.), 1936, Vol. XXVII, pp. 114-135.

(This paper was awarded the Bessemer Premium of the Society of Engineers)

Two contrasting aspects of farming are discussed in this paper; (*a*) the value of soil cultivation, and (*b*) the comparison of electricity and oil fuel as sources of power for farm machinery.

Numerous cultivation trials made by the Soil Physics Department have led to the unexpected conclusion that cultivation has much less effect on the yields of produce than is generally supposed. These conclusions, however, are in harmony with the laboratory studies of soil water movement made in the Department which show that little or no control of soil moisture is effected by cultivation operations.

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The comparison of the electric motor and the internal combustion engine has been made to obtain a reliable figure for the relative power consumption (units of electricity and gallons of fuel) for the same job of work. This figure is needed by farmers who have the choice of both forms of power.

For threshing a G.E.C. Witton 20 h.p. portable motor and an International 10-20 h.p. tractor were compared ; each was running at approximately 50 per cent. of full load. The paraffin equivalent of 10 kilowatt hours was 1.75 gallons ; this figure was about 7 per cent. higher than it need have been as the tractor was not running on the weakest possible mixture.

For grinding, the power requirements naturally depend greatly on the degree of fineness, the feeding rate, the moisture content of the grain, etc. Comparable tests over a power range of 4.5-5.3 h.p., were made with a G.E.C. 5 h.p. " Drumotor " and Bamford 6 h.p. diesel engine.The equivalent of 10 kilowatt hours was found to be 5.0 pints of diesel oil.

With the above equivalents of electricity and fuel oil, a comparison of the total costs of the alternative sources of power can be made for any given set of conditions for electricity rates, cost of fuel, depreciation of power units and machinery, etc.

XL. B. A. KEEN. *" Land Drainage : the Area of Benefit."* Journal of the Ministry of Agriculture, 1936, Vol. XLIII, pp. 521-526.

The Land Drainage Act of 1930 brings within the rating area of Internal Drainage Boards those lands which " derive benefit or escape danger " as a result of drainage operations. The working rule for agricultural areas is to include all land up to the contour line drawn 8 ft. higher than the level of the highest recorded flood, but provision is made for meeting special cases, either by exclusion or differential rating. The adoption of the 8 ft. line has increased the rateable area, and the objection of the occupiers is understandable, especially when the existing drainage works are adequate and no fresh constructions are contemplated. Their response to the explanation that the land is hence-forward to bear its fair share of benefits hitherto received free, is the very natural one of denying that it benefits in any way : in other words they suggest that a lower contour than 8 ft., or even flood level itself, should be taken.

This article explains the general principles underlying the movement of water in the soil and shows that the contour line 8 ft. above the highest recorded flood is a very reasonable level up to which land can be considered to derive benefit or avoid danger as a result of drainage operations.

(*b*) SOIL STRUCTURE

XLI. E. M. CROWTHER. *" Subsoil Structure and Crop Nutrition."* Transactions of the Third International Congress of Soil Science, 1936, Vol. III, pp. 126-129.

It is suggested that work on crop nutrition and soil morphology could be linked up by the hypothesis that some of the more deeply rooted farm crops in humid temperate climates utilise water, nitrates and possibly other soluble nutrients stored through the winter in the lower horizons of loams and heavier soils, provided that these are well drained and have a well-expressed soil structure.

Evidence in support of this hypothesis is advanced from systematic analyses of soils in rotation experiments, the statistical analysis of seasonal rainfall effects on contrasted soils, and the composition of drainage waters. A simple apparatus for measuring suction pressures at various depths in cropped and uncropped soils was used to estimate the rate of growth of sugar beet roots down to about 1 metre.

(*c*) CHEMICAL ANALYSIS

XLII. C. N. ACHARYA. *" Determination of Carbon and Nitrogen by the Action of Chromic Acid under Reduced Pressure."* Biochemical Journal, 1936, Vol. XXX, pp. 241-247.

A procedure is described for the estimation of carbon and nitrogen in soils, plant materials and organic compounds by the action of a mixture of chromic and sulphuric acids under reduced pressure.

The results for nitrogen in soils and plant materials are too low because one portion is oxidised to nitrate and another is lost in gaseous form. If the aliquot taken contains about 5 mg. or less of nitrogen the gaseous portion is also fixed

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as nitrate and correct figures are obtained by the estimation of the ammoniacal and nitrate-nitrogen present. For amounts higher than 5 mg. an average correction of 10 per cent. on the ammoniacal nitrogen formed gives results agreeing to within 98-100 per cent. of the Kjeldahl figure.

A procedure is described for the estimation of small amounts of nitrate in presence of large quantities of sulphuric and chromic acids.

MICROBIOLOGY

(Departments of Bacteriology, Fermentation and General Microbiology)

(*a*) Bacteria

XLIII. H. G. Thornton. "*The Present State of our Ignorance Concerning the Nodules of Leguminous Plants.*" Science Progress, 1936, Vol. XXXI, pp. 236-249.

This outline of our knowledge of the nodule bacteria and their association with the host legume is intended to emphasise how great and important are the gaps in this knowledge—gaps which occur at the critical point in almost every line of investigation. The nodules on legumes afford problems, whose solution would illuminate much wider fields in biology: such as those of bacterial genetics, growth-promoting substances, and the formation of pathological growths. The great mystery of biological nitrogen-fixation itself remains unsolved.

(*b*) Protozoa

XLIV. A. Dixon. "*Soil Protozoa; their Growth on various Media.*" Annals of Applied Biology, 1937, Vol. XXIV, pp. 442-456.

The investigation was started to test the present methods of culturing soil protozoa on peptone agar, as two earlier workers had obtained higher numbers by the use of soil-extract agar. Some 55 soils were used, from the tobacco growing regions of the U.S.S.R., sent by the State Institute of Tobacco Culture, Krasnodar. Protozoa of these soils, when grown on soil-extract agar and peptone agar gave, with three exceptions, considerably higher numbers with the former medium. The higher numbers of Rhizopoda and Ciliata were particularly noticeable. A complete list of protozoa from these soils on the two media is given. The same media were also used for samples of Woburn and Rothamsted soils, and for the latter soil extract and hay infusion as well. Soil extract agar and liquid soil extract as media gave the fullest record of protozoa, particularly for Rhizopoda and Ciliata. Hay infusion was useful for the development of Ciliata and an improvement on peptone agar.

(*c*) Biological Activities

XLV. J. Meiklejohn. "*The Reduction of Nitrate by Individual Strains of Free-living Bacteria.*" Transactions of the Third International Congress of Soil Science, 1935, Vol. I, pp. 180-183.

Eighty free-living strains of bacteria were tested for their ability to reduce nitrate in media of known composition. Five types of reaction with regard to nitrate were observed, and an attempt was made to relate the known physiological properties of each strain to the type of reaction it gave; it was found that the strains conforming to each type had other properties in common.

XLVI. J. Meiklejohn. "*The Oxygen Uptake of Suspensions and Cultures of a Free-living Bacterium.*" Journal of Experimental Biology, 1937, Vol. XIV, pp. 158-170.

The oxygen uptake of pure cultures and suspensions of a bacterial species isolated during the effluent investigations was measured at 26°C. Cultures in a liquid medium gave the greatest oxygen uptake per cell at 48 hours after inoculation, and the greatest total oxygen uptake 72 hours after inoculation. The maximum stationary phase of growth was reached about 96 hours after inoculation, after which the oxygen uptake of successive samples rapidly fell to a very low value.

In suspensions deprived of nitrogen, and showing no growth, and in cultures in the stationary phase, oxygen uptake proceeds at a constant rate. But in both suspensions and cultures where active growth is taking place, the rate of