ROTHAMSTED RESEARCH

Report for 1934

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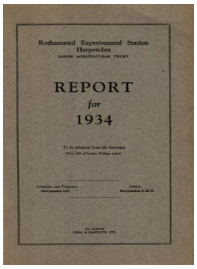

The Soil

Rothamsted Research

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THE SOIL.

(Department of Physics.)

(*a*) Soil Cultivation.

XXVIII. B. A. Keen. "*The Functions of Mechanical Power in Soil Cultivation.*" Journal of the Institute of Automobile Engineers, 1934-5, Vol. XXIX, pp. 179-194.

This paper reviews the cultivation studies made at Rothamsted and described in previous Reports. It describes experiments in which rotary cultivation was compared with the traditional methods. The immediate effect of the implements on the soil was measured by taking blocks of soil immediately before and after cultivation, and sieving them on a set of sieves. (See Paper No. XXIX, Report for 1933, p. 73.) It was shown that for spring cultivation, the extent of disintegration produced is controlled far more by the character of the preceding winter weather than by the implement. Rotary cultivation does not produce a much finer tilth than traditional implements, as is frequently alleged, but a much looser one.

Experiments on intensive surface cultivation between the rows of root crops such as kale and sugar beet, gave the unexpected result that cultivation in excess of the minimum necessary to keep down weeds, not only gave no benefit, but actually reduced the yield. The result was obtained both on a light sandy soil and a heavy loam, but it needs repetition in a variety of seasons before a final conclusion can be given.

(*b*) Physical Properties.

XXIX. E. W. Russell. "*The Interaction of Clay with Water and Organic Liquids as Measured by Specific Volume Changes and its Relation to the Phenomena of Crumb Formation in Soils.*" Philosophical Transactions of the Royal Society of London, A, 1934, Vol. CCXXXIII, pp. 361-389.

Clay particles can form strong aggregates, or crumbs, when dry, only if the clay particles are sufficiently small, if there are a sufficient number of small exchangeable ions on the clay, and if the clay has been dried from a dispersion medium whose molecules are polar and sufficiently small.

Individual clay particles have an appreciable interaction with the molecules of polar liquids ; they do not interact, or only slightly, with non-polar liquids. On the hypothesis that no differential interaction occurs between the exchangeable ions on the clay and a non-polar hydrocarbon, the magnesium ions on the clay have about seven and the calcium ions about three more molecules of water of hydration than the sodium or potassium ions. Independent evidence is given for this conclusion.

Clays interact with water and organic liquids containing a polar group by causing a contraction in volume of the liquid. For homionic clays, saturated up to *p*H7 with base, this contraction is nearly proportional to the number and mean charge density on the surface of the exchangeable ions on the clay and, to a less extent, it varies with a parameter specifying the shape of the titration curve of the clay.

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These results have been interpreted on the hypothesis that cations can orientate polar molecules of the dispersion liquid around them, and this power is proportional to their surface density of charge. This power is also possessed by the free negative charges on the clay particle. When the dispersion liquid has nearly all been removed the cations bind the negative charges on two clay particles together by means of bridges of strongly orientated molecules of the polar dispersion liquid.

XXX. E. W. RUSSELL and R. S. GUPTA. "*On the Measurement of Imbibitional Water.*" Journal of Agricultural Science, 1934, Vol. XXIV, pp. 315-325.

Two methods of determining the weight and one method of determining the volume of water imbibed by a soil have been discussed. The results of these methods have been shown to be concordant by an independent method.

The tentative conclusion reached is that the weight of water a soil imbibes can be readily determined by Fisher's method or from the Keen Raczkowski box, but that the volume of imbibed water cannot yet be directly determined accurately.

XXXI. B. A. KEEN. "*Physical Measurements of Soil in Relation to Soil Type and Fertility.*" Second Conference on Cotton Growing Problems, Empire Cotton Growing Corporation, 1934, pp. 311-319.

This paper summarises a number of separate investigations at Rothamsted which have one underlying principle in common—to ascertain what types of physical measurements on soil are most suited to distinguish differences in the natural or inherent fertility of different soils and, as a related investigation, to what extent soil types can also be distinguished by physical measurements. A wide variety of soils was employed, for which, as was expected, a number of general correlations existed between the results of different methods. But, as would also be expected, the relationships become more diffuse when an endeavour is made to distinguish one soil type from another. It seems possible that, when two different measurements are plotted together, a soil type will be characterised by an area on the paper and not by a curve ; one pair of measurements—the sticky point and exchangeable bases—showed a general segregation of the soil types examined into separate areas.

The assessment of inherent fertility by physical or physico-chemical tests is, naturally, a still more difficult problem. However, in the case of a series of Malayan soils, where the yield of rubber afforded some guide to the local worker in forming an estimate of the inherent soil fertility, it was found possible to differentiate between good fertility soils and the remainder by measuring the ignition-loss of the soil, and the ignition-loss per gram of clay.

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XXXII. J. M. ALBAREDA. "*Caracterización de Suelos Tropicales y Sub-Tropicales mediante Determinaciones Físicas y Físicoquímicas.*" (*The Characterisation of Tropical and Sub-Tropical Soils by Means of Physical and Physico-Chemical Determinations*). Publicado en la Revista de la Academia de Ciencias, de Madrid, 1934, Vol. XXXI, pp. 320-350 and 457-514.

An attempt is made to extend the method of "single-value" determinations, introduced by Keen and Coutts, to the classification of soils into their appropriate genetical type. A large number of "single value" determinations was made on 125 soils from four different soil types. By taking pairs or functions of these determinations, and plotting the value of one member against that of the other member of each pair for the soils, it is possible to pick out

(*a*) those groups of determinations which are measuring approximately the same fundamental property of the soil, so can give no information about differences between one soil type and another;

(*b*) those groups of determinations which are measuring soil properties that are more or less characteristic of the soil in any one soil type, but which vary from one type to another. While no pairs of determinations that were found rigidly belonged to either of these groups, several were found which nearly did, so that it is possible to make a fair separation of these soils into their four genetic types by the method of "single value" determinations.

XXXIII. J. M. ALBAREDA. "*Sobre la Fertilidad de Algunos Suelos Tropicales.*" (*The Fertility of Rubber Soils*). Publicado en la Revista de la Academia de Ciencias, de Madrid, 1934, Vol. XXXI, pp. 515-519.

An attempt is made to extend the method of "single value" determinations to the grading of rubber soils into different fertility groups. Two methods have been found which are reasonably efficient classifiers of the soils into the two groups of good and poor rubber soils, but there is as yet no method that can give a finer classification than this simple dichotomy.

XXXIV. R. K. SCHOFIELD. "*Soil Water.*" Transactions of the First Commission of the International Society of Soil Science, 1934, pp. 185-191.

Soil acts as a reservoir of water which is available to plants. Some of this water may be held between the cleavage planes of the clay minerals. The free energy of binding of the stored water can be found from determinations of freezing point depression and equilibrium humidity. The first determination covers the moisture range for normal plant growth and indicates that the sharp decrease in permeability with falling moisture is a dominating factor in wilting. The moisture content at 50 per cent. humidity and the heat of wetting are connected with base exchange, a cluster of water molecules being held rather firmly to the active "spots" where base exchange takes place. Base exchange capacity and fineness of subdivision largely influence the permeability of the compact masses in the soil, while these and also the humus content mainly control their

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structure stability. The circumstance that water within the compact masses will not drain away and can only be removed by suction of plants on neighbouring drier soil, or by direct evaporation, has its reflection in traditional agricultural practices.

XXXV. G. W. SCOTT BLAIR. *"Definition and Translation of Rheological Terms used in Soil Physics."* Transactions of the First Commission of the International Society of Soil Science, 1934, pp. 159-167.

Rheology is defined as the science of the flow of matter, and a great many terms used in soil physics therefore may be classed as "rheological terms."

The use of such terms in the international literature is subject to two types of uncertainty: (*a*) uncertainty as to definition of terms; (*b*) uncertainty as to translation of terms. With regard to (*a*), it is desirable that definitions should conform as far as possible to established usage not only in Soil Science, but also in other fields, and should not conflict with the traditional meaning of words. The term "plasticity" is discussed in this connection. Although (*b*) is a separate problem, it is a closely allied one. As an example, the translation of the English term "stickiness" is discussed.

It is recommended that a committee should investigate these problems, and standardise usage as far as is possible.

MICROBIOLOGY.

(Departments of Bacteriology, and Fermentation.)

(*a*) BACTERIA.

XXXVI. H. G. THORNTON and P. H. H. GRAY. *"The Numbers of Bacterial Cells in Field Soils, as Estimated by the Ratio Method." With appendix* by R. A. FISHER, F.R.S. Proceedings of the Royal Society of London, Series B, 1934, Vol. CXV, pp. 522-543.

There are two serious difficulties in estimating the bacterial numbers in a soil sample from the microscopic examination of stained films of that soil. The first is that of determining with sufficient accuracy the mass of soil in the film and the second that of estimating from random microscope fields the numbers of organisms in the film when these organisms are not distributed through it at random.

A technique is here described in which these difficulties are avoided, by determining, in random microscope fields from a parallel series of stained films, the ratio between the number of bacteria and the number of indigo particles, of which a counted suspension has previously been added to a given mass of soil. The bacterial numbers calculated from such ratios are, of course, independent of the mass of soil in the film.

It is found that the ratios obtained from parallel microscope fields are distributed at random, although counts of bacteria taken by themselves from the same fields are much less uniform.

The accuracy of the method has been tested in the following experiments:

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