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## Report for 1933

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## The Soil

### Rothamsted Research

Rothamsted Research (1934) *The Soil* ; Report For 1933, pp 73 - 76 - DOI:  
<https://doi.org/10.23637/ERADOC-1-3>

## THE SOIL

(Departments of Chemistry, General Microbiology, Physics and Statistics)

### (a) SOIL CULTIVATION

- XXIX. B. A. KEEN. "*Experimental Methods for the Study of Soil Cultivation.*" Empire Journal of Experimental Agriculture, 1933, Vol. I, pp. 97-102.

Samples of the soil immediately before and immediately after cultivation are sieved on a set of four sieves with mesh sizes from  $1\frac{1}{2}$  ins. square to  $\frac{1}{16}$  in. The fraction remaining on each sieve is weighed and expressed as a percentage of the total. Comparison of the pre- and post-cultivation figures affords a measure of the disintegration produced by the passage of the implement.

Results show that on the heavy loam soil of Rothamsted, the implement is much less effective than the weather in producing disintegration. Trials were also made with rotary cultivation, which showed the incorrectness of the common assertion that the rotary cultivator produces too fine a seed-bed. The soil disintegration is no greater than that produced by a ridging or bouting plough. The real difference is that the tilth is much looser: a 4-in. entry of the tines into ordinary compact soil produces a tilth that is 6 to 7 inches deep.

### (b) PHYSICAL PROPERTIES

- XXX. E. W. RUSSELL. "*The Significance of Certain 'Single Value' Soil Constants.*" Journal of Agricultural Science, 1933, Vol. XXIII, pp. 261-310.

A detailed statistical examination, using multiple regression analysis, has been made of Coutts' 64 Natal soils. The purpose was to discover what type of information is given by each physical constant and thus to specify which constants give the maximum amount of independent information about the soil.

Several physical measurements, such as the sticky-point, the moisture content at 50 per cent. relative humidity, and the weight of water held per gram of soil in the Keen-Raczkowski box (Report 1921-22, p. 41) are closely correlated with the base-exchange capacity as measured by Schofield's potassium phosphate buffer method. The clay content is of minor importance in predicting these properties.

The swelling and pore-space parameters in the Keen-Raczkowski box are more complex. The swelling depends on the base-exchange-capacity and a soil structure term; the pore-space depends on the clay content and a soil structure term.

The xylene equivalent measures a property of soil that is independent of the organic matter present, since it can be almost completely predicted from other measurements made on the soil after it has been treated with hydrogen peroxide to remove humified organic matter.

The so-called imbibitional water, as determined from the xylene and moisture equivalents, is of little value for prediction purposes; the two primary variates are always considerably better.

Given the Keen-Raczkowski box parameters, and the xylene equivalent for these Natal soils, none of the other parameters add very much extra information.

- XXXI. H. JANERT. "*The Application of Heat of Wetting Measurements to Soil Research Problems.*" *Journal of Agricultural Science*, 1934, Vol. XXIV, pp. 136-150.

The author's modification of the method used by Mitscherlich is described.

Measurements of the heat of wetting, obtained with a number of single-base (homoionic) clays prepared in the laboratory, show that this value represents a specific proportion of the heat of hydration of the adsorbed cation in its free state.

The heats of wetting with water and with organic liquids are proportional. The heats of wetting with a given liquid are not completely determined by its dipole moment and molecular volume.

The heat of wetting is correlated with other physical measurements. The method also distinguishes changes in the physical condition of some of the permanent plots at Rothamsted and Woburn.

- XXXII. R. S. KOSHAL. "*The Effects of Rainfall and Temperature on Percolation through Drain Gauges.*" *Journal of Agricultural Science*, 1934, Vol. XXIV, pp. 105-135.

Partial regression equations representing the average drainage observed in any month in terms of the temperature and rainfall of that month, and including terms representing the mean secular rate of change of the drainage discharge and of its regression coefficients on rainfall and temperature, have been fitted to the thirty-six series of observations provided by the three Rothamsted drain gauges in the twelve months of the year.

An account is given of adequate and direct numerical methods of handling equations involving observed quantities, and chosen functions of them, as independent variates, and of calculating standard errors appropriate to the several sorts of comparison which are to be made.

In the absence of direct knowledge of the amount of water contained from time to time in the soil mass of the gauge it has been customary to assume that the lower average drainage of the summer months is directly due to a greater amount of evaporation taking place in these months. The results of the present enquiry direct attention to a second possibility, namely that the water content of the gauges differs considerably at different times of the year, and that the high drainage in winter is in part to be ascribed to the accumulation of water during the rainy months of autumn, while the lower drainage in summer is due to the partial depletion of the gauges during the lower rainfall of the spring months.

#### (c) PHYSICAL CHEMISTRY

- XXXIII. R. K. SCHOFIELD. "*Rapid Methods of Examining Soils. II. The Use of p-Nitrophenol for Assessing Lime Status.*" *Journal of Agricultural Science*, 1933, Vol. XXIII, pp. 252-254.

By the use of a solution of *p*-nitrophenol in lime water a rapid and simple measurement can be made of the lime taken up by a soil sample in reaching neutrality. The same method applied to

acid-washed samples gives the exchangeable base content at pH7. With slight modifications in the technique other weak acids may be used, such as acetic acid and phenol. These enable the lime uptake to be measured to pH 4.6 and 9.8 respectively. By combining these determinations with the amount of base dissolved out of the soil by N/20 HCl the general course of the buffer curve can be traced from pH 1.4 to pH 9.8.

- XXXIV. R. K. SCHOFIELD. "*Rapid Methods of Examining Soils. III. The Use of Dihydrogen Potassium Phosphate in Study-Base Exchange Capacity.*" *Journal of Agricultural Science*, 1933, Vol. XXIII, pp. 255-260.

The reduction in the electrical conductivity of a mixed solution of  $K_2HPO_4$  and  $KH_2PO_4$  caused by the addition of soil is a measure of the potassium uptake, and is therefore an indication of the "base exchange capacity" of the soil at pH7. Two disturbing factors are noted, and it is concluded that the method is likely to be most useful where a rapid comparison of soils of a similar nature and pH is required.

- XXXV. E. M. CROWTHER AND S. G. HEINTZE. "*Oxides of Manganese and Quinhydrone Error in Measurements of Soil Reaction.*" *Proceedings and Papers of the Second International Congress (1930) of Soil Science*, 1933, Vol. II, pp. 1-6.

In earlier papers (Paper XVIII, Report 1929, p. 58 and Paper XXXVIII, Report, 1930, p. 84) the error of the quinhydrone electrode in many soils was attributed to the production of basic material by the reduction of oxides of manganese by the quinhydrone. Confirmation of this explanation was obtained by the demonstration that soils showing the quinhydrone error yielded up to 2.5 mg. equivalents per cent. of manganese, when extracted with potassium chloride saturated with quinhydrone, whereas soils without quinhydrone error never gave more than minute traces of manganese. Further, the amount of manganese reduced by quinhydrone and extracted by potassium chloride was sufficient to account quantitatively for the quinhydrone error, on the assumption that the manganese dioxide was reduced to hydroxide and after allowing for the buffer capacity of the soil. It was also shown that oxides of iron caused no disturbance and that the changes in the ratio of quinone to hydroquinone could have only trivial effects on the pH value.

- XXXVI. S. G. HEINTZE. "*The Use of the Glass Electrode in Soil Reaction and Oxidation-Reduction Potential Measurements.*" *Journal of Agricultural Science*, 1934, Vol. XXIV, pp. 28-41.

The glass electrode with an electrometer triode valve as amplifier gives accurate pH measurements on soil suspensions and on soil crumbs moist enough to wet the glass. It has the advantages that it may be used in highly oxidising or reducing systems and in alkaline

soil, but it has little merit over the quinhydrone electrode, where this is known to be reliable. The glass electrode forms a satisfactory reference electrode in oxidation-reduction potential measurements, as it allows both Eh and pH measurements without alteration to the system, whilst its high resistance minimises polarisation. Oxidation-reduction potentials of soils depend so closely on the pH values of the soils that they should not be considered separately. For constant pH values highly contrasted soil types may give similar oxidation-reduction potentials. After waterlogging in the laboratory for one or two days, there is a marked fall in potential for soils known from the conditions of their formation to contain organic matter which is capable of rapid decomposition as soon as moisture temperature and soil reaction become favourable. In the main soil zones of European Russia, this change on waterlogging reaches its maximum in the chernozem belt.

(d) ORGANIC CHEMISTRY

XXXVII. A. WALKLEY AND I. ARMSTRONG BLACK. "*An Examination of the Degtjareff Method for Determining Soil Organic Matter, and a Proposed Modification of the Chromic Acid Titration Method.*" Soil Science, 1934, Vol. XXXVII, pp. 29-38.

The chromic acid-hydrogen peroxide method of Degtjareff for the rapid determination of soil carbon was shown to give entirely fictitious results. The hydrogen peroxide not only served no useful purpose, but introduced a fundamental error, since its reaction with chromic acid follows a different course in the determination with soil from that in the corresponding blank. Two molecules of  $\text{CrO}_3$  react with four molecules of  $\text{H}_2\text{O}_2$  in the absence of soil but with three in the presence of soil or ignited soil. The gain in apparent carbon through this error approximately balances the incompleteness of oxidation for the conditions under which Degtjareff appears to have worked. A new approximate method giving about 76 per cent. recovery of carbon was proposed. Finely divided soil is treated with standard potassium dichromate and twice the volume of sulphuric acid added to raise the temperature; after being stirred for a minute the mixture is diluted and the excess dichromate titrated. This procedure is more rapid than others so far proposed, and it is believed that it may prove useful for comparative purposes where no very exact determination is required.

XXXVIII. J. A. DAJI. "*The Determination of Cellulose in Soil.*" Biochemical Journal, 1932, Vol. XXVI, pp. 1275-1280.

Cellulose in soil mixed with plant materials is determined by treating it with hot dilute alkali and acid and then with a solution of sodium hypochlorite in the cold. Cellulose is then extracted with Schweitzer's reagent, precipitated with alcohol and determined by loss of weight on ignition. This method will recover almost the whole of the cellulose added when different plant materials are mixed with soil.