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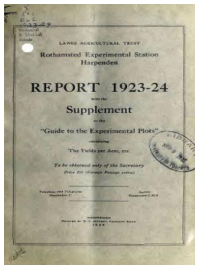
# Report for 1923-1924 With the Supplement to the Guide to the Experimental Plots Containing the Yields per Acre Etc.

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## The Soil

### Rothamsted Research

Rothamsted Research (1925) *The Soil ;* Report For 1923-1924 With The Supplement To The Guide To The Experimental Plots Containing The Yields Per Acre Etc., pp 49 - 59 **- DOI: https://doi.org/10.23637/ERADOC-1-116**

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## III. THE SOIL.

(Chemical and Physical Departments.)

### (*a*) MECHANICAL ANALYSIS.

XV. B. A. KEEN AND W. B. HAINES. "*On the Effect of Wear on Small Mesh Wire Sieves.*" Journal of Agricultural Science, 1923. Vol. XIII., pp. 467-482.

Fine mesh wire sieves play an important part in agricultural science, especially in specifications for certain artificial fertilisers, and in mechanical analysis of soil.

The uniformity of new and worn sieves was measured with respect to the linear dimensions and area of the holes, and the diameter of the wire.

Unused sieves woven to the specification of the Institute of Mining and Metallurgy compared well, on the whole, with the specification, but in used sieves the variations were much greater: in one instance, 70 per cent. of the apertures were 25 per cent. in excess of standard area, and no less than 36 per cent. were 50 per cent. over standard. In some of the sieves the frequency distribution curves of the data showed double peaks, and the actual observation showed that there was a systematic distribution of values corresponding to these two peaks. It would appear that the guides in one of the combs through which the warp wires are led during weaving had become displaced sideways, thus giving alternate strands of wide and narrow holes.

A calculation of the increase of area of the apertures due to stretch of the sieve in use led to values below those actually observed. This discrepancy is due to the wires becoming displaced from their original positions under the rubbing action employed in mechanical analysis.

Of the two systems of weaving—double and single—the former is stronger, but the latter is more uniform, since the warp and weft grip one another more tightly and more often in a given area. The fact that it is intrinsically neither as strong nor as durable as a double weave is an advantage, as with ordinary use, some of the strands break and the sieve is discarded before any very serious alteration in aperture area has arisen.

XVI. J. R. H. COUTTS, E. M. CROWTHER, B. A. KEEN, AND S. ODEN. "*An Automatic and Continuous Recording Balance. (The Odén-Keen Balance.)*" Proceedings of the Royal Society. A., 1924. Vol. CVI., pp. 33-51.

In connection with (*a*) the newer methods of mechanical analysis which involve only a single sedimentation, and (*b*) further experiments on the evaporation of water from soil, there arose an urgent necessity for some form of automatic self-recording balance. At the request of Prof. Sven Odén, of Stockholm, the Soil Physics Department has devised an improved form of his original type of recording balance. The control is effected electromagnetically. The current passing through a solenoid is automatically adjusted, so that the force of attraction on a magnet

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suspended from one pan of an analytical balance is just sufficient to keep the balance in equilibrium. The adjustment of this current is effected by the movement of a sliding contact along slide wires, and this movement is in its turn controlled by the slight swing of the pointer attached to the balance beam, as the latter moves from its equilibrium position. When the current —and hence the weight on the second pan of the balance— reaches a pre-arranged value, a subsidiary circuit is automatically closed, and a small phosphor-bronze ball of known weight is deposited on the pan above the magnet, the sliding contact is drawn back to its initial position, and the cycle of operations recommences.

The arrangement of the circuits is such that the distance of the sliding contact from its zero position is to a close approximation linearly related to the current, and hence a recording-ammeter is not needed, as a record on a rotating drum of the slider position is sufficient to give the required data. The records consist of a series of stepped curves and a very open scale is obtained.

The apparatus can be used with no loss of sensitivity up to the maximum load the balance is designed to carry. Further, the sensitivity can be very simply adjusted, so that both rapid and slow changes of weight can be recorded.

The apparatus can be employed with advantage in experiments involving a continuous measurement of increasing or decreasing weight, and its application to the study of sedimentation and flocculation of soil particles, and the evaporation of water from fibres is illustrated in the present paper.

The earlier work was carried out with the assistance of the Cambridge Instrument Company, 45, Grosvenor Place, London, and the completed form of the instrument has been placed by them on the market.

XVI. (*a*). B. A. Keen. "*The Odén-Keen Automatic Balance.*" Proceedings of the Fourth International Conference on Soil Science. Int. Inst. of Agric., Rome, 1924.

(See preceding paper for abstract.)

XVII. R. A. Fisher and Sven Oden. "*The Theory of the Mechanical Analysis of Sediments by Means of the Automatic Balance.*" Proceedings of the Royal Society of Edinburgh, 1924. Vol. XLIV., pp. 98-115.

Ideally the mechanical analysis of a soil should enable us to state what fraction of the soil consists of particles smaller than any assigned size. In 1916 Odén showed that the distribution by size of the particles could be obtained by a sedimentation process. The necessary sedimentation curve may most readily be obtained by means of the Odén-Keen automatic balance. (*See* paper XVI.) The present paper consists of :—

(*i*) A simplified mathematical statement of the theory of the changes taking place in the fluid during sedimentation, showing

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from what physical observations the required distribution curve may be derived, and verifying Odén's formula.

(*ii*) A criticism of Schloesing's sedimentation formula.

(*iii*) The development of practical methods for the statistical treatment of the readings of the automatic balance in order to derive the required curve of size distribution.

(*iv*) An examination of the degree of accuracy obtained in a duplicate experiment carried out on Rothamsted soil, by the Physical Department; and of the incidence of random and systematic errors in this experiment.

(*v*) A discussion of the causes of error in the current technique, and of the means of control of the fluid motions to which they appear to be due.

### (*b*) PHYSICAL PROPERTIES OF SOIL.

XVIII. B. A. KEEN. *"Recent Advances in Soil Physics."* Proceedings of the Fourth International Conference on Soil Science. (Int. Inst. of Agric., Rome, 1924.)

A review of work in this subject since 1900, and a critical discussion of some outstanding problems.

XIX. E. M. CROWTHER and J. R. H. COUTTS. *"A Discontinuity in the Dehydration of Certain Salt Hydrates."* Proceedings of the Royal Society. A., 1924. Vol. CVI., pp. 215-222.

During a preliminary study of the evaporation of water from soils and colloidal material, experiments were made with the simplest solid systems, viz., crystalline hydrates, using the automatic balance (paper XVI). In the evaporation of water from $CuSO_4.5H_2O$ and $BaCl_2.2H_2O$ at 100°C, a marked discontinuity was noticed. The evaporation proceeded rapidly up to the formation of the definite hydrates $CuSO_4.3H_2O$ and $BaCl_2.1H_2O$, but was almost completely interrupted at these points. After varying periods the evaporation recommenced and proceeded rapidly to the formation of $CuSO_4.1H_2O$ and $BaCl_2$. A tentative explanation is advanced, based on Langmuir's treatment of actions at surfaces.

XX. B. A. KEEN. *"On the Moisture Relationships in an Ideal Soil."* Journal of Agricultural Science, 1924. Vol. XIV., pp. 170-177.

This paper consists of a critical examination of a portion of Wilsdon's theoretical investigation on moisture relationships. Wilsdon's investigations appeared to show that the maximum moisture holding capacity of an ideal soil (*i.e.*, one built up of uniformly packed solid spheres all having the same radius) was 23.46 per cent. Further, his experimental and theoretical work indicated that the total amounts of water held by the soil colloids, as distinct from the "free" or interstitial water was 4.7 x (Hygroscopic Coefficient). The total moisture holding capacity of an ordinary soil would therefore be :—4.7 x (Hygroscopic Coefficient) + 23.46, which is remarkably close to Briggs' well

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known empirical expression :—4.3 x (Hygroscopic Coefficient) + 21. The present paper shows that the derivation of the value 23.46 per cent. cannot be substantiated, because the analyses take no account of the fact that the adjacent water wedges surrounding each point of contact of the spheres come into contact with each other at a moisture content very considerably below 23.46 per cent. The value is in fact much too high, and Briggs' figure 21 still remains empirical. An explanation is suggested for the gradual decrease with height in the moisture content of a long unbroken soil column saturated at the base.

XXI. E. M. Crowther and A. N. Puri. *"The Indirect Measurement of the Aqueous Vapour-pressure of Capillary Systems by the Freezing-point Depression of Benzene."* Proceedings of the Royal Society. A., 1924. Vol. CVI., pp. 232-242.

With a view to developing a technique for the measurement of vapour pressures in relatively dry soil, a study was made of the freezing-point depressions (F.P.D.) of moist benzene in equilibrium with the soil. Sidgwick's assumed proportionality between the F.P.D. of benzene and the aqueous vapour pressure of the with the soil. Sidgwick's assumed proportionality between the F.P.D. of benzene and the aqueous vapour pressure of the material with which it is in equilibrium, was substantiated by experiments on sulphuric acid-water mixtures. All soils showed a systematic deviation, the observed F.P.D. being in all cases greater than that calculated from the vapour pressure. By postulating a system of micropores or capillaries in the soil, and allowing for the effect of benzene on the surface tension of the soil water, an expression was obtained which agreed with the observed values. This agreement supports the view that many of the observed colloidal properties of soils can be interpreted in terms of minute capillaries.

XXII. A. N. Puri, E. M. Crowther and B. A. Keen. *"The Relation between the Vapour Pressure and Water Content of Soils."* Journal of Agricultural Science, 1925. Vol. XV., pp. 68-88.

Much of the modern work on the physical properties of soils has been interpreted on a colloidal basis. There is evidence that the colloidal portion can be regarded as possessing a reticulate structure, possibly analogous to that shown to exist in silica gels. These minute pores largely control the vapour pressure of soils at different moisture contents, and a measurement of this property offers a promising line of attack on the physical relations between the colloidal soil material and water.

Three experimental methods were tried and the most convenient was one in which the soils were allowed to come into equilibrium in a vacuum dessicator, over sulphuric acid of the desired strength. Some of the soils were subjected to various treatments known to affect other physical properties, such as successive wetting and drying, heating, and addition of salts. The general results were as follows :—The water absorption at

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definite relative humidities is almost independent of temperature over the range 20° to 40° for high relative humidities, but decreases markedly with increasing temperatures for the lower relative humidities. This influence of temperature on the relative vapour pressures of moist soils is connected with the fact that dry soils liberate heat when wetted. All soils show considerable hysteresis in their vapour pressure relationships. The apparent water content or loss on heating of a soil increases regularly with the temperature of heating up to about 200°C. Soils heated to various temperatures between 100° and 200° C. show substantially the same water absorptions at different relative humidities. The water absorption by a soil is markedly affected by previous treatment with agents known to disintegrate the soil.

The vapour pressure curves of the various soil fractions, including clay, differ only slightly in type from that of the soil, although the absolute amounts of water taken up increase with the increasing specific surfaces.

Some preliminary data are given to show the complicated effects resulting from addition of salts to the soil.

XXIII. A. N. Puri and B. A. Keen. "*The Dispersion of Soil in Water under Various Conditions.*" Journal of Agricultural Science, 1925. Vol. XV., pp. 147-161.

A study has been made of the intensity of the forces binding soil particles together, when the soil has been previously subjected to treatments simulating various field conditions, and certain laboratory processes connected with physical, chemical and biological investigations.

The technique consisted in shaking soil with water under reproducible conditions, allowing the mixture to stand for 24 hours, and then determining the concentration of soil in the top 8.5 cms. of the suspension: this was expressed as a percentage of the original concentration, and the value thus obtained was called the dispersion factor of the soil under the conditions of treatment.

The following conclusions emerge from the data :—

(*a*) Disintegration of soil aggregates by shaking in water proceeds continuously, rapidly at first and then more slowly. After nearly 100 hours of shaking, the dispersion factor is still slowly increasing, and its change with time after completion of the first rapid increase can be expressed by the equation :—

$$d = a + K \log t.$$

where d = disperson factor, t = time of shaking, a and K = constants

(*b*) The dispersion factor depends on the original concentration of the soil. There are slight but systematic changes in the lower concentrations and flocculation occurs when a certain maximum concentration is passed. It is probable that, besides the increase in concentration, the concomitant increase in the amount of soluble salts present is concerned in the flocculation process.

(*c*) The dispersion factor for clay decreases continuously with decrease in initial moisture content, whereas with soil a stationary value is reached when the moisture content is reduced to a certain



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value. Contact with water or water vapour breaks up soil aggregates only very slowly.

(*d*) A progressive decrease in the dispersion factor is caused by heating the soil to temperatures over 110° C., but up to this temperature no reduction appears. In the case of clay, heating to 100° C. greatly reduces the dispersion factor.

(*e*) The influence of electrolytes is progressive and gradual, and not a sharp flocculation or deflocculation. With successive increases in concentration of good deflocculants the dispersion factor increases to a maximum, then decreases slowly, and then rapidly until complete flocculation occurs.

(*f*) A comparison of various methods recommended for soil dispersion shows that the use of a rubber pestle is one of the most efficient means.

XXIV. A. N. Puri. "*A Critical Study of the Hygroscopic Coefficient of Soil.*" Journal of Agricultural Science, 1925. Vol. XV., pp. 272-283.

The Hygroscopic Coefficient, defined as the percentage by weight of water held by a soil when in equilibrium with an atmosphere saturated with water vapour, has been much used, especially in America, as a means of characterising a soil. Accurate determination of the value is not easy, owing, among other things, to the difficulty of maintaining a correctly saturated atmosphere. The present investigations were made with a technique deliberately refined beyond that possible in routine laboratory determinations, in order to obtain some idea as to the inherent value of the method itself, and of the justification of the conception of the Hygroscopic Coefficient.

The results, while incidentally clearing up the controversy whether the Hygroscopic Coefficient, as determined under ordinary conditions, increases or decreases with increase of temperature, show definitely that even with a very careful technique, only qualitative accuracy can be obtained. The paper concludes with a short discussion of the manner in which soil absorbs water vapour, in which the conception of the Hygroscopic Coefficient is criticised on physical grounds.

XXV. W. B. Haines. "*Studies in the Physical Properties of Soils. I. Mechanical Properties Concerned in Cultivation.*" Journal of Agricultural Science, 1925. Vol. XV., pp. 178-200.

The general problem considered in this paper is that of supplying, by means of laboratory tests, data as to the mechanical behaviour of soils sufficient to form a basis for the mathematical treatment of ploughing and cultivation operations in the same way that other engineering problems are usually treated. As a first step to this end certain physical investigations already carried out at Rothamsted have been grouped together under the following heads :—

(*a*) Soil cohesion.
(*b*) Soil plasticity.
(*c*) Friction between a metal surface and soil.

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In each case the variation of properties for different soil types is considered, as well as the variation in the same soil for different moisture contents.

(*a*) *Cohesion.* Atterberg's method was used, the apparatus being specially designed to give the cutting or breaking strain of prepared soil specimens. A comparison of the author's results with Atterberg's shows a difference in character of theoretical importance.

(*b*) *Plasticity.* A simple statement of the constants involved in measurements of plasticity is first made, in order to clear a certain confusion hitherto shown in applying the subject to soils. One of these constants, which may be called "the pressure of fluidity," was measured by a new method which has proved a sensitive means of classifying the behaviour of clays.

(*c*) *Surface Friction.* The apparatus used for friction measurements is described in another communication (*see* paper No. XXVI.). The results show very marked differences according to soil type, and throw an interesting light upon the theory of soil moisture relationships. The subject is a new one in soil measurements, and the method promises to be very effective in the physical examination of soils.

Although much remains to be done to fill in gaps in the data, the grouping together in this way has thrown into clearer relief many of the outstanding problems of soil physics.

### (*c*) SOIL CULTIVATION.

XXVI. E. M. CROWTHER and W. B. HAINES. "*An Electrical Method for the Reduction of Draught in Ploughing.*" Journal of Agricultural Science, 1924. Vol. XIV., pp. 221-231.

The frictional force between mouldboard and the soil constitutes an appreciable fraction of the total draught in ploughing. In this paper a simple electrical method is suggested and investigated for the reduction of friction on moist substances. In its application to ploughing, a current is passed through the soil having the mouldboard as the negative electrode. As moist soil exhibits the phenomenon of electro-endosmosis, and as the soil colloids have a negative charge, water moves through the moist soil towards the negative electrode under the action of the electric current. The mouldboard thus becomes covered with a water film, which should act as a lubricant and reduce the ploughing draught. Under laboratory conditions, striking reductions in friction were obtained. A number of field experiments showed that the device reduced the effort required in ploughing. The reduction was, however, much smaller than in the laboratory experiments, but there is considerable possibility of improvement in the method of applying the current, and thus obtaining greater reduction in draught. The method promises to have useful extensions to certain other cultivation processes such as mole drainage and deep ploughing. (*See* paper LXI.)

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(*d*) SOIL REACTION.

XXVII. E. M. CROWTHER. "*Studies in Soil Reaction. III. The Determination of the Hydrogen Ion Concentration of Soil Suspensions by Means of the Hydrogen Electrode.*" Journal of Agricultural Science, 1925. Vol. XV., pp. 201-221.

An improved hydrogen electrode apparatus is described and its use illustrated by reference to a number of soils showing characteristic crop failures. The buffer action of soils is represented by titration curves giving the equilibrium pH values corresponding to additions of varied amounts of lime water. Adjacent or similar soils may show considerable differences in pH value with no change in their buffer action. In such cases any "lime requirement" method is likely to show results which are correlated with the pH values, but this cannot be the case in soils of different types with different degrees of buffer action. Additions of neutral salts cause considerable increases in the hydrogen ion concentrations of both acid and slightly alkaline soils. Sodium salts, including sodium hydroxide, always give lower hydrogen ion concentrations than the corresponding potassium or calcium salts. The titration curves of a soil in the presence of different amounts of a neutral salt run parallel; the buffer action of a soil is not affected by neutral salts. Extraction of a soil with water causes a considerable reduction in the hydrogen ion concentration, *i.e.*, an increase in pH value. This effect may operate in wet seasons in diminishing the infertility of acid soils and in increasing the stickiness of heavy soils. A number of soils showed a regular decrease of 0.1 in pH value for a two-fold increase in the soil-water ratio. This "dilution effect" and the "salt effect" appear to result from a complex equilibrium between the hydrogen ions and metallic cations, at the soil surface, and form important cases of "base exchange." The indicator methyl red gives erroneous results in turbid suspensions owing to the absorption by the soil of the red form, which is apparently a cation exhibiting "base exchange" with the soil.

XXVIII. E. M. CROWTHER. "*Studies in Soil Reaction. IV. The Soil Reaction of Continuously Manured Plots at Rothamsted and Woburn.*" Journal of Agricultural Science, 1925. Vol. XV., pp. 222-231.

The continuously manured grass plots at Rothamsted and barley plots at Woburn are acid, except in one or two cases. Sulphate of ammonia has caused a marked increase in acidity, and nitrate of soda a slight increase. The farmyard manure plot at Woburn is appreciably less acid than the unmanured. Mineral manures have had little or no effect on the reaction of the surface soil, but sulphate of potash has slightly increased the acidity of the subsoil below the more acid plots. There is some evidence that the acidity of the surface soil at Rothamsted is approximating to an upper limit of pH value 3.8, where large dressings of sulphate of ammonia are applied. The change in

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pH value as a result of liming is less than that shown in the laboratory, owing in part to the reduction of the acidity of the subsoil. Application of amounts of lime equivalent to the Hutchinson-MacLennan " lime requirement " reduced the acidity by an amount equal to +0.5 to +0.7 in pH value, but the soils still remained appreciably acid.

XXIX. E. M. CROWTHER. *" Studies in Soil Reaction. V. The Depth-distribution of Reaction and Flocculation in Continuously Manured Soils."* Journal of Agricultural Science, 1925. Vol. XV., pp. 232-236.

The reactions of the unmanured and the limed and unlimed portions of the sulphate of ammonia plots on Rothamsted Park Grass and Woburn Barley plots change steadily with increasing depth, and at 36in. still show the same relations as in the surface soil. The difference in pH values between the limed and unlimed portions is substantially constant at all depths down to 36in. The reaction of the subsoil plays an important part in determining the effect of liming. The subsoils from the sulphate of ammonia plots at both centres are highly flocculated. Mixtures of 1 part of soil with 5 parts of water exhibit complete flocculation in the case of all samples below 9in. and the velocity of sedimentation decreases and the volume of the final sediment increases regularly and markedly with the depth. Such changes in soil texture possibly constitute an important factor in the effects due to a high surface acidity.

XXX. E. M. CROWTHER and W. S. MARTIN. *" Studies in Soil Reaction. VI. The Interaction of Acid Soils, Calcium Carbonate and Water, in Relation to the Determination of 'Lime Requirements.' "* Journal of Agricultural Science, 1925. Vol. XV., pp. 237-255.

The Hutchinson-MacLennan " lime requirement " method has given useful results in the hands of certain workers but not of all. The variations in " lime requirement " resulting from changes in the amounts of soil and calcium bicarbonate are shown to be connected with buffer action of the soil, as determined by electrometric measurements of the hydrogen ion concentration, after the addition of lime water. A systematic difference between the direct electrometric titration curves and the indirect titration curves calculated from the calcium bicarbonate experiments, is due to the variable calcium concentration of the bicarbonate solutions. In the presence of calcium chloride both methods show higher acidities for a given base absorption, and give almost identical titration curves. The Hutchinson-MacLennan " lime requirement " is always less than that equivalent to the amount of lime required to give a neutral solution (pH=7.0) in the electrometric titrations, a result which accords with the field results quoted in the preceding papers. The calcium bicarbonate solutions after treatment with soil are quite acid, with pH values always less than 6.2, but the salt effect tends to give higher base absorption than is given for the same pH value in the titration Curves. Better values for the " lime requirement " are obtained by interpolating the results to a constant,

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but arbitrary, calcium bicarbonate concentration. An empirical relationship has been found which enables such an interpolation to be made from a single experiment. The Hutchinson-MacLennan method can give no indication of the intensity of soil acidity, but it will serve a useful purpose in showing the amount of lime needed to reduce this acidity considerably; it gives guidance as to the amount of lime to apply, where pH measurements and other tests and observations have shown that lime is needed. The interaction of soil with calcium acetate and dicalcium phosphate give results of the same type as those given with calcium bicarbonate. Calcium carbonate suspensions, containing phenol red or cresol red, show an almost instantaneous colour change when poured on air-dry acid soil, owing to the decomposition of some calcium carbonate. The interaction of acid soil with calcium carbonate and water in full bottles liberates an amount of total acid, as carbonic acid and calcium bicarbonate, which is greater than that estimated by the Hutchinson-MacLennan method. Still greater quantities of acid are liberated when water is percolated through intimate mixtures of acid soil and calcium bicarbonate. These differences are to be explained by the higher pH values of the liquid at equilibrium, and the conditions approximate more closely to those obtaining in the field. (*See* paper LXII.)

See also Paper LVI.

XXXI. T. Eden. "*The Edaphic Factors Accompanying the Succession after Burning on Harpenden Common.*" Journal of Ecology, 1924. Vol. XII., pp. 267-286.

The floristic survey of Harpenden Common shows the succession of vegetation after the periodical fires to be *Rumex acetosella, Holcus lanatus, Agrostis.* Of the soil factors influenced by burning those of soil reaction (in terms of the Hutchinson-MacLennan Lime Requirement and pH measurement) and humus content show a gradation accompanying the progress of the succession. The nature of the acidity and its probable relation to the succession, the formation of humus and to burning are discussed.

(*e*) CHEMICAL PROPERTIES OF SOIL.

XXXII. H. J. Page and W. Williams. "*Studies on Base Exchange in Rothamsted Soils,*" Transctions of the Faraday Society, 1925. Vol. XX., pp. 573-585.

The content of exchangeable bases in the soil of certain plots on Broadbalk field, and the Grass Plots, Rothamsted, has been determined by Hissink's method. The results show that in the soil of Broadbalk field, containing excess of chalk :—

(*a*) The relative proportions of the different bases vary consistently with the manuring. In all the soils about 90 per cent. of the exchangeable bases (in equivalents) consists of calcium.

(*b*) The total content of exchangeable bases can be correlated with the amount of fine inorganic material (diameter of particles less than 0.005 mm.) and of organic matter.

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(*c*) There is probably a gradual conversion of exchangeable potash to a non-exchangeable form, or *vice versa*, depending on whether potash manures are used or not.

In the acid soil of the Grass Plots, from which chalk is absent, the soils are all unsaturated, and the amount of exchangeable calcium can be correlated with the pH of the soil.

The bearing of these results on current theories of base exchange in soils, and on the relation between soil acidity and ionic exchange, is discussed.

XXXIII. N. N. Sen Gupta. "*Dephenolisation in Soil, Part II.*" Journal of Agricultural Science, 1925.

Soils possess the power of destroying phenol under conditions precluding the possibility of biological action. This power, which is greatly increased by preliminary acid-treatment of the soil, varies greatly from soil to soil. It is shown that this chemical dephenolising power of soils depends upon the presence of an oxidising agent, and that most of the action is due to the presence of manganese in the soil, probably in the form of manganese dioxide.

(*f*) CHEMICAL ANALYSIS.

XXXIV. T. Eden. "*A Note on the Colorimetric Estimation of Humic Matter in Mineral Soils.*" Journal of Agricultural Science, 1924. Vol. XIV., pp. 469-472.

An application to mineral soils of the method worked out for peat soils by Odén.

XXXV. H. J. Page. "*On the Perchlorate Method for the Estimation of Potassium in Soils, Fertilisers, etc.*" Journal of Agricultural Science, 1924. Vol. XIV., pp. 133-138.

The presence of chloric acid in the perchloric acid used for the estimation of potassium in soils, fertilisers and plant material by Davis's method gives rise to very erratic and erroneous results. Every sample of perchloric acid should, therefore, be tested for freedom from chloric acid before being used for the estimation of potassium.

In the application of Neubauer's method of treatment of the soil extract to a soil deficient in carbonates, it is sufficient to add only 0.1 gm. of calcium carbonate to the extract instead of the 0.5 gm. generally used. A considerable economy of perchloric acid is thereby effected.

XXXVI. E. M. Crowther and W. S. Martin. "*The Volumetric Determination of Total Carbonic Acid in Dilute Solutions of Calcium Bicarbonate.*" Journal of the Chemical Society, 1924. Vol. CXXV., pp. 1937-1939.

In the course of studies on soil reaction (papers XXVII-XXX), it was found that the standard method for the determination of total carbonic acid (excess barium hydroxide and