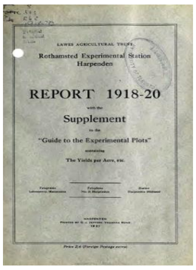
Report 1918-20 With the Supplement to the Guide to the Experimental Plots Containing the Yields per Acre Etc.



Full Table of Content

Environmental Factors : Physical Department XXIII-xxix

Rothamsted Research

Rothamsted Research (1921) *Environmental Factors : Physical Department XXIII-xxix ;* Report 1918-20 With The Supplement To The Guide To The Experimental Plots Containing The Yields Per Acre Etc., pp 45 - 48 **- DOI: https://doi.org/10.23637/ERADOC-1-109**

3.—There appears, however, to be some non-biological slow decomposition also, since the decomposition in unmanured soil poor in micro-organisms is much slower than in manured soils, and altogether different in character.

Autoclaving the soil at 130° for 20 minutes destroys the cause or causes of the decomposition altogether, but the action proceeds, although much more slowly, than in untreated soil, in the presence of a considerable amount of toluene and mercuric chloride.

Partial sterilisation by treatment with toluene which was evaporated before the addition of phenol increases the rate of decomposition, but steaming does not.

The decomposition takes place even in soil air-dried to 2.4% moisture, but it is extremely slow compared with the rate in normal soil.

When successive doses of phenol are applied to the same soil, each dose is decomposed at a higher rate than the preceding one. This is entirely in accordance with a decomposition mainly biological in character. The same effect has been observed in the case of *m*-cresol.

The treatment of the soil with sulphuric acid (50% by volume) either before or after the addition of phenol greatly augments the instantaneous loss, which may amount to 90% in case of phenol This loss is not affected by autoclaving.

CONDITIONS DETERMINING ENVIRONMENTAL FACTORS IN THE SOIL.

XXIII. B. A. Keen. "*A Note on the Capillary Rise of Water in Soils.*" Journal of Agricultural Science, 1919. Vol. IX. pp. 396-399.

A simple formula for the theoretical maximum rise in an ideal soil, composed of closely packed and uniform spherical grains, may be obtained from a consideration of the triangular pores existing in such a soil. The formula reduces to $h = \frac{.75}{r}$ where h = height of rise and r = radius of spherical grain. The capillary rises given in the following table are calculated on the assumption that a soil is made up entirely of one given soil fraction, and not of a mixture of fractions, and the particles are taken as closely packed spheres :—

Soil Fraction	Diameter in mm.		Capillary Rise in cms.		Average Rise in Ft.
	Max.	Min.	Min.	Max.	
Fine gravel .	3	1	5	15	⅓
Coarse sand .	1	.2	15	75	1½
Fine sand .	.200	.040	75	375	7½
Silt . . .	.040	.010	375	1500	31¼
Fine silt . .	.010	.002	1500	7500	150
Clay . .	.002	--	7500	—	150 upwards

XXIV. B. A. KEEN. "*A quantitative Relation between Soil and the Soil Solution brought out by Freezing-point Determinations.*" Journal of Agricultural Science, 1919. Vol. IX. pp. 400-415.

An analysis is made of the experimental data accumulated by Bouyoucos and others in their investigations of the freezing-point depression of the soil solution *in situ* under various conditions. Bouyoucos finds that the soil solution in quartz sand and extreme types of sandy soil behaves approximately like dilute solutions, the freezing-point depression varying as the concentration, or, in the present case, inversely as the moisture content, *i.e.*,

$$M_n D_n = K$$

where K = constant, D_n = freezing-point depression at moisture content of M_n. In the vast majority of soils, however, the freezing-point depression increases much more rapidly with decreasing moisture content than this equation would imply, and Bouyoucos was led to suppose that the soil rendered a definite amount of water "unfree," in the sense that it did not take part in the freezing-point depression.

This hypothesis is quantitatively examined in the present paper, and it is shown from Bouyoucos' experimental data that :—

1.—The water rendered unfree is not a constant amount, but varies with the moisture content.

2.—A definite relation exists between the free, unfree and total moisture, expressed by the equations :—

$$Y_n = cM_n^x$$

$$Z_n = \frac{1}{c^{\frac{1}{x}}} Y_n^{\frac{1}{x}} - Y_n$$

where c and x are constants for any one soil,
M_n = total moisture content,
Y_n = free water,
Z_n = unfree water.

XXV. B. A. KEEN. "*The Relations existing between the Soil and its Water Content.*" Journal of Agricultural Science, 1920. Vol. X. pp. 44-71.

This paper is a general survey of the literature of the subject. Until recently, most of the experimental data was interpreted on the assumption that the moisture was distributed in a thin film over the surface of the soil grains. The water in this film was divided into three classes: hygroscopic, capillary and gravitational. The gravitational water could drain away into the subsoil, the capillary water was retained by the soil, and was capable of movement therein, and the hygroscopic moisture was assumed to be incapable of movement under capillary or gravitational forces.

It was found that these divisions were insufficient to explain the observed facts, and a number of auxiliary divisions and equilibrium points were introduced, mainly by American workers. This carried with it the serious defect that each sub-section was more or less detached from its neighbours, and thus the hypothesis did not give a complete picture of the *continuous* processes operating between soil and its moisture content when the latter varied over wide limits. Endeavours were therefore made to link up the sub-divisions by means of cross-relations between the variables, but they were mainly applicable over some small range of moisture content or to some approximate equilibrium values.

The development of the study of colloids rendered it possible to consider the relations between soil and its moisture content by an alternative hypothesis which would stress their continuous nature. It is now considered that the soil particles are coated with a colloidal complex, derived from the clay and the organic matter. In the concluding section of the paper a number of investigations are considered and interpreted on this hypothesis, and some of the most promising future lines of work are indicated.

XXVI. B. A. Keen. "*The Physical Investigation of Soil.*" Science Progress, 1921. Vol. XV. pp. 574-589.

This is a general account of the scope of physical science in investigations on soil. It deals with the dimensions of soil particles and the manner of their arrangement in the soil, the temperature, moisture, and atmospheric relations in the soil, and indicates also the great need for research on methods of cultivation and the effect on the soil of the form of implement used, in view of the important changes in farming practice brought about by the introduction of the tractor.

XXVII. B. A. Keen and E. J. Russell. "*The Factors determining Soil Temperature.*" Journal of Agricultural Science, 1921. Vol. XI.

The purpose of this paper is to discuss the factors influencing soil temperature and the extent to which other measurements (air, temperature, hours of sunshine, etc.) can be utilised in cases where direct determinations of soil temperature are not made.

An analysis has been made of one year's records given by a special recording thermometer embedded at the 6in. depth in bare soil, together with continuous records of air temperature and hours of sunshine; these have been supplemented by daily readings of rainfall, radiation, and soil temperature at the 12in. depth. The extent of the temperature rise at the 6in. depth is largely determined by the amount of solar radiation reaching the earth's surface (correlation co-efficient $.877 \pm .009$). As would be expected, the hours of sunshine also provide a good measure of this radiation.

The maximum temperature at the 6in. depth during the summer months is about equal to that of the air, and the minimum temperature is from 6°—8° C. higher than the air minimum.

During this period, the conditions therefore resemble those in a 20° C. incubator.

In the winter months the minimum temperature at the 6in. depth is usually about 2°—3° C. higher than that in the air, and the maximum temperature is a little below the maximum air temperature. The effect of rainfall is generally to diminish the rise of temperature, but the relation is by no means exact. No evidence was found supporting the belief that spring rains warm the soil; on the other hand, autumn rains apparently prevent the soil from cooling as much as it would otherwise have done.

There is no satisfactory substitute for a recording soil thermometer, but a fair estimation of the mean daily temperature at the 6in. depth can be obtained over the greater part of the year by regarding the maximum air temperature as the maximum soil temperature, and the 12in. depth soil temperature at 9 a.m. as the minimum, and then taking the mean.

The relations between the daily temperature rise in the soil and the air have been studied in detail by following the changes in the ratio $\frac{\text{soil amplitude}}{\text{air amplitude}}$ from day to day. These ratios fall into a well-defined frequency curve whose maximum occurs between the values .2—.3. This range of the ratio is prevalent in spring and early summer, and also in early autumn. A similar curve is given by the ratios of the daily cooling of soil and air, the maximum in this case being between .3—.4. The ratio $\frac{\text{soil amplitude}}{\text{air amplitude}}$ of course alters when either, or both, numerator and demominator change. A series of relations between these changes, both for individual and averaged values is given in the paper.

XXVIII. E. A. Fisher. "*Studies on Soil Reaction—I. A résumé.*" Journal of Agricultural Science, 1921. Vol. XI. pp. 19-44.

A critical account of the various hypotheses put forward to explain the phenomena of soil acidity and the methods that have been suggested for estimating it. All present methods are shown to be defective. The hydrogen ion concentration gives useful indications, but the titration methods, lime requirement methods, etc., are defective because the lime requirement is really very complex, being made up of two factors; the lime required to neutralise soil acids, and the lime actually absorbed by the soil. It is impossible at present to differentiate these or to compare with any degree of strictness one soil or one base with another.

XXIX. E. A. Fisher. "*Studies on Soil Reaction—II. The colorimetric determination of the hydrogen ion concentration in soils and aqueous soil extracts.*" Journal of Agricultural Science, 1921. Vol. XI. pp. 45-65.

Details to be observed and difficulties to be overcome in the colorimetric determination of the hydrogen ion concentration in soils. It is shown that the fineness of division of the soil is of considerable importance.

PLANT PATHOLOGY.

XXX. A. D. Imms and M. A. Husain. "*Field Experiments on the Chemotropic Responses of Insects.*" Annals of Applied Biology, 1920. Vol. VI. pp. 269-292.

During the course of these experiments the insects attracted consisted almost exclusively of *Diptera; Hemiptera, Coleoptera* and *Neuroptera* were unrepresented. A small number of *Noctuid Lepidoptera* entered the traps, which however were not adapted for such relatively large insects as many *Lepidoptera*. Beer, cane molasses, and mixtures of these two substances are powerful

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