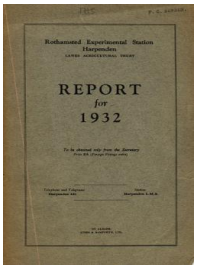
ROTHAMSTED RESEARCH

# Rothamsted Report for 1932

*Full Table of Content*




# Summaries of Papers Published in 1932 - I. Scientific Papers

## Rothamsted Research

Rothamsted Research (1933) *Summaries of Papers Published in 1932 - I. Scientific Papers ;* Rothamsted Report For 1932, pp 67 - 90 **- DOI: https://doi.org/10.23637/ERADOC-1-64**

# SCIENTIFIC PAPERS

Published 1932, and in the Press

## PLANT GROWTH, PLANT PRODUCTS AND ACTION OF MANURES

(Departments of Botany, Chemistry, Fermentation, Physics and Statistics ; and the Imperial College Staff)

### (*a*) PLANT GROWTH.

I. F. J. RICHARDS. "*Physiological Studies in Plant Nutrition. III. Further Studies of the Effect of Potash Deficiency on the Rate of Respiration in Leaves of Barley.*" Annals of Botany, 1932, Vol. XLVI, pp. 367-388.

The part played by water content in determining the differences in the usual characteristics between leaves from barley grown under various types of mineral salt deficiency is discussed ; the conclusion is reached that differences in the ratio of dry weight to leaf area between treatments are almost wholly accounted for by differences in water content, whereas the variation of this ratio from leaf to leaf on the same plant is due primarily to variation in anatomical structure.

Results of experiments on the respiration rate of the successive leaves from plants grown at four external potash concentrations are presented. They show clearly that, in general, as the level of potash concentration is lowered, respiration rate increases, but that there is an optimum concentration below which the rate again decreases.

The positive correlation between respiration rate and amount of potash supplied, at very low concentrations, is apparently entirely due to the fact that carbohydrate concentration within the leaf is in the minimum. When abundant carbohydrate is present, the evidence is that over the complete range of manuring used there is a negative correlation between respiration rate and amount of potash supplied. A theory based on the amino-acid content of the leaf is put forward in explanation of this.

As the external concentration of potash decreases, so does the internal, but the relationship is not linear. There is strong evidence that where the amount of potash within the leaves is high, much of it may be washed out by rain, but under conditions of starvation what potash is present cannot be removed in a like manner.

II. W. E. BRENCHLEY AND S. G. HEINTZE. "*Colonisation by Epilobium angustifolium.*" Journal of Ecology, 1933, Vol. XXI, pp. 101-102.

*Epilobium angustifolium* (Rose-bay) established itself on certain acid areas of Park Grass plots on which the herbage had been devastated by the severe frosts of 1928-9, which was followed by exceptional drought. Examination of the pH value of the soil indicated

*https://doi.org/10.23637/ERADOC-1-64* 

that the varying distribution of Epilobium was a question of competition rather than soil reaction.

Where most Epilobium appeared, the return of the normal vegetation on the devastated patches was less complete than on the other plots, and the young Epilobium seedlings had therefore a better chance of establishing themselves. This fits in with the known facts of the habits of the species, which tends to spring up freely where areas have been cleared by fire, blizzard or similar drastic agencies, to disappear again as other vegetation reasserts itself, as has since happened in this case with the steady improvement in the grass herbage.

III. W. E. BRENCHLEY AND K. WARINGTON. "*The Weed Seed Population of Arable Soil. II. Influence of Crop and Methods of Cultivation upon the Relative Abundance of Viable Seeds.*" Journal of Ecology, 1933, Vol. XXI, pp. 103-127.

The weed seed population of the soil is greatly influenced by the type of crop grown. Soil conditions being similar, the composition of the flora under continuous wheat and barley is very much the same, but the relative abundance of the constituent species varies greatly, some being favoured by the wheat crop and others by the barley.

When fallowing operations are carried out, most species of weeds are reduced in number, but the degree of reduction ranges over a wide percentage, while a few species may even be increased. These variations seem to depend upon the correlation between the times of the fallowing operations and the periods of maximum germination of the different species, coupled with the length of their natural dormancy. If the intervals between cultivations are too prolonged, some species are able to reach maturity and replenish the soil with so many seeds that the beneficial effect of the fallowing is entirely lost.

When land is cropped, the processes of cultivation affect the weed flora more variably than is the case with fallowing. On the same area some species may be drastically reduced, while others may be doubled or trebled in quantity. This again depends on the correlation between the date of sowing the crop, the method of cultivation, and the habits of the weed species as regards maximum period of germination and length of natural dormancy.

Some weed species respond to cropping and fallowing in the same general direction, being reduced by both methods of cultivation. Other species may be generally reduced by fallowing, but behave variably under crop, being increased or decreased in different seasons.

From the agricultural point of view it is apparent that unless fallowing operations can be carried out with a much greater degree of thoroughness than is usual, reduction of many weeds can be effected almost as well and more economically by intensified cultivation while the land is under crop. Other species, however, which tend to increase in some seasons under crop conditions, may be more effectively dealt with by fallowing if their predominance justifies the expense, which implies loss of crop as well as the cost of numerous cultivations.

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IV. R. J. KALAMKAR. "*A Statistical Examination of the Yield of Mangolds from Barnfield at Rothamsted.*" Journal of Agricultural Science, 1933, Vol. XXIII, pp. 161-175.

Series of yields (root weight) of twenty-five plots of Barnfield mangold field are analysed into components representing (*a*) deterioration, (*b*) slow changes other than steady deterioration, (*c*) annual fluctuations. The first two of these components are exhibited graphically from 1876 to 1930.

Yields are well maintained on the dunged strip, except for the last few years. This falling off does not appear in the other strips, and may be due to a falling off in the quality of the farmyard manure in the last five years.

On the strip receiving farmyard manure, and on that receiving superphosphate, the plots receiving nitrate of soda yielded more highly than any others ; on the strips receiving complete minerals, and on that receiving superphosphate and potash, the two plots receiving rape cake in one case, and sulphate of ammonia and rape cake in the other, gave higher yields than nitrate of soda ; on the strip receiving no minerals the result is intermediate, there being little to choose between these three plots. On all strips sulphate of ammonia is the least satisfactory of the four nitrogenous dressings tested.

In 1876 the land had been already for many years under experiment, and the deterioration from this date is not very striking. The complete minerals and the superphosphate plots Series O (without nitrogenous manure) show significant deterioration, as does the strip without minerals on Series AC (rape cake and ammonium sulphate). On the strip without minerals the unmanured plot also, and that receiving rape cake, both show a strongly suggestive deterioration.

Slow changes other than deterioration are unimportant relatively to annual variation except on the dunged plots. Change in the type of cultivation, prevalence of weeds and change in the quality of the manure, are suggested as the probable causes of the slow changes occurring on these plots.

Plots receiving organic manures or potash have shown relatively smaller annual variance. Plots receiving nitrogenous fertilisers have a large annual variation.

### (*b*) PLANT PRODUCTS

V. R. K. SCHOFIELD AND G. W. SCOTT BLAIR. "*The Relationship Between Viscosity, Elasticity and Plastic Strength of Soft Materials as Illustrated by Some Mechanical Properties of Flour Doughs. I.*" Proceedings of the Royal Society of London, A, 1932, Vol. CXXXVIII, pp. 707-718.

An extended significance is given to Maxwell's " time of relaxation," and this has been used in quantitatively describing the viscous and elastic behaviour of flour dough. The length of the time of application of a stress in relation to the corresponding time of relaxation determines what proportion of the deformation is elastic (recoverable) and what proportion plastic (non-recoverable). This fact is illustrated by a comparison of the behaviour of dough in the " pachimeter " and on the " rack," the behaviour in the " pachi-

*https://doi.org/10.23637/ERADOC-1-64* 

meter" (rapid stressing) being paralleled by that exhibited in a ballistic experiment. The decay of internal stress in pieces of dough which had been stretched out and held stretched has been followed, and the times of relaxation and the corresponding viscosities have been evaluated for a series of stresses. Dough shows a phenomenon similar to the hardening of metals under working as a result of which the time of relaxation and the viscosity for a given stress depend on the total deformation.

The internal structure of the dough thus revealed is briefly considered.

VI. R. K. SCHOFIELD AND G. W. SCOTT BLAIR. "*The Relationship between Viscosity, Elasticity and Plastic Strength of a Soft Material as Illustrated by some Mechanical Properties of Flour Dough. II.*" Proceedings of the Royal Society of London, A, 1933, Vol. CXXXIX, pp. 557-566.

The dependence of the viscosity of a flour dough on the shear which has taken place as well as on the shearing stress is brought out by a series of observations on the rate of shear in cylinders of unyeasted dough hung vertically and allowed to elongate under the action of gravity.

The deformations were recorded by marking a millimetre scale in enamel on the surface of the dough cylinders, and, after elongation had proceeded for a measured time, printing the deformed scale off on to a strip of duplicator paper. The print has been called a rheogram.

The conditions of test correspond closely with those ruling inside a dough distending under the action of yeast, but whether the method is capable of distinguishing the small differences which are of importance in baking has still to be determined.

VII. R. K. SCHOFIELD AND G. W. SCOTT BLAIR. "*The Relationship between Viscosity, Elasticity and Plastic Strength of a Soft Material as Illustrated by some Mechanical Properties of Flour Dough. III.*" Proceedings of the Royal Society of London, A, 1933, Vol. CXXXIX, pp.

A further study of the mechanical properties of flour dough has revealed the presence of two properties in addition to hardening, both of which are well known in the study of metals: namely, elastic after-effect and elastic hysteresis.

The first necessitates the addition of a term $d\alpha/dt$ to the Maxwell equation, which then becomes:

$$\frac{de}{dt}=\left(\frac{l}{n}\frac{dS}{dt}-\frac{d\alpha}{dt}\right)+\frac{1}{n}\cdot S$$

This term is only important when abrupt changes of stress have recently occurred.

The second property causes $n$ to decrease steadily whenever $dS/dt$ preserves the same sign for some time, and to increase abruptly when the sign of $dS/dt$ is changed.

In Paper II it was shown that the viscosity, as determined from the rate of flow, agreed roughly but not exactly with that calculated as the product of the rigidity modulus and the relaxation time. It is

*https://doi.org/10.23637/ERADOC-1-64* 

now clear that the value adopted for $n$ was a mean value, and differed somewhat from that appropriate to the conditions during stress relaxation. Due appreciation of this point renders the agreement quantitative.

VIII. F. E. DAY. "*Laboratory Trial Brews with New Varieties of Hops.*" Journal of the Institute of Brewing, 1932, Vol. XXXVIII, pp. 16-18.

Samples of several of the new varieties grown at E. Malling in 1930 were compared with E. Kent Goldings, Saaz, and Oregon hops by means of small-scale brewings. Oregon x English and German x English crosses had flavours intermediate between their parents. Manitoba seedlings gave very bitter flavour. Small-scale brewings are definitely of value in comparing hops. Bitterness of beer is not proportional to $\alpha$-resin addition.

IX. F. E. DAY (in part). "*A Method for the Quantitative Comparison of the Relative Stabilities of Hopped Worts before and after Fermentation.*" Journal of the Institute of Brewing, 1932, Vol. XXXVIII, pp. 308-310.

Small-scale brewing tests gave evidence of the dependence of beer stability on hop resin content, other things being equal. Support is therefore given to the value of analyses of hops for determining their preservative strength.

### (*c*) ACTION OF MANURES

X. W. E. BRENCHLEY. "*The Action on the Growth of Crops of Small Percentages of Certain Metallic Compounds when Applied with Ordinary Artificial Fertilisers.*" The Journal of Agricultural Science, 1932, Vol. XXII, pp. 704-735.

*Copper.* No beneficial effect on the growth of barley or mustard on two types of soil was obtained by the addition of quantities of copper sulphate ranging up to 4 per cent. of the total artificial fertilisers applied.

*Vanadium.* Increased fineness of grinding of basic slag in some cases brings about a certain reduction of crop, which may be due to the presence of vanadium in such slags.

*Lithium.* Barley is less sensitive to the toxic action of lithium than of copper, and a suggestion of stimulation was obtained with very dilute solutions in the presence of nutrient salts. Buckwheat is more sensitive to the action and exhibits stimulation with any concentration.

*Titanium.* The growth of mustard on two different soils was not improved by small proportions of titanium compounds added to the usual artificial fertilisers.

*Aluminium.* Barley proved to be very sensitive to the toxic action of aluminium sulphate, the harmful effect becoming more evident when the nutrient solutions were renewed, so that fresh supplies of poison were brought into contact with the roots. Peas were much less affected, remaining quite healthy in concentrations

https://doi.org/10.23637/ERADOC-1-64 

which killed barley. No evidence of stimulation was obtained with barley, peas, or maize, with any strength of aluminium sulphate, however dilute.

XI. E. M. CROWTHER. "*The Present Position of the Use of Fertilisers.*" Journal of the Royal Agricultural Society of England, 1931, Vol. XCII, pp. 16-18.

A survey of the statistics for the world's production of fertilisers from the beginning of the industry to 1930 showed that for long periods before the war the annual percentage increase in output was remarkably steady. By the time of the "nitrogen crisis" of 1931, the total world output had reached the level that would have been attained if the relative rate of increase had continued at its pre-war rate. Comparisons of the results of large numbers of fertiliser trials brought out the uniformity of the average responses to unit N, $P_2O_5$, and $K_2O$ in their effects on crops, but the wide differences in the ratios of the amounts of the fertiliser consumed in different countries.

XII. E. M. CROWTHER. "*The Loss of Lime from Light Soils (an Examination of the Woburn Barley and Wheat Soils).*" Journal of the Royal Agricultural Society of England, 1932, Vol. XCIII, pp. 199-214.

The exchangeable calcium contents of soil samples taken from the Woburn Experimental Station in 1927 after 50 years of continuous cultivation for wheat and barley and again in 1932 after two years of fallow and three years of cropping without manure are discussed in relation to the recovery of the lime added and the effects of farmyard manure, nitrate of soda, ammonium sulphate, and mineral manures. The conclusions are used in order to interpret past and present practices in light land farming and to show the type of field experiment now urgently required at a number of representative centres.

XIII. E. M. CROWTHER AND R. G. WARREN. "*Report on Field, Pot and Laboratory Work. Appendix to Tenth Interim Report of Permanent Committee on Basic Slag, Ministry of Agriculture,*" 1932, Vol. X, pp. 4-21.

This report gives (*a*) the yields and chemical composition of hay in a series of field trials on four phosphatic fertilisers, mostly in the second year of experimentation; (*b*) the results of a similar trial on pasture grazed by cattle and sheep except for a short period in the season when the produce was mown, weighed and analysed. A series of such separate experiments with interrupted grazing and one with repeated mowing without grazing has shown high effects from the more soluble fertilisers. Over 16 per cent. of the phosphoric acid added in superphosphate was recovered in the first year; (*c*) the results of a repeated mowing experiment for three years in Devon; (*d*) the results of pot experiments for three years on barley.

XIV. H. L. RICHARDSON. "*The Behaviour of Nitrogenous Fertilisers in Grassland Soils.*" Agricultural Progress, 1933, Vol. X, p. 160-163.

Systematic determinations of ammonia and nitrate nitrogen in grassland soils showed that the ammonia level was generally higher

*https://doi.org/10.23637/ERADOC-1-64* 

than the nitrate level. There was a very rapid disappearance of added nitrate and a rather less rapid removal of added ammonia. The rate of removal of the latter, however, was such as to suggest that some of the ammonia might be taken up directly without nitrification. This was made practically certain by a study of the rate of nitrification, which was very low in certain soils from which ammonia was rapidly removed.

The equilibrium between ammonia and nitrate production in these soils is discussed.

XV. J. G. SHRIKHANDE. "*The Degree of Humification in Manures Measured by the use of Hydrogen Peroxide.*" Soil Science, 1933, Vol. XXXV, pp. 221-228.

It is known that humified organic matter can be distinguished from non-humified by the action of hydrogen peroxide. The action of three per cent. hydrogen peroxide has been used for measuring the degree of humification which appears to be a useful measure of the decomposition undergone by any one kind of plant material under different treatments. The loss after extraction with peroxide is not an infallible guide to the value of organic manures in general. A comparison has also been made between the extractive properties of water and peroxide.

## STATISTICAL METHODS AND RESULTS

(Department of Statistics)

### (*a*) MATHEMATICAL THEORY

XVI. R. A. FISHER. "*Inverse Probability and the Use of Likelihood.*" Proceedings of the Cambridge Philosophical Society, 1932, Vol. XXVIII, pp. 257-261.

An explanation of the distinction between these two methods of reasoning from experience, with a correction of some allusions to likelihood in which they are confused.

XVII. R. A. FISHER. "*The Concepts of Inverse Probability and Fiducial Probability Referring to Unknown Parameters.*" Proceedings of the Royal Society, A, 1933, Vol. CXXXIX p.p. 343-348.

The argument of Jeffreys in favour of a particular frequency distribution *a priori* for the precision constant of a normally distributed variate rests on the fallacy that the probability of the last of three observations, lying between the previous two, should be one-third, *irrespective of the distance apart of the two previous observations.*

The apparent simplicity of the results of assuming this particular distribution *a priori* rests on the fact that the *inverse* and the *fiducial* probability statements about the unknown parameter are thereby made to coincide, though logically they are entirely distinct. This particular distribution *a priori* is, however, not only hypothetical but unacceptable as such, since it implies that all ranges of values of the parameter covering finite ratios, however great, are infinitely improbable.



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XVIII. F. YATES. *"The Principles of Orthogonality and Confounding in Replicated Experiments."* Journal of Agricultural Science, 1933, Vol. XXIII, pp. 108-145.

The procedure of confounding certain treatment effects, either direct effects or high order interactions, with fertility differences, has been utilised in certain agricultural field trials of the complex type at Rothamsted and elsewhere for some years. The present paper describes the principles underlying this procedure, and the appropriate methods of analysis, and draws attention to certain dangers which must be guarded against when designing or analysing experiments of this type.

The discussion of confounding necessarily involves the consideration of the independence, or *orthogonality*, of the various sets of degrees of freedom appearing in the analysis of variance. The concept of orthogonality is therefore discussed, and the modifications which are necessary in the ordinary procedure of the analysis of variance when dealing with non-orthogonal data are illustrated by application to an example where there is a double classification (in this case classification by sex and treatments in a poultry feeding trial) and where the numbers in the various sub-classes are unequal, treatments not being equalised for sex, or sex for treatments. This type of data is of frequent occurrence where observation rather than planned experiment is the source of information. In addition to the accepted method of fitting constants by the method of least squares, various shorter methods of analysis are described, and their validity and applicability discussed.

XIX. F. R. IMMER. *"The Efficiency of the Correlation Coefficient for Estimating Linkage Intensities."* American Naturalist, 1931, Vol. LXV, pp. 567-572.

Takezaki and Owen had independently derived a method of estimating linkage by means of the correlation coeffcient.

Takezaki derived a formula for the standard error of his estimate of $p$ from the assumption that the standard error of $r$, obtained from the fourfold table, could be equated to the standard error of a correlation coefficient derived from a normal frequency surface having the same number of observations. This mistaken assumption has led to the precision of this method of estimating linkages being greatly over-estimated.

It is found that the curve for the actual efficiency of the correlation method calculated from the correct formula, does not exceed 100 per cent. for any possible values of $p$, from 0 to 1, in accordance with the general theory. The correlation method is fairly efficient in the coupling phase, and for loose linkage in repulsion. For close linkage in repulsion it is not efficient. Since there are other formulæ such as the maximum likelihood method, and the product ratio method, which are efficient for all values of $p$, it would seem preferable to use these formulae in most cases.

XX. R. S. KOSHAL. *"Application of the Method of Maximum Likelihood to the Improvement of Curves Fitted by the Method of Moments."* Journal of the Royal Statistical Society, 1933, Vol. XCVI, pp. 303-313.

A method is given for the improvement of inefficient statistics obtained by the method of moments. It consists in the evaluation of

*https://doi.org/10.23637/ERADOC-1-64* 

a number of $L$'s directly from the equation $L=S$ ($n_s \log p$). For the estimation of S parameters it requires the calculation of $\frac{1}{2}(S+1)(S+2)$ values of $L$. These values of $L$ provide simultaneous equations from which the corrections to be added to the moment estimates of the parameters can be calculated. The method is illustrated by its application to a coarsely-grouped skew distribution to which Pearson's Type I was fitted by the method of moments. It is shown that the calculation of additional fourteen values of $L$ is not laborious, as most of the material for this calculation is provided by the moment solution.

XXI. T. EDEN AND F. YATES. *"On the Validity of Fisher's z Test when Applied to an Actual Example of Non-normal Data."* Journal of Agricultural Science, 1933, Vol. XXIII, pp. 6-17.

The validity of Fisher's $z$ test depends theoretically on the assumption of normally distributed data. Since certain types of agricultural and other data to which the test may be usefully applied are decidedly non-normal in distribution practical tests with data of this nature are of importance in order to establish that the departures from normality ordinarily met with do not, in fact, invalidate the test. In this paper a test is described on data from the observation of height measurements on wheat. The data were arranged as an 8 block uniformity trial of 4 plots per block, and the distribution of the values of $z$ obtained for a thousand random arrangements of the treatments. This distribution was found to agree satisfactorily with the theoretical distribution for normal data.

### (*b*) TECHNIQUE OF FIELD EXPERIMENTS

XXII. S. H. JUSTESEN. *"Influence of Size and Shape of Plots on the Precision of Field Experiments with Potatoes."* Journal of Agricultural Science, 1932, Vol. XXII, pp. 366-372.

A uniformity trial with potatoes was used for investigating the effect of size and shape of plots on the precision of field experiments. Up to a certain limit the standard deviation in per cent. of the mean decreases when the size of plots is increased; further increase of plot size increases the errors as a lesser part of the soil variation can be removed.

Two-row plots show less variation than either 1 or 3-row plots. This may be explained by row competition.

When the area to be used is fixed, smaller plots are more efficient than larger, owing to the greater number of replications in the former case. One exception occurs in the case where border rows are not harvested; here 4-row plots are more efficient than 3-row plots, owing to the fact that a larger part of the area is included in the calculation when 4-row plots are used.

Long and narrow plots are more efficient than shorter and wider of the same size. The only exception is again explained by row competition.

In field experiments with potatoes, fairly large plots should be used; at least two rows wide and preferably long and narrow strips.

*https://doi.org/10.23637/ERADOC-1-64* 

XXIII. R. J. KALAMKAR. "*Experimental Error and the Field Plot Technique with Potatoes.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 373-385.

The present investigation consists of the statistical analysis of a uniformity trial with potatoes, conducted by Dr. Kirk. In this study the standard error in per cent. of the mean decreased slightly with the increase in the widths up to plots five rows wide, but any further increase in the width of the plot resulted in the higher standard error. The fertility contour map of the field is given to show graphically the effect of soil heterogeneity on the yield. The increased size of the plot resulted in decreased efficiency in the use of the land when the entire plot was harvested ; in other words, given a piece of land of certain size, it is advantageous to have a greater replication of smaller plots than a smaller number of larger plots. Four-row plots proved to be the most efficient when the border rows are discarded. The superiority of long and narrow plots over shorter and wider ones is demonstrated.

XXIV. R. J. KALAMKAR. "*A Study in Sampling Technique with Wheat.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 783-792.

The edge rows give significantly higher yields than the inside rows, indicating thereby the inadvisability of using edge rows in yield trials.

The variation between rows is very much greater than within rows. Different parts of the same drill row should therefore not be regarded as subject to independent error. The present investigation emphatically confirms Clapham's conclusions on this point.

A slight advantage may be gained by the subdivision of the area to be sampled, without additional labour.

In order to study the effect of the structure of a sampling unit of given size, five types of unit have been examined. Of these, method (1), in which the " sampling unit " consists of four parallel half-metre lengths on adjacent rows, appears to be the most precise, and may be recommended on the basis of this trial. The half-metres within such sampling units appear to be negatively rather than positively correlated, and a significantly lower sampling error is obtained in consequence.

Effect of competition between the rows is suggested as the probable explanation for the smaller variation between the sampling units than within them in method (1). Similar analysis on the ear number for the same method, moreover, showed that variation within sampling units was significantly less than the variation between sampling units. This is regarded as additional evidence that there is a competition effect in samples obtained by method (1).

Eighteen such complex units amounting to 36 metres of drill from one-fortieth acre plots would give about 5 per cent. sampling error.

A significant correlation of 0.73 between yield and ear number is obtained. This fact can be used to obtain increased precision for the prediction of yield when the number of ears is known.

*https://doi.org/10.23637/ERADOC-1-64* 

XXV. F. R. IMMER. "*A Study of Sampling Technic with Sugar Beets.*" Journal of Agricultural Research, 1932, Vol. XLIV, pp. 633-647.

Sampling technique was studied in relation to the determination of sugar percentage in sugar beets.

Regression of sugar percentage on weight of roots was not entirely linear. Ninety-two per cent. of the quadratic regression could be explained in terms of the linear function.

Soil heterogeneity between plots was found to affect sugar percentages significantly, even when the effect of weight was held constant by means of the regression relationship.

Tables are given showing the number of beets per plot needed to reduce the standard error of the mean to 0.3, 0.2, and 0.1 per cent. sugar for various sizes of plots and numbers of replications.

Variability in sugar percentage between plots and within plots must be considered in estimating the size of sample required and the number of replications needed to reduce the standard error to a given level.

The standard error of the mean of total sugar per beet was somewhat lower than the standard error for weight and much higher than that for sugar percentage.

Variability in sugar percentage between plots was essentially the same whether calculated from the mean of 10 beets analyzed individually or from a composite sample of the same number.

XXVI. F. R. IMMER. "*Size and Shape of Plot in Relation to Field Experiments with Sugar Beets.*" Journal of Agricultural Research, 1932, Vol. XLIV, pp. 649-668.

Studies of size and shape of plot in relation to field experiments with sugar beet have been made, and the relationship determined between weight, sugar percentage, and apparent purity.

Standard errors, expressed in percentage of the mean, decreased in general with increased size of plot. An explanation is offered to account for a greater standard error from 6-row plots than from 3 or 4-row plots, when the entire plot is harvested.

Efficiency in use of land decreased with increased size of plot when the entire plot was harvested. When the border rows of the plots were removed, 4-row plots were most efficient.

Weight of beets was significantly correlated (negatively) with sugar percentage, but not with apparent purity. Sugar percentage was highly correlated (positively) with apparent purity. Intra-plot regression and correlation coefficients were given.

Contour maps for weight of roots, sugar percentage, and apparent purity were drawn from data on one hundred 6-row plots 2 rods long.

Sugar percentage varied significantly from plot to plot apart from its relation to weight. Fifty-four per cent. of the variability in apparent purity between plots was due to factors that affected sugar percentage as well.

The sampling error was calculated for sugar percentage and apparent purity determination for 4-row plots 2 rods long. The manner in which the standard error between plots may be reduced by replication and size of sample has been demonstrated.

*https://doi.org/10.23637/ERADOC-1-64* 

(*c*) GENETICS

XXVII. R. A. FISHER. "*The Social Selection of Human Fertility.*" (The Herbert Spencer Lecture, delivered at Oxford, June 8th, 1932.) Oxford: The Clarendon Press, 1932, 32 pp.

Lecture delivered at Oxford in commemoration of Herbert Spencer. It is argued that the existence of natural law and the reliability of scientific prediction has the same basis in the physical, the biological and the social sciences.

XXVIII. R. A. FISHER. "*The Bearing of Genetics on Theories of Evolution.*" Science Progress, 1932, Vol. XXVII, pp. 273-287.

Lecture delivered before the Royal Society of Dublin. The biological phenomena of the recessiveness of mutations, of loss of vigour through inbreeding, and of adaptation to ensure cross-fertilisation, are interpreted as evidence that evolution is opposed rather than promoted by the mutations which occur.

XXIX. R. A. FISHER. "*On the Evidence Against the Chemical Induction of Melanism in Lepidoptera.*" Proceedings of the Royal Society, B, 1933, Vol. CXII, pp. 407-416.

A method is given of assessing by calculation the value of evidence of the non-occurrence of recessive mutations under experimental conditions. It appears that the evidence against the induction of melanic mutations in moths by feeding with lead, is insufficient to disprove the existence of mutation rates up to 5 per cent. or 8 per cent., according to the stage at which mutation is postulated.

Mutation rates of this magnitude would be far greater than those which can be certainly induced by any other agency.

The use of back-crosses instead of inbreeding would increase the value of experimental data of this kind by approximately thirty-fold.

## THE SOIL

(Departments of Chemistry, Physics and Statistics.)

(*a*) SOIL CLASSIFICATION

XXX. L. L. LEE. "*The Possibilities of an International System for the Classification of Soils. Being a Consideration of the Influence of Geology and Climate on Soil Types. A Comparative Study of South-East England and Central New Jersey, U.S.A.*" Journal of the South-Eastern Agricultural College, 1931, No. 28, pp. 65-114.

An examination of the soils of South-East England, using the American methods of classification as modified for the New Jersey area of the United States. In both areas the soils occur in belts corresponding to the geological formations. Since geology has been the dominant factor in the soil formation of these areas, geological factors therefore receive first consideration in classifying the soils. Climatic factors have altered soil reaction more in Central New Jersey than in South-Eastern England, and, in general, podsolization is further advanced in the soils of Central New Jersey. A similar regional profile is developed in both districts, and consists typically

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of A horizons which are lighter in texture than the B horizons overlying C horizons, which are heavy or light in texture, depending on the nature of the geological parent material. The textural relation between the A and B horizons is much more marked in Central New Jersey.

XXXI. E. M. CROWTHER. *"Climate, Clay Composition and Soil Type."* Proceedings of the Second International Congress (1930) of Soil Science, Commission 5, 1932, pp. 15-23.

The results of an earlier (*see* Report 1931, XXXI) statistical analysis of the composition and distribution of American soils in relation to climate are reviewed and similar methods are used to compare the distributions of soils in U.S.A. and U.S.S.R.

### (*b*) MECHANICAL ANALYSIS

XXXII. E. M. CROWTHER AND K. TROELL. *"Oxidation of Organic Matter in the Pretreatment of Soils for Mechanical Analysis."* Proceedings of the Second (1930) International Congress of Soil Science, Commission 1, 1932, pp. 48-51, pp. 253-255.

A critical comparison of the hydrogen peroxide, sodium chloride and sodium hypobromite methods (*cf.* Report 1931, XXVIII).

### (*c*) SOIL CULTIVATION

XXXIII. B. A. KEEN AND G. H. CASHEN. *"Studies in Soil Cultivation. VI. The Physical Effect of Sheep Folding on the Soil."* Journal of Agricultural Science, 1932, Vol. XXII, pp. 126-134.

The folding of sheep on light land is commonly believed to improve its tilth by the consolidating effect of the sheep hooves. This belief has been criticised on the grounds that the subsequent ploughing will destroy the consolidation.The matter was investigated in two stages. An instrument, based on the principle of the pile-driver, was used to measure the actual consolidation ; the effect extended to a depth of 10 cm., the maximum compression occurring at 3-4 cm. The effect of subsequent ploughing was measured by passing the soil through a series of sieves of different mesh sizes, and it was found that the consolidation produced by sheep treading was not totally destroyed by ploughing, and further, it was still apparent five weeks later when the seed was drilled.

XXXIV. H. JANERT. *"Die Anforderungen des Maulwurfdränverfahrens an den Boden."* (Soil Conditions necessary for Mole Drainage). Transactions of the Sixth Commission of the International Society of Soil Science, 1932, Vol. A, pp. 163-176.

The object of mole-drainage is to remove rain-water as rapidly as possible from the surface of the soil, and for this to be achieved the drains must be stable. The drains can only be stable if :

(*a*) The soil is heavy enough. This can conveniently be measured by the heat of wetting of the soil, which should exceed 4 cals./gram.;

(*b*) The soil structure is stable. This stability is measured by the ratio of the percentage of particles of diameter less than 0.02 mm.

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(as determined in the Kopecky elutriator) and the heat of wetting. If this value is below 8, the fine particles are sufficiently flocculated not to be re-peptised by water.

### (*d*) Physical Properties

xxxv. B. A. Keen. "*Soil Physics in Relation to Meteorology.*" Quarterly Journal of the Royal Meteorological Society, 1932, Vol. LVIII, pp. 229-250.

This paper was the Symons Memorial Lecture for 1932, delivered to the Royal Meteorological Society. It consists of an account of those physical properties of soil of interest to meteorologists, and its scope is sufficiently indicated by the following subject headings : soil classification in relation to climatic zones ; soil temperatures ; the soil atmosphere ; soil moisture ; soil cultivation.

xxxvi. G. H. Cashen. "*Measurements of the Electrical Capacity and Conductivity of Soil Blocks.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 145-164.

An improved method has been devised for measuring the electrical capacity and conductivity of soil blocks at different moisture contents. While the phenomena are complicated, and depend on the nature of the electrodes as well as on the soil texture, there is evidence that the soil moisture passes through characteristic points. Two of these are identified with Atterberg's constants—the lower plastic limit ; and the moisture content at which air enters the pores. The two lower moisture contents have not yet been completely identified, but one of them seems to be related to the shrinkage and cohesion behaviour of soil and the rate of evaporation of water.

xxxvii. R. K. Schofield and G. W. Scott Blair. "*Rapid Methods of Examining Soils. I. Measurements of Rolling Weights.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 135-144.

A small cylinder of moist clay is rolled backwards and forwards between two plates by giving a reciprocating motion to the upper one. Weights are gradually added to the top plate until the cylinder just elongates. This weight is a measure of the weight required to deform the soil and is thus related to the agricultural property known as heaviness. The apparatus is suitable for other plastic materials besides soil, and accounts of it have therefore been published in other appropriate journals.

xxxviii. J. R. H. Coutts. "*' Single Value ' Soil Constants : A Study of the Significance of Certain Soil Constants. VI. On the Changes Produced in a Soil by Exposure to High Temperatures.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 200-202.

Measurements on the loss of ignition of four soils of different physical type are not affected by changes in the temperature of furnace, provided that the temperature is above 600°. Errors in the determination of the loss on ignition are of the order of 1 per cent. of the true value.

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The loss in weight of the soils can be ascribed in the main to loss of free and interstitial water up to about 100° ; to destruction of organic colloids between 100° and 250° ; and to destruction of inorganic colloids at higher temperatures.

XXXIX. J. R. H. COUTTS. "*' Single Value ' Soil Properties: A Study of the Significance of Certain Soil Constants. VII. The Moisture Equivalent and Some Related Quantities.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 203-211.

The moisture equivalent has been measured (by a technique requiring only small quantities of soil) for a number of samples comprising Natal and Sind soils. It is concluded that while with the latter (alkaline and saline) soils the moisture equivalent gives valuable information, it adds little to the data obtained by other methods for the Natal soils. The xylene equivalent of the Natal soils has also been measured ; from the moisture equivalent and the xylene equivalent, the imbibitional water can be calculated if the specific gravity of the soil is known.

Equations expressing the moisture equivalent and the xylene equivalent of the Natal soils in terms of their loss on ignition and mechanical composition are obtained, and the significance of the relative values of the numerical coefficients in these equations is discussed.

XL. G. W. SCOTT BLAIR AND F. YATES. "*The Effect of Climatic Variations on the Plasticity of Soil.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 639-646.

The plasticity of a soil as measured by the flow plasticity (Soil Science, 1931, Vol. XXXI, p. 291) depends on the climatic history of the soil from which the paste is prepared. In general, soil has a higher plasticity in cold and dry weather than in warm and wet weather, thus affording independent evidence of seasonal fluctuations in the quantity of highly dispersed particles. Mechanical treatment of the soil, *e.g.* flattening and digging, did not produce any regular effect in comparison with the untreated soil, but the design of the experiment was not such as to enable the differences that were observed to be distinguished from the seasonal fluctuations.

### (*e*) PHYSICAL CHEMISTRY

XLI. E. W. RUSSELL. "*The Present Position of the Theory of the Coagulation of Dilute Clay Suspensions.*" Journal of Agricultural Science, 1932, Vol. XXII, p. 165-199.

A critical review : the influence of Brownian motion and mass motion of one particle group relative to another in causing collisions between suspended particles ; the electro-kinetic potential and the absence of exact experimental methods of measuring it ; the influence of electrolytes and non-electrolytes on the electrokinetic-potential and the stability of suspensions ; the influence of the type and amount of exchangeable ions on the stability of clay suspensions and their rapid flocculation in electrolyte media with special reference to the effect of secondary chemical reactions.

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## (*f*) Organic Chemistry

XLII. H. J. Page. "*Studies on the Carbon and Nitrogen Cycles in the Soil. V. The Origin of the Humic Matter of the Soil.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 291-296.

The results so far recorded in this series of papers support the hypothesis that the humic matter of the soil is derived from lignin, and emphasise the importance of studying the part played by nitrogen in the formation of soil humic matter.

XLIII. R. H. Hobson and H. J. Page. "*Studies on the Carbon and Nitrogen Cycles in the Soil. VI. The Extraction of the Organic Nitrogen of the Soil with Alkali.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 297-299.

The alkali-extraction of the nitrogen from soils of certain plots of the classical permanent experiments on Barnfield and Broadbalk, follows a closely similar course to the alkali-extraction of carbon from the same soils.

XLIV. R. P. Hobson and H. J. Page. "*Studies on the Carbon and Nitrogen Cycles in the Soil. VII. The Nature of the Organic Nitrogen Compounds of the Soil; 'Humic' Nitrogen.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 497-515.

The nitrogen contained in purified preparations of humic acid obtained from Rothamsted soils cannot be eliminated by methods which would be expected to remove simple nitrogenous impurities. The distribution of nitrogen in the hydrolysates of these preparations of humic acid by hydrochloric acid resembles that in the hydrolysates of proteins. A mixture of egg albumen and artificial humic acid from lignin resembles soil humic acid in the behaviour of its nitrogen on treatment with chemical reagents or enzymes. In soil humic acid the combination of non-nitrogenous humic acid and protein is more intimate than that involved in the formation of a colloidal "salt" by the precipitation of two oppositely charged colloids.

XLV. R. P. Hobson and H. J. Page. "*Studies on the Carbon and Nitrogen Cycles in the Soil. VIII. The Nature of the Organic Nitrogen Compounds of the Soil: 'Non-Humic' Nitrogen.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 516-526.

The nitrogen extracted from Rothamsted soils by alkaline solutions but not precipitated by subsequent addition of acid, is made up of 30-40 per cent. as peptides, 5 per cent. as free amino compounds, 12 per cent. as ammonia with the remainder as other, non-basic forms.

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# MICROBIOLOGY

(Departments of Bacteriology, Fermentation and General Microbiology)

## (*a*) Bacteria

XLVI. E. McCoy. "*Infection by* Bact. Radicicla *in relation to the Microchemistry of the Host's Cell Walls.*" Proceedings of the Royal Society, B, 1932. Vol. CX, pp. 514-533.

It is statistically proved that infection of the root hairs is not a mere invasion of mechanically injured or broken root hairs. The presence of the bacteria, even of strains belonging to foreign inoculation-groups, causes a significant increase in the number of curled and bent hairs. The bacteria produce a secretion capable of modifying the wall, as evidenced by the abnormal curling of the root-hair tips. This secretion is separable from the cells by filtration, and is not specific for the plants of the cross-inoculation group to which the bacteria belong.

The bacteria in culture were unable to attack cellulose, pectin or calcium pectate. Curled tips of root hairs, whether infected or not, contain the same constituents as normal hairs. These constituents are cellulose, calcium pectate, and probably pectose, and a very resistant hemicellulose.

The cell walls of the nodule contain cellulose, a hemicellulose, calcium pectate in the mature parts, and pectose at least in the meristematic tip. Walls of the tip also give a protein reaction. There are numerous pits perforating the secondary layers of the walls, but the middle lamellae appear to be continuous. These pits are of sufficient size to admit infection threads, and it is suggested that the bacterial zoogloea crosses a cell wall by way of the pits. The infection thread is surrounded by a definite sheath consisting of cellulose and hemicellulose ; calcium pectate is absent and the presence of other pectic materials has not been confirmed. The sheath is probably a deposit of the individual plant-cell.

XLVII. Jadwiga Ziemiecka. "*The* Azotobacter *Test of Soil Fertility applied to the Classical Fields at Rothamsted.*" Journal of Agricultural Science, 1932, Vol. XXII, pp. 797-810.

The kneaded plate (*plaque moulée*) method of detecting deficiency in lime and available phosphate was applied to 79 soil samples taken from the classical Rothamsted arable plots.

The test correctly indicated whether phosphate had been applied in soils receiving little or no nitrogen manures. In soils receiving 86 lb. or more mineral nitrogen per acre, the test usually showed little or no *Azotobacter* growth, even in the presence of phosphate and calcium carbonate. Silica jelly counts showed that *Azotobacter* cells were very much reduced in number in such soils. In some cases the test was modified by inoculating the sample with a culture of *Azotobacter* and it then gave correct indications as to phosphate content.

In general, *Azotobacter*, when present, was found to develop on kneaded plates, if the soil contained at least 10 mg. of water-soluble $P_2O_5$ per kilogram of soil, but below this limit little growth occurred.

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(*b*) PROTOZOA

XLVIII. D. WARD CUTLER, L. M. CRUMP AND A. DIXON. "*Some Factors Influencing the Distribution of Certain Protozoa in Biological Filters.*" Journal of Animal Ecology, **1932**, Vol. I, pp. **143-151**.

The purity of a medium, as measured by the amount of reducing material present in the solution, and the food supply, are two of the principal factors influencing the distribution of protozoa in sewage filters. The protozoa considered occur throughout a wide range of pH values, but the optima for different species are different.

Where chemical compounds added to the solution affect the protozoan population adversely, it may be due either to the formation of deleterious oxidation products, or to the development of a bacterial flora which is inimical to the protozoa.

(*c*) BIOLOGICAL ACTIVITIES

XLIX. (a) A. G. NORMAN. "*The Biological Decomposition of Plant Materials. VII. The nature of the residual hemicelluloses of rotted straw.*" Biochemical Journal, **1932**, Vol. XXVI, pp. **573-577**.

The nature of the residual hemicelluloses of well-rotted straw has been investigated. Only very small quantities were obtained, and there was no indication of variation in availability or the accumulation of less available groupings. The results indicate that the distribution and arrangement of the hemicelluloses in the cell-wall are such that microbial attack is not hindered by the presence of any resistant barrier. A water-soluble polysaccharide, probably of microbial origin, was also prepared. It contained **33** per cent uronic acid anhydride, and **66** per cent hexosan, and gave evidence of the presence of glucose units.

XLIX. (b) A. G. NORMAN. "*The Biological Decomposition of Plant Materials. VIII. The Availability of the Nitrogen of Fungal Tissues.*" Annals of Applied Biology, **1933**. Vol. XX, pp. **146-164**.

Fungal tissue was found to be as suitable a source of nitrogen as ammonium salts or nitrates for the decomposition of straw both by mixed soil flora and by pure cultures of certain fungi. Nitrification in soils of a number of samples of fungus tissue was compared with that of artificial mixtures of equal C/N ratio built up from glucose, cellulose and straw, each with added inorganic nitrogen. A clear correlation was found between the C/N ratio of the fungal material and the nitrogen nitrified. In all cases fungus tissue was at least as readily nitrified as the artificial mixtures. No evidence was found for the existence of a very resistant and unnitrifiable residue from fungus tissue.

L. S. H. JENKINS. "*The Biological Oxidation of Carbohydrate Solutions. II. The Oxidation of Sucrose in the Presence of Different Inorganic Nitrogen Compounds.*" Biochemical Journal, **1933**, Vol. XXVII, pp. **245-257**.

The effect of different sources of nitrogen on the biological oxidation of sucrose through a percolating filter was studied. Under

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the conditions of filtration in these experiments there was a considerable disappearance of nitrogen from solutions having C/N ratios of 8.4/1 and 4.2/1, irrespective of the form in which the nitrogen was supplied. Greatest disappearance of nitrogen occurred with nitrite and less with ammonia. The apparent losses when nitrogen was supplied as nitrite and nitrate were most marked in that part of the filter in which carbohydrate oxidation was most active. These apparent losses include the nitrogen immobilised by the micro-organisms of the film, and it was impossible to state how much of this was due to losses of elementary nitrogen.

LI. S. H. JENKINS. "*The Biological Oxidation of Carbohydrate Solutions. III. Nitrogen, Phosphorus and Potassium Balances in Percolating Filters.*" Biochemical Journal, 1933, Vol. XXVII, pp. 258-273.

By studying the decomposition of sucrose in percolating filters filled with glass, and so allowing the recovery of the synthesised film, it was possible to draw up balance sheets for the nitrogen, phosphorus and potassium salts added. The recovery of the last two elements was not quantitative, possibly owing to inadequate methods of analysis. In experiments containing sugar and ammonium salts, giving a C/N ratio of 8.4/1, the balance sheets for nitrogen showed that about 14 per cent. of that supplied was lost. With a ratio of 8.4/1 a slight gain was recorded. When filters were supplied with an ammonium salt as the source of nitrogen neither nitrite nor nitrate was detected in the effluents. When the source of nitrogen supplied to the filters was organic neither ammonia nor oxidised compounds of nitrogen were found. The observed losses, therefore, could not have taken place through formation of ammonia or the production of nitrite or nitrate and subsequent denitrification. Liberation of elementary nitrogen is probably carried out entirely within the cells of the organisms.

LII. S. H. JENKINS. "*The Design of Experimental Percolating Filters.*" Biochemical Journal, 1933, Vol. XXVII, pp. 240-244.

Percolating filters of a new design have been constructed composed of sections which fit together so that no air spaces occur between individual sections. These have been made in wood built from six octagonal units, the top and bottom edges of each being bevelled at an angle of 60°. The medium was supported in each section by means of a rustless steel tray. Similar filters have been made with cylindrical glass units joined together by means of wide bands of rubber. The medium was held in each section on a perforated aluminium plate cemented to the bottom of each cylinder. Such filters may be operated as a whole or the changes taking place at any given depth investigated by sampling.

LIII. J. MEIKLEJOHN. "*The Effect of* Colpidium *on Ammonia Production by Soil Bacteria.*" Annals of Applied Biology, 1932, Vol. XIX, pp. 584-608.

In two series of experiments using different media (peptone dissolved in soil extract in the first series, and a synthetic medium

*https://doi.org/10.23637/ERADOC-1-64* 

containing alanine in the second), cultures containing the ciliate protozoon *Colpidium* with two species of soil bacteria were compared against control cultures containing only the two species of bacteria.

On both media an appreciable reduction in bacterial numbers, as compared with the numbers in the control cultures, was observed in the *Colpidium* cultures, but in spite of this reduction, the *Colpidium* cultures produced more ammonia from peptone than the controls, and nearly the same amount of ammonia and carbon dioxide from alanine as the controls.

In both series of experiments an inverse linear relation was found to exist between total bacterial numbers and the amount of ammonia or carbon dioxide produced per 1,000 million bacteria (efficiency).

In the second series of experiments, the regression coefficients of efficiency on average bacterial numbers are significantly different in the *Colpidium* and the control cultures.

It follows that the presence of *Colpidium* has a stimulating effect on ammonia production, which is not due solely to the reduction of bacterial numbers to an optimum value, and it is suggested that in the cultures in which *Colpidia* are present, the bacteria are kept in a state of physiological youth for a longer period than the normal.

LIV. D. WARD CUTLER AND L. M. CRUMP. "*Some Aspects of the Physiology of Certain Nitrite-Forming Bacteria.*" Annals of Applied Biology, 1933, Vol. XX, pp. 291-296.

One hundred and four species of bacteria which produce small quantities of nitrite from ammonium sulphate have been isolated from filters receiving waste water from a beet sugar factory and these bacteria do not differ in their behaviour on carbohydrates from non-nitrifying bacteria obtained from the same source.

Ammonium lactate is more readily oxidised than is ammonium carbonate, phosphate, sulphate or acetate, and in the majority of cases nitrite itself can also be utilised by these bacteria in the course of growth.

There is positive correlation between increase in bacteria numbers and the percentage nitrite in a culture during the initial growth period and there is evidence that nitrite may disappear slowly from acid solutions without the intervention of bacteria, though this is not invariably the case.

LV. N. W. BARRITT. "*The Nitrification Process in Soils and Biological Filters.*" Annals of Applied Biology, 1933, Vol. XX, pp. 165-184.

Nitrifying cultures in mineral salt solutions were obtained from laboratory percolating filters and resembled similar cultures obtained from soils in their ability to grow on silica gel plates and in showing a low thermal death point. The addition of organic matter depressed the rate of nitrification in comparison with the rate of nitrification in the presence of mineral carbonates. The addition of a solution of carbonic acid also depressed nitrification, and it is inferred that the supposed toxic effect of organic matter is not a direct one, but due to the liberation of excessive amounts of $CO_2$.

The optimum pH for nitrification is between 6.7 and 8.0. It ceases at pH 9.2 and 5.5, at which point the free acid is spontaneously oxidised to nitric acid without the aid of a specific organism.

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An increase in nitrifying power of soil after passage through earthworms is recorded and accounted for by the digestion of organic matter and addition of $CaCO_3$ from the subsoil.

It is suggested that the evidence of many workers points to a possible autotrophic phase in the life cycle of heterotrophic organisms.

## THE PLANT IN DISEASE: CONTROL OF DISEASE

(Departments of Entomology, Insecticides and Fungicides, and Plant Pathology)

### (*a*) Insects and Their Control

LVI. H. F. Barnes. "*Studies of Fluctuations in Insect Populations. I. The Infestation of Broadbalk Wheat by the Wheat Blossom Midges* (*Cecidomyidae*)." Journal of Animal Ecology, 1932, Vol. I, pp. 12-31.

Fluctuations of insect populations are being studied in three directions: (1) the intensity of attack by the larvae; (2) the degree of parasitism; and (3) the dates of emergence and number of broods. Study of the two wheat blossom midges reveals considerable fluctuations in intensity of attack and the extent to which they are parasitised by other insects. Extensive new information regarding the bionomics of these two midges, *C. tritici* and *S. mosellana*, is given.

LVII. H. F. Barnes. "*A Study of the Segmentation of the Antennae in Gall Midges.*" Proceedings of the Zoological Society of London, 1932, pp. 323-334.

From a study of over 14,300 individuals of fourteen species of economic importance, it is shown that, in some species and genera, food affects the size of the adult midges only; in others it affects the size of adult midges and, in addition, the number of antennal segments. A formula is given for the frequency and range in the number of antennal segments.

LVIII. H. F. Barnes. "*On the Gall Midges Injurious to the Cultivation of Willows. I. The Bat Willow Gall Midge* (Rhabdophaga terminalis *H.Lw.*)" Annals of Applied Biology, 1932, Vol. XIX, pp. 243-252.

The bionomics of the bat willow gall midge, which does serious damage to certain willows grown for basket-making and the cricket bat willow grown for sets, are described. The midge exhibits a distinct host-plant preference, choosing the bat willow (*S. coerulea*) when possible. But it also breeds readily on a golden willow (*S. alba* var. *vitellina*). It will not attack Black Maul (*S. triandra*), Long Skin (*S. viminalis*) and Dicky Meadow (*S. purpurea*).

LIX. Margot E. Metcalfe. "Dasyneura leguminicola (*Lint.*), *the Clover Seed Midge.*" Annals of Applied Biology, 1933, Vol. XX, pp. 185-204.

An attempt was made, after studying the biology of this midge, to find resistant or immune varieties of red clover. It is suggested that clovers grown for seed production should be in the green-head

*https://doi.org/10.23637/ERADOC-1-64* 

either before or after the time of maximum emergence of the midges. The dates for cutting the first crop as a means of ensuring a clean second crop are discussed.

LX. MARGOT E. METCALFE. "*Some Cecidomyidae Attacking the Seed of* Dactylis glomerata L. *and* Lolium perenne L." Annals of Applied Biology, 1933, Vol. XX, pp. 327-341.

Three species, two of which were new to science, have been found on these grasses in the Park Grass plots. Unsuccessful efforts were made to compel the midges to attack other grasses. Their biologies are described.

LXI. MARGOT E. METCALFE. "*The Morphology and Anatomy of the Larva of* Dasyneura leguminicola *Lint.* (*Diptera*)." Proceedings of the Zoological Society of London, 1933, pp. 119-130.

The title of this paper is self-explanatory.

LXII. MARGOT E. METCALFE. "*Notes on the Structure and Development of the Female Genital System in* Dasyneura leguminicola *Lint.* (*Cecidomyidae, Diptera*)." Quarterly Journal of Microscopical Science, 1933, Vol. LXXVI, pp. 89-105.

Genitalia of an appendicular nature are absent, the tubular abdominal segments being modified to form a tubular retractile ovipositor. Apart from the ovaries and a portion of the paired oviducts, the efferent system is unpaired and ectodermal in structure. The gonopore is posterior to the ninth sternite and is derived from the primitive spermathecal invagination as in the Coleoptera.

LXIII. H. C. F. NEWTON. "*On* Atomaria linearis *Stephens* (*Coleoptera, Cryptophagidae*) *and its Larval Stages.*" Annals of Applied Biology, 1932, Vol. XIX, pp. 87-97.

A brief survey is made of the habits and life history of *Atomaria linearis* Steph., the Pigmy Mangold Beetle, a pest of sugar beet and mangolds. The egg and larval stages are described for the first time.

LXIV. F. TATTERSFIELD AND C. T. GIMINGHAM. "*The Insecticidal Properties of* Tephrosia macropoda *Harv. and other Tropical Plants.*" Annals of Applied Biology, 1932, Vol. XIX, pp. 253-262.

Preliminary data are reported on the insecticidal properties of three tropical fish poison plants (*Tephrosia macropoda* Harv., *Mundulea suberosa* Benth. and *Neorautanenia* (*Rhynchosia*) *fisifolia* C. A. Sm.).

A list is given of other plants (most of them known to be fish poisons) from many different countries, which have been tested but appear to have little or no toxicity to *Aphis rumicis* L.

Extracts of the stems of black Haiari (*Lonchocarpus* sp.) are shown to be toxic as contact insecticides to young larvae of two species of moths. Older larvae are much more resistant.

All the plants so far tested which are toxic to both fish and to insects are members of the natural order Leguminosae.

https://doi.org/10.23637/ERADOC-1-64 

LXV. F. TATTERSFIELD. *"The Loss of Toxicity of Pyrethrum Dusts on Exposure to Air and Light."* Journal of Agricultural Science, 1932, Vol. XXII, pp. 396-417.

Pyrethrum powders and dusts, prepared by grinding or by the incorporation of extracts of pyrethrum flowers upon absorbent earths, such as talc and kieselguhr, lose their insecticidal activity on exposure to light and air. The loss is more rapid in the case of artificially-prepared dusts than with ground flower-heads.

Both light and air play an important part in the process of inactivation, as samples of kieselguhr-pyrethrum and talc-pyrethrum dusts stored in closed vessels in the dark or exposed to air in the dark are relatively stable; also samples exposed to light in an atmosphere of carbon dioxide, nitrogen or *in vacuo* lose little of their toxicity under the same conditions of illumination; samples exposed in oxygen, however, rapidly lose their activity.

Both wet and dry oxygen were effective in destroying the activity of the dusts, but apparently at different rates, and the type of reaction may be different in the two cases.

The incorporation of anti-oxidants with talc-pyrethrum and kieselguhr-pyrethrum dusts retards loss of activity due to exposure to light and air.

Such compounds as pyrocatechol, resorcinol, hydroquinone, pyrogallol confer a large measure of protection against loss of toxicity. Phenol and phloroglucinol were not effective.

Tannic acid exerted a considerable measure of protection.

The protection was greater in the case of artificially-prepared dusts than with ground pyrethrum flowers.

There is no conclusive evidence that anti-oxidants, naturally occurring in pyrethrum, play any great part in stabilising the pyrethrins against inactivation. The greater part of the protection would appear to be due to particle size or to cellular inclusion.

### (*b*) BACTERIAL DISEASES

LXVI. R. H. STOUGHTON. *"The Morphology and Cytology of* Bacterium malvacearum, *E.F.S., Part II. Reproduction and Cell-Fusion."* Proceedings of the Royal Society B, 1932, Vol. CXI, pp. 46-52.

New morphological forms have been observed in *Bacterium malvacearum*. The production of coccoid bodies, their liberation and subsequent development to form apparently normal rods are described, as well as the formation of densely spherical bodies, which apparently arise from the fusion of two cells and are liberated by the degeneration of the parent cells.

LXVII. R. H. STOUGHTON. *"The Influence of Environmental Conditions on the Development of the Angular Leaf Spot Disease of Cotton. IV. The Influence of Atmospheric Humidity on Infection."* Annals of Applied Biology, 1932, Vol. XIX, pp. 370-378.

It was found in control chambers that high humidities favour the development of the disease. Maximum infection occurred at 85 per

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cent., and diminished rapidly at humidities below this figure. The relation of these results to the experiments on the influence of air temperature is discussed ; and it is concluded that the importance of humidity is mainly physical in nature, by affecting the time of persistence of the infection droplets.

### (*c*) Virus Diseases

LXVIII. J. Caldwell. "*The Physiology of Virus Diseases in Plants. III. Aucuba or Yellow Mosaic of Tomato in* Nicotiana glutinosa *and other hosts.*" Annals of Applied Biology, 1932, Vol. XIX, pp. 144-152.

The symptoms induced by aucuba or yellow mosaic of tomato in certain other members of the Solanaceae (notably *N. glutinosa* and *D. stramonium*) differ markedly from those in tomato. Neither formation of intracellular inclusions nor systemic infection occurs in those plants. In *N. glutinosa* the symptoms appear only on the rubbed leaves or portions of a leaf and little multiplication of the virus takes place. In *D. stramonium*, although no mosaic symptoms appear on the host, the virus travels through the tissues and can infect susceptible grafts. The use of *N. glutinosa* as a ready means of demonstrating the presence of a virus agent in a juice has been confirmed and simplified.

It is possible to inject the intracellular spaces of the leaf of *N. glutinosa* with virus juice without rupturing the cells, in which case no symptoms of the disease develop. The virus apparently is unable to enter unbroken cells.

LXIX. D. MacClement and J. Henderson Smith. "*Filtration of Plant Viruses.*" Nature, 1932, Vol. 130, p. 129.

By the use of graded collodion membranes it was shown that plant viruses vary in size, as judged by their ability to pass membranes of known porosity. Tobacco mosaic and yellow mosaic have a size of 15 $\mu\mu$, aucuba mosaic of tomato 40-50 $\mu\mu$, a virus of Hyoscyamus 150 $\mu\mu$. With these membranes it is possible to separate two viruses which occur together in nature.

LXX. Marion A. Hamilton. "*On Three New Virus Diseases of* Hyoscyamus niger." Annals of Applied Biology, 1932, Vol. XIX, pp. 550-567.

The source and general characters of three virus diseases occurring naturally in *Hyoscyamus* are described under the names of Hy. II, III and IV. They have a host range of various solanaceous plants, so far excluding potato. Hy. II and III are not filterable through a Pasteur-Chamberland filter of L3 grade, and are transmitted to and from all hosts except tomato by the peach aphid *Myzus persicae*. They survive for a relatively short period in clarified juice. They have many points in common with, and are probably related to the potato viruses X and Y. Hy. IV is filterable through an L3 candle and no insect vector has yet been found for it.

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