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SCIENTIFIC PAPERS

Published 1929 and in the Press.

CROPS, PLANT GROWTH AND FERTILISER INVESTIGATIONS.

(Botanical, Bacteriological, Statistical and Fermentation Departments; and the Imperial College Staff.)

- I. W. E. BRENCHLEY AND K. WARINGTON. "*The Weed Seed Population of Arable Soil. I: Numerical Estimation of Viable Seeds and Observations on their Natural Dormancy.*" *Journal of Ecology*, 1930. Vol. XVIII, pp. 235-272.

Counts have been made of the seedlings germinating from soil samples of known area taken from fields undergoing specified schemes of fallowing. Poppy was the most plentiful weed, an average of 113 millions per acre being recorded.

Most species exhibited a periodicity in germination, the majority of seedlings appearing in the autumn or winter. Many weeds showed a period of "natural" dormancy, during which they failed to germinate in spite of favourable conditions.

An association was found between the weed flora and the manurial treatment of the soil when the same manuring is repeated for a large number of years.

- II. T. EDEN AND R. A. FISHER. "*Studies in Crop Variation, VI. Experiments on the response of the Potato to Potash and Nitrogen.*" *Journal of Agricultural Science*, 1929. Vol. XIX, pp. 201-213.

While rather precise comparisons were obtained on the qualitative question by means of Latin squares in 1925-26, the reality of the depression ascribable to chloride could not be demonstrated in these years, but became clearly apparent when, in the following year, the qualitative experiment was merged with the quantitative one.

In the earlier quantitative experiments, although satisfactory responses were obtained, the precision of the results left much to be desired, since only four replicates could be used. When, by merging the experiments, this was increased to nine replicates, much smaller responses were clearly measurable.

The large and complex type of experiment finally adopted thus supplied more precise information on both heads than could previously be obtained, and led in addition to a more thorough exploration of the different combinations possible.

- III. H. G. THORNTON. "*The Effect of Fresh Straw on the Growth of Certain Legumes.*" *Journal of Agricultural Science*, 1929. Vol. XIX, pp. 563-572.

In pot experiments with *Glycine hispida* and *Vicia faba* L., fresh chaff incorporated with the soil caused a significant increase in the number of nodules produced on inoculated plants, this increase being augmented by the further addition of phosphates.

Fresh chaff, added at the time of sowing and inoculation, had more effect than chaff which was allowed to decompose in the soil for a month. Fresh chaff increases the multiplication of the nodule organism in sterilised soil.

In soy beans without nodules, the chaff depressed the growth of the tops, but this depression did not occur either with soy or broad beans where nodules were present.

In a field experiment made at Rothamsted, chaff, freshly ploughed in, increased the growth of broad beans and also of wheat sown the next season on the same ground.

- IV. A. G. NORMAN. "*The Chemical Constitution of the Gums, Part I. The Nature of Gum Arabic and the Biochemical Classification of the Gums.*" *Biochemical Journal*, 1929. Vol. XXIII, pp. 524-535.

Gum arabic is built up of varying amounts of a nucleus acid, consisting of galactose, and a uronic acid (probably galacturonic), to which is linked by glucosidic linkages the pentose, arabinose, which is, in consequence, more easily split off than the other components.

There seems to be no essential difference in structure and composition between gums and hemicelluloses, both consisting of hexose and pentose sugars linked to uronic acids. On the basis of sterical similarities, it is suggested that it is by the protracted mild oxidation of linked hexose, and in particular galactose units that pectin, and the hemicelluloses and gums are formed.

- V. F. G. GREGORY AND F. J. RICHARDS. "*Physiological Studies in Plant Nutrition, I. The Effect of Manurial Deficiency on the Respiration and Assimilation Rate in Barley.*" *Annals of Botany*, 1929. Vol. XLIII, pp. 120-161.

The use of the katharometer for the measurement of respiration and assimilation rates of leaves is discussed; methods are indicated of overcoming some of the difficulties in its use.

The effect of deficiency in nitrogen, phosphorus and potash on water content and weight per unit area of successive leaves of barley, as compared with those of fully manured plants, are studied; they lead to the conclusion that leaf area is a better basis than is dry weight for the expression of water content of leaves.

Respiration rates for successive leaves of nitrogen, phosphorus and potash deficient plants, as compared with fully manured plants, are given. In all the deficient series, the rate of respiration falls to a minimum, with a subsequent rise; while in the case of the fully manured plants the rate falls rapidly at first, becoming constant later. Nitrogen starved plants are shown to have a consistently lower respiration rate than fully manured, potash a consistently

higher rate, and phosphate to be unaffected. The differences found are as follows :—

	Differences of Means
Fully Manured—Nitrogen Deficient ...	+0.489 ± 0.127
Fully Manured—Phosphate Deficient ...	-0.106 ± 0.127
Fully Manured—Potash Deficient ...	-1.574 ± 0.127

Analysis of Variance shows that the effect of age of plant and manurial deficiency are both very significant ($P > 100 : 1$).

Assimilation rates at known high and low light intensities are given for successive leaves of fully manured plants, and also for each of the deficient series.

It is shown that changes in assimilation rate are due to the action of two factors, namely, age of plant and manurial deficiency. By Analysis of Variance the following facts were established :—

(i.) At low light intensity, the effect of age is quite insignificant, but the manurial effect is almost significant, due predominantly to the value of the potash deficient series.

(ii.) At high light intensity, the effect of age is very highly significant ($P > 100 : 1$), and the manurial effect is also very significant.

The bearing of these results on the nature of the “internal factor” in photosynthesis is discussed. It is shown that two types of subnormality occur, namely, that due to age and that due to manurial deficiency. Subnormality of later formed leaves, as compared with earlier, is found in all the series.

Subnormality due to manurial deficiency is found to be specific in effect for the various constituents. The results obtained may be summarised thus :—

	Respiration.	Assimilation.	
		Low Light Intensity.	High Light Intensity.
Fully Manured ..	Normal ..	Unaffected by age of plant.	Falling with age of plant.
Nitrogen Deficient ..	<i>Subnormal</i>	Normal ; unaffected by age of plant.	Subnormal ; falling with age of plant.
Phosphate Deficient ..	Normal ..	Slightly supernormal. <i>Falling with age.</i>	Slightly supernormal. <i>Falling with age.</i>
Potash Deficient	<i>Supernormal</i>	<i>Subnormal.</i>	<i>Subnormal.</i>

The subnormality due to potash deficiency is further discussed, and its theoretical bearing indicated.

VI. F. G. GREGORY AND F. CROWTHER. “*A Physiological Study of Varietal Differences in Plants, Part I. A Study of the Comparative Yields of Barley Varieties with Different Manurings.*” *Annals of Botany*, 1928. Vol. XLII, pp. 757-770.

The experiment described establishes the existence of a differential response of varieties of barley to various types of manuring.

Five varieties were grown with eleven types of manuring, including deficiency of nitrogen, of phosphate, and of potash. Seven replicates of each variety for each manuring were used, requiring the use of 385 pots in all.

The resulting dry-weight data are treated by the "Analysis of Variance" method, and significant values are obtained for the differential response of the varieties to manuring.

The varieties are compared in pairs to indicate the particular varietal differences contributing to this differential response.

The agricultural importance of the results is indicated.

VII. F. R. TUBBS. "*Physiological Studies in Plant Nutrition, II. The Effect of Manurial Deficiency upon the Mechanical Strength of Barley Straw.*" *Annals of Botany*, 1930. Vol. XLIV, pp. 147-160.

The paper deals with the results of an investigation of the effect of manurial deficiency upon the strength and anatomical structure of barley straw. The force in grm. weight required to crush 1cm. length of stem radially is taken as a measure of strength.

The strength of succeeding internodes of fully-manured plants falls off rapidly. Nitrogen and phosphorus deficiency results in a large increase in the strength of the lower internodes, while potassium starvation decreases the strength of the lower and increases that of the middle internodes. The effects of manurial deficiency are most marked in the lower internodes, the upper ones approximating to the normal.

The variation in the thickness of the mechanical tissues follows that of strength, but is not sufficient to account for the large differences observed. Total and partial linear correlations between strength and the morphological status of the internode, and between strength and the thickness of the three tissues, sclerenchyma, lignified parenchyma, and unligified parenchyma, have been calculated. The conclusion is reached that the observed fall in strength of succeeding internodes is due both to decrease in the efficiency of the mechanical tissues and also to decrease in their actual amount.

Equations connecting strength and the morphological status of the internode are found to give a good fit in the fully-manured, nitrogen-deficient and phosphate-deficient series. The relation between strength and internode number is logarithmic, the strength of each internode being a constant fraction of that next below, within the limits of the error of the experiment, the value of the fraction being dependent on the type of manuring applied.

The ratio of the external radius to the internal radius of the mechanical tissues is found to be constant for internodes of the same status, independent of manuring. It appears that the mechanical function of the elements composing them is determined at a very early stage.

It is suggested that the observed effects of mineral deficiency are explicable on the assumption that potassium is essential to the production of an efficient mechanical tissue.

- VIII. W. O. JAMES. "*Studies of the Physiological Importance of the Mineral Elements in Plants, I. The Relation of Potassium to the Properties and Functions of the Leaf.*" *Annals of Botany*, 1930. Vol. XLIV, pp. 173-198.

In order to investigate the physiological importance of potassium, field experiments were carried out upon certain attributes and functions of potato leaves. Number, area, weight, water content, and rates of starch formation, translocation, and senescence were examined. The primary data were subjected to statistical analysis, and the following conclusions arrived at.

The number of leaves formed on an average per plant was found to be significantly reduced by the application of potassium sulphate or "potash manure salts," a low grade fertiliser. Potassium chloride could not be shown to have any effect.

Area of a selected leaflet. The area of the penultimate pinnæ of the fourth leaf, from the stem apex, was not affected in adult plants by the addition of potassium sulphate, but addition of "potash manure salts" or potassium chloride caused an increase of surface. This is ascribed to the action of the chloride ion present in both the latter fertilisers. Taken in conjunction with the reduced leaf number, the lack of effect of the sulphate suggests that potassium itself tends to decrease rather than increase the total leaf area of the plant. There is, however, some evidence of an increase in the earliest stages of growth.

Leaf water content, expressed as water weight/dry weight showed no significant response to potassium manuring. The presence of chlorides, however, again caused an increase. It is shown that a very high correlation exists between leaf area and the water weight/dry weight ratio, and the increase of leaf area due to chlorides is probably brought about by an increase of water content.

Dry weight of the selected leaflet was found to be unaffected by the addition of potassium compounds.

Starch formation per unit leaf area showed a significant increase in response to potassium, particularly when in the form of sulphate. There was little or no response to the presence of chlorine.

Translocation could not definitely be shown to be affected by the same treatment, but reasons are given which make it probable than an acceleration in its rate is brought about.

Senescence, as indicated by the yellowing of the leaves, was delayed by the addition of one or two cwt. of potassium sulphate per acre. Four cwt. per acre did not have a similar effect. In all these concentrations, there was no detectable effect on the colour of healthy green leaves. "Coppering," a characteristic spotting of young foliage, was shown to be clearly related to a deficiency of potassium.

These points are discussed, and it is shown that one important effect of potassium in leaves is an increase of catalytic activity, leading to greater efficiency in three of the four stages of starch formation. It is further suggested that loss of potassium is a casual factor in leaf ageing.

STATISTICAL METHODS AND RESULTS.

(Statistical Department.)

- IX. A. J. PAGE. "*On the Annual Revision of Forecasting Formulas based on Partial Regression Equations.*" Journal of the American Statistical Association, 1929. Vol. XXIV, pp. 123-126.

A simple labour-saving formula is developed, by means of which multiple regression equations may be modified appropriately for the inclusion of a new set of observations. The process is recommended as a routine measure for official crop forecasts and other purposes, in which it is important to keep the prediction formula employed up to date, and to make use of all available information.

- X. R. A. FISHER. "*Tests of Significance in Harmonic Analysis.*" Proceedings of the Royal Society (A), 1929. Vol. CXXV, pp. 54-59.

Considerable discrepancy exists among meteorologists and others as to the test of significance to be applied to real or imaginary periods apparent in the data. Schuster's test is correct for testing the significance of a Fourier submultiple chosen in advance, if the variance of the individual values is known *a priori*. Walker's test is appropriate to the largest amplitude among the Fourier submultiple periods. In practice, the variance must be estimated from the observations, and formulæ are given for both cases in which exact allowance is made for the sampling errors of the estimate.

- XI. J. O. IRWIN. "*Note on the χ^2 Test for Goodness of Fit.*" Journal of the Royal Statistical Society, 1929. Vol. XCII, pp. 264-266.

A critical note on two different methods of applying the χ^2 test of goodness of fit. In the first, no allowance is made for the reduction of the number of degrees of freedom when estimates of the population parameters are made from the sample. In the second, the allowance is made. The author points out the differences between the hypotheses on which the two methods are based and gives his reasons for preferring the second method.

- XII. J. O. IRWIN. "*On the Frequency Distribution of any Number of Deviates from the Mean of a Sample from a Normal Population and the Partial Correlations between them.*" Journal of the Royal Statistical Society, 1929. Vol. XCII, pp. 580-584.

An extension of a result which had previously been obtained only for one or two deviates.

- XIII. J. WISHART. "*The Correlation between Product Moments of any Order in Samples from a Normal Population.*" Proceedings of the Royal Society of Edinburgh, 1929. Vol. XLIX, Part I, pp. 78-90.

It is shown that by means of a new method of attack, devised by R. A. Fisher, problems on the correlation between product

moments, which had hitherto been solved only to a limited extent and by approximate methods, can be worked out in their full generality. The correlation between the t^{th} semi-invariant estimates is shown to be equal to the t^{th} power of the correlation between the variates in the normal population considered, while that between any two estimates of the product semi-invariants is also worked out.

- XIV. A. R. CLAPHAM. "*The Estimation of Yield in Cereal Crops by Sampling Methods.*" *Journal of Agricultural Science*, 1929. Vol. XIX, pp. 214-235.

Cereal plots were sampled for yield by three different methods. In one, the location of units (metre-lengths of drill) was wholly systematic, in a single regular pattern: in the second, five drills were selected at random, but six units were cut at different intervals along each row: and in the third, ten units were selected at random from each third of the plot. The results were subjected to statistical analysis, and the disadvantages of the first two methods were clearly demonstrated. These disadvantages were further emphasised in an analysis of earlier data on sampling methods, which made it evident that a direct estimate of sampling error is greatly superior in accuracy to an indirect estimate. It is important, therefore, when carrying out investigations on the precision of such methods, and on possible means of increasing the precision, to ensure that a direct estimate shall be obtainable. This is achieved only by securing some element of random location of units.

By the use of a random sampling method, such as the third (whose superiority to the second depends on the greater representativeness of the sample), the variance due to sampling errors can be made a satisfactorily small fraction of the total variance of cereal experimental plots about 1/40th acre in area.

- XV. J. WISHART AND A. R. CLAPHAM. "*A Study in Sampling Technique: the Effect of Artificial Fertilisers on the Yield of Potatoes.*" *Journal of Agricultural Science*, 1929. Vol. XIX, pp. 600-618.

Methods for sampling cereal crops have already been discussed. Certain modifications of these are necessary in the case of a root crop such as potatoes, owing to the fact that the variability usually met with in the spacing makes the individual plant the logical unit, while for ease in working, a systematic method of selecting the plants is to be preferred. The statistical requirements are satisfied by a simple systematic distribution within the sampling unit, provided at least two randomly chosen sampling units are taken from each plot to constitute the sample. An analysis is made of the yields of part of the Rothamsted potato experiment of 1928, both as estimated by a sampling method and as determined by large scale lifting. It is concluded that a larger proportion of plants than were actually taken is necessary to give a sampling error as small as 4 per cent., and that it would then be profitable only to sample plots of 1/20th acre or more in area.

THE SOIL.

(Chemical and Physical Departments.)

(a) PHYSICAL PROPERTIES.

- XVI. B. A. KEEN AND G. W. SCOTT BLAIR. "*Plastometric Studies of Soil and Clay Pastes.*" *Journal of Agricultural Science*, 1929. Vol. XIX, pp. 684-700.

The laboratory study of the physical properties of soil and clays can conveniently be divided into three stages: (a) moisture content comparable to that under field conditions; (b) thick pastes; (c) weak suspensions. This paper deals with the results of work on the intermediate or thick paste stage. The experimental method has already been described (Paper XLI, Report 1927-28, p. 70). Certain constants defining the material can be obtained from the experimental data. The two of immediate interest are the pseudo-viscosity (analogous to the viscosity of true fluids) and the static rigidity, which measures the energy required just to cause the paste to flow. The latter is a measure of the solid cohesive properties of the system and is found to be related to other physical measurements made under very different conditions; examples of such measurements are (i) the resistance of soil to the passage of cultivation implements (Paper XXXI, Report 1925-26, p. 66); (ii) the effect of chalk on soil resistance; and (iii) the moisture content at which a well-kneaded mass of soil is about to become sticky (Paper XXXV, Report 1927-28, p. 66).

(b) PHYSICAL CHEMISTRY.

- XVII. E. M. CROWTHER AND J. K. BASU. "*Note on a Simple Two-Compartment Electrodialysis Cell for the Determination of Exchangeable Bases.*" *Transactions of the Second Commission of International Society of Soil Science*, Budapest, 1929. Part A, pp. 100-102.

Bradfield's two-compartment cell for the determination of exchangeable bases has been modified to enable the bases to be obtained in a smaller volume of solution. The soil is placed on the bottom of a wide Alundum thimble resting on a perforated nickel kathode, and the anode is a perforated platinum disc close to the surface of the soil. With this arrangement, the whole of the soil, but none of the uncovered membrane, lies immediately between the electrodes. The ratio of endosmotic flow to ionic transport is reduced to a minimum.

- XVIII. S. G. HEINTZE AND E. M. CROWTHER. "*An Error in Soil Reaction Determination by the Quinhydrone Method.*" *Transactions of the Second Commission of International Society of Soil Science*, Budapest, 1929. Part A, pp. 102-111.

In several series of soils from West Africa, Siam and England, the pH values obtained by the quinhydrone electrode occasionally exceeded those by the hydrogen electrode by more than 1.0. Such erratic soils could be detected by the fact that in potassium chloride suspension the soil paste gave a higher pH value than the clear supernatant liquid when both were measured by quinhydrone. The reduction in acidity is clearly shown when quinhydrone is added to a mixture of an erratic soil with an indicator solution. It is

ascribed to the production of manganous hydroxide by an interaction of quinhydrone with manganese dioxide associated with the soil colloids.

THE SOIL POPULATION AND ITS BEHAVIOUR.

(Bacteriological and General Microbiological Departments.)

(a) BACTERIA.

- XIX. P. H. H. GRAY. "*Vibrio (Microspira) Agar Liquefaciens.*" Gray and Chalmers. *Annales de l'Institute Pasteur*, 1929. Vol. XLIII, p. 1058.

A reply to a criticism in a previous number of the above journal as to the cultural purity of the organism described by Gray and Chalmers in 1924.

(b) PROTOZOA.

- XX. D. WARD CUTLER AND L. M. CRUMP. "*Carbon Dioxide Production in Sands and Soils in the Presence and Absence of Amoebæ.*" *Annals of Applied Biology*, 1929. Vol. XVI, pp. 472-482.

Experiments are described on carbon dioxide production from soil and sand cultures containing a species of bacterium with and without amoebæ. The following results were obtained:—

1. Carbon dioxide production and bacterial numbers are correlated provided that amoebæ are not present, or are present in very small numbers.

2. The bacteria are more efficient as producers of carbon dioxide when their numbers are not rising, and less efficient when their numbers are increasing. This does not hold for young cultures. Also each bacterium becomes less efficient as the density of the population increases.

3. The amoebæ cause a decrease in carbon dioxide production in sands containing peptone, but an increase in sands containing mineral salts solution with glucose or soil extract.

THE PLANT IN DISEASE; CONTROL OF DISEASE.

(Entomological and Mycological Departments.)

(a) INSECT PESTS AND THEIR CONTROL.

- XXI. A. D. IMMS. "*Some Methods of Technique applicable to Entomology.*" *Bulletin of Entomological Research*, 1929. Vol. XX, pp. 165-171.

Describes methods of technique applicable to entomology that have been used by the author in the course of a number of years' experience. It deals with methods of mounting, staining, preserving and rearing insects adapted for different lines of investigation, and has been written with a view to assisting research workers both in this country and in other parts of the Empire.

- XXII. J. DAVIDSON AND H. HENSEN. "*The Internal Condition of the Host Plant in Relation to Insect Attack, with Special Reference to the Influence of Pyridine.*" *Annals of Applied Biology*, 1929. Vol. XVI, pp. 458-471.

Certain substances administered to the roots of broad beans are absorbed and transferred to the leaves and stems. Pyridine,

applied in this way in suitable concentrations, exercises a marked detrimental effect upon the aphids : the exact conditions, however, are rather difficult to define : among the important factors are those governing absorption by the plant and the effect of the pyridine on the plant after absorption. In the sand experiments, the effect on the aphids was largely proportional to the amount of pyridine administered to the plant : pyridine, however, depressed the growth of the plant. In soil cultures, the pyridine had a less detrimental effect on the plants and on the aphids, though in sufficiently high concentration, higher than was needed in sand, it proved to be toxic.

- XXIII. H. F. BARNES. "*Two Gall Midges (Cecidomyidæ) found in Stored Products.*" Bulletin of Entomological Research, 1929. Vol. XX, pp. 119-122.

Describes two new species of gall midges affecting stored products on the Continent, both species probably being more or less beneficial, since their larvæ possibly prey upon mites.

(b) FUNGUS PESTS AND THEIR CONTROL.

- XXIV. W. B. BRIERLEY. "*Variation in Fungi and Bacteria.*" Proceedings of the International Congress of Plant Sciences, 1929. Vol. II, pp. 1629-1654.

An introductory survey of the present position is followed by a brief critique of genetic phenomena, concepts and terminology in groups of organisms other than bacteria and fungi. The two latter groups are then considered and a critical analysis is made of the phenomena of variation that have been described. These may be classified from two points of view; firstly, on a basis of morphological and physiological criteria which arranges the data in phenotypic values and, secondly, according to the factors of their appearance and their mode of behaviour, which arranges the data in genetic values. Correlations between the two systems of classification are discussed. The types of variation in fungi and bacteria classified on the genetic basis are treated in relation to processes of growth and reproduction in these groups of organisms : aberrant types of genetic phenomena are considered. Fungi and bacteria are compared with other groups of organisms in respect of the types of genetic phenomena exhibited, the interpretation and classification of these types, the genetic concepts which emerge and the terminology adopted. Finally, the directions of genetic research on fungi and bacteria, and the possibilities and limitations are considered.

- XXV. M. S. MARTIN. "*Additional Hosts of Synchytrium endobioticum (Schilb). Perc.*" Annals of Applied Biology, 1929. Vol. XVI, pp. 422-429.

Infection of numerous species of Solanaceæ by *Synchytrium endobioticum* has been obtained, using Glynne's "green wart" method. Plants grown in contaminated soil did not show infection. The following new hosts are recorded : *Solanum dulcamara* var. *villosissimum*, *Nicandra physalodes*, *Solanum dulcamara* alba, *Solanum nodiflorum* and *Solanum villosum*.

In certain hosts the fungus may occur in the tissues, with little or no external sign of its presence.

XXVI. M. D. GLYNNE. "A Note on Some Experiments dealing with Sulphur Treatment of a Soil and its Effect on Wheat Yield." Proceedings of the Royal Society of Victoria, 1929. Vol. XLII, pp. 30-35.

This work was carried out by Miss Glynne during a visit to Australia.

A plot of land near Melbourne University, on which wheat had been grown for fourteen years, was reported to be so badly infested with fungi, causing foot and root-rot diseases in wheat, that a good crop could not be grown.

Soil treatment with sulphur gave large increases in crop, up to over 800% with sulphur as 0.15% of the soil.

In case sulphuric acid should reduce both crop and disease, treatment with acid was followed in some plots by an application of calcium carbonate after an interval for the acid to affect the fungus in the soil, before the wheat was sown. Increases in crop similar to those obtained with sulphur were obtained, both when sulphuric acid was applied alone and when it was followed by calcium carbonate.

A survey of the disease showed a relatively small amount present in controls and treated plots, and no significant difference between them.

The results indicate not an effect on disease, but a hitherto unsuspected sulphur deficiency or a deficiency in some other element or compound which is rendered available by the treatment.

An increase in crop obtained with ammonium sulphate, larger than that produced by the amount of sulphur contained in it, suggests also a nitrogen deficiency.

(c) BACTERIAL DISEASES.

XXVII. R. H. STOUGHTON. "The Morphology and Cytology of *Bacterium malvacearum* E.F.S." Proceedings of the Royal Society (B), 1929. Vol. CV, pp. 469-484.

Studies have been made of the internal structure and the growth forms of *Bacterium malvacearum*, the organism causing the Black-arm or Angular Leaf Spot disease of cotton.

By means of a special technique, it has been shown that all the cells of the bacterium possess a centrally-placed structure which divides at the same time as the cell, one-half of the structure passing into each of the daughter cells. The details of this division have been followed and reasons for believing it to be a true bacterial nucleus adduced.

Apart from this central structure, cells in a young culture of the organism frequently produce very small deeply staining bodies, which are liberated from the cell either by simple extrusion or by growth on a long stalk. These bodies appear to be identical with the "gonidia" described by other workers for various species of bacteria.

A second growth form which has been described is a larger coccoid body, which is formed by a process of budding from the parent cell. The details of this process have been followed.

TECHNICAL PAPERS

CROPS, SOIL AND FERTILISERS.

- XXVIII. E. J. RUSSELL. "*Recent Agricultural Developments in Australia.*" *Geography*, 1929. Vol. XV, pp. 267-273.
- XXIX. E. J. RUSSELL. "*Soils and Fertilisers.*" *Agricultural Research in 1928*, pp. 131-162. (Royal Agricultural Society of England, 1929.)
- XXX. E. J. RUSSELL. "*Science and Crop Production.*" *Transactions of the Oxford University Junior Scientific Club*, 1929. Fifth Series, pp. 54-59.
- XXXI. E. J. RUSSELL. "*Fertilisers.*" "*Yorkshire Post*" Royal Show Agricultural Supplement, July, 1929.
- XXXII. E. J. RUSSELL. "*The Future of Agriculture.*" *Discovery*, 1929. Vol. X, pp. 355-358.
- XXXIII. E. J. RUSSELL. "*The Conquest of the Waste Places: a Triumph of Modern Science.*" *The Realist*, 1929. Vol. I, pp. 39-54.
- XXXIV. E. J. RUSSELL. "*Soil Fertility and its Control.*" British Association, Report of South African Meeting, 1929, pp. 413-415.
- XXXV. B. A. KEEN. "*Physical Factors and their Control.*" British Association, Report of South African Meeting, 1929, p. 415.
- XXXVI. J. O. IRWIN. "*Crop Forecasting and the Use of Meteorological Data in its Improvement.*" Conference of Empire Meteorologists, 1929, H.M. Stationery Office.
- XXXVII. H. L. RICHARDSON. "*Agricultural Meteorological Work on Soils and Manures.*" Conference of Empire Meteorologists, 1929, H.M. Stationery Office.
- XXXVIII. J. WISHART AND H. J. G. HINES. "*Fertiliser Trials on the Ordinary Farm.*" *Journal of the Ministry of Agriculture*, 1929. Vol. XXXVI, pp. 524-532.
- XXXIX. A. G. NORMAN. "*The Biochemistry of Pectin.*" *Science Progress*, 1929. Vol. XXIV, pp. 263-279.
- XL. R. K. SCHOFIELD AND B. A. KEEN. "*Rigidity in Weak Clay Suspensions.*" *Nature*, 1929. Vol. CXXIII, pp. 492-493.
- XLI. E. M. CROWTHER. "*Soils and Fertilisers: a Report on Recent Developments.*" *Annual Report of the Society of Chemical Industry*, 1928. Vol. XIII, pp. 469-506.
- XLII. H. LLOYD HIND AND F. E. DAY. "*The Fermentation Industries: a Report on Recent Developments (especially Yeasts and Barley).*" *Annual Report of the Society of Chemical Industry*, 1928. Vol. XIII, pp. 531-564.

BIOLOGICAL.

- XLIII. W. B. BRIERLEY. "*Science of the Year—1928. The Biological Sciences.*" The Annual Register for 1928. Vol. CLXX, pp. 37-41.
- XLIV. W. E. BRECHLEY. "*The Dormancy of Weed Seeds in the Soil as affected by Cultivation and Fallowing.*" British Association, Report of South African Meeting, 1929, pp. 417-418.

METEOROLOGICAL OBSERVATIONS.

Meteorological observations have been systematically made at Rothamsted for many years. The deviation of sunshine, mean air temperature and rainfall from their average monthly values for the season ending September, 1929, is shown in the diagram on the following page, an excess being recorded above the horizontal line and a deficiency below.

The records now taken at Rothamsted are as follows :—

Continuous self-registering records of:—

Barometric pressure. (Negretti and Zambra barograph.)

Radiation. (Callendar recorder.)

Sunshine. (Campbell Stokes recorder.)

Wind direction and velocity. (Negretti and Zambra anemobiograph.)

Rainfall. (Negretti and Zambra hyetograph.)

Drainage through 20-inch, 40-inch and 60-inch gauges. (Negretti and Zambra special design.)

Air temperature. (Negretti and Zambra thermograph.)

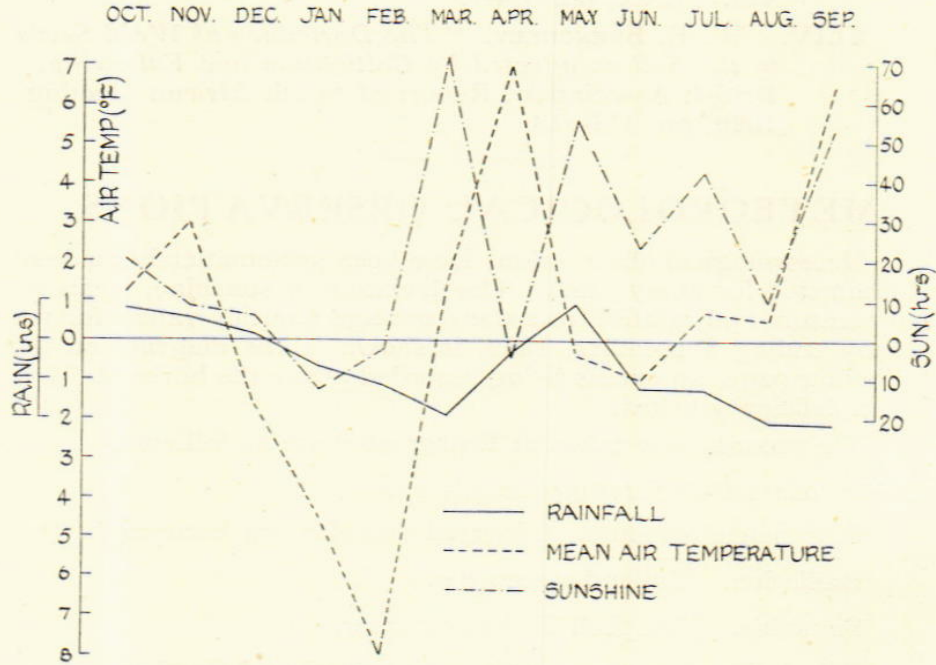
Soil temperatures at 4-inch, 8-inch and 12-inch depths, both under grass and in bare soil. (Negretti and Zambra recording thermometers and Cambridge Instrument Company electrical resistance recording thermometers.)

Records taken at stated hours each day.

In addition to the above, the usual barometer, air and soil temperatures and rainfall readings are taken at 9 a.m.; these are supplemented by further readings at 3 p.m. and 9 p.m. of certain selected factors—wet and dry bulb for relative humidity and dew-point, soil temperature at 4-inch and 8-inch depths. A daily reading is also made of a simple atmometer, to obtain a measure of the amount of evaporation from a wet surface during the preceding 24 hours. Full notes are also made of the general weather conditions.

The detailed information obtained from these records and observations is employed by the Statistical Department in interpreting the crop records, and is also used, together with phenological notes and observations of crop growth, in drawing up the monthly statement for the purpose of the Crop-Weather Report

of the Ministry of Agriculture. The continuous self-registering records are used by the Physical Department in their studies of border-line problems in Meteorology and Soil Physics.



Deviation from average monthly values of sunshine, mean air temperature, and rainfall—Season 1928-29.