ROTHAMSTED RESEARCH

Report for 1935

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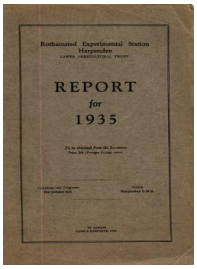

Scientific Papers Published in 1935

Rothamsted Research

Rothamsted Research (1936) *Scientific Papers Published in 1935 ;* Report For 1935, pp 98 - 123 **- DOI: https://doi.org/10.23637/ERADOC-1-67**

SCIENTIFIC PAPERS

(Published 1935 and in the Press)

PLANT GROWTH, PLANT PRODUCTS, AND ACTION OF MANURES

(Departments of Bacteriology, Botany, Chemistry, Physics, Plant Pathology, and Field Experiments Section.)

(*a*) PLANT GROWTH

I. E. J. RUSSELL. "*The Place of Soil Science in Agriculture.*" Transactions of the Third International Congress of Soil Science, Oxford, 1935, Vol. II, pp. 1-10. (Presidential Address.)

II. E. J. RUSSELL. "*Interactions between Roots and Soils. The Growing Plant: its Action on the Soil and on its Neighbours.*" Proceedings of the Sixth International Botanical Congress, Amsterdam, 1935, Vol. II, pp. 1-3.

III. E. J. RUSSELL. "*La Transition d'un Art à une Science: l'Étude de la culture Agricole.*" Lecture delivered to the Academy of Sciences, Lisbon. May 23rd, 1935.

IV. E. J. RUSSELL. "*The Future of British Agriculture.*" The Royal Institution of Great Britain, Discourse, March 8th, 1935.

V. W. E. BRENCHLEY. "*The Influence of Season and of the Application of Lime on the Botanical Composition of Grassland Herbage.*" Annals of Applied Biology, 1935, Vol. XXII, pp. 183-207.
(Figures of complete botanical analyses for this paper were published in the Annual Report for 1934, pp. 142-59.)

The botanical composition of the herbage of grassland under constant manurial treatment varies considerably from year to year. With complete fertilisers including nitrogen and minerals the relative proportions of the three main groups of species, i.e., grasses, leguminous and miscellaneous plants, are not usually much affected by season, but with unbalanced fertilisers and on unmanured areas wide fluctuations occur in the percentage of these groups. Variations of individual species, however, occur on all plots. They may be caused by direct or indirect response to season and are much influenced by the type of manuring.

The application of lime to plots with long established manurial treatment does not affect the balance of the three main groups provided the fertilisers are complete, but with unbalanced manures a definite bias in one direction appears sooner or later. Individual species usually respond to lime at once, showing a change of proportion at the first succeeding cut, but under certain soil condi-

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tions a delay may occur until a second dressing has been given. It would appear that the maximum effect of liming is reached within a few years from the first application, after which fluctuations with season may again become more obvious.

Shade is also a factor which influences the balance of species in herbage, some species being more sensitive than others. In general, no correlation can be traced between the annual variations in yield and the botanical composition of the herbage.

VI. W. E. BRENCHLEY. *"The Weed Flora in its Relation to Crop and Agricultural Treatment."* Proceedings, Zesde Internationaal Botanisch Congres, Amsterdam, 1935, Vol. II, pp. 5-7.

The weed flora of arable land consists largely of plants native to the soil, but the association of species is much modified by cultivation and crop competition, the nature of the competition depending on the type of crop. Root crops help to clean the land on account of the intense cultivation during their growth, while clover, lucerne, and similar plants act as "smother" crops, preventing the development of many weed seedlings. In the case of cereals, the time of sowing, whether autumn or spring, is a principal factor in determining the weed flora.

Rotation of crops is usually the most efficient means of controlling weeds, but sometimes fallowing is necessary, the principle of this being to encourage germination of the weed seeds and, by destroying the seedlings repeatedly, to prevent the formation of fresh seed. Most seeds need a dormant period before they can germinate and the length of dormancy is a vital factor in determining the efficiency of fallowing. Many species also germinate most freely at particular seasons of the year, a fact which decides the time of their greatest vulnerability. For successful fallowing, cultivation must begin directly after harvest and be carried out at sufficiently short intervals to prevent rapidly growing species from ripening fresh seed. Fallowing improves soil fertility, and as weeds and crop alike benefit after-care is important, for the weeds may reassert themselves with extraordinary rapidity.

On old grassland the vegetation itself constitutes the crop, the less desirable species being regarded as weeds. The flora is much influenced by soil fertility, manuring and methods of cultural treatment. Grazing has a direct influence on the weed flora as the various animals eat down the herbage differently, and alternate grazing and taking off crops of hay is a valuable method of weed control.

VII. K. WARINGTON. *"The Effect of Constant and Fluctuating Temperature on the Germination of the Weed Seeds in Arable Soil."* Journal of Ecology, 1936, Vol. XXIV, pp. 185-204.

Germination of all species was definitely inhibited if the soil was kept in an incubator or cellar where the temperature was practically constant, and light wholly or partially excluded. Some weed seeds were more adversely affected than others, *Alopecurus*

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agrestis being the least and *Papaver rhoeas* the most sensitive of the more important species encountered. Removal of the same samples of soil to a glasshouse after one or two years in the incubator or cellar resulted in a rapid germination of a variety of weed seeds, showing that their failure to appear sooner was due to unfavourable conditions in the previous circumstances. This inhibiting effect on germination is attributed to a lack of sufficient fluctuation in temperature rather than to any reduction in light intensity, though with certain species this may also have played a part. Too long an exposure to the constant temperature resulted in loss of seeds by death, the capacity for survival varying with the different species, *Alopecurus agrestis*, for example, generally failing to survive one year, whereas *Alchemilla arvensis* aud *Papaver rhoeas* remained viable after two years.

VIII. E. M. CROWTHER AND F. CROWTHER. "*Rainfall and Cotton Yields in the Sudan Gezira.*" Proceedings of the Royal Society of London, B., 1935, Vol. CXVIII, pp. 343-370.

The relationships between seasonal yield and weather fluctuations for cotton grown under irrigation in the Sudan Gezira were analysed for periods up to 23 years.

The analysis confirmed the generally recognised bad effects of high rainfall about the period of sowing cotton, but showed that this effect was not universal. An unsuspected but apparently general effect was discovered. Cotton yields were negatively correlated with the amount of early—May and June—rainfall. In some areas yields were negatively correlated with late rainfall and with the total rainfall in the preceding year. The differences between areas in their responses to weather could be partially interpreted in terms of their situations and agricultural histories.

The progressive decline in yield at the oldest trial farm could be largely accounted for by a significant increase in total rainfall during the period of cotton cultivation. The total annual rainfall in the Sudan Gezira exhibited a significant seven-year periodicity, which was reflected in cotton yields, dura exports, and recorded famines. It happened that the first trial of irrigated cotton and the first use of the Sennar Dam coincided with minimal rainfalls on this periodicity. The early promise and rapidly increasing difficulties may well have been due in part to the recurrence of unfavourable weather conditions and not necessarily to soil deterioration and pests.

Uniformly treated record areas could easily be established on a normal commercial basis in irrigation projects under central control, and would provide valuable material for research in agricultural meteorology, and a surer background for determining both experimental and commercial programmes.

IX. E. M. CROWTHER. "*Rainfall and Cotton Yields in the Sudan Gezira.*" Empire Cotton Growing Review, 1936, Vol. XIII, pp. 110-119.

The conclusious from the preceding paper (No. VIII.) were summarised, and extended by testing the rate of change of the

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rainfall effects with time. In no set of data examined was there evidence that the effect of unit rainfall had increased or decreased significantly over the period of cultivation. It is not, therefore, possible to use the striking agreement between actual and forecasted yields in some of the recent years as support for the view that soil deterioration was being manifested in greater sensitivity to the harmful rainfall.

x. D. J. WATSON. *"The Effect of Potassium Chloride on the Diurnal Changes of the Carbohydrates of the Potato Leaf."* Annals of Botany, **1936**, Vol. L, pp. 59-83.

The effect of application of potassium chloride on the diurnal changes of carbohydrates in potato leaflets was studied on five plots of the Six-Course Rotation. The changes in composition were all expressed on the basis of 100 gm. initial dry weight, by using a method of sampling which utilises the correlation between opposite leaflets, so that the effect of changes in other constituents was eliminated.

It was found that the rate of formation and removal of starch was not affected, which confirms the work of James and Maskell. The sucrose content was depressed but only during the middle of the day, and there was no effect on reducing sugars.

Significant diurnal variations of starch, sucrose and reducing sugars were found. There was evidence of rapid starch hydrolysis with formation of sucrose at sunset, and of the reverse effect at sunrise.

It has been suggested that "residual dry matter," (dry matter—total carbohydrate) might be used as a constant basis of reference for changes of carbohydrate content. Significant changes of residual dry matter were found, however, during the course of the day, so that this method of expressing the results would have led to erroneous conclusions.

xi. H. G. THORNTON and HUGH NICOL. *"Reduction of Nodule Numbers and Growth, produced by the Addition of Sodium Nitrate to Lucerne in Sand Culture."* Journal of Agricultural Science, **1936**, Vol. XXVI, pp. 173-188.

A sand culture experiment with inoculated lucerne was made to test the effect of increasing doses of sodium nitrate upon the yield and nitrogen content of tops and roots, and upon the number and development of nodules.

There was no correlation between yield or nitrogen content of the lucerne, and the dose of nitrate.

The number of nodules, though unaffected by 1 gm. of sodium nitrate, was progressively decreased by the stronger doses.

The length of nodules was reduced about 30 per cent. by 1 gm. of sodium nitrate, and decreased progressively with stronger doses.

Nodules were found to show a definite relationship between their overall length and the volume of contained bacterial tissue. Using this relation, the mean volumes of bacterial tissue per nodule and per pot for each series were calculated. The reduction effected by nitrate was far greater when measured in this way, owing to the

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small contribution of bacterial tissue derived from nodules less than 1.5 mm. in length.

Increasing doses of nitrate also progressively decreased the nodule numbers, and the content of bacterial tissue, per gram of root. The effect of nitrate was thus not due to reduced root growth.

XII. H. G. THORNTON and J. E. RUDORF. "*The Abnormal Structure Induced in Nodules on Lucerne* (Medicago Sativa *L.*) *by the Supply of Sodium Nitrate to the Host Plant.*" Proceedings of the Royal Society of London, B, 1936, Vol. CXX, pp. 240-252.

Lucerne seedlings carrying very young nodules were transplanted into and grown in an agar medium (1) with no nitrate, and (2) containing concentrations of sodium nitrate ranging from 0.05 to 0.2 per cent. The presence of nitrate greatly reduced the growth of the nodules.

The following abnormalities were associated with the supply of nitrate to the host plant :

(1) The cell-walls of the distal cap were very much thickened, the cell-wall material often projecting into the cells in the form of concretion-like lumps. These thickened walls and the lumps gave the same micro-chemical reactions as did the thin cell-walls of the normal tissue. The cell-contents were usually reduced and the nuclei greatly shrunken.

(2) The endodermis that surrounds the central tissue of the nodule and also that which ensheathes the vascular strands were abnormally thickened by a deposition throughout the cell-walls of material giving the suberin reaction.

(3) There was an increased tendency towards necrotic decay of the central bacterial tissue and, where this did not occur, the cell-contents were usually much reduced.

(4) In the younger portions of the bacterial tissue, the bacteria occurred principally in the coccus stage of their life-cycle, a stage usually associated with food deficiency.

XIII. H. G. THORNTON. "*The Action of Sodium Nitrate upon the Infection of Lucerne Root-hairs by Nodule Bacteria.*" Proceedings of the Royal Society of London, B, 1936, Vol. CXIX, pp. 474-492.

The actions of living nodule bacteria and of sterile filtrates containing their secretions were tested upon root-hairs of lucerne grown in agar medium in the presence and absence of sodium nitrate and ammonium sulphate.

Sodium nitrate at initial concentrations of from 0.1 to 1.0 per cent. prevents infection of the root-hairs.

Sodium nitrate at the above concentrations, and ammonium sulphate at a concentration of 0.1 per cent., check the deformation of the root-hairs by the nodule bacteria. This deformation is a necessary prelude to infection and the checking of it accounts for the absence of infection by the nodule bacteria.

Sodium nitrate at a concentration of 0.1 per cent. also checks

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the deformation of root-hairs by sterile secretions of the nodule bacteria.

Both the living bacteria and their sterile secretions not only cause deformed growth of the root-hairs but in addition stimulate an increase in their number and length. Sodium nitrate also checks this growth-stimulation.

These effects of nitrate in inhibiting the action of the bacterial secretions upon root-hairs are mitigated by the addition of dextrose, together with the nitrate, to the medium surrounding the roots. This suggests that the nitrate interferes with the carbohydrate supply to the piliferous layer of the root.

XIV. L. HAVAS and J. CALDWELL. *"Some Experiments on the Effects of Animal Hormones on Plants."* Annals of Botany, 1935, Vol. XLIX, pp. 729-748.

Present knowledge on the effect of animal hormones on plants is examined; and experiments described in which a number of glandular extracts was administered to plants. On the whole the effect was small.

XV. J. CALDWELL. *"Occurrence of Copper Poisoning in a Glasshouse Crop."* Annals of Applied Biology, 1935, Vol. XXII, pp. 465-468.

Small traces of copper may produce in cucumbers a disease simulating virus diseases, and care is necessary in commercial practice to avoid any chance of copper contamination, e.g. in sterilising pots.

(*b*) PLANT PRODUCTS.

XVI. A. G. NORMAN. *"The Hemicelluloses. Part I. Alcoholic Sodium Hydroxide as a Pretreatment to Extraction."* Biochemical Journal, 1935, Vol. XXIX, pp. 945-952.

As a pretreatment to the preparation or direct determination of hemicelluloses, an extraction of the material with 1 per cent. NaOH in 50 per cent. alcohol has been advocated as a delignifying agent. The effect of various concentrations of alcoholic soda has been studied.

When hot, 1 per cent. NaOH in alcohol concentrations up to 90 per cent. extracts in addition to lignin a considerable amount of polyuronide material, the amount increasing as the alcohol concentration is decreased. When cold, the action is less drastic in 70 per cent. alcohol and higher concentrations, but is still appreciable in 50 per cent. alcohol and lower concentrations. Alcoholic soda is not a very effective delignifying agent in any of these concentrations.

The polyuronide hemicelluloses of different materials vary in the degree of susceptibility to alcoholic soda. Those of immature tissues seem to be more easily removed than those of older lignified materials. No indication has been obtained that the material removed by alcoholic soda represents a special group or type of polyuronide.

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XVII. A. G. NORMAN, and (in part) J. G. SHRIKHANDE. "*The Hemicelluloses. Part II. The Association of Hemicelluloses with Lignin.*" Biochemical Journal, **1935**, Vol. XXIX, pp. **2259-2266**.

The removal of polyuronide hemicelluloses from plant materials by extraction with hot sulphite solution is affected by previous chlorination to almost the same degree as that of lignin, for which the process was especially designed. Some form of association or combination between lignin and this type of hemicellulose is probable since the extraction of the latter depends on a treatment effecting the solution of the former. Aqueous extractions following chlorination are nearly as effective in the removal of the hemicelluloses as sulphite treatments, once the linkage has been ruptured. The possibility arises that both lignin and hemicellulose may be present in two forms in plant materials, attached and unattached, dependent on the relative quantities of each present.

XVIII. W. T. ASTBURY, R. D. PRESTON, and A. G. NORMAN. "*X-Ray Examination of the Effect of Removing Non-Cellulosic Constituents from Vegetable Fibres.*" Nature, **1935**, Vol. CXXXVI, p. **391**.

X-ray studies of the progressive removal of the xylan associated with the cellulosic fibres of manilla hemp support the view that the incorporation of xylan in cellulose is a form of mixed crystallisation. The effect of purification of common fibres by removal of lignin and encrusting hemicelluloses was also studied. Improved definition through sharpening of the crystallite orientation was observed, without reduction of intensity.

XIX. A. G. NORMAN. "*The Composition of Crude Fibre.*" Journal of Agricultural Science, **1935**, Vol. XXV, pp. **529-540**.

The determination of crude fibre is one of the oldest of routine agricultural analyses and is widely used in checking the composition of commercial feeds and similar materials. For research purposes or digestibility studies its use may be misleading because the crude fibre fraction obtained does not bear any definite or constant relationship to the structural constituents of the material or to the crude fibre of any other material. The cellulose is partially attacked, and the lignin extensively removed in the process of its isolation. Much variation is found in the lignin contents of crude fibre fractions, highly lignified materials not necessarily yielding a crude fibre high in lignin.

Since the presence of lignin exercises a direct effect on the digestibility of the material, any empirical method of determination of "fibre" should include all the lignin and to achieve this any alkaline treatment must be avoided. Acid hydrolysis may be a possible alternative method, if a correction for protein be made in the case of materials high in nitrogen and the lignin content subsequently determined.

XX. L. W. SAMUEL. *"The Amino-Acid Content of Wheat Flour Dough."* Biochemical Journal, 1935, Vol. XXIX, pp. 2331-2333.

In an unyeasted flour dough the amino-acid content increased steadily with time.

In a yeasted flour dough the amino-acid content increased slightly for about an hour and then decreased to an almost constant value.

The rate of utilisation of amino-acid by yeast in a solution similar to the dough liquid indicates that in a yeasted dough the protein is decomposed about twice as rapidly as in an unyeasted dough.

XXI. L. W. SAMUEL AND R. K. SCHOFIELD. *"The Binding of Glacial Phosphoric Acid by the Proteins of Wheat Flour."* Transactions of the Faraday Society, 1936, Vol. XXXII, pp. 760-769.

Making use of the fact that glacial phosphoric acid is a protein precipitant, measurements have been made of the capacity of the proteins of wheat flour to bind this acid by shaking them up with an excess of the acid and determining the amount remaining in solution by back titration on an aliquot.

Solutions of potassium chloride, hydrochloric acid and trichloroacetic acid are slightly diluted by shaking with wheat starch, but there is no appreciable change in the concentration of a solution containing about 8 gm. of glacial phosphoric acid per litre, owing to the balancing of a very small uptake of acid by a " binding " of some water by the starch. The concentration change caused by adding flour is therefore due to acid taken up by the protein.

The capacity of thirty-seven flours to bind glacial phosphoric acid varied from 6.7 to 10.1 milliequivalents per 100 gm. of flour. The uptake tended to be greater for the flours of higher nitrogen content, but the acid bound per gram of nitrogen varied from 3.52 to 4.82.

Although electrometric titrations revealed differences in the proportions of the constituent metaphosphoric acids in different batches of glacial phosphoric acid, determinations of the binding capacity of a gluten with eight different solutions gave a variation of only 5 per cent. between the highest and lowest values.

The uptake per gram of a gluten varied only slightly with the concentration of the acid between 0.02 and 1.0 normal, and was independent of the amount of gluten added, provided not more than a quarter of the acid was removed from the solution. In confirmation of a theory of the molecular structure of the metaphosphoric acids, put forward in an earlier paper (No. LXI, Report for 1934), it has been found that protein removes certain metaphosphate ions from solution in preference to others. It has further been found that different proteins are selective to different degrees showing that their basic groups can be differentiated as regards their action on glacial phosphoric acid.

Reasons are given for thinking that the uptake of trichloroacetic

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acid by gluten from a 0.5*N* solution is a measure of its hydrion binding capacity; if so, the additional titratable acid bound (roughly 30 per cent.) when glacial phosphoric acid is used, must be in the form of hydrions associated with polybasic anions.

The lowest *p*H at which the materials could be washed free of anions (the isoelectric point) was found by Loeb's ferrocyanide method to be: the gluten, *p*H 6.1; the gliadin, *p*H 6.85; the glutenin, *p*H 5.5; and one of the flours, *p*H 5.95. The *p*H values were in each case close to those of the materials as procured, and a correction of a few per cent. only had to be applied to the acid uptake to obtain the acid binding capacity.

(*c*) Action of Manures

XXII. E. M. Crowther (with D. N. McArthur). "*Report on Swede Experiments in* 1934." Appendix II. to Thirteenth Interim Report of Permanent Committee on Basic Slag, Ministry of Agriculture and Fisheries, 1935.

A series of eight 6 x 6 Latin square field experiments on swedes in Scotland was carried out to compare two medium-soluble slags against low- and high-soluble slags and mineral phosphate. At two centres the crops without phosphate failed completely. On the average of the six experiments with highly significant responses low-soluble slag doubled and high-soluble slag trebled the yield. The medium-soluble slags gave intermediate results, but the difference between them was greater than would be expected from their citric acid solubilities.

XXIII. E. M. Crowther and R. G. Warren. "*Report on Field Experiments in England and Pot Culture Work and Laboratory Work at Rothamsted.*" Appendix I to Thirteenth Interim Report of Permanent Committee on Basic Slag, Ministry of Agriculture and Fisheries, 1935.

A series of pot culture experiments on eleven basic slags, including two new medium-soluble slags, showed that the yield of perennial rye-grass and its phosphoric acid uptake followed very closely the amount of citric soluble-phosphoric acid supplied in both single and double dressings of all of the slags. Mineralogical analyses on the ground slags showed that two medium-soluble slags had different assemblages of crystals. One contained the two silicophosphates commonly found in high-soluble slags, and the other contained a new form of silicophosphate. The medium-soluble and the low-soluble slags contained apatite, often intergrown with a calcium silicate.

XXIV. E. M. Crowther. "*The Manuring of Sugar Beet.*" British Sugar Beet Review, 1935, Vol. IX, pp. 71-73 and 105-6.

The results of over 100 manuring experiments on sugar beet during 1928 to 1934 are reviewed and compared with those for similar experiments on potatoes. The sugar beet gave significant

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responses to nitrogen in half the experiments, to phosphoric acid in one-tenth and to potash in one-fifth. Potatoes were much more responsive, significant effects being obtained in about five-sixths of the experiments with nitrogen and in one-half of those with phosphoric acid and potash.

STATISTICAL METHODS AND RESULTS
(Department of Statistics)

(*a*) TECHNIQUE

XXV. F. YATES. "*Incomplete Latin Squares.*" Journal of Agricultural Science, **1936**, Vol. XXVI, pp. **301-315.**

A description is given of the statistical procedure appropriate for the analysis of a Latin square having missing the whole of one row, one column or one treatment, or one row and one column, or either and a treatment. These are the only types of incomplete Latin squares (except those which can be dealt with by the missing plot technique), of which a neat statistical analysis is possible.

It is shown that incomplete Latin squares of these types give unbiased estimates of error and are therefore valid experimental arrangements. They are consequently likely to be of use when the experimental material is such as to preclude the use of a complete Latin square owing to the fact that numbers in one or both of the natural groups is one less than the number of treatments to be tested.

XXVI. F. YATES. "*A New Method of Arranging Variety Trials involving a Large Number of Varieties.*" Journal of Agricultural Science, **1936**, Vol. XXVI, pp. **424-455.**

A new method of arranging variety trials involving a large number of varieties is described. This type of arrangement, for which the name "pseudo-factorial" arrangement is proposed, enables the block size to be kept small without the use of controls.

Various possible types of pseudo-factorial arrangement are discussed in detail and the necessary formulae developed. The appropriate methods of computation are illustrated by numerical examples based on the results of a uniformity trial on orange trees. It is shown that pseudo-factorial arrangements are likely to be more efficient than arrangements involving the use of controls. In cases where there is considerable soil heterogeneity they are also markedly more efficient than randomised blocks containing all the varieties. In the chosen example gains in efficiency ranging from **26** to **57** per cent. were obtained.

XXVII. F. YATES and I. ZACOPANAY. "*The Estimation of the Efficiency of Sampling, with Special Reference to Sampling for Yield in Cereal Experiments.*" Journal of Agricultural Science, **1935**, Vol. XXV, pp. **545-577.**

The estimation of the yields of the individual plots of replicated experiments on cereals by sampling methods has been practised since the year **1929** at Rothamsted and its associated outside centres.

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The present paper contains an investigation of the actual efficiency of the sampling processes adopted in the Rothamsted experiments, as revealed by the sampling and experimental errors. Opportunity is taken to review the theory of sampling errors and their estimation. It is shown that with a given relation between experimental and sampling variation and between the work involved in sampling and in the rest of the experiment there is an optimal percentage of sampling. It is also shown that in many cases there is little to be gained by pushing the sampling beyond certain fairly well-defined limits, even when the work involved in sampling is small.

This discussion is of importance not only in considering the application ot sampling to the estimation of yield, but also in all sampling processes performed on replicated experiments. The estimation of plot yields by sampling is an application of only minor importance, since it is always possible, and often simpler, to harvest the whole of each plot ; but in many other cases sampling is a vital necessity, and results can be obtained by its aid which could otherwise only be obtained with excessive labour, or not at all. The determination of the necessary amount of sampling in such cases, and the balance between the sampling and the size of the experiment, is a problem which continuously confronts the experimenter. In particular, the individual observation of every plant, of every tree, or of every animal in an experiment, may often prove to be unnecessary when consideration is given to the amount of information obtained.

The paper also contains suggestions for certain modifications of the present sampling procedure for cereal crops. The most important of these (already employed by some workers) is the use of sampling to determine the proportion of grain to total produce on each plot, the yield of total produce being determined by full harvesting. It is shown that this method is capable of greatly reducing the sampling errors with considerably smaller samples than are at present taken, and it seems likely that the method will prove a useful alternative to the present method. The details of an efficient field technique remain to be worked out and tested in practice before it is possible to make a definite assessment of the relative advantages of the two methods.

(*b*) Examination of Results.

xxviii. W. G. Cochran and D. J. Watson. "*An Experiment on Observers' Bias in the Selection of Shoot-Heights.*" Empire Journal of Experimental Agriculture, 1936, Vol. IV, pp. 69-76.

In this experiment twelve observers were asked to select by eye and measure the heights of two shoots from a quarter-metre of each of 24 rows of wheat, so as to give what they considered a representative sample of the distribution of shoot heights. None of the observers' samples was found to be representative of the population sampled, and their estimates of the mean shoot height were all positively biased. This supports the evidence from other investigations that the only sure method of avoiding bias is for the sampling to be random.

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The sampling process actually used in the Wheat Sampling Observations—selection of the two shoots nearest the ends of the quarter-metre—appeared to be satisfactory.

XXIX. W. G. COCHRAN. "*The Statistical Analysis of Field Counts of Diseased Plants.*" Supplement to the Journal of the Royal Statistical Society, 1936, Vol. III, pp. 49-67.

The statistical analysis of the data obtained by examining every plant in a field or green-house for disease at certain intervals is discussed. Tests of significance are given, with numerical examples, to detect (1) whether diseased plants tend to congregate in patches scattered over the area or in groups along or across the rows; (2) whether the distribution of plants recently infected is related to that of plants previously infected; (3) whether neighbour infection is present.

XXX. W. G. COCHRAN. "*A Note on the Influence of Rainfall on the Yield of Cereals in Relation to Manurial Treatment.*" Journal of Agricultural Science, 1935, Vol. XXV, pp. 510-522.

The study of the effect of rainfall on the yields of wheat from the continuous experiments on Broadbalk, Rothamsted, gave clear evidence of a close relation between the linear response in yield to rainfall and the manurial treatment of the soil. In later investigations of a similar nature on barley at Rothamsted and on wheat and barley at Woburn, the linear effect of rainfall on yield was not significant. This note shows that the relation between seasonal variations in yield and manurial treatment is just as clear at Woburn as on Broadbalk, the difference between the two centres being that similar studies on rainfall effects have had more definite and successful results on Broadbalk. At Woburn, indeed, little progress has been made towards elucidating the particular weather factors whose quantitative influence is important.

For both barley at Woburn and wheat at Rothamsted, which were the cases examined in detail, the grouping of yields according to manurial treatment remained after eliminating the effect of the significant weather factors which were found. This shows that at both centres there are influences, other than rainfall effects of the type examined, whose effect on the seasonal variations in yield is closely associated with manurial treatment.

Some discussion is given of the appropriate test of significance of the difference between two rainfall curves and of a somewhat analogous case which arises in the interpretation of the results of a series of replicated experiments at different centres.

XXXI. M. M. BARNARD. "*An Examination of the Sampling Observations of Wheat of the Crop-Weather Scheme.*" Journal of Agricultural Science, 1936, Vol. XXVI, pp. 456-487.

Sampling observations are now being taken at ten British agricultural stations on each of two standard varieties of wheat. These observations form part of the Crop-Weather scheme spon-

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sored by the Ministry of Agriculture and Fisheries and the Meteorological Office, and their function is to provide information on the influence of meteorological conditions on all stages of the wheat crop's growth from germination to harvest. They also supply information on the connections existing between the different stages of the crop's growth.

The present paper describes a preliminary investigation of the results of the first three years, 1933, 1934 and 1935. The following points have been investigated: (*a*) the length of the interval from the time when the crop is sown until it appears above ground; (*b*) the date at which the crop has twice as many tillers as plants and the rate at which this tillering occurs; (*c*) the maximum number of shoots formed per unit length of drill row; (*d*) the maximum rate of increase of shoot height; (*e*) the yield of grain per acre.

Associations have been found to exist between each one of these quantities, and either specific meteorological factors, or earlier measurements of the crop's progress. In some cases both types of association occur. In the case of the yield of grain, no association with meteorological factors has manifested itself. It would appear, therefore, that such relations are likely to be complex and must await further data for their elucidation.

During the last three years a close connection was found to exist between the yield and the shoot height at ear emergence, greater yields being associated with taller crops. It is probable, therefore, that measurements of the crop's growth, possibly in conjunction with meteorological measurements, will give more reliable predictions of the yield than those obtained from the latter alone. The practical application of this aspect of the results is discussed in Paper No. XXXII below.

XXXII. F. YATES. *"Crop Estimation and Forecasting: Indications on the Sampling Observations on Wheat."* Journal of the Ministry of Agriculture, 1936, Vol. XLIII, pp. 156-162.

The estimation of the yields of agricultural crops, and the forecasting of such yields before harvest, are problems of considerable importance in agriculture, especially since the introduction of a measure of control in agricultural production and marketing. The present paper discusses the forecasting of the yield of the commercial wheat crop about six weeks before harvest by means of simple measurements on the growing crop.

That this is a possibility is indicated by the results of the first three years of the sampling observations on wheat, which were taken at ten stations under the Agricultural Meteorological Scheme. These revealed a very close connection between shoot height at ear emergence and final yield of grain. There was also a slight negative correlation with plant number.

The problem of estimating the yields of commercial crops at harvest by sampling the standing crops is also discussed. Some trial sampling of this type was undertaken by the observers of the Agricultural Meteorological Scheme.

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THE SOIL

(Departments of Chemistry and Physics.)

(*a*) Soil Classification.

XXXIII. E. M. Crowther. "*Some Inductive Methods in Pedology.*" Transactions of the Third International Congress of Soil Science, 1935, Vol. I, pp. 339-343.

Three supplementary methods of collecting and analysing soil data are proposed with the object of placing soil classification on a firmer inductive basis.

The collection of local soil names would reveal many natural units which must be accommodated in any general soil classification, and might also show the dominant pedogenic factors. Thus in Great Britain the traditional names emphasise the parent material or the recent geological history, whilst there is a conspicuous absence of names for soils now recognised as belonging to the major world groups.

The genetic interpretation of typical soils might be expressed in terms of a logarithmic time scale analogous to the *p*H scale (i.e. negative logarithms to the base 10 of time in years). Empirical methods of classification and mapping for advisory purposes tend to emphasise local differences and obscure the common factors which become important when the soils are to be linked up with those of other regions. In partially surveyed countries there is a danger that valuable observations may be missed by non-specialists working from crude statements of too restricted genetic theories.

An analysis of the distribution of the soils of the European U.S.S.R. in relation to rainfall and temperature brought out the major characteristics of the Russian soil zones and showed which ones were sufficiently widely and regularly spread to be regarded as in substantial equilibrium with climatic factors, and which were not.

(*b*) Physical Properties.

XXXIV. R. K. Schofield. "*The pF of the Water in Soil.*" Transactions of the Third International Congress of Soil Science, 1935, Vol. II, pp. 37-48.

A treatment of soil moisture relationships based on energy considerations has the advantage that the results obtained are true regardless of the mechanisms at work.

Buckingham's assumption that there is an equilibrium suction for each moisture content does not provide a satisfactory practical basis.

The suction needed to withdraw water from a moist soil is, in general, greater than that against which water will enter the soil at the same moisture content.

In order to deal conveniently with the whole range of suction, use is made of the logarithm of the height in centimetres of the equivalent water (or other liquid) column. The symbol *p*F is used for this quantity.

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The determination of *p*F by direct suction, freezing point, vapour pressure, vertical columns, centrifuge and absorbent materials is considered.

It is shown that by carefully distinguishing wetting from drying conditions the results of investigations on plant wilting and field moisture capacity receive a rational interpretation.

It is suggested that in ordinary soils the difference between the behaviour on wetting and drying is due more to micro-plastic resistance to swelling and shrinking, than to surface-tension effects.

Further lines of enquiry are indicated.

XXXV. R. K. SCHOFIELD and J. V. BOTELHO DA COSTA. "*The Determination of the pF at Permanent Wilting and at the Moisture Equivalent by the Freezing Point Method.*" Transactions of the Third International Congress of Soil Science, **1935**, Vol. I, pp. 6-10.

Attention is drawn to two defects in the technique of Bouyoucos and McCool for determining the freezing point of moist soil which lead to serious errors.

Results obtained, when due regard is paid to these points, agree well with the best determinations by vapour pressure and seed adsorption, and give the "wetness" of soil at permanent wilting as approximately *p*F 4.2.

Determinations of the freezing point at the moisture equivalent give values between *p*F 2.5 and *p*F 3.0. A truly constant figure for all soils is not to be expected.

XXXVI. E. W. RUSSELL. "*The Adsorption of Liquids by Clays.*" Transaction of the Third International Congress of Soil Science, **1935**, Vol. I, pp. 48-50.

An analysis is made of the factors on which the apparent specific volume (or density) of a clay in different liquids depends.

The results of this analysis are in accord with the hypothesis that clays adsorb non-polar liquids only weakly, if at all; but that the adsorption of polar liquids is due to the orientation of the electric dipoles in their molecules in the electrostatic fields around the exchangeable ions held by the clay and around the negative charges on the clay substrate.

XXXVII. E. W. RUSSELL. "*The Binding Forces between Clay Particles in a Soil Crumb.*" Transactions of the Third International Congress of Soil Science, **1935**, Vol. I, pp. 26-29.

The hypothesis is put forward that clay particles are held together in a crumb by orientated molecules of a polar liquid, which was the dispersion medium in the paste from which the crumb was formed. These polar molecules lie between the negative charges on the clay surface and the exchangeable cations that have dissociated from the clay, and they are strongly orientated in the electrostatic field between these charges. The binding link postulated between two clay particles consists of three units: orientated molecules, an exchangeable cation, orientated molecules, and it binds a negative

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charge on the surface of one clay particle to a negative charge on the surface of a second. This hypothesis accounts satisfactorily for the main experimental facts concerning the hardness of crumbs and the conditions under which they are found.

(*c*) Physical Chemistry.

XXXVIII. G. Nagelschmidt. "*On the Lattice Shrinkage and Structure of Montmorillonite.*" Zeitschrift für Kristallographie, A, 1936, Vol. XCIII, pp. 481-487.

A detailed investigation was made of the lattice shrinkage upon dehydration and the structure of montmorillonite, described by Hofmann, Endell and Wilm. The $d_{(001)}$ spacing shows a proportional increase from 10.5 Å to nearly 15 Å during the uptake of the first four molecules of water per $Al_4Si_8(OH)_4O_{20}$, and a slight increase of 0.6 Å during the uptake of the next ten molecules of water. At still higher moisture contents this spacing rises to nearly 19 Å.

These results can be explained by assuming that the first four molecules of water per unit cell enter between the layers of the structure and thus change their distance, whereas the bulk of the next ten molecules of water remains at the surfaces of the crystals.

When water is replaced by methylene iodide or by methyl iodide there is no indication that the liquid takes up definite positions within the lattice.

Some difficulties of explaining these results quantitatively by the detailed structure of montmorillonite are pointed out.

XXXIX. E. M. Crowther and S. G. Heintze, (with D. J. Hissink, Chairman.) "*Report of the Soil Reaction Committee on the Investigation of the Glass Electrode Method.*" Transactions of the Third International Congress of Soil Science, 1935, Vol. I, pp. 128-132.

The glass electrode method was tested on 21 soils at six laboratories and proved satisfactory.

The agreement between the quinhydrone and the glass electrode methods is satisfactory for soils without quinhydrone drift, i.e., for soils which give closely similar potentials about 10 seconds and 60 seconds after adding the quinhydrone. For soils with quinhydrone drift the glass electrode results are similar to those measured by quinhydrone after about 10 seconds. Such rapid measurements by quinhydrone are not reproducible and for soils with large quinhydrone drifts the *p*H values should be measured by the glass electrode.

In order to decide whether the quinhydrone method is appropriate, determinations should always be made rapidly (preferably within 10 seconds) and again after 60 seconds, and the latter readings used when the drift is small.

XL. S. G. Heintze. "*Soil Oxidation-Reduction Potentials and pH Values.*" Soil Research, 1935, Vol. IV, pp. 351-355.

The oxidation-reduction potentials (EH) of the majority of a

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large number of widely differing soils, measured by four independent workers, tend to follow the *p*H values of the soils. The relationship is similar to that between platinum electrode potentials and *p*H values in buffer solutions. It is suggested that the EH values for most soil-water suspensions are essentially rough *p*H measurements made by a platinum-platinum oxide electrode. EH values may be used to detect acutely reducing conditions in soils but otherwise appear to have little value. A proposal to use EH measurements on acid-treated soils for diagnostic purposes was criticised on the grounds that they include several independent factors which could be separated and measured accurately.

XLI. R. K. SCHOFIELD. "*The Interpenetration of the Diffuse Double Layers Surrounding Soil Particles.*" Transactions of the Third International Congress of Soil Science, 1935, Vol. I, pp. 30-33.

Evidence is set out to show that the simple equation, $x^2=y(y+z)$, for the Donnan membrane equilibrium is not applicable to soils, because the diffuse double layers surrounding neighbouring particles only interpenetrate to a limited extent.

Freezing point measurements of moist $Li^{\cdot}$, $Na^{\cdot}$,$K^{\cdot}$, $Mg^{\cdot\cdot}$, $Ca^{\cdot\cdot}$ and acid-washed soils demonstrate that the interpenetration is less the wetter the soil.

The additional freezing point depression due to ionic dissociation is, broadly speaking, a measure of the repulsive pressure caused by the interpenetration of the diffuse double layers which is liable to destroy the structure of alkali soils.

(*d*) ORGANIC CHEMISTRY

XLII. E. M. CROWTHER. "*First and Second Reports of the Organic Carbon Committee.*" Transactions of the Third International Congress of Soil Science, 1935, Vol. I, pp. 114-127, Vol. III, pp. 82-83.

The reports summarise co-operative work conducted for the International Society of Soil Science and organised from Rothamsted.

Nine soils were analysed for organic carbon by several methods at eleven laboratories. The dry combustion results by a number of methods gave such concordant results that the choice between these methods is probably to be made on the grounds of laboratory convenience. The removal of carbonates by repeated treatment with sulphurous acid solution gave results agreeing with those from separate determinations of total and inorganic carbon. In wet combustions the recoveries of carbon varied with the details of the technique. A number of rapid chromic acid or dichromate titration methods gave useful approximate results when corrected by appropriate factors. Chloride in two of the soils interfered seriously with many of the analyses.

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XLIII. ALAN WALKLEY. *"An Examination of Methods for Determining Organic Carbon and Nitrogen in Soils."* Journal of Agricultural Science, 1935, Vol. XXV, pp. 598-609.

The details of the Dennstedt dry-combustion method for determining carbon in soils were described, and some simplifications suggested.

The Bangor modified Kjeldahl method for carbon and nitrogen in soils requires carefully standardised heating. Error may arise from contamination of sandy soils by material abraded during grinding in iron or porcelain mills.

For many heavy soils the addition of water before the Kjeldahl digestion is convenient but not essential. For heavy alkaline soils with little organic matter it is advisable to grind the soil very finely and to add water.

The rapid dichromate titration method of Walkley and Black for soil carbon gave satisfactory approximate results. The details of the technique were improved and methods were devised for overcoming disturbances due to chlorides. The method should be useful in advisory and survey work in which the errors of soil sampling in the field are inevitably high.

MICROBIOLOGY

(Departments of Bacteriology, Chemistry, Fermentation and General Microbiology)

(*a*) BACTERIA

XLIV. C. B. TAYLOR. *"Short-period Fluctuations in the Numbers of Bacterial Cells in Soil."* Proceedings of the Royal Society of London, B, 1936, Vol. CXIX, pp. 269-295.

Significant changes in total bacterial numbers, as counted microscopically by the ratio method, have been shown to take place from day to day, in (*a*) soil freshly taken from the field; (*b*) soil incubated at constant temperature and moisture conditions; (*c*) sterilized and re-inoculated soil incubated at constant temperature and moisture conditions.

Using mannite-salts and soil extract media with the plate count method, significant day-to-day changes in bacterial numbers have been recorded in fresh soil.

Significant changes in bacterial numbers at two-hourly intervals have been obtained in fresh soil by both total and plate count methods.

In fresh soil, fluctuations in bacterial numbers have been correlated with moisture on one occasion only, when intermittent rainfall may have been a limiting factor. In the experiment here described fluctuations were at all times independent of soil temperature changes.

By incubating soil under constant conditions of temperature and moisture it has been shown that the bacterial population may change in spite of those conditions being kept uniform.

There is evidence that fluctuations in total numbers are made

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up of a series of fluctuations occurring independently in different groups of bacteria.

XLV. H. G. THORNTON and C. B. TAYLOR. "*Short-period Fluctuations in Bacterial Numbers in Soil.*" Transactions of the Third International Congress of Soil Science, 1935, Vol. I, pp. 175-179.

Methods used for the estimation of bacterial numbers in soil fall into two groups, plating methods and microscope counts of bacterial cells in a film of soil suspension. The accuracy of both types of method is discussed. The latter alone can give an absolute figure and has attained a satisfactory degree of accuracy with the development of the "ratio method," which is described. The method is based on obtaining the ratio between counts in a soil film of bacterial cells and of indigo particles, a known number of which have been added to a known mass of the soil.

Both plate and ratio methods show that the bacterial population of soil fluctuates at short intervals during the day and night. These fluctuations are commonly independent of changes in soil moisture or temperature and also take place when soil is kept in an incubator. Their cause is as yet undetermined.

XLVI. H. G. THORNTON. "*The Symbiotic Relationship between Soil Bacteria and Higher Plants, as exemplified by the Leguminosae.*" Transactions of the Third International Congress of Soil Science, 1935, Vol. II, pp. 81-94.

The normally beneficial relationship between the nodule bacteria and their host plant can be disturbed by changes in the physiology of the latter, especially where these lead to a narrowing of the ratio of available carbohydrate to nitrogen in the tissues. Where narrowing is due directly to a shortage of carbohydrate, the bacteria tend to become actively parasitic and to destroy the nodule tissues. Where the ratio is narrowed by excess of inorganic nitrogen uptake, host resistance both to infection of the root-hairs and to growth of the nodule sets in.

Different examples of host resistance are apparently specific to the variety of nodule organism. These include a resistance to infection by nodule bacteria derived from most other legume species. There are also experiments which suggest that nodules produced by one strain may confer an acquired immunity against infection by certain other strains normally capable of infecting the plant in question.

This problem is of special importance owing to the discovery that some strains produce nodules that do not benefit the host plant, owing to causes as yet unexplained.

(*b*) AMOEBAE

XLVII. D. WARD CUTLER and L. M. CRUMP. "*The Effect of Bacterial Products on Amoebic Growth.*" Journal of Experimental Biology, 1935, Vol. XII, pp. 52-58.

The two common soil amoebae *Hartmanella hyalina* and

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Naegleria gruberi were grown in pure culture with the addition of filtrates from bacterial cultures, and also with the filtrate derived from a suspension of crushed bacterial cells. Filtrates prepared from young cultures of two bacteria, both of which could be used as food by the amoebae, were without effect on *H. hyalina*; a filtrate prepared from the crushed cells of *B. mycoides* inhibited reproduction in *N. gruberi*, and also hastened the onset of cyst formation.

(*c*) Biological Activities

XLVIII. C. N. Acharya. "*Studies on the Anaerobic Decomposition of Plant Materials. IV. The Decomposition of Plant Substances of Varying Composition.*" Biochemical Journal, 1935, Vol. XXIX, pp. 1459-1467.

In the anaerobic decomposition of oat, wheat, rice and barley straws, bracken leaves, young grass mowings and rape seed cake, it was found that in all cases the chief decomposition products were acetic and butyric acid, CH_4 and CO_2. The materials richer in nitrogen yielded more butyric acid and CH_4. Addition of nitrogen had only a slight stimulating effect on the decomposition of materials of low nitrogen content (e.g., straw). Hemicellulose and to a less extent cellulose was decomposed, whilst lignin appeared to remain unchanged. Lignin has a marked inhibiting effect on the decomposition of protein and other constituents.

XLIX. S. H. Jenkins. "*The Biological Oxidation of Carbohydrates. V. The Decomposition of Cellulose in the Activated Sludge Process and in Percolating Filters.*" Biochemical Journal, 1936, Vol. XXX, pp. 497-505.

Cellulose is one of the constituents of sewage and trade effluents which decomposes readily under anaerobic conditions with the formation of methane. As little is known about its rate of decomposition in the aerobic processes used for purifying sewage, suspensions of pulp cellulose were added to an activated sludge and the rate of decomposition under different conditions found when air was blown through the mixture. In another experiment the cellulose was passed through biological filters. Contrary to expectations, as much cellulose disappeared in the activated sludge process when the C/N ratio in the mixtures supplied was 80/1 as when it was 8/1. But in the filtration experiments 10 per cent. more cellulose was oxidised with the lower ratios. The results showed that the amount of N used by micro-organisms decomposing cellulose may vary within wide limits depending upon the amount of N supplied. Thus, by providing plenty of N in the filtration experiments, for every 100 parts of C decomposed 4.3 of N were used; with a small supply, 100 of C used 1 of N; while Hutchinson and Richards found that for straw to decompose properly the initial requirement of 100 parts of C was 2.5 of N.

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L. N. W. BARRITT. "*The Treatment and Disposal of Milk Factory Effluents. I. By Means of Percolating Filters and Septic Tanks.*" Journal of the Society of Chemical Industry, 1936, Vol LV, pp. 48T-54T.

Milk factory effluents equivalent in strength to 1 per cent. of fresh milk contain the organic and inorganic substances required for bacterial growth and in this respect are suitable for treatment by biological oxidation in percolating filters. Mechanical separation of the fat, however, with its accumulation in the filter, inhibits its own oxidation and causes clogging of the filter, resulting in a low rate of purification. This effect appears to be associated with an abnormal growth of fungi.

Preliminary treatment in a septic tank brings about separation of fat, and thus avoids this difficulty in subsequent treatment on a percolating filter. A rapid lactic acid fermentation also occurs, the effect of which depends on the buffer capacity of the salts in solution. With distilled water containing 1 per cent. of milk the reaction of the liquid falls below *p*H 4.6 (the isoelectric point of casein) and causes precipitation of casein and inhibition of proteolysis. When hard tap water is used the *p*H of the liquid may not fall below 5.5 ; the casein then remains in solution and undergoes digestion by proteolysis. Such a liquid is quite suitable for treatment on a percolating filter at a rate of 100 gallons per cubic yard per day and leaves behind a tank sludge of low nitrogen content.

The use of alkali in the wash waters also favours proteolysis in the storage tank, but the addition of waste waters containing sugar will result in abnormally high acidities and may cause precipitation of casein even in solutions of high buffer capacity. Such tank effluents, especially if of high biochemical oxygen demand, have wide C/N ratio and would not be particularly suitable for treatment on a percolating filter without addition of available nitrogen and probably also of phosphates.

LI. A. G. NORMAN. "*The Decomposition of Lignin in Plant Materials.*" Transactions of the Third International Congress of Soil Science, Oxford, 1935, Vol. III, pp. 105-108.

Knowledge of the defects in the determination of lignin have permitted conclusions as to the availability of lignin to be placed on a surer basis. The determination of lignin is affected by the presence of pentose units and proteins unless special precautions be taken. Determinations made on decomposing materials are apt to be misleading because pentose-containing constituents are progressively removed and microbial protein concurrently synthesised. When these disturbing factors are taken into account it may be shown that lignin under aerobic conditions is slowly but steadily fermented. Over 40 per cent. and probably more than 50 per cent. of the lignin of oat straw was removed in twelve months.

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LII. H. L. RICHARDSON. "*The Nitrogen Cycle in Grassland Soils.*" Transactions of the Third International Congress of Soil Science, 1935, Vol. I, pp. 219-221.

In normal grassland soils the equilibrium levels of ammonia and nitrogen are low, the level of ammonia being consistently above that of nitrate. These equilibrium values show no clear seasonal changes or effects of long-continued manurial treatments. They are rapidly restored after the addition of nitrogenous fertilisers. Added ammonia nitrogen appears to be absorbed by the herbage no less rapidly than nitrate nitrogen. Incubation experiments on soil from the Park Grass plots showed that the amount of mineralisable nitrogen rose to a maximum in early spring and fell to a minimum in late summer, unless the summer were unusually dry.

THE PLANT IN DISEASE: CONTROL OF DISEASE

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

(*a*) INSECTS AND THEIR CONTROL

LIII. C. B. WILLIAMS and P. S. MILNE. "*A Mechanical Insect Trap.*" Bulletin of Entomological Research, 1935, Vol. XXVI, pp. 543-551.

The trap consists of two nets in the mouth of which are electric fans which blow a current of air and the insects therein into the nets. The arm bearing the two nets revolves slowly and the level can be altered.

LIV. C. B. WILLIAMS and F. J. KILLINGTON. "*Hemerobiidae and Chrysopidae* (*Neur.*) *in a Light Trap at Rothamsted Experimental Station.*" Transactions of the Society for British Entomology, 1935, Vol. II, pp. 145-150.

A list of the species of two families of Neuroptera captured in the light trap together with an analysis of their sexes, times of appearance during the year and times of flight during the night.

LV. C. B. WILLIAMS, "*The Times of Activity of Certain Nocturnal Insects, chiefly Lepidoptera, as indicated by a Light Trap.*" Transactions of the Royal Entomological Society of London, 1935, Vol LXXXIII, pp. 523-555.

The paper contains a description of the light trap with its bottle-changing mechanism which enables the insects to be sorted according to the time of night that they enter the trap. Tabulations are given showing the time of flight at night of about eighty species of Lepidoptera, as well as some species of other orders and also certain families and orders. The results obtained in two years are shown to be very similar.

LVI. C. B. WILLIAMS. "*Further Evidence for the Migration of Butterflies.*" Bulletin de la Société Royale Entomologique d'Egypte, 1935, pp. 250-261.

A collection of about thirty records of directional movements of butterflies in various parts of the world published as evidence of migration.

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LVII. H. F. BARNES. "*On the Gall Midges Injurious to the Cultivation of Willows.* II. *The So-called 'Shot Hole' Gall Midges* (Rhabdophaga *spp*)." Annals of Applied Biology, 1935, Vol. XXII, pp. 86-105.

Previous workers assumed that only one species of gall midge was responsible for "shot hole" damage on willows. In this paper four species, three of which are described for the first time, are recognised. Their bionomics have been worked out. All the species reproduced by means of unisexual families while three of them are single brooded, the remaining species having two broods a year. All the species are restricted to one species of cultivated willow. Certain parasites which attack the midges are recorded.

LVIII. H. F. BARNES. "*Studies of Fluctuations in Insect Populations. IV. The Arabis Midge,* Dasyneura arabis (*Cecidomyidae*)." Journal of Animal Ecology, 1935, Vol. IV, pp. 119-126.

The bionomics of this species are given. The dates of emergence and the number of generations during the period 1928-34 have shown the constancy with which the minor variations caused by differences in weather conditions become levelled out by the end of each year. Delayed fertilisation of the females is shown to send up the numbers of males in the ensuing family. In addition as the season advances the percentage of males decreases.

LIX. H. F. BARNES. "*Studies of Fluctuations in Insect Populations. V. The Leaf-curling Pear Midge,* Dasyneura pyri (*Cecidomyidae*)." Journal of Animal Ecology, 1935, Vol. IV, pp. 244-253.

The dates of emergence and number of generations of this species during the period of 1928-1933 are given. A limitation of generations by the length of the season in which new growth can be found on pear trees is suggested. The parasite *Misocyclops marchali* is recorded as attacking the second and ensuing generations of the midge but in no case the first generation of the year. The sex ratios of the various generations of the midge varies, as the season advances so the percentage of males increases. This is exactly the reverse of what happens in *Dasyneura arabis* (see Paper No LVIII). This can be explained on the hypothesis that the further developed the eggs are at the time of entry of the sperm the more males result.

LX. H. F. BARNES. "*Studies of Fluctuations in Insect Populations. VI. Discussion on Results of Studies I-V.*" Journal of Animal Ecology, 1935, Vol. IV, pp. 254-263.

Additional data on the wheat blossom midges and the button top midge of willows brings the published information complete up to 1935. It is shown that the major fluctuations in numbers of gall midges are caused by the action of weather on the insect, the host plant, and the insects' parasites. The whole series of studies is discussed from this view point.

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LXI. J. MARSHALL. "*The Location of Olfactory Receptors in Insects : a Review of Experimental Evidence.*" Transactions of the Royal Entomological Society of London, 1935, Vol. LXXXIII, pp. 49-72.

LXII. J. MARSHALL. "*On the Sensitivity of the Chemoreceptors on the Antenna and Fore-tarsus of the Honey-bee,* Apis mellifica L." Journal of Experimental Biology, 1935, Vol XII, pp. 17-26.

LXIII. H. L. A. TARR. "*Studies on European Foul Brood o Bees. I. A Description of Strains of* Bacillus alvei *obtained from different Sources and of another Species occurring in Larvae affected with this Disease.*" Annals of Applied Biology, 1935, Vol. XXII, pp. 709-718.

Strains of *Bacillus alvei* from four countries have been studied in detail, and certain differences were found with respect to the ability of these organisms to produce acid from a series of fermentable carbon compounds. It has been suggested that these variations might form a basis for differentiating strains of this organism. The characteristics of another spore forming bacillus which appears to take the place of *B. Alvei* in certain cases of European foul brood have been described in detail. The various theories which have been presented in an attempt to explain the etiology of this disease are briefly discussed.

LXIV. F. TATTERSFIELD and J. T. MARTIN. "*The Problem of the Evaluation of Rotenone-containing Plants.* 1. Derris Elliptica *and* Derris Malaccensis." Annals of Applied Biology, 1935, Vol. XXII, pp. 578-605.

Seven samples of *Derris* root have been examined chemically, and the following determinations carried out : rotenone (crude and and recrystallised), ether extract, methoxyl content, and dehydro compounds. The importance of using standard methods of analysis is stressed.

Insecticide tests have been carried out and comparisons made between pairs of samples tested on the same day.

When comparisons were made between pairs belonging to different species of *Derris*, the determinations of rotenone by the present methods, ether extract or methoxyl content did not express accurately the relative insecticidal potencies of the pairs of samples. When comparisons were made between pairs of the same species, all these determinations appeared to give a closer measure of their relative activities.

The estimation of the dehydro compounds, or of rotenone plus the dehydro compounds in the resin, gave a better assessment of the relative potencies than the other determinations, whether comparisons were made between samples of the same, or of different species. Further work on other samples is, however, needed.

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LXV. F. TATTERSFIELD. "*Fish-Poison Plants as Insecticides. A Review of Recent Work.*" The Empire Journal of Experimental Agriculture, **1936**, Vol. IV, pp. **136-144**.

The insecticidal importance of the various crystalline derivatives isolated from fish-poison plants, and the difficulties met with in the chemical evaluation of these insecticidal plants are briefly discussed. The relative importance of several species of *Derris*, *Lonchocarpus*, and *Tephrosia* is discussed.

(*b*) VIRUS DISEASES.

LXVI. J. CALDWELL. "*Physiology of Virus Diseases in Plants. VII. Experiments on Purifications of the Virus of Yellow Mosaic of Tomato.*" Annals of Applied Biology, **1935**, Vol. XXII, pp. **60-85**.

Purification by Vinson and Petre's method, slightly modified, gave an infective material that always contained organic nitrogen, and was active over a *p*H range from **2.0** to **10.5** ; but there was no evidence that the virus could be recovered pure in crystalline form. Various methods used to purify the virus still further are described.

LXVII. J. CALDWELL. "*On the Interaction of Two Strains of a Plant Virus. Experiments on Induced Immunity in Plants.*" Proceedings of the Royal Society, B, **1935**, Vol. CXVII, pp. **120-139**.

Two strains of the Yellow Mosaic Virus of tomato have been isolated, of which one, although not apparently an attenuated form of the other, immunises host plants against the second. The types of interaction which may occur when two viruses are present simultaneously in the one host are discussed and differentiated.

LXVIII. G. SAMUEL, R. J. BEST and J. G. BALD. "*Further Studies on Quantitative Methods with Two Plant Viruses.*" Annals of Applied Biology, **1935**, Vol. XXII, pp. **508-524**.

The arrangement of experiments for the comparison of several virus samples is discussed and suitable methods suggested. The amount of inoculum, provided enough is used to cover the eaf, does not affect the number of lesions produced by the spatula technique ; but the conditions to which test plants were subjected shortly before inoculation had a considerable effect. The *p*H and electrolyte content of the inocula influence the number of lesions. The optimum *p*H for tomato spotted wilt is from **6.0—8.5**, for tobacco mosaic (with concentration **0.05—0.2** M) about **7.0**. The influence of oxidising and reducing agents on the virus of spotted wilt is further discussed.

LXIX. M. A. HAMILTON. "*Further Experiments on the Artificial Feeding of* Myzus persicae (*Sulz*)." Annals of Applied Biology, **1935**, Vol. XXII, pp. **243-258**.

A method is described for the feeding of *M. persicae* on media containing a radioactive indicator. By this means it was shown that *M. persicae* picks up the indicator from the medium and transmits to a leaf, on which it is fed later, a constant proportion of the amount imbibed. Evidence is given to show that the virus probably behaves as does the radioactive indicator.

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(*c*) FUNGUS DISEASES.

LXX. M. D. GLYNNE. "*Incidence of Take-all on Wheat and Barley on Experimental Plots at Woburn.*" Annals of Applied Biology, 1935, Vol. XXII, pp. 225-235.

Surveys made in 1931, 1932 and 1933 of the incidence of Take-all, *Ophiobolus graminis* Sacc. in the continuous wheat and barley manurial experiments at Woburn Experimental Station showed the disease was present in varying amount in most plots; the percentage being usually higher in wheat than in barley and little or no disease occurring in plots with a *p*H value of 5 or less. In wheat Take-all appeared to increase in each plot until 35 per cent. of the plants were infected and then to decrease.

TECHNICAL AND OTHER PAPERS

GENERAL.

LXXI. E. J. RUSSELL. "*Jacob G. Lipman and Soil Science.*" Soil Science, 1935, Vol. 40, pp. 3-7.

LXXII. R. K. SCHOFIELD and G. W. SCOTT BLAIR. "*The Infuence of the Proximity of a Solid Wall on the Consistency of Viscous and Plastic Materials.*" Journal of Physical Chemistry, 1935, Vol. XXXIX, pp. 973-981.

Measurements have been made of the rate of flow of an aqueous paste of barium sulphate through tubes differing considerably both in radius and length under a series of pressure heads. The results show that for tubes of the same radius and under the same pressure gradient, the rate of flow is independent of the length of the tube; from which it is concluded that under the conditions of these experiments, this material shows no progressive breakdown with time under shear, as suggested by Ambrose and Loomis for bentonite.

For different radii, however, curves for $V/\pi R^3$ against $PR/2L$ were obtained which, as previously recorded, do not coincide as they should if at every point in the tube the velocity gradient depends only on the shearing stress.

The hypothesis previously advanced that the proximity of the wall of the tube causes a sheath of material to shear more easily than does the bulk of the material, appears therefore to be the only one at present that accounts for the facts.

The case of this barium sulphate paste is particularly interesting, as the particles are roughly cubical in form, and the thickness of the modified layer is many times the average particle diameter.

LXXIII. C. B. WILLIAMS and G. A. EMERY. "*A Photographic Moonlight Recorder.*" Journal of Scientific Instruments, 1935, Vol. XII, pp. 111-115.

An apparatus in which a cylindrical lens produces a line image of the moon on a strip of photographic paper. The lens is moved by clockwork to follow the moon's apparent movement across the sky and the sensitised strip is darkened when the moon is shining. The apparatus can also be used, with some adjustments, as a sunshine recorder.

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