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## Report for 1933

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### Crops, Plant Growth, Plant Products and Action of Manures

#### Rothamsted Research

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## SCIENTIFIC PAPERS

Published 1933 and in the Press

### PLANT GROWTH, PLANT PRODUCTS AND ACTION OF MANURES

(Departments of Bacteriology, Botany, Chemistry, Fermentation  
and Statistics)

#### (a) PLANT GROWTH.

- I. E. J. RUSSELL. "*The Rothamsted Experiments on the Growth of Wheat, 1843-1933. Ninety years of continuous wheat on one field.*" Proceedings of the World's Grain Exhibition and Conference, Regina, Canada, 1933. Vol. II (also Mezogazdasagi Kutatasok. 1933. Vol. VI, pp. 522-543.)

The broad conclusion from these experiments is that wheat can be grown year after year on the same land, but even with good cultivation the yield deteriorated. Better yields are obtained by growing the wheat in alternate years with fallow in between and deterioration is then slower to set in, but it comes all the same. Still better yields are obtained by growing wheat only once in four years and having other crops in between ; here also there may be deterioration but it takes very much longer to set in and is easily avoided. At Rothamsted the continuously cropped wheat fell off in yield in the first 25 years, from 17 bushels down to 11 bushels per acre but for the past 65 years there has been only little further fall. The alternate wheat-fallow also fell to 11 bushels per acre but took 60 years to do it instead of 25. The four-year rotation has been going on for 85 years and the yields of wheat are as good as they were 70 years ago on the continuous plots, so that we must apparently wait a good deal longer before the 11 bushel level is reached.

At Rothamsted it seems impossible to obtain an average of less than 10 bushels per acre by mere exhaustion of the land and so long as weeds are kept down. If, however, weeds are allowed to grow, the yields rapidly fall to low levels. We know of no way of reducing crop yields more effective than permitting the competition of weeds.

The continuous growth of wheat at Rothamsted has not, apparently, led to increased tendency to disease.

- II. H. H. MANN. "*Report on Tea Cultivation in the Tanganyika Territory and its Development.*" Crown Agents for the Colonies, London, 1933, pp. 1-54.

This report was the result of a visit to the Tanganyika Territory in the summer of 1932. As a result the opinion is expressed that the conditions are favourable for the extension of tea cultivation to an area of 50,000 acres. The areas suitable lie both in the Usambara Mountains in the north of the Territory, and in the Southern Highlands in the south.

- III. H. H. MANN. "*Report on Tea Cultivation and its Development in Nyasaland.*" Crown Agents for the Colonies, London, 1933, pp. 1-41.

The author visited Nyasaland in 1932 on behalf of the Colonial Office, and this report is based on observations made during that visit. In this colony there is a well-developed tea area, lying in the extreme south, and the cultivation already extends to a little over 12,000 acres. It lies on soils derived from a series of granite ranges, and has proved itself very favourable to the crop. The report makes a critical examination of the present position of the industry with suggestions for its improvement, especially in the matter of increasing the yield and improving the quality of the tea.

- IV. H. H. MANN. "*The Climatic and Soil Requirements of Tea.*" *Empire Journal of Experimental Agriculture*, 1933, Vol. I, pp. 245-252.

This paper summarises the information at present available on the soil and climatic needs of tea culture, especially as they have been revealed by the recent work done in India and Ceylon.

- V. R. J. KALAMKAR. "*The Influence of Rainfall on the Yield of Mangolds at Rothamsted.*" *Journal of Agricultural Science*, 1933, Vol. XXIII, pp. 571-579.

Analysis shows that the variation in the yield due to annual causes cannot be accounted for by a single weather element, rain.

An additional inch of rain above the normal, during the period extending from the middle of March to about the end of May, is harmful, possibly because of the difficulty in securing a proper tilth and delay in sowing, which results in a shortening of the growing period.

The yield appears to be benefited by an additional inch of rain above the normal, particularly during the months of June and July.

- VI. K. WARINGTON. "*The Influence of Length of Day on the Response of Plants to Boron.*" *Annals of Botany*, 1933, Vol. XLVIII, pp. 430-457.

The delay in appearance both of flowers and of boron deficiency symptoms observed in spring and autumn compared with summer grown plants is due to the reduction in length of day rather than the lowered temperature, but no special association between the function of boron and flower production has been found except in so far as all meristematic processes are affected by a lack of this element. Within a range of 7-16 hours, the length of day has no bearing on the need of the plant for boron and the characteristic deficiency symptoms are similar under long or short day conditions, though they tend to be less pronounced in the latter instance. Shortening the day does not result in degeneration effects as are induced by a lack of boron, but the influence of the two factors may bear a superficial resemblance to each other as where flowering is prevented. The presence of each factor modifies the effect of the other, but the lack of boron exerts the more fundamental influence on the plant.

(b) PLANT PRODUCTS.

- VII. E. J. RUSSELL and L. R. BISHOP. "*Investigations on Barley. Report on the Ten Years of Experiments under the Institute of Brewing Research Scheme. 1922-1931.*" Journal of the Institute of Brewing, 1933, Vol. XXXIX, pp. 287-421.

A summary report which brings together the results of laboratory and field experiments over ten years on the effects of soil, season, manuring, variety and cultivation on the yield and quality of barley and on the relationship of the chemical composition of the barley to the properties of the malt and beer prepared from it.

- VIII. L. R. BISHOP and F. E. DAY. "*Prediction of Extract, II. The Effect of Variety on the Relation between Nitrogen Content and Extract.*" Journal of the Institute of Brewing, 1933, Vol. XXXIX, pp. 545-551.

The effects of nitrogen content and thousand corn weight on extract yield proved to be similar for all varieties of barley tested. For constant values of nitrogen content and thousand corn weight there are constant differences between varieties. A list of these varietal constants is given.

- IX. L. R. BISHOP and D. MARX. "*Regularities in the Carbohydrate Composition of Barley Grain.*" Journal of the Institute of Brewing, 1934, Vol. XL, pp. 62-73.

In each variety the individual carbohydrates of barley grain increase regularly with the total carbohydrate. There are small differences between individual varieties which are more marked in the general distinction between two- and six-row barleys. The carbohydrates of extract ("reserve carbohydrates") increase more rapidly than the remaining carbohydrates ("cell carbohydrates") with increase of total carbohydrate. The unit on which these relations show most accurately is for quantities calculated at so much per corn (or per thousand corns).

In each of the above respects the behaviour of the carbohydrates parallels that of the proteins. Both suggest the regularities result from equilibria of a mass action type during development of the grain.

The similarity between the proteins and carbohydrates also holds in malting, during which the proteins are broken down to give asparagine and the carbohydrates to sucrose.

- X. L. R. BISHOP. "*Prediction of Extract, III.*" Journal of the Institute of Brewing, 1934, Vol. XL, pp. 74-91.

The carbohydrate regularity principle has been applied to give practical results in the form of an extract prediction equation, which can be used where the variety of the barley is unknown—a common position in practice. It appears to be particularly accurate and useful with Californian barleys.

The size of the protein factor in this equation demonstrates the incompleteness of the original hypothesis of Haase, that protein simply replaces carbohydrate and so exerts a corresponding reduction of extract. While this is responsible for half the observed effect the other half is due to a "sealing up" of carbohydrate by protein,

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which becomes more marked in high nitrogen barleys. This applies to the Institute of Brewing Standard Method of Extract Determination; with fine grinding "sealing up" does not occur.

The success of the insoluble carbohydrate factor over a wide range of barleys affords strong support to the "carbohydrate regularity" hypothesis.

- XI. A. G. NORMAN. "*A Preliminary Investigation of the Development of Structural Constituents in the Barley Plant.*" *Journal of Agricultural Science*, 1933, Vol. XXIII, pp. 216-227.

Barley plants were sampled weekly during the season and various analyses, especially for structural constituents were carried out. The natural cellulose fraction increased from 30 to 35 per cent. The amount of cellulosan in this fraction increased with development and markedly so after the point at which growth increments lessened. In the later stages the quantity remained constant. Lignin increased steadily till the last week or so. In the young plant the major portion of the total pentose material is in the polyuronide hemicellulose, while in the mature plant it is accounted for by the cellulosan.

- XII. (a) A. G. NORMAN and S. H. JENKINS. "*A New Method for the Determination of Cellulose Based upon Observations on the Removal of Lignin and Other Encrusting Materials.*" *Biochemical Journal*, 1933, Vol. XXVII, pp. 818-831.

- XII. (b) A. G. NORMAN and S. H. JENKINS. "*Lignin Content of Cellulose Products.*" *Nature*, 1933, Vol. CXXXI, p. 729.

In any method for the estimation of cellulose, the cellulosan fraction should remain intact. Many methods heretofore proposed involve some pre-treatment, either alkaline or acid or both, which attacks or removes the fraction in part. A new method is proposed suitable for all classes of material, employing neutral and acidified sodium hypochlorite followed by sodium sulphite and avoiding the use of gaseous chlorine.

The products obtained from cereal straws are found to be not quite lignin-free, even after allowance is made for an error in that determination. The error is due to the production of some resistant material from pentosan groupings in the presence of 72%  $H_2SO_4$ . The magnitude of the error in lignin content of natural materials such as woods, due to this disturbing factor, is very considerable, and there is reason for believing that the figures hitherto quoted for straw and hardwoods are as much as 25-30% too high, but for soft woods rather less, owing to their lower pentose content.

#### (c) ACTION OF MANURES.

- XIII. H. G. THORNTON and HUGH NICOL. "*The Effect of Sodium Nitrate on the Growth and Nitrogen Content of a Lucerne and Grass Mixture.*" *Journal of Agricultural Science*, 1934, Vol. XXIV, pp. 269-282.

Inoculated lucerne was grown alone and in association with Italian rye grass, in pots of sand watered with food solution and given three different doses of sodium nitrate. The dose of nitrate did not affect the dry weight or nitrogen content of lucerne when

grown alone, save that the highest dose checked the root growth somewhat.

When lucerne and Italian rye grass were grown in association, the growth of the grass varied directly with the dose of nitrate applied, and the growth of the lucerne varied inversely to it. Checking of the lucerne growth was probably due to root competition with the grass. The nitrogen contents of the combined lucerne and grass tops and that of the combined roots were also inversely related to the quantity of nitrate applied. There was evidence that within 3 months of sowing the grass had obtained nitrogen fixed by the lucerne nodules.

- XIV. J. A. DAJI. "*The Decomposition of Green Manures in Soil.*" *Journal of Agricultural Science*, 1934, Vol. XXIV, pp. 15-27.

The following four materials were used as green manures and their decomposition in admixture with soil was studied under laboratory conditions: sugar beet tops, young mustard, young tares and mature mustard. Soluble carbohydrates, hemicellulose as measured by the furfuraldehyde yield, and cellulose are chiefly responsible for the total loss of organic matter during decomposition. The ratio of available carbohydrate to available nitrogen determines the rate of decomposition, this being rapid when the ratio is low and slower when the ratio is high. Young plant materials used as green manure decompose so quickly that nitrogen may be lost either by very rapid nitrification or by some process as yet unknown.

- XV. E. M. CROWTHER and H. H. MANN. "*Green Manuring and Sheep Folding on Light Land—An Account of the Green Manuring Experiments at the Woburn Experimental Station 1893-1933.*" *Journal of the Royal Agricultural Society of England*, 1933, Vol. XCIV, pp. 128-151.

The agricultural details and the wheat yields of the two series of green manuring experiments at the Woburn Experimental Station are summarised and discussed in relation to the composition of the soil and the green crops, and to the results of recent pot culture and laboratory experiments on the manurial value of green manure material. It is concluded that a large mustard crop rapidly grown in soil of moderate to high fertility provides a means of avoiding loss by carrying over some of the nitrogen and other nutrients to a later period when they may be utilised by some more valuable crop. A good crop of tares provides a direct addition of nitrogen in a form which becomes available at once. Whether it is used or lost depends on the immediately following crop and the weather. The whole art of successful green manuring on light land lies in careful adjustment of the cropping so that the nutrients in the green manures will be efficiently used by the following crop.

- XVI. HUGH NICOL. "*Rothamsted Experiments on Residual Values of Leguminous Crops.*" *The Empire Journal of Experimental Agriculture*, 1933, Vol. I, pp. 22-32.

The results of cropping experiments lasting from 1899 to 1922 showed that the effect of preceding crops of legumes could be traced

by increased yields of grain for several years after legumes had ceased to be grown. The residual value of lucerne was markedly superior to that of red clover and six other legumes.

- XVII. E. M. CROWTHER AND W. E. BRENCHLEY. "*The Fertilising Value and Nitrifiability of Humic Materials Prepared from Coal.*" *Journal of Agricultural Science*, 1934, Vol. XXIV, pp. 156-176.

Humic acids and ammonium humates prepared by a patented process of gentle oxidation of coal were examined as fertilisers by laboratory nitrification experiments and pot-culture tests on four soils and by a number of field experiments on a range of soils and crops during a single season. In all tests the effects of ammonium humate could not be distinguished from those of ammonium sulphate of equal ammonium content. The nitrification tests and the pot cultures afforded some evidence of a slow production of nitrate or available nitrogen from the humic acid. In the field experiments, as in the pots, there was no clear evidence of any fertiliser value apart from that due to the ammonium present. The close agreement between laboratory measurements on nitrate accumulation and yields and nitrogen contents of barley for seven treatments in four soils shows that the laboratory technique afforded an adequate measure of the availability of the fertiliser nitrogen.

- XVIII. E. M. CROWTHER AND R. G. WARREN. "*The Fertiliser Value of Basic Slags and Other Phosphates.*" *Agricultural Progress*, 1934, Vol. XI, pp. 99-105.

The results of recent field and pot experiments carried out under the aegis of the Ministry of Agriculture Permanent Committee on Basic Slag are reviewed. Most of the field experiments were on land mown for hay for four seasons, but a few experiments were also made on frequently-mown young grass. In all of the experiments the phosphoric acid percentage in the produce was considerably increased by the more active fertilisers, and in several of them the protein content of the hay was also increased. The percentage recovery in the crops of three or four years of the phosphoric acid added gave consistent results throughout the series of experiments. The mean recoveries were: for superphosphate, 21 per cent.; for high soluble slag, 20 per cent.; for low soluble slag, 6 per cent. Basic slags with from 20 to 35 per cent. of their phosphoric acid soluble in the conventional 2 per cent. citric acid are much less effective as sources of available phosphate than those with more than 80 per cent. of their phosphoric acid soluble in this reagent. A sharp distinction must be drawn between acid soils (pH about 5) and neutral soils in considering the value of mineral phosphate. On the acid soils it was as effective as the more soluble phosphates (17 per cent. recovery), but on the neutral soils it was as ineffective as the low soluble slag (6 per cent. recovery).

In an experiment on grassland which was grazed for most of the year the effects of the phosphatic fertilisers were similar to those on repeatedly mown young grass.