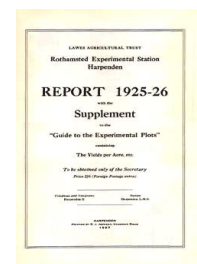


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Crops, Plant Growth and Fertiliser Investigations

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SCIENTIFIC PAPERS

Published 1925 and 1926, and in the Press.

I.—CROPS, PLANT GROWTH AND FERTILISER INVESTIGATIONS.

(Botanical, Chemical, Insecticides and Fungicides Departments, and Field Experiments Section.)

- I. K. WARINGTON. "*A Botanical Study of the Flax Plant. Manurial Pot Experiments with Flax.*" The Linen Industry Research Association, Research Institute Memoirs, Vol. III., pp. 29-36.

As varied opinions are held on the best manuring for flax, water culture and pot experiments (with soil and sand) were carried out to test the matter further, particularly with regard to the importance of potassium and phosphorus. When a heavy and poor Rothamsted soil was employed, an addition of potassium or nitrogen caused but little improvement in the crop, whereas a dressing of phosphate was of considerable benefit. Thus, although potassic fertilisers are usually regarded as especially beneficial for flax, in the case of this soil phosphate plays the more important part. Early start and early maturation in particular appear to depend on the supply of phosphate. On the other hand, nitrogenous dressings definitely retard ripening, and are unsuitable as fertilisers for flax, unless, of course, there is an actual nitrogen deficiency in the soil.

In sand and water culture, as would be expected, the use of both potassium and phosphate, as well as the other nutrient salts, was found to be necessary. The greater importance of phosphate was also evident in these cases, especially in sand cultures, since additional supplies of potassium proved useless in the absence of an adequate amount of phosphate; and further, luxuriant growth was possible for some time where no potassium had been given, provided that a large quantity of phosphate was present.

The results from these three types of experiment thus afford corroborative evidence as to the importance of a liberal supply of phosphate, and at the same time show the possibility of danger arising from lack of potassium or excess of nitrogen.

- II. W. E. BRENCHLEY, E. J. MASKELL, and K. WARINGTON. "*The Inter-relation between Silicon and other Elements in Plant Nutrition.*" *Annals of Applied Biology*, 1927, Vol. XIV., pp. 45-82.

The role of silicon in plant nutrition has attracted much attention owing to the large amount that is found in cereal plants, but the true function of the element is still debatable. Widespread belief exists that silicon is capable of replacing phosphorus or other essential elements to some extent, and experiments were undertaken to endeavour to throw light on this point.

Under controlled conditions in water cultures, soluble silicate was found to have little effect upon the growth of barley if phosphorus were also present, but if the latter were absent, a significant increase in dry weight was induced by the silicate. The addition of silicate caused an appreciable increase in the height

of the main shoot, which was most marked in phosphate-free solutions, becoming less evident as the quantity of phosphate present was increased. Leaf development was retarded by phosphate deficiency, and hastened by the addition of silicate. A close association exists between the amount of phosphate present and the effect of silicate upon the rate of tillering and the number of tillers developed.

The possibility of obtaining soluble silicates in considerable quantity from certain manufacturing processes led to an enquiry as to whether such silicates could advantageously be used to supplement or even replace certain of the artificial fertilisers in common use. Soluble silicates tend to cause increase in dry weight with deficient mineral manuring, and in some cases also with complete manuring, and they are more active in this respect than are glass silicates. Further soil experiments revealed variations in the response of barley and mustard to silicate on different types of soil. A general improvement occurred with increasing doses of silicate together with various combinations of manures, notably when phosphorus or potash was deficient.

The significance of the results obtained has been examined statistically, and an attempt made to formulate the effect of added silicate in terms of an increase in the efficiency of the superphosphate present.

III. W. E. BRECHLEY and K. WARINGTON. "*The Rôle of Boron in the Growth of Plants.*" *Annals of Botany*, 1927, Vol. XLI., pp. 1-21.

The important rôle of boron in the nutrition of *Vicia faba* was clearly shown in Warington's earlier work, but it remained to be proved whether the beneficial action of the element is a general phenomenon or is confined to particular conditions of growth. Further experiments suggest that the need of certain plants for boron is unaffected by the nature of the substratum on which they grow, the conditions of aeration at the roots or, in the case of leguminous plants, the presence or absence of nodules thereon. Plants grown in water cultures need the element irrespective of the composition or pH value of the nutritive solution. The concentration of boric acid appears to be of little moment provided that an adequate, though not excessive, total supply is provided over a given period, but this total supply can be reduced when the nutritive solution is frequently renewed. The need for boron still manifests itself even when the nutrient solution is kept at approximately constant concentration by means of drip cultures.

Boron *per se* is shown to be the active principle in these phenomena, for the chemical combination in which boron is presented to the plant is immaterial, even the so-called "insoluble" borates being effective; but no other element, out of fifty-two tested, has proved capable of replacing boron. Special attention has been given to manganese in this connection. It has been claimed by other workers that boron is probably essential to the growth of all plants, but so far in these experiments this has only been proved for several leguminous plants and for melon, whereas various cereals and candytuft complete their development in its absence. It is not yet certain whether the distinction between these two classes is real or merely a matter of degree, i.e., whether

the second class require so little boron that a sufficient supply is stored up in their seeds. The physiological function of boron in the nutrition of broad bean is under investigation. Boron is not able to replace any one of the essential nutritive elements, but a definite association with the absorption or utilisation of calcium is very strongly marked. The boron does not act as an ordinary catalyst, but is itself absorbed, and in some way removed from action, a constant supply thus being necessary.

- IV. K. WARINGTON. "*The Changes Induced in the Anatomical Structure of Vicia faba by the Absence of Boron from the Nutrient Solution.*" *Annals of Botany*, 1926, Vol. XL., pp. 27-42.

Broad beans grown in a medium entirely free from boron exhibit characteristic symptoms in the shoot and root. The stem withers and blackens at the apex, the injury gradually travelling down the plant, while the root system became stunted, the laterals being few in number and often thickened. The anatomical structure of such plants is shown to be abnormal, whereas the anatomy of plants supplied with a nutrient solution containing a small quantity of boron, e.g., boric acid 1 : 2,500,000, is similar to that of plants grown in soil.

The principal changes induced by the omission of boron are :

- (a) Hypertrophy of the cells of the cambium followed by degeneration with discoloration, or direct disintegration of the same tissue without previous enlargement.
- (b) Frequent disintegration of phloem and ground tissue.
- (c) Poor development of xylem and in some cases ultimate breaking down of this tissue.

A definite connexion exists between the presence or absence of boron and the anatomical structure, and the correlation of this with the meristematic activity of the plant is discussed.

- V. E. J. MASKELL. "*Field Observations on Starch Production in the Leaves of the Potato.*" *Annals of Botany*, 1927, Vol. XLI., pp. 327-344.

This paper gives a preliminary survey of the physiological processes of starch production in the leaves of potato plants (variety Kerr's Pink) subjected to various manurial treatments. The four treatments were (1) No Potash; (2) Potash as Sulphate of Potash; (3) Equivalent Quantity of Chloride of Potash; (4) Potash Manure Salts equivalent to other treatments in K_2O content. This manure contains a higher concentration of chloride than (3). Full details of treatments are given on page 138.

The method used to estimate the starch consisted of comparing the colour tones developed by the Sachs iodine test with the appropriate colour standard in Ridgeway's "*Colour Standards and Nomenclature*," (No. 59 ⁱⁱⁱⁱ). Laboratory experiments with starch impregnated filter paper showed that an increment in tone number corresponded with a proportional increment in starch concentration.

The experimental procedure consisted of covering a pair of

leaflets with small light proof paper bags, leaving them to translocate over-night. Next day, one of the bags on each of six pairs was removed for 3 hours, and after the leaf had been exposed for 3 hours, that leaf and its covered pair were removed. This gave a measure of net assimilation. On eleven occasions between September 4th and 21st, samples were taken.

The data were analysed by Fisher's variance method, and the difference between two means which was statistically significant determined to be 0.588.

The following table shows the superiority of the K_2SO_4 treated samples :—

K_2SO_4 —KCl :	0.528.
K_2SO_4 —P.M.S. :	0.774.
K_2SO_4 —NoK :	0.654.

The chloride treatments give a starch production not significantly greater than the no potash plot. The low rate of starch production in the less favourable treatments is shown to be associated with, though not casually related to, a low rate of starch removal. The analysis of variance shows that those portions due to occasion are significant. Some of this is ascribable to age and some to radiation.

A series of correlations between (1) Starch production, (2) Radiation, (3) Age, was determined with the following results :—

$r_{1.2}$ is hardly significant, but $r_{2.3}$ and $r_{1.3}$ are definitely so. The partial correlations $r_{12.3}$ and $r_{13.2}$ for each treatment separately show that the only significant correlation of starch production with radiation is on the no potash plot, and that this plot has the lowest correlation of starch production with age.

- VI. W. A. ROACH. "A Laboratory Apparatus for the Wet Grinding of Plant Tissues out of Contact with Air." *Biochemical Journal*, 1925, Vol. XIX., pp. 783-786.

A simple laboratory apparatus was designed by means of which potato tubers or similar tissues could be pulped sufficiently finely to ensure almost every cell being broken. The whole operation may be done in an atmosphere of an inert gas.

- VII. W. A. ROACH. "On a Labile Blue Compound from the Potato Tuber." *Annals of Botany*, 1925, Vol. XXXIX., p. 883.

Juice obtained by pulping potatoes and filtering the juice, both operations being carried out with careful exclusion of all oxygen (Paper No. VI.), was of a bluish green colour. When air was admitted very cautiously, the colour became bluer and darker, then changed through shades of green to a bright yellow; the blue colour was discharged by sodium hydrosulphite, but came again on introducing more oxygen. The yellow colour was unaffected by the sodium hydrosulphite. In these respects the blue compound resembled the one obtained by Haas and Hill (*Biochem. J.* 1925, XIX. 236) from *Mercurialis perennis*.

- VIII. E. M. CROWTHER. "A Note on the Availability of Organic Nitrogen Compounds in Pot Experiments." *Journal of Agricultural Science*, 1925, Vol. XV., pp. 300-302.

A comparison was made of the manurial action of sixteen typical nitrogen compounds in pot experiments on barley, followed by mustard. An index of the availability of the nitrogen was afforded by the values for the total amount of nitrogen recovered in both crops (excluding the roots) in excess of that of the untreated series, expressed as a percentage of the added amount (0.5gm. per 10 kilos of soil). In order of decreasing availabilities the compounds gave the following percentage recoveries of nitrogen: 60-70 per cent., animoacetic acid; 50-60 per cent., sodium nitrate; 40-50 per cent., oxamide, ammonium sulphate, dried blood, acetamide; 30-40 per cent., egg albumen (nitrobenzene), peptone, pyridine, sodium urate; 20-30 per cent., sodium cyanide; 10-20 per cent., *d*-Naphthylamine (aniline); less than 10 per cent. (acetanilide), hydrazine. The three substances enclosed in brackets gave irregular results; nitrobenzene prevented the germination of barley, aniline and acetanilide seriously reduced the germination and final yield of barley; nitrobenzene and aniline gave abnormally heavy growths of mustard.

- IX. E. M. CROWTHER. "*Further Experiments on the Effect of Removing the Soluble Humus from a Soil on its Productiveness.*" *Journal of Agricultural Science*, 1925, Vol. XV., pp. 303-306.

In 1915, Weir published an account (*Journ. Agric. Sci.* (1915), VII, 246-253) of pot experiments from which it appeared that the removal of a considerable proportion of the soluble humus by acid treatment and repeated extraction with alkali had no effect in diminishing the productiveness of the soil. Six further crops have been grown in the pots set up by Weir, and an analysis of the whole of the data from two independent series of experiments (with 10 and 7 crops respectively) in each of the two soils shows that his conclusion must be modified. The results of several catch-crops of mustard and rye, grown out of season, are excluded, as they failed to make appreciable growth. The remaining crops (5 in the first and 4 in the second series) made a satisfactory growth. In both series the extraction of a heavy loam from Harpenden Field increased the yield in the first and second crops, but decreased it in the succeeding crops. The extraction of a garden soil from the Allotment decreased the yield in all cases, except for a slight and scarcely significant increase in the first crop in one series only. There is thus no evidence for the view that the soluble humus is unimportant as a source or reserve of plant food.

- X. E. J. RUSSELL. "*The Institute of Brewing Research Scheme: Third Report on the Experiments on the Influence of Soil, Season and Manuring on the Quality and Growth of Barley*, 1924." *Journal of the Institute of Brewing*, 1925, Vol. XXXI. (Vol. XXII., New Series), pp. 548-561.

This paper gives a full account of the work discussed on p. 20.

- XI. H. LLOYD HIND, H. THREADGOLD and C. W. B. ARNOLD. "The Determination of the Diastatic Power of Malt and Barley." *Journal of the Institute of Brewing*, 1926, Vol. XXXII., pp. 26-32.

An improvement in the standard method of determination of diastatic power, by working at a constant hydrogen ion concentration corresponding to pH 4.6, obtained by the addition of an acetate buffer.

- XII. R. G. WARREN, C. T. GIMINGHAM and H. J. PAGE. "The Chemistry of Basic Slag I. The Determination of Fluorine in Basic Slag." *Journal of Agricultural Science*, 1925, Vol. XV., pp. 516-528.

A method is described for the determination of fluorine in basic slag. The fluorine content and the citric solubility of a number of basic slags are compared. On the assumption that fluorine in basic slag locks up in an unavailable condition an equivalent amount of phosphate, in the form of fluorapatite $[\text{Ca}_3(\text{PO}_4)_2]_3\text{CaF}_2$, an "availability value" is calculated from the fluorine content. In general, the values so obtained run parallel with the citric solubilities, but certain discrepancies occur, which will form the subject of further work.

II. STATISTICAL METHODS & RESULTS.

(Statistical Department.)

- XIII. R. A. FISHER. "Theory of Statistical Estimation." *Proceedings of the Cambridge Philosophical Society*, 1925, Vol. XXII., pp. 700-725.

An ordered exposition of the recent developments of the theory of statistical estimation, and of the criteria which now exist for judging the value of statistical methods. The properties, first of consistent, and then of efficient statistics, are deduced, and a general method is given of obtaining an efficient statistic without the solution of transcendental equations. A property of efficient statistics is utilised to supply a measure of the intrinsic accuracy of error distributions, and this in turn to extend the notion of efficiency to statistics derived from small samples. The peculiar character of statistical estimates classed as sufficient is elucidated; and, in the absence of these, a method is given of evaluating the loss of information involved in the maximum likelihood solution, and of other efficient statistics. Finally, it is shown how ancillary statistics may be used to remove this residual loss of information.

- XIV. P. R. ANSELL and R. A. FISHER. "Note on the Numerical Evaluation of a Bessel Function Derivative." *Proceedings of the London Mathematical Society*, June 1925.

In the evaluation of a numerical expression involving the derivative of a Bessel function with respect to its modulus, it was found to be expressible in terms of the cosine-integral tabulated by