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## Crops, Plant Growth and Fertiliser Investigations

### Rothamsted Research

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## SCIENTIFIC PAPERS

Published 1929 and in the Press.

### CROPS, PLANT GROWTH AND FERTILISER INVESTIGATIONS.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The agricultural importance of the results is indicated.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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