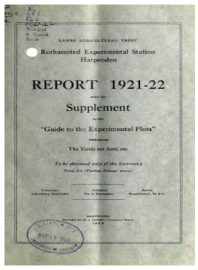
Report 1921-22 With the Supplement to the Guide to the Experimental Plots Containing the Yields per Acre Etc.


Rothamsted Experimental Station
Harpenden
REPORT 1921-22
Supplement
"Guide to the Experimental Plots"
The Yields per Acre, etc.

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Rothamsted Research

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PUBLICATIONS DURING THE YEARS 1921-22.

SCIENTIFIC PAPERS.

CROPS AND PLANT GROWTH.

I. WINIFRED E. BRENCHLEY. *"Effect of Weight of Seed upon the Resulting Crop."* Annals of Applied Biology, 1923. Vol. X. pp. 223-240.

Experiments were carried out in water cultures with peas and barley, in which the competitive factors were eliminated as far as possible in order that the results could be more closely correlated with the initial weights of the seeds.

The chief results are as follows :—

1.—There is a steady and considerable rise in the dry weight of the plants as the initial weight of the seed increases. This occurs with both a limited and an abundant food supply.

2.—The efficiency index (rate per cent. increase per day) falls gradually as the weight of the seed rises. With prolonged periods of growth this tends ultimately to counter-balance the initial advantage gained by plants from the heavier seeds, but with annual crops as cereals, roots, peas, etc., harvesting occurs before this equilibrium is reached, leaving the advantage with the heavier seeds.

3.—The relative development of shoot and root is to some extent influenced by the initial weight of the seed, but may vary with the species and with the amount of available food.

4.—The results lend support to the growing agricultural practice of advocating the use of large heavy seed, especially with annual crops. The advantage in the case of perennials would appear to be less, if any, but this has not been determined by laboratory experiments.

II. WINIFRED E. BRENCHLEY, assisted by KHARAK SINGH. *"Effect of High Root Temperature and Excessive Insolation upon Growth."* Annals of Applied Biology, 1922. Vol. IX. pp. 197-209.

When similar water culture experiments are repeated at different seasons of the year and under different environmental conditions, certain variations in result occur which appear to be associated with the temperature of the nutrient solution in which the roots are immersed. Under ordinary environmental conditions of temperature and sunlight the growth of peas, as of barley, is seriously hindered by overcrowding, even when each plant receives a similar supply of food and water. Not only is less dry weight produced, but the pods become thin and distorted, and fail to develop their seeds properly.

Growth tends to be depressed in hot sunny weather when no protection is afforded. The chief detrimental factors concerned appear to be high temperatures at the roots, acting together with strong and prolonged sunshine, though the two factors acting individually are much less harmful. Under these conditions, crowding shelters the roots from overheating and the leaves from too much sunlight, and up to a certain point crowded plants make better growth than those spaced well apart. Overcrowding,

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however, still depresses growth, probably because the light and root temperature reductions are too great.

Provided insolation is not excessive, the amount of daily fluctuation of root temperature over a total range of about 22° C. (6.7°—28.9° C.) has comparatively little influence upon growth; high maxima and low minima give similar results to low maxima and relatively high minima, provided the average mean temperatures are not too dissimilar. With high root temperature a difference in the degree of insolation or in the angle of incidence of the sun's rays may have a considerable influence on growth, a slight easing off of the solar conditions enabling much better growth to be made. With very strong sunshine, reduction of high maximum root temperatures (29° C. or above) allows of satisfactory growth when unprotected plants are rapidly killed. The inhibitory action of too high temperatures at the roots is thus clearly shown.

Nevertheless, the growth so made is less good than under more normal conditions of insolation, thus demonstrating the harmful action of too powerful sunlight, when all the root temperatures rule high.

Root temperatures appear to be of greater importance than atmospheric temperatures, as good growth can be made in hot atmospheres, provided the roots are kept relatively cool. There is some reason to believe that the minima are of as much importance as the maxima, *i.e.*, that plants can withstand very high maximum temperatures provided there is a considerable drop to the minima, but cannot put up with the constant conditions of heat induced by fairly high maxima and high minima.

III. KHARAK SINGH. *"Development of Root System of Wheat in Different Kinds of Soils and with Different Methods of Watering."* Annals of Botany, 1922. Vol. XXXVI. pp. 353-360.

A study of the development of the root system in different kinds of soil and under varying conditions of manuring, watering, and cultivation, is of considerable importance in the Punjab (India), especially where the crops have to depend mainly on artificial irrigation. Duplicate pot experiments were carried out in which wheat plants were grown in various kinds of soil, watering being done on the surface in one case, and in the other through a small porous pot sunk to the level of the soil in the middle of each large pot, thus carrying the water directly to a lower level. The observations were preliminary in nature, but indicate that wheat plants in pots show better growth when watered from below than when watered from above. The difference is greater in light soil in the early stages of growth, but it is more marked in heavy soil in the later stages of growth.

Under the experimental conditions the development of root and shoot was best in pure sand, provided it was supplied with an adequate amount of water and was underlaid by a layer of farmyard manure. The growth of wheat is better in a mixture containing 25 per cent. sand and 75 per cent. Rothamsted soil, than in pure Rothamsted soil, or in a mixture of 50 per cent. sand and 50 per cent. Rothamsted soil. Moreover, wheat plants do not grow well in brick powder even when underlaid with a layer of farmyard manure.

IV. VIOLET G. JACKSON. *"Anatomical Structure of the Roots of Barley."* Annals of Botany, 1922. Vol. XXXVI. pp. 21-39.

The root system of a well-developed barley plant, whether grown in soil or water culture, consists of two types of roots : (*a*) a thin branched type, and (*b*) a thick "unbranched" type, with very abundant root hairs. The present paper embodies the results obtained from an anatomical investigation of the two types.

A branched root possesses a much thickened stele with a single large axile vessel and six to eight xylem groups, all bounded by a very thick-walled endodermis. In an "unbranched" root neither the endodermis nor the stelar tissues are thickened, the xylem groups number from twelve to sixteen, and the middle of the root consists of thin-walled pith cells traversed by four to six ducts.

The chief function of the "unbranched" roots is probably to provide the plant with a plentiful supply of water and its dissolved food, at the time when vigorous growth is setting in. This function is provided for by :—

(*a*) Abundant root hairs ;
(*b*) An increased number of large vessels and central ducts ;
(*c*) The existence of a stele composed almost entirely of thin-walled elements.

This view receives support from the fact that these roots are formed only during the early stages of the plant's vigorous growth. Researches on the development of root and shoot showed that the formation of "unbranched" roots had entirely ceased by time the plant had finished its vegetative growth and was entering on its reproductive phase. At this period of the plant's history, the nitrogen and ash constituents are migrating steadily from the straw into the grain, so that there is no need for a large root-absorbing area. On the other hand, if the "unbranched" roots functioned chiefly as buttress-roots, the plant would need them even more when the heavy grain is being formed; but that is just the time when their development ceases. Therefore the most probable function for the "unbranched" roots is to ensure a good supply of water, etc., when the plant is in a condition of strong vegetative growth.

V. KATHERINE WARINGTON. *"The Effect of Boric Acid and Borax on the Broad Bean and certain other Plants."* Annals of Botany, 1923. Vol. XXXVII. pp. 1-44.

Boron appears to have some special function in the nutrition and development of the broad bean, as this plant fails to grow satisfactorily in nutritive solution from which boron is withheld. The results of the experimental work are:—

1.—In water culture a continual supply of boric acid appears to be essential to the healthy growth of the broad bean plant, concentrations of one part of boric acid (H_3BO_3) in 12,500,000 parts—25,000 parts of nutrient solution being beneficial.

In its absence, death occurs in a characteristic manner, the apex of the shoot becoming withered and blackened. The addition of boric acid after these symptoms have set in, but before death finally occurs, results in a renewal of growth by means of new lateral shoots and roots. This type of dying has not been observed in broad bean plants grown in pot culture, and it is concluded that sufficient boron is present, as a trace has been detected in the soils used.

2.—The absence of boron does not cause death in barley, growth being healthy in ordinary culture solution.

3.—Excess of boric acid is poisonous to the broad bean, injury being apparent with one part of boric acid (H_3BO_3) in 5,000 parts of the water culture medium and with 0.5 gm. or 1.0 gm. per 22½ lbs. of soil in pot culture, according to the method of application.

4.—Boric acid is more poisonous to barley than to the broad bean; in water culture a concentration of one part of H_3BO_3 in 2,500,000 parts of nutrient solution, and in pot culture .5 gm. per 22½ lbs. of soil is injurious. Smaller quantities are either ineffective or slightly favourable, though the benefit is usually evident to the eye only and not shown in the dry weight.

5.—Injury is marked by (i.) retardation of germination, (ii.) first chlorosis and later brown markings of the leaves; the barley leaf becomes spotted but that of the broad bean shows a band of brown along the margins. (iii.) Retardation in maturing in the case of barley in soil culture.

6.—Preliminary experiments show that several other plants, and especially *Phaseolus multiflorus* and *Trifolium incarnatum,* appear to benefit from the addition of small quantities of boric acid to the nutrient solution, though rye, like barley, is apparently indifferent to low concentrations.

7.—Boron is found to be present in considerable quantity in the dried shoots of the broad bean plants grown in a nutrient solution containing no boron, and also in the seed. In garden-grown plants a larger proportion of boron was present in the pods than in either the stems or leaves. No more than a trace was detected in the barley seed or in the dried shoots of untreated barley grown in water culture.

8.—It is suggested that the function of boron in the case of the broad bean is probably nutritive rather than catalytic, since a supply is required throughout the life of the plant. A parallel is drawn between the action of boron on plants and the vitamines on animal life.

VI. KATHERINE WARINGTON. *"The Influence of Manuring on the Weed Flora of Arable Land."* Journal of Ecology, 1924. Vol. XII.

Examinations have been made of the weed species present on the variously manured plots of fields which have been cropped continuously for a considerable period with :—

1. Winter wheat (Broadbalk Field).
2. Spring barley (Hoos Field).
3. Mangolds (Barn Field).

The data show that the chief factors which determine the dominant species are the crop and the methods of cultivation, the most important weeds being quite different in the three fields. Winter fallowing has a particularly striking influence on the weed flora.