ROTHAMSTED RESEARCH

Rothamsted Report for 1947

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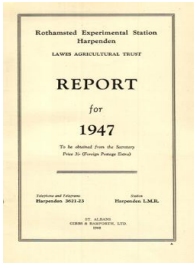

Physics Department

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DEPARTMENT OF PHYSICS

By R. K. SCHOFIELD

Shortly after his return from West Africa Dr. Keen went, at the request of the British Government, to East Africa to preside at an inter-territorial conference on agricultural problems and to advise on agricultural policy. He was appointed Director of the East African Agricultural and Forestry Research Organisation with effect from 1st August, 1947, since when Dr. Schofield has been in charge of the Physics Department.

FIELD WORK

Deep ploughing experiments

This series of experiments has continued to expand. Of the 15 experiments started on farms in 1944, 7 remained in experiment in 1947; of the 15 started in 1945, 12 remained in experiment; and 17 new experiments were started in the autumn of 1946 for the 1947 season. During 1947 arrangements have been made to start another 24 for the 1948 season; and all but one or two of the 36 fields under experiment in 1947 are expected to be under experiment in 1948.

These experiments are now situated in many counties of England and in two of Scotland, and the policy has been to ask the counties to undertake the actual responsibility for carrying out the experimental work on the fields. This Department remains responsible for the design, the choice of sites, and the working up of the results of all the experiments.

The results for the 1947 series have, in the main, followed the previous results. Thus, in spite of the opinions of many very successful growers, potato yields remain for the third year in succession unaffected by the depth of ploughing. For eight out of the nine comparable fields available this year the average yield on the 6–9 in. deep ploughing was 9·2 tons per acre, whilst it was 9·5 tons on the land ploughed to this depth and subsoiled and also on the land ploughed to 12-15 in. The corresponding figures for the average yields in the two previous years are 13·1, 13·0 and 13·1 tons per acre respectively. On the ninth field deep tillage appeared to increase the yield from between 1–4 tons per acre depending on the particular deep tillage treatment chosen for comparison, but the yields on different parts of the same plot were so variable that the precision of the experiment must be considered extremely low. The Rothamsted experiment again gave an increase of 0·7 tons per acre due to 12 in. ploughing compared to 6 in., making the average increase over the four years of the experiment 0·9 tons per acre. The result of this experiment thus continues to differ from those found elsewhere.

In 1947, as in 1946, deep ploughing either for wheat or for the previous crop may have increased yields by as much as 2–3 cwt. of grain. On one field on a very intractable silty clay it doubled the yield from 16–32 cwt. per acre compared with the normal ploughing of the farm. The soil on this field is typical of much of the silty soils of South-East England, and these lie in a region where deep ploughing is not practised at the present time. Deep ploughing

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had little effect on the yield of barley, whether done in the autumn for the crop or for the previous crop, although, again at Rothamsted, it increased the yield by about 2 cwt. per acre.

In 1947 the effect of depth of ploughing and of the time of application of the mineral fertiliser to sugar beet were examined in more detail than previously. The result shows that on the clay soils deep ploughing increased the yield of sugar beet by about 2 tons per acre compared with normal ploughing if the fertiliser was applied in the spring after autumn ploughing, but it had little effect on yield if the fertiliser was put on the land before autumn ploughing. Ploughing in the fertiliser in the autumn to 6–9 in. increased the yield by about 1 ton compared with putting it in the seedbed, as is the usual practice. However, on the deep ploughed plots, ploughing in the fertiliser tended to give a lower yield than applying it in the spring, probably because the seedbed of these plots, made out of subsoil, was too poor for the beet to start well.

On fields on sands and limestones deep ploughing had little effect on yield compared with shallow. But there was a tendency, both this year and last, for ploughing in the fertiliser in the autumn to give about half a ton of extra beet compared with applying it in the spring, whatever the depth of ploughing.

These deep ploughing experiments have now shown that, at least for sugar beet, they must include investigations on the response of the crop to different distributions of mineral fertiliser in the cultivated layer of the soil.

On the effect of inter-row cultivations on the growth of potatoes

The experiment has been continued for another year in which the effect of earthing up, of the depth of setting the hoes and grubbers used between the rows, and of mulching on the growth and the yield of potatoes. This year none of the treatments had any significant effect either on yield or on the proportion of potatoes greened.

METEOROLOGICAL WORK

Evaporation and transpiration

Observations have been continued, but no further analysis of data has been made as the main requirement at present is the collection of records over a period of some years to see if the earlier generalisations are valid. From the earlier work an attempt has been made to estimate transpiration losses from extended areas of grassland when rainfall is insufficient to keep soil moisture at a level high enough to maintain maximum transpiration rates. Using "field capacity" as an identifiable and reproducible reference level it is assumed that a moisture deficit is built up as transpiration exceeds rainfall, and that up to a limiting value, symbolised by C, transpiration rates are independent of the deficit. When the deficit exceeds C inches, soil factors limit water movement to the roots, and hence transpiration rates decrease. A quantitative expression of this falling off was obtained from earlier work on evaporation from bare soil. With knowledge of the time in spring when soil was at field capacity, of the succeeding weather, and of a value of C, it has been possible to follow the change in soil moisture deficit throughout the summer and autumn. Times of the first running of field drains on Cambridge University Farm have been

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successfully predicted within a few days, using values of C of about 3 in. This order of magnitude can be justified from the known rooting habit of the pasture, but further research will be needed to show how it depends on crop type, manuring, crop management, and spring weather.

The concept of soil moisture deficit, referred to above, has been presented in detail to show how it can give guidance in problems associated with soil mechanics.

Meteorological equipment

Attempts to improve equipment continue. The apparatus (referred to in the 1946 report) set up to measure dew-point continuously has not been very successful, but deficiencies in the recording instrument itself have been a contributory factor, and when certain faulty components are replaced the method will be given another test before a final verdict is reached. Apparatus has been built, and is undergoing laboratory trial, for continuous recording of transpiration so that variations during the day can be determined.

An exhaustive examination of the several rain gauges at the enclosure has revealed the sources of long standing discrepancies. These are partly due to exposure and partly due to a defective gauge glass in a new 5-in. gauge. A circular turf embankment has been built round one of our gauges, and this particular gauge will be used as the standard rain gauge in future.

During the year a standard pattern of evaporimeter has been set up to trace the source of discrepancies between open water evaporation, as measured by Meteorological Office pattern tanks, and our Rothamsted equipment.

Agricultural meteorology

A short article has been published on the nature of the physical and biological problems associated with agricultural meteorology, and some steps toward their solution have been taken in collaboration with the Entomology and Plant Pathology Departments.

With the former, a tower 105 ft. high has been set up, and the Physics Department has equipped it at two levels with continuous recorders for temperature, humidity and run-of-the-wind, with the dual purpose of providing the Entomology Department with contemporary physical data to link up with insect catches (aphides) and of supplying our own needs for more detailed knowledge of temperature, vapour pressure and wind velocity profiles in connection with evaporation and transpiration studies. Preliminary surveys indicate that the first purpose has been successfully achieved; as indicated above, no detailed analysis for the second purpose has yet been attempted.

For the Plant Pathology Department a small portable general purpose field unit has been designed and built to measure the same three weather elements in the restricted space available inside growing potato crops. The instrument is based on the very large negative temperature coefficient of electrical resistance of semi-conducting elements known as "thermistors". From the point of view of both Departments the year's work has been exploratory, and successfully so. In the light of experience gained a new instrument is being built which will be simpler to use and more

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precise. Judging by visitors' interest a satisfactory instrument of this kind will meet a real need.

At the request of a joint sub-committee of the Meteorological, Entomological and Ecological Societies Dr. Penman is writing a book on the meteorological principles and methods of importance in the study of the effect of weather on biological activity.

Laboratory work

Physico-chemical studies

The review on p. 95 covers those sections of the physico-chemical studies which have been under investigation for a number of years. There remains for mention here a new investigation on the migration of ions through soil and other porous materials. This investigation has two objects. In the first place it should throw light on the factors controlling the rate of movement of nutrient ions towards the plant root. In the second place, since the migration must take place through water, these studies may throw light on the condition of the water in the minute interstices of the soil. The investigation has already brought to light an interesting effect when bentonite is added to a salt solution. The conductivity of N/10 potassium bromide solution is reduced 16 per cent. by adding 0·91 per cent. of a very fine bentonite which, under these conditions, forms a thixotropic gel, whereas the conductivity of N/40 potassium bromide is increased 3 per cent. by adding 0·57 per cent. of the same bentonite which in this case forms a deflocculated suspension devoid of rigidity. These bentonite particles are plates 10 A. thick.

These results strongly support the view that the bentonite particles in a thixotropic gel form a kind of network in which the edges of neighbouring particles are drawn towards each other.

Vapour pressure of solutions

The work on vapour pressure of solutions was first undertaken in order to supply information to the Bee Department about the relationship of the aqueous vapour pressure of honey to its water content. Some measurements were made using pure glucose and fructose and the question arose as to how the results should be set out. A study of the literature shows that no convenient method had been devised for expressing the departure of very concentrated solutions of non-electrolytes from ideal behaviour. Since there is an obvious analogy between the behaviour of water in a concentrated solution and water in moist soil, the problem has been examined in a more general way. We have hit upon a new handling of vapour pressure data, and a paper on this subject is in course of preparation.

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