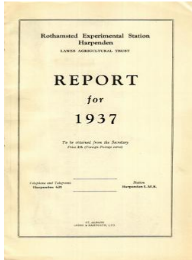
Report for 1937

Full Table of Content



Chemistry Department Work

Rothamsted Research

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CHEMISTRY DEPARTMENT

The extension of the Chemical laboratories gives special interest to the work being done there and to the developments it is proposed to make as soon as the new buildings are completed.

Soil Fertility.—The numerous field experiments on commercial farms are used as a basis for testing laboratory methods of soil analysis for fertilizer requirements. The 1936 and 1937 results with sugar beet showed much larger responses to fertilizers than in any of the three preceding dry seasons, and in consequence it was for the first time possible to make adequate tests of the success of laboratory methods in forecasting the responses of crops to added fertilizers. For nitrogen there was a fair correlation in 1936 between the response to sulphate of ammonia and the amount of inorganic nitrogen obtained in the soil samples after incubation. For phosphoric acid the fraction soluble in acetic acidwas significantly related to the responses to superphosphate, the agreement being better in 1936 than in 1937. The more commonly used citric acid method was less successful. For potash neither the water-soluble nor the acetic acid-soluble fractions were significantly related to the field responses in 1936 though they were in 1937.

When the data were set out in groups according to textural classes of soils it became clear that fertilizer recommendations, whether based on soil analyses or not, must be adjusted to the soil texture, for it happened that on the heavy soils the sugar beet yield was depressed by potassic fertilizers in 1936, in spite of the fact that some methods of soil analysis actually in use always give lower results for heavy than for light soils. The field experiments hold out considerable promise that soil analysis may give useful results for soils of normal fertility, provided the methods are standardised by field trials on related soils.

During 1937 soils were collected from a series of field experiments on potatoes carried out at over twenty centres and investigations are being made on the lines set out above. For both potash and phosphate the field results agree fairly well with the analytical data.

Preliminary trials have been made of very rapid methods of soil analysis which are now proving extremely popular in the United States. One of these methods agreed well with the standard method of determining acetic acid-soluble phosphoric acid and potash, except for calcareous and fen soils.

Basic Slags.—As in the preceding years, work was carried out for the Permanent Committee on Basic Slag to compare the agricultural value of medium-soluble slags with the better known high- and low-soluble slags. In Scotland Prof. McArthur carried out field experiments with several kinds of slag, each at two or more rates of dressing. Samples of the produce were analysed at Rothamsted to determine the recovery of phosphoric acid in the crops. The experiments again showed that, in effects on yield and recovery of phosphoric acid, the available phosphoric acid could be expressed as a first approximation by the amount of citric-soluble phosphoric acid applied. Dressings of medium-soluble and low-

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soluble slags gave similar results to much smaller amounts of high-soluble slag providing the same amount of citric-soluble phosphoric acid. The experiments showed that the yields of swedes approached a limit for applications of the order of 7 cwt. of high-soluble basic slag per acre. Earlier experiments with slags at a single heavy rate of application had failed to differentiate clearly between the various types of slag tested, because the dressings used raised the yield towards this limit. In pot cultures at Rothamsted an attempt was made to compare basic slags under widely contrasted conditions of crop, soil and method of incorporating the basic slag with the soil. Some of the **1936** experiments were carried on into **1937** to compare clover, timothy and rye grass. The final data are not yet available, but it was apparent during growth that all three crops grew well without added phosphate in a soil which had failed to produce good swede crops in the field in **1935** or good growth of turnips in pots in **1936**, unless phosphates were added. Grasses and clover can thus use soil phosphates which are not available to swedes. This fact may explain why the residual effects on oats and hay in the field experiments have been so small by comparison with the immediate effects of the basic slags on swedes.

A new silico-phosphate has been isolated from some medium-soluble slags and shown by optical and X-ray methods to be very similar to, if not identical with, one of two silico-phosphates recently prepared synthetically in Germany.

The nature of the phosphorus and potassium compounds in soil.—A considerable proportion—some **25** per cent.—of the total phosphorus is present in soils in organic combination. Methods have been developed for determining its amount ; its form has not yet been established, but it is very stable and is probably not available to plants.

In acid soils most of the phosphate added in fertilizers appears to pass over in a few years to unavailable iron phosphates. In neutral soils the reserves may, however, be built up as calcium phosphates.

Even although potassium forms no simple insoluble compounds a good deal of the potash added to many soils may be locked up in inert forms which are neither available to plants nor capable of being washed down into the lower depths of soil. On the other hand, plants can undoubtedly utilise potassium from forms other than the readily soluble exchangeable potassium. It is hoped partly by chemical work and partly by empirical methods to define more closely the conditions under which potassium added in fertilizers will become more highly effective.

The nature of the inorganic soil colloids.—These substances—often regarded as the same as the clay—play an extremely important part in soil fertility. X-ray studies are being made to find out more about their constitution. The X-ray diagrams of soil colloids from a widely differing collection of soils all gave the same type of pattern with only minor variations. More detailed work has, therefore, been undertaken on minerals related to those found in clays with the object of discovering sharper criteria for differentiation.

BACTERIOLOGY DEPARTMENT

This department is also to be housed in the new wing, it having entirely outgrown the old laboratory erected in 1906 as the result of the James Mason donation.

The work of the department has for some years been devoted to a study of the strains of nitrogen-fixing bacteria that produce nodules on the roots of leguminous plants. The nodule bacteria form a group which can be divided into species, each of which can infect only a small group of legumes. Within these species, strains or varieties of the bacteria can be found that vary very greatly in the benefit which they confer on the host plant ; indeed some strains are purely parasitic and do not benefit the plant at all. Such strains are particularly prevalent amongst pea and clover nodule bacteria, and probably account for the poor growth of clover in certain pastures.

The anatomy of nodules produced by beneficial and "parasitic" strains has been studied and the latter have been found to differ from beneficial nodules in three respects. (1) In young "parasitic" nodules, the cells in which the bacteria lie contain an excessive amount of starch. This may indicate that the bacteria are unable properly to utilise the sugars supplied to them in the nodule. (2) The "parasitic" nodules stop growing at a very young stage and remain small. (3) The bacteria in such nodules very soon begin to attack and destroy the tissues of the nodule in which they lie.

Not only do the "parasitic" strains of bacteria behave abnormally within the nodules, but the plant infected with them also produces some substance, or "antibody," in its root juice that inhibits the growth of the bacteria ; filtered root juice from plants bearing "parasitic" nodules has been found to check growth of the bacteria in culture, whereas juice from uninfected plants or from plants bearing beneficial nodules, has no such effect (Table XLV).

TABLE XLV

Growth of Soybean Nodule Bacteria in Media Containing Root Juices

Medium with juice from plants :—	Millions of bacteria per millilitre
Uninoculated..	1757
Inoculated with beneficial strain	1706
Inoculated with parasitic strain	852

It seems unlikely that we shall be able to alter these fundamental differences so as to make "parasitic" strains of nodule bacteria become beneficial. The problem therefore is to ensure that a leguminous crop becomes infected with beneficial strains. This might be supposed easy, since we possess a practical method of "inoculating" legume seed with the bacteria. But unfortunately the problem is