ROTHAMSTED RESEARCH

Report for 1935

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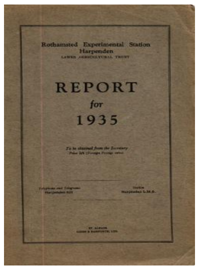

Design of Field Experiments

Rothamsted Research

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conflicting opinions have been expressed. Studies on the availability of lignin involve analyses from time to time on materials that are changing in composition. It is very significant that changes are especially marked in those two groupings which contribute so largely to errors in the lignin determination, for pentoses are rapidly fermented away and proteins synthesised under normal conditions of ærobic decomposition. To some extent these two errors are compensatory and their effect varies widely with the nature of the material and period of decomposition. Previous observations have been re-examined in the light of these facts.[12] The ærobic decomposition of lignin in straw has been studied and determinations made over a period of eighteen months by four different methods, all of which show losses of 40-50 per cent. of the lignin in the first year and 50-60 per cent. in eighteen months.[13] Lignin is certainly not so resistant to biological attack as has sometimes been claimed, but being the most resistant plant constituent tends to accumulate. Highly decomposed organic residues composed largely of lignin and protein are readily susceptible to oxidation, and this property is being investigated in humic residues from various sources.

Certain of the oak timbers of Rothamsted House have been very extensively attacked by the Death-watch Beetle, and on their replacement the opportunity was taken of analysing samples of the decomposed wood and comparing them with the sound wood from the same source. The results leave no doubt that the main constituent removed by the larvæ was the cellulose, and in so far as it was possible to form any estimate, the total loss suffered by the wood was in the region of one third.[14]

Other Investigations. The oxidation of amino acids with hypochlorite has been studied in detail, and the route of the reaction and products determined. Glycine gives rise to CO_2, water and gaseous N, through the intermediate formation of HCN, which is subsequently hydrolysed to formic acid and ammonia, both then being completely oxidised. The rate of the reaction is enormously affected by the *p*H of the mixture, being most rapid in the region of *p*H 7-9.[15] When extended to higher amino acids, this work has provided another example of the great disparity between the first and succeeding members in a homologous series, since the products and conditions of oxidation are very different from those found for glycine. The acids formed from the cyanide are not oxidisable, and from a dibasic amino acid, a cyano-acid has been obtained and identified.

DESIGN OF FIELD EXPERIMENTS

The earlier work of the Statistical Department included the designing of field experiments so that a valid estimate could be made of the magnitude of the errors affecting the results, and at the same time as much as possible of the variation due to soil irregularities

(12) A. G. Norman—" The Biological Decomposition of Lignin." Sci. Progress., 1936, Vol XXX, pp. 442-456.

(13) A. G. Norman—" The Decomposition of Lignin in Plant Materials." Trans. 3rd Internat. Cong. Soil Sci., Oxford, 1935, Vol. III, pp. 105-108.

(14) A. G. Norman—" The Destruction of Oak by the Death-watch Beetle." Biochem. Journ., 1936, Vol. XXX (in press).

(15) M. F. Norman—" The Oxidation of Amino-acids by Hypochlorite, I, Glycine." Biochem.. Journ., 1936, Vol. XXX, pp. 484-496.

could be eliminated. This purpose was accomplished, and designs such as randomised blocks and the Latin square are now superseding the older types of lay-out in almost all classes of agricultural experiment, both in this country and overseas.

During the last few years attention has been devoted to methods of increasing the efficiency attainable by simple randomised blocks and Latin squares, and to methods of widening the scope of a single experiment so that several problems can be investigated concurrently. *Factorial designs* have been developed, in which all combinations of different levels of several treatments (or factors) are included. A simple and very effective example of this type of design is the 27 plot experiments of the factory sugar beet series. In these experiments all 27 combinations of double, single and no dressings of each of the three standard fertiliser components, nitrogen, phosphate and potash are represented, only one plot being devoted to each treatment combination. Each plot is in effect used three times over, once to assess the value of nitrogen, once for phosphate and once for potash. In addition, information, which would be wholly lacking if three separate experiments, each confined to one of the three fertilisers, were used, is obtained on possible variations in response to one fertiliser at different levels of the other two. Such factorial designs, therefore, represent a great advance in experimental technique, and they will probably supplant the simpler methods in the same way as randomised blocks and Latin squares have supplanted the older systematic arrangements.

The attention of the department has also been directed to problems of sampling, which are of immense importance in agricultural experiments. The most efficient technique in any given instance can be determined only by statistical methods ; indeed if statistical principles are not borne in mind sampling may be almost unbelievably inefficient. An example of the rapid advances in knowledge that can be obtained by the discriminating use of a good sampling technique, applied co-operatively by workers at several centres, is provided by the sampling observations of the growth of the wheat crop, which are described in a later section.

SOILS

The chemical and physical work consists in attempts to discover the composition and constitution of the soil, and to follow the changes taking place therein.

The clay is recognised as one of the most important components and much work is being done on it in the Chemical Department. Dr. Nagelschmidt has found by X-ray analyses that its commonest constituent differs from all known minerals, but is apparently related to halloysite : he is also studying the swelling of the montmorillonite lattice in presence of water. This investigation requires continuous access to very costly physical apparatus and we are greatly indebted to Sir William Bragg for allowing all that side of the work to be done in the Davy Faraday laboratory of the Royal Institution.

Soil Analysis. Considerable attention has been given to the old problem of finding some chemical means of forecasting the probable effects of fertilisers. For soils suffering from some serious