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Statistical Control of Field Experiments

Rothamsted Research

Rothamsted Research (1939) *Statistical Control of Field Experiments* ; Rothamsted Report For 1938, pp 50 - 51 - DOI: <https://doi.org/10.23637/ERADOC-1-86>

The chief factor in the persistence of the disease in a particular field is therefore the length of time that the mycelium can continue to survive in the soil. Fortunately the mycelium does not live indefinitely : it is attacked and decomposed by other soil organisms. The most favourable conditions for this appear to be (1) high microbiological activity in the soil ; (2) maximum soil aeration ; (3) temporary scarcity of nitrogen, which drives the soil organisms to attack the *Ophiobolus* mycelium for the sake of its nitrogen. Co-operative experiments have been started with the Norfolk Agricultural Station to apply these results to farm practice.

Fortunately the English variety of the fungus does not attack oats and in consequence oats can be sown on infested land in Eastern and Southern England. Grasses also are not affected.

In Wales, however, it is different. Another strain or perhaps even another species of the fungus has been found there which attacks both oats and grasses, thus differing widely from the English strain. One hopes it will not invade Eastern or Southern England.

The fungus *Fusarium culmorum*, which causes trouble to wheat growers has also been studied : it can colonise dead plant remains, and was indeed the dominant fungus, with *Mucor spp.* as sub-dominant, in decomposing wheat stubble for at least the first three months after it had been ploughed into the land. Later on these were replaced by *Penicillium spp.* as dominants. Enrichment of the straw with nitrogen accelerated the decomposition but did not alter the succession of fungi. The practical significance of the results lies in the fact that *F. culmorum* must now be considered a regular member of the fungus flora of the soil, since it can colonise dead plant remains, and is therefore not restricted to a parasitic life. It is, therefore, highly improbable that any system of crop rotation will eliminate this wheat parasite from the soil, so that control measures must rather be directed towards raising by appropriate cultural measures the resistance of the cereal host plant to disease.

The fungus *Cercospora herpotrichoides*, which causes lodging in wheat, was first found in this country by Miss M. D. Glynne at Rothamsted in 1935. It was afterwards recognised in a number of places on wheat in the southern half of England, and occasionally on winter barley, and it was much commoner in the wet season of 1937 than in the drier season 1938 when there was much less lodging and the percentage of infection was lower.

The effects of the fungus are more marked when wheat has closely to follow wheat or barley than when a wider interval is possible.

STATISTICAL CONTROL OF THE EXPERIMENTS

Design of Field Experiments and Analysis of the results

It is obviously useless to make field experiments unless the results are reliable, and long experience has shown that the old simple designs frequently give untrustworthy results ; moreover no estimate of their validity can be made. In the Statistical Department new methods have been developed which enable the experimental errors to be properly assessed and which are far more efficient than the older methods. The new methods are now widely used in the Empire, especially in India, Ceylon, Malaya, Australia,

the Sudan, and in many parts of Canada and Great Britain as well as in the United States. They are continuously being improved, and during 1938 quasifactorial and incomplete block designs were studied: these are already much used in plant breeding work, in experiments on virus disease and other problems. Designs for rotation and other long term experiments are also being investigated, and numerous experiments of this type involving many novel features have been commenced at Rothamsted and Woburn.

When the experiments are done the results have to be analysed and relations with meteorological and other data investigated. The results of the Saxmundham experiments are being worked out on these lines. Methods of dealing with survey data have been developed, and used in an enquiry into potato blackening carried out for the Potato Marketing Board in conjunction with the Imperial College Botany Department.

The Statistical Department also does a good deal of work in association with other bodies: during 1938 it carried out an investigation for the Forestry Commission on methods of sampling for yield of timber.

Special attention is given to the study of methods of crop forecasting: this is done in association with the Plant Physiologist. The particular crops at present under investigation are wheat, potatoes, and sugar beet.

FIELD EXPERIMENTS AT OUTSIDE CENTRES, 1922-38

When the wheat experiments on Broadbalk field had been carried on for eight years, Lawes repeated certain of them on lighter soil at Holkham, Norfolk ⁽¹⁾ for four successive years, the manures being made up at Rothamsted. Five years later some Kentish farmers who had visited Rothamsted were so interested in the wheat field that they offered to repeat the experiment in their own area: this they did for six years at a centre near Sittingbourne. Writing of these experiments ⁽²⁾ Lawes and Gilbert say: "It is highly desirable, in a practical as well as a scientific point of view, to determine, by means of careful experiments, whether or not the action of particular manures on particular crops is substantially similar on different descriptions of soil and in different localities."

Although the need was clearly appreciated the early records show few excursions to outside farms apart from the above. In 1876 the Woburn experiments began and the main treatments of Broadbalk and Hoosfield were repeated on a light soil and maintained for 50 years.⁽³⁾

Until after the War the small size of the staff had not allowed of any but occasional experiments outside of Rothamsted; this became possible as soon as the staff was enlarged. There were, however, certain administrative difficulties as the scheme under which research institutes then worked did not envisage investigations outside the institutes, except at the request of the local authorities.

⁽¹⁾ J. B. Lawes. *Jour. Roy. Agric. Soc. Eng.*, 1855; 16; p. 207.

⁽²⁾ J. B. Lawes and J. H. Gilbert. *Jour. Roy. Agric. Soc. Eng.*, 1862; 23; p. 31.

⁽³⁾ E. J. Russell and J. A. Voelcker. *Fifty years of field experiments at Woburn Experimental Station. Rothamsted Monographs Agric. Sci.*, 1936.