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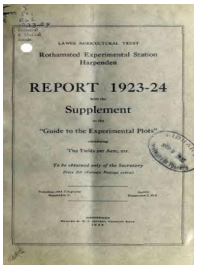
Report for 1923-1924 With the Supplement to the Guide to the Experimental Plots Containing the Yields per Acre Etc.



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Control of Pests and Disease Organisms

Rothamsted Research

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activities. Food stuffs (especially nitrogen compounds and phosphates) are supplied, along with calcium carbonate to obviate acidity, and decomposition then proceeds rapidly, converting waste useless straw and other materials into valuable manure.

The large scale development is carried out by the non-profit making " Adco " syndicate, of which Lord Elveden is Chairman, thus relieving the Station of much exploitation work for which it is not suited. The numerous scientific problems constantly arising out of the field experience are studied by Messrs. E. H. Richards and R. L. Amoore in these laboratories.

The organisms are naturally present in the straw or in the dust and they need not be deliberately added. It is, however, important to discover exactly what they use, how they do their work, and what conditions are necessary to their efficiency. These problems are studied in the Bacteriological Department. A new organism has recently been found by Mr. P. H. H. Gray, which not only decomposes cellulose rapidly, but unlike the *Spirochæta Cytophaga* previously isolated in the laboratory, acts in presence of sugar and is indeed stimulated by small quantities of xylose and lignin such as occur in straw. It seems probable that this new organism plays a considerable part in the decomposition of straw in practice, in the making of farmyard manure and other important changes.

PARTIAL STERILISATION AND CONTROL OF SOIL. PESTS AND DISEASE ORGANISMS.

These are conveniently dealt with together. The methods first tested in these laboratories 17 years ago involved either heating the soil or treatment with volatile antiseptics such as toluene and carbon disulphide. The first applications were made in glass houses, and the method first used in practice was heat. This is effective but costly, and it cannot be much cheapened. Chemicals offer much better prospects and search is being made in Mr. Tattersfield's Department for agents which will effect the same purpose as heat at less cost. The obvious method of utilising industrial waste products is less useful than might be expected owing to their variable composition: the first investigation is, therefore, directed to the discovery of the organisms to be put out of action and the testing of chemical compounds in a definite systematic manner, so as to obtain information as to the relationships between chemical constitution and effectiveness. The proper quantity and the suitable time and method of application have all to be determined by direct trial, while laboratory experiments are made to discover more particularly the precise actions going on. The most interesting result thus far obtained is that organic substances, such as the cresols, phenol and cresol derivatives, and the chlornitro derivatives, such as chlorpicrin and chlordinitrobenzene, can, when applied to soil in proper quantity, determine substantial crop increases, though it is not yet known how far the effect is due to removal of disease organisms, and how far to improvement in nitrate production or to direct stimulation of the plant. Under this treatment tomatoes

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under glass gave no less than 5 additional tons of fruit per acre, worth between £250 and £300.

Some of the substances are solids and are easily handled and applied. The significance of the advances made in recent years in these laboratories will be appreciated when it is recalled that the first agents used were highly inflammable substances, difficult and expensive to transport, and that they were applied to the soil at the rate of 10 tons per acre by means of a special injector—another difficult and costly process. These dangerous liquids were soon replaced by a crude cresylic acid (called carbolic acid), an oily liquid watered into the ground at the rate of 2½ tons per acre—but the process was still expensive, the material alone costing over £160, while the labour was considerable. The new substances are solids, and are so potent that 2 cwt. per acre has proved effective. Although they are not as yet on the market, there seems no reason why they should not be made as intermediate products in connection with one of the large organic chemical industries, such as the making of dyes. It is essential to success that the added substances should be removed from the soil as soon as their work is done, otherwise they may injure the plant: this removal is accomplished by a perfectly natural process. Although the compounds are so poisonous to certain undesirable organisms, they serve as food and energy materials to others among the remarkable population of the soil—an illustration from the lowliest type of life of the old adage: "What is one man's meat is another man's poison."

Among the phenol destroying bacteria one has been found by Mr. Gray to possess the interesting property of converting indol into indigo—a change of great biochemical interest.

The laboratory studies of the effects of partial sterilisation on the soil micro-organisms have been continued by Mr. Cutler and Miss Dixon, using heat and phenol as the two agents; application of either results in an increase in the numbers of bacteria and the destruction of active protozoa, but the course of events is not the same in the two cases. Phenol induces rapid multiplication of specialised types of bacteria capable of using it as a source of energy, but the general bacterial population undergoes little change. Moreover, when applied in small quantities, the phenol does not kill the protozoan cysts; these remain dormant until it has disappeared, and then resume their active existence. A temperature of 65° C. causes the complete destruction of protozoa and an initial depression of the bacteria. Subsequently the bacteria increase and attain high numbers which are kept up for long periods.

It has been found that this partial sterilisation effect takes place within relatively short ranges of temperature; 55° C. or less does not bring it about, but 65° C. gives a result as marked as that of higher temperatures. It is worthy of note that 65° C. is the death point for soil protozoa.

An interesting problem has arisen as to the effect of storage of the soil in bottles or open jars on the soil population. When soil is taken from the field, and after sieving placed in bottles,

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the numbers of both bacteria and protozoa decrease rapidly for the first two or three days, after which there is a slow but steady fall for periods exceeding three months. No explanation can as yet be offered.

Wart Disease of Potatoes.—An important case of control of a soil micro-organism has been investigated by Dr. Brierley, Mr. Crowther, Miss Glynne and Mr. Roach. Wart disease, one of the worst potato troubles in this country, is caused by an organism having a remarkable power of persisting in the soil so that it cannot be eliminated by the ordinary method of ceasing temporarily to grow potatoes. The direct method of studying the effect of various chemicals on the organism is inapplicable owing to the difficulty of germinating the winter sporangia: pot experiments failed owing to difficulties of obtaining infection in pots, till Miss Glynne showed how this could be brought about. Direct field experiments were the only satisfactory method of procedure, and these, while tedious and costly, showed that heat (which owing to obvious practical difficulties was tried only in pot experiments), formaldehyde and sulphur were all effective in dealing with the disease. Heat is too expensive, so also is formaldehyde at present, and possibly for a long time to come, but sulphur is relatively cheap. Mr. Roach overcame the earlier failures by using the Simar cultivator, and so ensuring a better mixture of the sulphur with the soil. There is evidence that on light soils, such as are generally used for potatoes, an application of 12 cwts. per acre of sulphur eliminates wart disease. A large scale trial is now being made to test the practicability and effectiveness of the treatment. Heavier soils apparently require bigger doses of sulphur.

On the other hand, it does not appear that the "scab" of potatoes caused by the fungus *Spongospora subterranea* is amenable to treatment by sulphur, although in America, positive results are said to have been obtained.

INSECTICIDES.

The Staff of the Department of insecticides, fungicides, and partial sterilising agents, under Mr. F. Tattersfield, have for the past three years been engaged in a search for a substitute for nicotine. The seeds and leaves of a tropical plant, *Tephrosia vogelii*, have been found to possess approximately the same toxicity as nicotine; these could readily be obtained should the need arise. Special attention has been directed to the possibility of using synthetic substances, since these can be made to any desired standard of purity, and in any quantity. The work is done on systematic lines, the effects of the various groups being studied as they are substituted in a relatively simple molecule such as benzene. Thus it is found that the introduction of a nitro (NO_2) group into the benzene molecule considerably increases the toxicity, while the methyl (CH_3) group has less effect than any of those tested, the order being:—

$$NO_2 > NH_2 > OH > Cl > CH_3$$