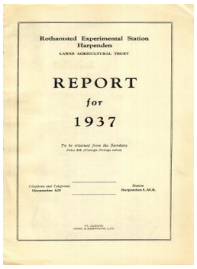
ROTHAMSTED RESEARCH

Report for 1937

Full Table of Content



Bacteriology Department Work

Rothamsted Research

Rothamsted Research (1938) *Bacteriology Department Work ;* Report For 1937, pp 56 - 59 **- DOI: https://doi.org/10.23637/ERADOC-1-69**

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

https://doi.org/10.23637/ERADOC-1-69

complicated by the facts that strains of nodule bacteria compete together in producing nodules, and that this competition almost always ends in favour of the " parasitic " strain. Thus, when pea plants were supplied with a mixture of a good and a " parasitic " strain in equal numbers, 90 per cent. of the nodules were found to have been produced by the latter.

One way to meet the problem of soils infected with " parasitic " strains of nodule bacteria is to seek beneficial strains that can compete effectively with them. The search for " dominant " good clover strains has been successful. Most of the good strains of clover bacteria, like those of peas, seem unable, under normal conditions, to compete with the " parasitic " strains. Table XLVI shows the number of nodules produced by a typical good strain (" 205 "), and a " parasitic " strain (" C "), when the two strains were supplied in equal numbers to clover grown in sand. Two beneficial strains have now been found that can dominate the " parasitic " strain, and the lower line of the table shows the success with which one of these strains (" A "), can compete for nodule production with strain " C."

It has been found that nitrate greatly checks nodule formation by strains " C " and " 205 " but affects strain " A " very much less. It is likely that relative tolerance of nitrogen may explain the dominance of this strain.

The discovery of these "dominant " beneficial strains should enable us to use seed " inoculation " to make clover grow well even in soil heavily populated with a " parasitic " strain.

TABLE XLVI

Results of mixed Inoculation of Red Clover with good and " parasitic" strains

Strains of nodule bacteria supplied in equal numbers	Total nodules	*Numbers of Nodules* Produced by good strain	Produced by " C "
" C " (parasitic) + "205" (good, but not dominant)	364	40	324
" C " (parasitic) + " A " (good and dominant) . .	116	113	3

Before clover inoculation trials are carried out with these " dominant " beneficial strains, more knowledge is needed of the distribution of " parasitic " strains and of the districts where the poor growth of clover seems to be attributable to their prevalence. Such a survey is now being planned.

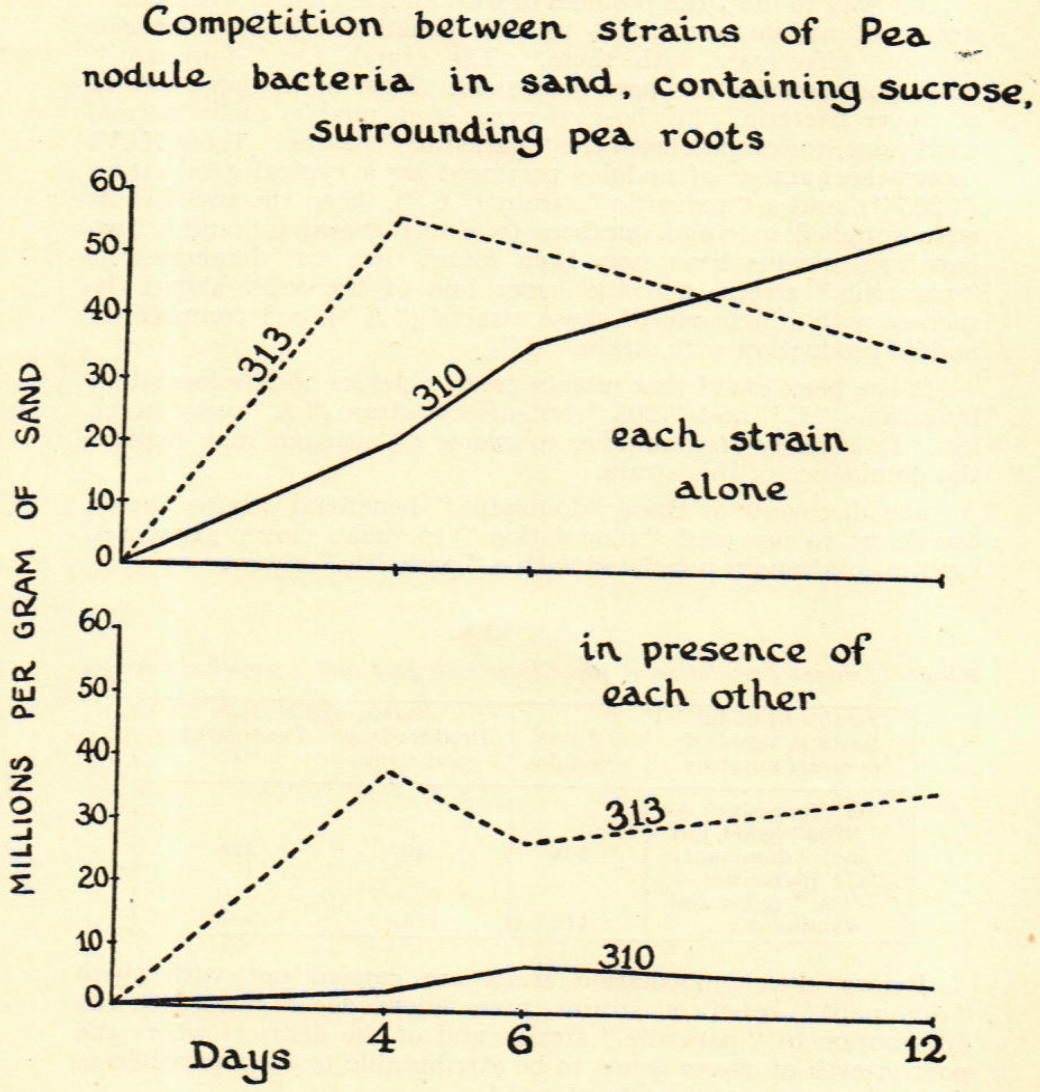
The dominance which " parasitic " strains show over most beneficial strains seems to be due to competition taking place between the strains outside the plant roots. When peas were grown in sand containing good and " parasitic " strains each in pure culture, both strains were found to multiply in the sand surrounding the roots. But when the two strains were mixed together in the sand, the " parasitic " strain alone increased its numbers and

https://doi.org/10.23637/ERADOC-1-69

entirely repressed the multiplication of the good strain. (Fig. 1.)

If the chemical state or the physical condition of the sand or soil were suitably modified, it might be possible to encourage the multiplication of the good relatively to the poor strains and so to develop a method of improving the quality of the nodules by manur-

FIG. I



Strain 313, parasitic. Strain 310, beneficial.

ing or soil treatment. Such a method may be needed for legume crops for which " dominant " good strains cannot be found. This idea is being explored.

The competition outside the roots between good and " parasitic " strains of nodule bacteria illustrates the need for more knowledge of the behaviour of soil bacteria in the neighbourhood of plant

https://doi.org/10.23637/ERADOC-1-69

roots. There is no doubt that roots exert a stimulating effect on bacterial growth. Thus when nodule bacteria were placed in sand without any plants, their numbers after a fortnight rose from 1 to 3 millions per gram of sand, but in sand in which peas were growing, the numbers of bacteria rose in the same time from 1 to 6.1 millions. It is also known that the number of other soil bacteria is much increased by the near presence of plant roots. This large population of micro-organisms amongst the roots must be of great importance in affecting crop growth, and yet it affords an almost untouched field of investigation.

The development in this department of a method for estimating the total numbers of bacteria in soil now makes it possible to investigate the interaction of plant roots with soil bacteria, and it is proposed to undertake this when better laboratory accommodation is available.

There is some evidence that the important problem of clover sickness is related to this growth of micro-organisms upon or near the plant's roots. The fact that clover so often fails when grown too often on the same ground is sometimes attributed to definite fungal or eelworm infections, but there are instances which cannot be attributed to these causes and in which the commencement of the symptoms occurs so early as to exclude the factor of nodule formation by " parasitic " strains. A case at Woburn has been under investigation in collaboration with Dr. Mann. A sterile extract of clover-sick soil from this source has been found so toxic that, in its presence, clover seed is prevented from germinating or killed immediately after germination. It would seem that bacteria growing upon the roots of the preceding clover crop have produced some persistent toxic substance. The nature of this substance and the conditions which make for its formation offer a promising line of investigation which it is proposed to follow up.

But bacteria growing in the proximity of roots also produce effects beneficial to the plant. Thus it has been shown in our earlier work that the growth of root hairs is stimulated by the secretions of nodule bacteria living outside legume roots. This production of growth-promoting substances by soil bacteria may well be of great agricultural importance.

THE WORK OF THE PLANT PATHOLOGY DEPARTMENT AT ROTHAMSTED, 1918-1937

By J. Henderson Smith

The Mycology Department was instituted in 1918, and Dr. W. B. Brierley put in charge, with Miss Jewson as Assistant. At first it was housed in a single room of the old building, but in 1924 moved to the less cramped quarters in the new laboratory which it now occupies. The change gave scope for an increase in the staff, and in 1929 three additional members were added on the formation of the Virus Section. In 1932 Dr. Brierley left to take up the Chair of Agricultural Botany at Reading University ; and a few months later Dr. R. H. Stoughton who had joined the staff as bacteriologist was appointed Professor of Horticulture, also at Reading. On

https://doi.org/10.23637/ERADOC-1-69