Legumes and Legume Bacteria

A SUGGESTED EXPLANATION OF THE "INEFFICIENCY" OF CERTAIN STRAINS OF RHIZOBIUM SP.1

Abstract

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The term "inefficient strain" of Rhizobium is here used to mean those strains which produce nodules that cause but little increase in the nitrogen content of their host legume. It has been natural to suppose that the inefficiency of such strains was due to some defect in their nitrogen fixing ability, but this hypothesis remained unsupported because no strain of Rhizobium can certainly be shown to fix nitrogen apart from its host-plant. The problem of inefficiency was therefore studied by comparing the development and structure of nodules produced by efficient and inefficient strains.

In the case of clover, nodules produced by an inefficient strain differ from efficient nodules by their much smaller size, due to an early cessation in activity of the apical meristem cap. There is consequently a relatively small volume in these inefficient nodules, of the central tissue largely composed of cells filled with bacteria, here described as the "bacterial tissue". Such nodules also show a much earlier disintegration of this bacterial tissue, although this disintegration ultimately takes place in all nodules by whatever strain they are produced. In comparing clover nodules produced by an efficient and by an inefficient strain, it was found that the efficient nodules contained on an average about five times the volume of bacterial tissue that was found in the inefficient nodules and that this tissue remained without disintegration for about six times as long a time. Determinations of the nitrogen fixed by clover bearing these two types of nodules showed that the combination of the two factors of volume and duration of the bacterial tissue was just sufficient to account for the differences in nitrogen fixation.

Similar differences in the volume of bacteria-infected cells and in their duration in time were also found in peas and in soy bean, though in the latter plant the difference in bacterial content of the two types of nodule was due less to total volume of bacterial tissue than to the fact that there were fewer infected cells within that tissue.

The problem of inefficient nodules thus resolves itself into that of explaining why, in these nodules, the bacteria fail to multiply so well as do those in efficient nodules and why they disintegrate sooner. The phenomenon suggests some maladaptation to the host plant.

Some evidence has been obtained to show that the root juice of plants bearing these inefficient nodules contains a substance harmful to the growth of the nodule bacteria. Peas and soybeans infected with efficient and inefficient strains as well as uninoculated plants were grown in sand, and the root juice from each set was extracted and sterilized by filtration. These filtered root juices were added to culture media known to be otherwise suitable for the growth of the nodule organism, and these media were inoculated with various strains of pea and soy bean nodule bacteria. The media containing root juices from plants bearing inefficient nodules produced a smaller growth of the bacteria than did the media containing juice of uninoculated roots or juice from roots of plants bearing efficient nodules.

It seems possible, therefore, that certain strains of nodule bacteria owe their inefficiency to the induced production by the host plant of a substance harmful to the bacteria and that the presence of this substance in the nodules inhibits the growth of the bacteria and causes their early disintegration.—Author abstract.