Leaflet AG.

The Bacteria in Soil and their Value to the Farmer.

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Soil bacteriology a new subject.

A comparatively short time ago very few people realized that there were bacteria in the soil. Today, every progressive farmer knows that the reason why some soils fail to yield a good crop of alfalfa, clover, or other legume is because they do not contain the right kind of bacteria. If an up-to-date farmer has a field of such soil he tries to get the right kind of bacteria into it by inoculating it with cultures that he has bought or with soil from some field that does allow a good growth of the kind of legume he wishes to raise. Many farmers, however, do not realize how many other kinds of bacteria live in the soil nor suspect how great their importance is.

Abundance of bacteria in the soil.

A teaspoonful of soil often contains at least a hundred million bacteria, as many as there are inhabitants of the entire United States. Ordinarily, the richer the soil, the more bacteria there are to be found in it. A freshly manured soil may contain such large numbers that no good estimate of them can be made. Among these numerous bacteria there are kinds that differ greatly from one another. There may be as many different kinds of bacteria growing in the soil as there are of plants growing on it.

What do bacteria do in the soil?

The most important function of bacteria in the soil is to cause the decomposition of organic matter. If there were no bacteria, the stable manure or green manure applied

to the soil would never rot and never become available as plant food. It is only because of the microscopic life within the soil that manures are of value as fertilizers. The importance of this cannot be overestimated.

Making nitrogen available for plant use.

Perhaps the most important phase of this decomposition of organic matter is that which concerns the element nitrogen. Nitrogen is one of the elements most necessary to plants. The great demand for it is shown by the high price of fertilizers that contain it. Yet it is the one element that can be added to soil without spending a cent on fertilizers. The method of doing this, by the use of an occasional leguminous crop which is turned under before setting out the next crop, is a system of agriculture that is dependent upon the activities of bacteria. Bacteria help the legumes obtain nitrogen from the air, and bacteria make the organic nitrogen of green manures available to plants.

This organic nitrogen becomes available by a complex process in which many different kinds of bacteria take part. There are two distinct steps in the process: the first known as ammonification because it results in converting the organic nitrogen into ammonia; the second known as nitrification because it results in converting the nitrogen of ammonia into nitrate, the form most available to plants. Several different kinds of bacteria take part in the first step; but only certain special bacteria in the second. They are all of great importance; but

as they are almost always present in soil, the farmer does not need to pay much attention to them.

Obtaining nitrogen from the air.

The air is so full of this important element, nitrogen, that if plants could use it directly they would never be nitrogen-starved. Unfortunately it exists there in a form unavailable to plants. There are, however, certain kinds of bacteria that can use the nitrogen of the air, and, after they have used it, it becomes available for plant use. Among these bacteria are the ones that grow in the nodules of legumes and help the legumes obtain their nitrogen from the air. The legume bacteria are of great importance because they not only enable a farmer to obtain a good yield of legumes on nitrogen-poor soil, but also enrich the soil with nitrogen for future crops.

Making other elements available for plant use.

It is also known that bacteria are active in decomposing rocks containing phosphorus and potassium, and that they help make these elements avilable; but the process is not yet fully understood.

Other kinds of bacteria.

There are still other kinds of bacteria in the soil, more numerous than any of those just mentioned. They are undoubtedly of great importance; but their functions have not yet been discovered. Because they are so numerous and their activities still unknown, the Station is carrying out an extensive investigation of them.

Bacteriological soil analyses.

Until it is possible to recognize these bacteria in all cases and until it is known what they do, a bacteriological analysis of any particular soil is of no practical value. A mere statement of the kinds of bacteria present in a sample of soil is of no use to the farmer unless it is known what these bacteria do and how to stimulate their growth, if useful, or to prevent it, if harmful. The object of the work in progress at the Station is to obtain the knowledge necessary to make an analysis of this sort of practical value.

Detecting the presence of of legume bacteria.

It is often important to know whether a soil contains the bacteria that produce nodules on legume roots; and they happen to be among the few bacteria that can be detected in soil by laboratory tests. Such tests would often be of practical value except that there are several varieties of legume bacteria, and each variety is able to produce nodules upon only a few kinds of legumes. Unfortunately the only method yet known to distinguish between these different varieties of the bacteria is to grow legumes in their presence and see which kind bears nodules; and such a test takes time. There is no quicker way for a farmer to learn whether his soil contains the bacteria adapted to any particular legume than to plant that legume on it and observe whether nodules appear on the roots.

Testing commercial cultures of legume bacteria.

Quite frequently a sample of some commercial culture of legume bacteria is sent to the Station to learn whether it contains the bacteria in question. It is possible to make a laboratory test taking about ten days that shows whether or not bacteria of this general sort are present; but such a test does not show which variety of bacteria they may be; and would be of no real value to either farmer or dealer. The information of real value to either of these men is whether the bacteria are adapted to the particular legume named on the label and whether they are actually capable of producing nodules on this legume. This information can be obtained only by experiments for which the Station has not the facilities and which ordinarily require too much time to be of use to the man desiring the information.

The future.

The chief service of soil bacteriological studies to the farmer in the past has been in connection with the bacteria that produce legume nodules. There is every reason to believe that in the future they will be of practical value in many other ways. When the kinds of bacteria in the soil can all be recognized, when their functions are understood, and when it is known how to stimulate the useful and suppress the harmful kinds, a bacteriological analysis of a soil will undoubtedly be a most valuable method for determining the kind of treatment to give it.