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MICROORGANISMS OF THE SOIL

Soil Bacteria -- How They Help Plants Grow

Bacteria are minute forms of life that live abundantly in healthy soils. They, along with millions of other living organisms such as fungi, algae and protozoa, make up the life in the soil.

Each particle of soil under our feet is a little world of its own. Over each particle's surface is a thin film of water, teeming with many types of microbes. Bacteria are some of the smallest forms of these microorganisms. They are so small and complex that science still has a great deal to learn about them.

Although little is known about their anatomy, much is known about their effect on all living things. Only recently have we realized how dependent quality crops are on the bacterial population of the soil. Without soil bacterial activity it would be useless to dung crops, to try to improve land by tilling a legume cover crop into the soil or any attempt to fertilize soil. There is no dispute over the prominent role soil bacteria play in soil fertility. The types discussed can thrive either in the presence of air (aerobic) or if air is excluded (anerobic). They fall into several major classes with hundreds of varieties in each class.

The first major type of bacteria we're concerned with are decomposition and decay organisms which live on dead plant and animal remains in the soil. They are called saprophytic bacteria. Their function is very important in the process of soil building. As they decompose organic debris nitrogen, carbondioxide and many minerals are liberated. Stems, leaves, roots, and virtually all vegetable and animal matter is turned into humus vital in maintaining soil condition and fertility.

> Simple carbohydrates and many proteins are decomposed by many soil microorganisms, but cellulose and nucleoproteins are difficult to decompose and relatively few soil organisms can do it. Cellulose may be digested by members of the genera Cellulomonas, Cellvibrie, Clostridium, Pseudomonas, Actinomyces, some molds, etc. This decomposition of cellulose which is found as plant residues in large quantities in soil, results in the production of acids which react

> with insoluble material rendering them available as plant foods. . . Cellulose ferments are used in waste disposal, water purification, and soil humus formation.
> --Bryan and Bryan, Bacteriology, pp. 114-115.

Another major type, nitrogen-fixing bacteria, convert atmospheric nitrogen to compounds utilizable by plants. Nitrifying bacteria also convert ammonia to utilizable nitrates. Without soil microorganisms continually at work replenishing the supply, plants would soon totally deplete nitrogenous substances from the soil. The mutually beneficial (symbiotic) nitrogen-fixing bacteria (of the genus Rhizobium) live in nodules on the roots of various leguminous plants. Legumes help replenish soil with this type of bacteria. The aerobic Azotobacter and the anaerobic Clostridium are non-symbiotic nitrogen-fixing bacteria. Nitrification or conversion of ammonia to nitrates occurs in two steps accomplished by autotrophic bacteria of the genera Nitrosomonas, Nitrosococcus and Nitrobacter. (Ibid. pp. 104-109).

Disease fighting microorganisms of the soil exert a natural biological control (antibiosis) on many of the parasitic organisms responsible for soil-borne diseases of plants. Antibiosis is accomplished in several ways. Sometimes they produce destructive toxic materials or antibiotics such as chloromycetin from the soil-borne Streptomyces venezuelae useful against brucellosis, typhoid and other microbial diseases (Bryan & Bryan, Bacteriology, p. 13). Some produce antibiotics to combat fungus diseases, nematodes, root rot and insects. In still other instances nonparasitic disease fighters compete more successfully for oxygen and nutrients and thus cause suffocation or starvation of parasites. "When fresh organic material, such as green manure, is added to the soil the nonparasitic microorganisms multiply rapidly, and whatever ill effects they exert on parasites are intensified" (Soils, 1957 Yearbook of Agriculture, p. 338).

A culture containing many varieties of these types of microorganisms is available on request from the Ambassador College Agriculture Department, Big Sandy, Texas. If a farmer does not have enough manure and compost filled with bacteria to spread on his land to restore bacterial life in the soil, a special culture of soil organisms will be very beneficial. The culture may be added for speeding the restoration of soil balance and fertility for growing abundant disease-free crops.

In summary, soil bacteria benefits you by (a) overcoming and breaking down harmful chemical residues from previous wrong practices, and (b) encouraging higher soil life such as earthworms which will create new balanced soil. Once you have the needed soil bacteria--continue adding plant and animal residue to feed and keep the soil life cycle going. Simple methods of farming, incorporating the life designed to help nature work for you, reap rich dividends.

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GUIDELINES FOR GROWING MICROORGANISMS OF THE SOIL

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Instructions upon receiving one pound of bacteria material:

1. Add material to one gallon of water.
2. Add one pint (or about 3/4 lb.) of yeast or bloodmeal. (Do not use the yeast commonly sold under the name brewer's yeast. It has been heated to remove the bitter flavor and in so doing the yeast cells are killed.)
3. Add one-half pint (one lb.) of sugar or molasses. This feeds the bacteria allowing them to multiply.

Care

1. Let the mixture set about four days at around 70° F. It will multiply best at this temperature but will not die at another temperature.
2. After four days, add this to 50 gallons of water. Use a wooden or cement container. A plastic garbage container will also be fine.
3. Add about five pounds bloodmeal or natural yeast and five pounds of sugar or molasses. Be careful you do not over-feed the bacteria. Extreme over-feeding causes the culture solution to sour or form a thick scum on its surface. The scum reduces the availability of air and may cause the culture to die. Under-feeding may cause starvation.
4. Let the mixture set until bubbles begin rising. After 30 hours or longer (can be up to 7 days) depending upon the temperature, it is ready for application. The bacteria should be re-fed in about three weeks if not used. You can save a gallon if you wish to begin a new batch. The above is simply a feeding guide. Larger quantities may be made by increasing items proportionately. With proper care, the liquid culture teems with bacteria. Solid matter at the bottom of a container need not be saved for starting a new quantity. When spraying the culture, just pour the liquid off the settled material and apply.

Water varies in different areas in regard to acid and alkaline content. The bacteria may die in highly acid conditions. We have found ground limestone acts as a buffer to help control the pH or acid balance. If you have trouble keeping your culture alive, we recommend you add one-half pound of limestone to 10 gallons of water. In case you need to replace your bacteria, we can mail you another starter culture with a small amount of yeast for your first gallon for $1.50 (prepaid).

To check if the bacteria is alive it may be observed under the microscope, or if lacking a microscope, one might try the following:

1. Put a drop on a glass slide. If the droplet has some body to it and does not spread out flat, it is most probably teeming with bacteria. (You may compare it with a regular drop of water.)
2. After the mixture has set for 30 hours to a week (depending on the temperature), bubbles will rise. This is a sign of life.
3. If the mixture is cloudy and moving, it is a sign of life.
4. A noticeable odor is also a sign of an active culture.

We have completed numerous tests determining how long bacteria live in the package in which sent out. After many months in a hot, dry place, the bacteria will live and remain active. Though the carrier material may become dry, when water is added, the bacteria is fine.

Bacteria can be kept alive throughout the winter months.

Some keep an active liquid culture of it in their basement, covering the container to prevent freezing. If one does not need an active culture for application to plants or indoor gardens, a small amount may even be kept in a freezer. The culture will also remain alive, though dormant, if frozen in an organic carrier material. You need not be concerned about the condition of the bacteria outdoors as its activity simply slows down during the winter months.

When should the bacteria be applied?

The bacteria may be applied at any time, though a warm, moist soil with plenty of organic matter will produce best results. It is good to disc the soil following application; however, we have applied it with helpful results on crops, such as wheat and oats, after they were several inches high.

Application

Bacteria may be used in fields at the rate of 20 to 30 gallons per acre with a regular sprayer (garden rates - ½ gallon per square yard). It is helpful to disc it in. On pasture land, apply when the soil is wet or apply more gallons of water to the mixture per acre. It may also be applied by letting it drip into irrigation water when irrigating crops.

The bacteria may be applied on gardens, shrubbery, flowers, and lawn with a sprinkling can or small hand sprayer. Be sure your sprayer is clean and free of insecticides. If in doubt about it being clean, baking soda and warm water solution is very effective in clearing and neutralizing the sprayer. Agitate this solution in your sprayer about 15 minutes and drain it out completely. After this, the sprayer is ready for use.

If you have lifeless, sterile soil, applying soil bacteria (as well as organic matter on which bacteria can feed) will give you a resurrection and rejuvenation of topsoil. Following the process outlined will help dead soil become alive. It is one of the first steps in the restoration of poisoned lifeless soil. Soil bacteria represents only one facet in maintaining a balanced and living soil, but it is basic for right agriculture.

F O O D F O R B A C T E R I A G R O W T H

The Use of Yeast and Bloodmeal in Soil Bacteria Reproduction

We have found three types of material which may be purchased as food for culturing soil bacteria. They are bloodmeal, natural livestock yeast, or non-debittered brewer's yeast.

One of these products will generally be available at local feed stores. You should plan ahead if you desire or need many pounds of yeast or bloodmeal for culturing large quantities of soil bacteria. Make sure the food source is available and adequate before you begin.

Natural Livestock Yeast

Natural livestock or poultry yeast is becoming increasingly popular as a feed supplement. It is also an excellent food for culturing soil bacteria. If you use this feed supplement type yeast, the quantity of yeast fed the culture may be cut down by one-fourth because of the more active enzymes.

Bloodmeal

Through experiments at Big Sandy we have found that bloodmeal is a most satisfactory food for growing bacteria. It is a high protein organic material containing many enzymes. It does an excellent job and in some parts of the United States may be more readily available than yeast. It is somewhat cheaper and may be purchased at almost any feed store.

Non-debittered Brewer's Yeast

Natural yeast contains many enzymes and unidentified vitamins needed by living things. Brewer's yeast also contains many enzymes if it is not debittered. It is a natural brewer's yeast after it has fermented grain.

In drying or debittering the yeast it is commonly heated sufficiently (pasteurized) to kill the yeast cells and destroy the fermenting power. After this it may be used as a food supplement. Without this debittering or pasteurization process, fermentation might be produced in the digestive tract, causing severe indigestion if used as a food.

Debittered yeast is the commonly purchased dried brewer's yeast which has had the life taken out of it. Some types of yeast cells cause a bitter flavor and so they are killed by heat. Often the yeast is also fortified with vitamins. Because a high heating process kills the cell life, the yeast will not work in rapid reproduction of your bacteria culture for lack of the needed enzymes. Therefore, non-debittered brewer's yeast works best. Large quantities generally cost 15-30¢ per pound. One source from which you may order non-debittered brewer's yeast is: St. Louis Brewer's Yeast Corp., Box 65, St. Louis, Missouri, 63119.

Enough yeast is included with the initial package of bacteria culture for you to grow and feed five gallons of active soil organisms if you only need a small quantity (i.e. for a flower bed or garden plot). After adding the bacteria carrier material and the yeast to the first gallon of water (as per instructions) an additional four gallons of water may be added and after a few days you will have liquid bacteria culture to cover about 100 square feet. Please check in your local area if you need additional yeast or any of the above mentioned materials for culturing or reproducing large quantities of soil bacteria.

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