Ultra Gro Plant Food
Quality and Performance Creating Value

GROWERS BULLETIN

ULTRA GRO PLANT FOOD COMPANY

Microbes and Soil Fertility

Dr. G.S. Sidhu – Department of Biology
California State University Fresno, CA 93740

Microbes are absolutely essential for the survival of higher forms of life including humans, animals and plants. Without microbes the earth would become a huge 'waste dump'. They do the house cleaning job and at the same time manufacture very useful bio-products that are beneficial in the fields of medicine and agriculture. For example, they produce antibiotics to combat bacterial infections and carry out the process of fermentation to yield wine and cheese. In agriculture, microbes decompose organic matter and produce enzymes that help plants to assimilate macro and micro nutrients from the soil and commercial fertilizers.

Soil Types and Microbial Activity

If you cut out a large wedge of soil and examine its' profile, a number of distinct vertical layers or horizons become visible.

Table 1

(1) **Top Horizon**: It is composed of decaying organic matter (dead plants, animals and microflora) often called Humus. In this horizon the microbial activity is intense.

(2) **Second Horizon**: It contains decomposed organic matter where aerobic microbial activity is at its' peak.

(3) **Third Horizon**: This zone is made up of sub-soil containing minerals and leached Humus. It has no organic matter, therefore, anaerobic microbes live here.

(4) **Fourth Horizon**: It is the soil base containing bed-rock with no microbial activity.

Microbial Population

If you gather soil samples from different soil horizons and determine their microbial population in the laboratory, you will find variable number of different types and kinds of microbes (Table 1). One gram of soil contains tens of millions of microbes. Approximately, 75-95 percent of the total microbial population is found within the upper 10 centimeters of soil (see Table 1). This is due to the presence of organic matter on which the microbes feed and decompose. But the number is low at the very surface of the soil because of exposure to ultraviolet radiation.

Rhizosphere and Microbes

The rhizosphere, the region of soil closely surrounding the plant roots, has the most dense population of microbes. This region contains, approximately, 10 billion bacteria per gram of soil which is five to twenty fold greater than the root-free-soil. In this region plant roots and microbes interact and help each other to flourish. Plants excrete sugars, amino acids and vitamins for the microbes. Microbes, in turn, produce organic compounds, enzymes and hormones that metabolize food for plants. Particularly, bacteria help plants to take up macronutrients (N, P, K, Ca, S) and micronutrients (Zn, Fe, Mn, Mg, B, Mo, Co, Cu). Figuratively, you can visualize that microbes are 'cooks', rhizosphere is a 'kitchen', organic matter is 'groceries', microbial enzymes are cooking 'recipes' and various nutrients are 'meals'. The complex compounds from the organic matter are broken down by microbes into simple ionic elements (dishes) that plants assimilate into their body structure. Before assimilation various elements go through cooking cycles called nitrogen cycle, carbon cycle, sulfur cycle and phosphorus cycle. At each juncture of a given cycle, a given microbial species plays a definitive role.

Rhizosphere is also the place where atmospheric nitrogen is fixed by *Rhizobium* into the root nodules of leguminous crops. In this zone, 'mycorrhizae' fungus

transport nutrients (phosphorus) from soil to plant roots. Rhizosphere also contains pathogens that cause diseases. But some beneficial bacteria compete with pathogens for nutrients and also kill them by producing toxic compounds. Rhizosphere is a place of great microbial activity which should be kept healthy either by natural manipulation of soil microflora or by artificial inoculations of beneficial microbes. As a well known microbiologist, Jacob Lipman says, "a soil devoid of microorganisms is a dead soil".

Artificial inoculations of beneficial microbes have gained importance in recent years due to intensive cultivation that requires the usage of chemicals such as pesticides (fungicides, insecticides, nematicides), herbicides and fumigation. These chemicals destroy soil microflora which needs to be replenished either by cultural practices such as tillage and with cover crops or by artificial inoculation of cultivated microbes.

Main Groups of Microbes

Soil contains five main groups of microorganisms. These are bacteria, actinomycetes, fungi (molds), algae and protozoa. Bacteria, actinomycetes and fungi are the most abundant groups in the rhizosphere. Among bacterial species *Pseudomonas, Bacillus*, and *Rhizobium* species are very important. *Actinomycetes* are also a kind of bacteria that produce slender branched filaments like fungal mycelium.

Role of Microbes in Plant Nutrition

Pseudomonas Species: These species are aerobic (breath oxygen like us) and are most abundant in the lively rhizosphere. They metabolize Nitrogen, Potassium, Phosphorus and Manganese from organic and inorganic materials and make them available to the plants.

Bacillus Species: These are spore forming aerobic species. Bacillus also help in the metabolism of Nitrogen, Phosphorus and Manganese compounds for the plants.

such as peas, lupine, alfalfa etc. *Rhizobium* species are also abundant in the rhizosphere.

Rhizobium Species: These are aerobic bacteria that fix atmospheric nitrogen in the roots of leguminous crops such as peas, lupine, alfalfa etc. Rhizobium species are also abundant in the rhizosphere.

Actinomycetes: These Bacteria produce slender branched filaments like fungal mycelium. They are aerobic feeders on complex molecules like celluloses, sugars, polysaccharides, lipids, chitins, and proteins. *Actinomycetes* make other microbial work easy by splitting complex compounds into simple molecules. They improve the structure and texture of the soil and impart a pleasant musty odor reminiscent of freshly turned soil. *Actinomycetes* also produce antibiotics that keep in check some bad microbes.

Biocontrol Activities of Microbes

There is an intense competition among microbes in the rhizosphere. In this process they learn to reduce the number of each other by competition or by producing poisonous compounds such as antibiotics or toxins. Some of the relevant examples are given below.

Bacterial Species	Fungal / Pathogens Controlled
Pseudomonas Species	Pythium, Phytophthora, Fusarium, Sclerotium, Ceratocystis
Bacillus Species	Sclerotium, Rhizoctonia, Nematodes, Insects.
Actinomycetes	Pythium, Phytophthora, Rhizoctonia

Microbes and Soil Treatment

Soil can be fertilized along with the microbial 'inoculants'. New blends of liquid fertilizes make it possible to add useful and relevant species of bacteria. Species that can make the nutrients readily available to the plant by decomposing organic matter and by metabolizing the commercial fertilizers. Importantly, certain bacterial species can be added also to the fertilizers that control diseases. Microbes are always present in the soil, however, their regular destruction by agricultural chemicals make 'inoculants' very important.

Numbers Game

Of course, soil contains microbes. But their number is reduced by the harsh activity of so many chemicals

Inoculants

Useful species of bacteria are grown under controlled condition from original 'seed cultures'. Seed cultures are maintained and prepared under strict laboratory conditions using standard microbiology techniques. Large amounts of various bacterial cultures are grown in tanks filled with commercial 'nutrient media' which is inoculated with original seed cultures. Various cultures are then mixed with appropriate liquid fertilizers or soil treatments before packing.

currently used on agricultural soils. Artificial inoculation is a sure means of increasing the number of useful bacterial cultures. One bacterial cell becomes one million in ten hours under laboratory conditions.

Let us suppose that under soil conditions, one bacterial cell becomes on million in twenty-four hours. This will enormously increase the number of useful bacteria in the soil which will enhance its' useful effect merely by the 'numbers game'.

TABLE 1: DISTRIBUTION OF MICROORGANISMS IN SOIL

Depth	Organisms per gram of soil			
CMS	Aerobic-Bacteria	Anaerobic-Bacteria	Actinomycetes	Fungi
3-8	7,800,000	1,950,000	2,080,000	119,000
20-25	1,800,000	379,000	245,000	50,000
35-40	472,000	98,000	49,000	14,000
65-75	10,000	1,000	5,000	3,000
135-	100	400		3,000

*from Martin Alexander - Introduction to soil microbiology (2nd Edition), 1977.

1043 S. Granada Dr. Madera, California 93637-4801
Phone (559) 661-0977 • www.ultragro.net