PLANT NUTRITION TODAY

2018 ISSUE 3, NO. 7

PLANT & MICROBE INTERACTIONS ARE IMPORTANT TO HEALTHY SOILS AND HIGH YIELDING CROPS

Legume root nodule/root nodules, where needed nitrogen is converted to ammonium (NH_4^+) from airborne nitrogen gas (N_2) by Rhizobia bacteria.

Dr. Tom Jensen
Director, North American Program
tjensen@ipni.net

In agricultural systems we often use the term "agroecosystem", which is a modification of the more general term "ecosystem." "Ecosystem" is often used to describe natural systems, such as a forest ecosystem, a wetland ecosystem, or a grassland ecosystem, but a concise definition is *"a community of interacting organisms and their physical environment."* Agroecosystems are indeed ecosystems, but are managed by humans to produce harvested products such as food for humans and livestock, and also other fiber and biofuel products used by society. We most commonly notice crop plants present in an agroecosystem. Plants are key to harnessing sunlight energy through photosynthesis and storing energy in sugars and biochemical energy bonds, later used to grow the plants themselves, and these plant products and compounds, such as proteins and starches, are subsequently used as food sources by other organisms in the ecosystem.

It is possible to grow plants in a water solution containing appropriate concentrations of nutrient salts, called hydroponic or soilless plant culture, but by far the majority of cropping systems consist of plants grown in fields of soil. Soil's three basic components are: 1) fine mineral particles of sand, silt, and clay (55%); 2) soil pores filled with about half water and half air (40%); and 3) organic matter consisting of decaying plant and other dead organism residues and living organisms (5%). The living organisms include those you can see such as insects and worms, but the unseen to the eye organisms are called microbes, consisting of bacteria, fungi, and other single cell organisms.

PLANT NUTRITION TODAY is a monthly publication of compiled scientific information developed by the International Plant Nutrition Institute (IPNI). Website: http://www.ipni.net/pnt

"There have always been mutually beneficial interactions between crop plants and soil microbes, but research has helped us to understand the specific mechanisms of action."

Research has shown that soil microbes interact with plants, and this interaction is vital to having healthy crop plants, and a healthy group of soil microbes. This results in soils that continue to grow crops now and in the future. The bacteria and fungi are key in the decomposition of previous crop residues, dead soil macro animals (e.g., insects and worms), and other organic residues. This decomposition is an important part of the cycling of plant nutrients within the soil.

The microbes present within a few millimeters of plant roots are in a zone called the rhizosphere, defined as *"soil that surrounds and is influenced by the roots of a plant."* The roots of plants exude compounds such as photosynthetic sugars and other plant products that are used as food sources by the microbes. These plant root exudates have been estimated to be up to one third of total carbon absorbed and fixed into plant compounds by plants (Glick, 2012).

Soil microbes, and especially the rhizosphere microbes help plants in numerous ways:

1. They help dissolve and supply some plant nutrients that are low in availability to crop roots. For example, some types of soil fungi are capable of converting low solubility phosphorus-containing compounds (e.g., calcium or iron phosphates), into soluble phosphate ions ($H_2PO_4^-$ and HPO_4^{2-}) needed and used by plants.
2. Some rhizosphere bacteria produce compounds, including plant hormones, that promote and maintain crop growth, especially under environmentally stressful conditions (e.g., moisture, heat or cold stresses). These microbes are called Plant Growth Promoting Rhizobacteria (PGPR).
3. Some groups of soil microbes produce antibiotics, biocides, and compounds that reduce the populations of crop pests (e.g., insects, and fungal or bacterial pathogens).
4. The physical presence of large numbers of rhizobacteria around crop roots can act as a physical barrier to root infection by crop disease microbes.

There have always been mutually beneficial interactions between crop plants and soil microbes, but research over the past number of decades has helped us to understand the specific mechanisms of action. In some instances, beneficial microbes can be isolated from soils generally, or specifically from the rhizosphere, grown and increased in numbers exponentially under controlled growth conditions, and commercial inoculants can be formulated. A well understood and long used bacterial inoculant, *Rhizobia* species, are used with many legume crops (e.g., field pea, lentils, and soybeans), to facilitate root hair nodulation and symbiotic nitrogen fixation. It is anticipated that in the future there will be an increasing number of microbial inoculants, many of them in the plant growth enhancing category, but also new biological inoculants to reduce crop pest damage to crops in place of synthetic chemical biocides.

The next time you see a field with a healthy crop, remember that the soil microbes interacting with the crop plants are a vital part of the agroecosystem.

References

Glick, B.R. 2012. Scientifica Vol 2012, Article ID 963401.

IPNI International Plant Nutrition Institute

5550 Triangle Parkway, Suite 300, Peachtree Corners, GA 30092-6515 U.S.A.
Phone: 770-447-0335 | Fax: 770-448-0439 | www.ipni.net