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"From the Ground Up"

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News and Information on natural resource management in western North Dakota

Fertilizer and Soil Health

Story and photo by Jon Stika

In an article recently published in the No-Till Farmer magazine, "Forget What You've Learned About Applied Nitrogen Rates", Ron Perszewski elucidates on the role of soil as the source of plant nutrients, not commercial fertilizer.

In the article, Mr. Perszewski discusses nitrogen fertilization with Richard Mulvaney, a Professor of Soil Science at the University of Illinois. Mulvaney points out that; "By the time we get to the end of the growing season, for most soils in the Midwest, the corn has taken up the majority of its nitrogen from the soil, not the fertilizer. If the soil is that important as a source of nitrogen, it stands to reason that we ought to get some good yields without fertilizer – and we often do."

Mulvaney points toward crop rotation diversity and soil organic matter, major factors that contribute to soil health, as reasons why some soils do not respond significantly to applied nitrogen fertilizer. Inversely, degraded soils low in soil organic matter responded the most to application of nitrogen fertilizer. Mulvaney summed up the discussion by saying; "Clearly, there's a need for something better than the proven yield method to make nitrogen recommendations… but that will only come when we begin to account for the soil."

In a presentation at the 2011 Soil Health Workshop held in Bismarck, Jim Hoorman, Extension Educator, Cover Crops & Water Quality of Ohio State University Extension stated that "Only 33% of nitrogen from fertilizer ends up in corn… the rest comes from [soil] organic matter." Hoorman went on to say that "[Soil] Microbes process 90% of the energy in the soil". Soil organic matter often makes up less than 5% of the soil by weight, but is responsible for approximately 90% of the functions essential for plant growth such as nutrient and water supply.

The capacity of the soil to provide essential plant nutrients when the soil is managed to improve microbial habitat is also evidenced in the recent revision of nitrogen recommendations for spring wheat production in North Dakota. The new recommendation allows for a 50 pound per acre nitrogen credit for land that has been continuously no-tilled for at least five years.

In This Issue:

Kalen Hartel points out a turnip from last year's cover crop on his Grandfather's ranch near Watford City, ND early this spring.

Each of these examples point toward a greater understanding of how improving soil health contributes to increased crop production efficiency and profitability. Soil management that strives to achieve less soil disturbance, more crop diversity, living roots in the soil as much as possible and keeping the soil covered all the time will improve soil health and reduce the need for inputs such as fertilizer and pesticides. A no-till cropping system, diverse crop rotation and multi-species cover crop are good management approaches that can be implemented to improve soil health.

Soil Microbial Diversity and Plant Health

Story and photo by Jon Stika

Recent research by U.S. Dept. of Energy scientists at the Berkeley National Lab and the Netherland's Wageningen University have demonstrated that plant disease suppression in the soil is often produced by combinations of soil microorganisms rather than by only

one species. In research conducted with Rhizoctonia fungus that attacks sugar beets, the scientists found that the sugar beets provided up to 20% of the carbohydrates captured through photosynthesis to groups of soil microorganisms that suppressed the disease-causing fungus. Gary Anderson, one of the Berkeley researchers, noted that; "We now see that the complex phenomenon of disease suppression in soils cannot simply be attributed to a single bacterial group, but is most likely controlled by a community of organisms".

A strand of soil fungi (1000x) from soil in Southwest North Dakota

This research emphasizes the importance of crop rotation and cover crop diversity that fosters biologic diversity in the soil. A diverse soil food web would lend itself to a greater potential for not only disease suppression, but nutrient cycling, accumulation of organic matter, in addition to soil aggregate formation and stability. The diversity of microorganisms in the soil is directly proportional to the diversity of plants growing in that soil. A diverse crop rotation and a diversity of species in a cover crop mix are management strategies that can help increase soil microbial diversity.

Infrared Sheds Light on Beneficial Microbes *USDA-ARS*

Infrared spectroscopy can quickly spot beneficial fungi on roots in soil, according to Francisco Calderon, a soil scientist at the Agricultural Research Service Central Great Plains Resources Management Research Unit in Akron, Colorado. This type of spectroscopy has become established practice for quick and reliable analysis of grain and forage quality, as well as other agricultural uses, thanks in part to ARS scientists.
But Calderon's idea to use it for detecting fungal-root associations in soils was never explored before. The ability to quickly analyze field soils for these beneficial fungi, called "mycorrhizae," would allow scientists to judge which crop rotations or other farming practices increase the fungi. This is important nationwide for improving crop yields and is especially critical for semiarid areas like those found in the Central Great Plains.

Mycorrhizal fungi live in a symbiotic relationship with plants. The fungi help plants by taking up soil nutrients and water that would otherwise be difficult for plant roots to reach. In exchange, the fungi feed on the carbon sources that plants provide.
Calderon says the test could simplify, accelerate, and improve the objectivity of measurements of mycorrhizae in root samples, compared to the standard method of visual scoring through a microscope.
It may also be more accurate than the newer technique of analyzing fatty acids in mycorrhizae on roots. Also, he says, "Since there is no destruction of the samples, researchers can perform other analyses on the same samples after this test is done."
Calderon developed the technique with soil scientists Veronica Acosta-Martinez at Lubbock, Texas, and Merle Vigil at Akron. Other ARS colleagues in this study include microbiologist David Douds at Wyndmoor, Pennsylvania, and chemist James Reeves at Beltsville, Maryland.

They measured the reflectance of infrared light from dried, powdered carrot root samples. They found that the cell wall chitin and fatty acids in mycorrhizal fungi have distinct spectral signatures, absorbing infrared light at different wavelengths than standard chitin, fatty acids, and nonmycorrhizal roots. The researchers accomplished this using both mid-infrared and near-infrared spectroscopy.
Next, they plan to study the spectral properties of other crop fungal species to see whether there are universal spectral signatures for this important group of organisms.

"Infrared Sheds Light on Beneficial Microbes" was published in the November/December 2010 issue of *Agricultural Research magazine*.

The Cover Crop Tool

Story and photo by Jon Stika

A good carpenter or mechanic has many tools in his/her toolbox. Knowing how and when to use each tool separates the master from an apprentice. Land managers also have many tools to choose from to help them be productive and sustainable. One very versatile tool in the land management toolbox is cover crops. Because soil is a biologic system, cover crops (plants) are a natural fit to help increase soil function.

In western North Dakota, 2008 brought a withering drought. In 2011 we are experiencing late/prevented planting and floods due to wetness. By improving water infiltration, permeability and conservation, cover crops can be an effective tool to build soil health and manage moisture during droughts, floods, or normal (whatever that is) weather conditions.

During periods of extreme precipitation cover crops can:

- Use water that is in excess of the soil's ability to store it.
- Increase the soil's aggregate stability to increase infiltration and reduce ponding of water on the soil surface.
- Increase the porosity of the soil to increase permeability so water can move through compacted soil and reduce surface soil saturation.
- Recover nitrate nitrogen that may have leached deep into the soil and retain it in cover crop residues until they decompose.
- Feed soil microorganisms to cycle nutrients and feed the next crop.
- Use excess water that might contribute to saline seeps.
- Provide supplemental forage for livestock.
- Increase plant species diversity to improve soil health and increase crop nutrient cycling.

During periods of drought cover crops can:

- Use only the water that is available to them while increasing the soil's ability to capture and store water over winter for use by the next crop.
- Increase the soil's aggregate stability to increase infiltration to allow capture of incoming precipitation when it occurs.
- Increase the porosity of the soil to increase permeability so water can move through compacted soil and be stored in the subsoil.
- Recover nitrate nitrogen that may have leached deep into the soil and retain it in cover crop residues until they decompose.
- Feed soil microorganisms to cycle nutrients and feed the next crop.
- Keep the soil covered to reduce evaporation and salinization of the soil surface.
- Provide supplemental forage for livestock.
- Increase plant species diversity to improve soil health and increase crop nutrient cycling.

Both surviving and decomposing turnips plus crop residues on a field of the SW ND Soil Health Demonstration in spring of 2011.