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DOES FERTILIZER NITROGEN HELP OR HARM SOIL BIOLOGY?

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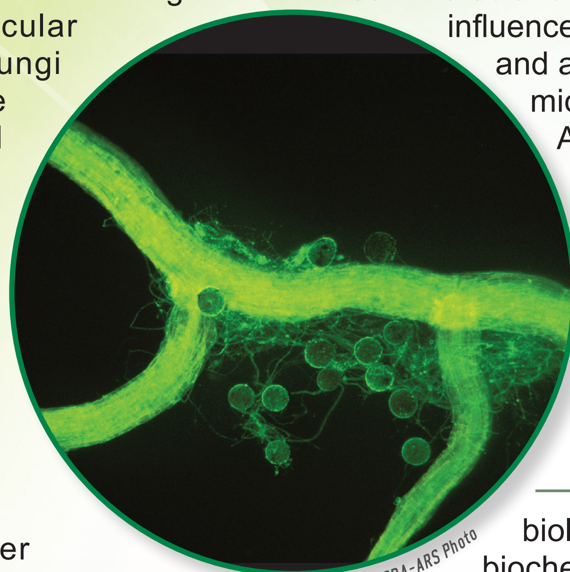
Many farmers and their advisers have learned that reduced tillage (including no-till) and continuous soil vegetative cover favor the presence and activity of beneficial fungi termed arbuscular mycorrhizal fungi (AMF). These fungi are well recognized for their symbioses with the roots of corn, wheat, soybean, and many other major crops—including cover crops—and their ability to enhance root acquisition and uptake of phosphorus, water, and micronutrients.

In addition, AMF contribute a substance called "glomalin" in the crop rooting zone that favors the development of stable soil aggregates; enhancing the development and maintenance of soil porosity, soil structure, water infiltration, and resistance to erosion. Recent science has shown that AMF obtain a sizeable amount of nitrogen (N) from decomposing organic matter; and they also obtain inorganic N in direct competition with plant roots. Changes in tillage practices, crop systems and rotations, the addition and removal of soil carbon (i.e., soil organic matter), and the addition of manures, crop residues, and fertilizer can affect the total soil microbial biomass and also influence the distribution and activity of different microbes in addition to AMF.



S. Wright/USDA-ARS Photo

Glomalin, the substance coating this microscopic fungus growing on a corn root, can keep carbon in the soil from decomposing for up to 100 years.

Soil chemical and physical properties affect soil biology, microbiology, biochemistry, and ecology ...and vice versa. With the emergence and sophistication of tools like DNA extraction, fatty acid markers, specific enzymatic analyses, other advanced methods, and computing and analytical tools we are learning much more about the diversity and function of different groups of soil microbes.

Adding N, irrespective of source, affects N availability in soil-crop systems and often shifts the population of microorganisms. Where the N source has a net soil acidifying effect, the fungal population tends to thrive more so than the population of bacteria. Nitrogen and other essential nutrients affect the ability of plants

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to capture carbon dioxide, and return carbon (C) to the soil in residues, roots, and root exudates. Long-term studies from around the world have shown that balanced fertilization to meet crop nutritional needs and soil fertility optimization usually increases soil microbial biomass N and C; as well as soluble N and C, and total soil N and C. Increases in soil N availability as affected by N fertilization at Long-Term Ecological Research sites in Minnesota and Michigan were not found to have any consistent effects on the richness or the diversity of soil bacterial communities. Other long-term work in Nebraska showed that agronomic rates of N had only minimal effects on AMF diversity and colonization of corn roots, but the frequency of different AMF types did vary with the N rate applied.

As the management and protection of soil physical properties improves, and as we enhance the chemical and soil fertility properties for increased crop production and resiliency, we should strive to better understand those management impacts on soil biology and microbiology. There is so much more to learn, especially about the effects of crop and soil management on the important soil functional attributes noted above, and many more processes whose understanding remains in an infant state. For now, we can say that appropriate agronomic N management can lead to increased and replenished soil organic matter levels, sustained beneficial root relationships with AMF, higher yielding and better quality crops, and the potential for sustainable soil health.

K. Stepnitz/Michigan St. Univ. Photo

Aerial view of the KBS LTER Resource Gradient Experiment examining crop response to different levels of nitrogen fertilizer and water; stripes in the field demonstrate effects of different fertilizer rates.

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