

Building better soils

# The miracle of mycorrhiza

*This hidden soil fungus can help farmers feed the world—if they'll let it*

There's a feathery, rarely seen fungus that grows in healthy soils that just might help farmers do the heavy lifting needed to feed those 9 billion people showing up for dinner in a couple of decades. It's called arbuscular mycorrhiza, and it works as a silent partner with plants to enhance their uptake of water and nutrients. Farmers who are focused on improving the quality of their soils are quickly learning to appreciate this miracle of mycorrhiza.

"We're very familiar with mycorrhizal fungi and the important role it plays in our soils," says Ideal, S. D., farmer Bryan Jorgensen. "We know that it grows best in a no-till system with diverse crop rotations and cover crops that keep live roots in the soil. And, we know that it's helping cut our fertilizer bill nearly in half without sacrificing any yield."

**Unlocking soil bank.** Mycorrhizal fungi have a symbiotic relationship with plants. They attach themselves either on or inside plant roots to tap into the sugars and carbohydrates translocated from the plant leaves. In turn, the fungal hyphae (filaments) grow out from the roots and bring water and soil nutrients back.

Because the fungi are about one-tenth the size of root hairs, they contact more of the soil profile (20% versus 2%) and get into tighter spaces to extract nutrients, such as nitrogen and phosphorus, that are locked

►**Left:** Mycorrhizal fungi are seldom seen, but the telltale signs include a healthy "cottage cheese" soil structure, a thriving root system, and vigorous plant growth. Strands of the fungi can total more than a mile in just a handful of soil.

*By Larry Reichenberger*



► **Above:** James Hoorman says fungi and other microorganisms make nutrients more available to crops and increase active carbon in the soil.

away there. There are plenty to choose from, says Ohio State University soil quality specialist James Hoorman.

"For each 1% of soil organic matter there are 1,000 pounds of nitrogen, 100 pounds of phosphorus, and 100 pounds of potash in the top 6 inches of soil. In a healthy soil with 4% to 5% organic matter, those nutrients could be worth more than \$3,000 per acre. They become available to plants at

a very slow rate, but it occurs about twice as fast in a healthy soil, thanks partly to mycorrhizal fungi," he says.

Jorgensen says his greatest savings come from phosphorus. "We apply just 10 to 15 pounds per acre with the seed. The rest of our phosphate needs are coming from the soil and that wouldn't be possible without mycorrhizae and other microorganisms."

With his corn yields averaging around 100 bushels per acre, Jorgensen removes about 35 pounds of phosphate per year in grain. "Some people tell us that all we're doing is



ILLUSTRATION: PAUL LANKIE

► **Above:** Mycorrhiza fungi extend a plant's root system to explore more soil and to tap into previously unavailable water and crop nutrients.

mining the soil, but that's not the case. We take both P1 (available phosphate) and P2 (phosphate not readily available) soil tests, and the values are steady or increasing," he says.

USDA Agricultural Research Service soil microbiologists Mike Lehman and Wendy Taheri from the North Central Agricultural Research Laboratory in Brookings, S. D., are studying mycorrhizal fungi at multiple locations.

**W**e're consistently finding that in tilled fields, and even no-till fields that are monocropped and kept clean, there are almost no mycorrhizae. But when cover crops are used to keep live roots growing in the soil throughout the season, the population can double," says Lehman.

"We're also finding that applied phosphorus contributes to the decline of mycorrhizal fungi," adds Taheri. "Only about 20% of what's applied as fertilizer ends up in the plant—the rest is bound up in the soil—so you end up overloading the system to get any benefit. This convinces the plant that it doesn't need the phosphate supplied by mycorrhizae, so the plant rejects it and, without a living root to partner with, the fungus dies." ■