Soil Fungi Are The Root Of All Yields

Invisible to the naked eye, soil fungi bring nutrients and water to roots and fend off disease, too.

By Dan Zinkand, Managing Editor

IF YOU ASKED 1,000 people what part of the plant is responsible for uptake of moisture and nutrients, 999 would say it's the roots, says Larry Simpson, director of education and training for Mycorrhizal Applications in Grants Pass, Ore.

"It's actually the mycorrhizae — or fungi — that live on the roots and in the soil that are the primary means for bringing nutrients and water into the plant through its roots," Simpson says. "The root does anchor a plant, but it's the mycorrhizae that become the main system to absorb water and nutrients from the soil.

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"The roots function as a backup system in case the fungi are lost."

Colonizing Roots. Mycorrhizal fungi are living organisms that naturally grow on the roots of about 95% of all terrestrial plant species, says Simpson, adding that most land plants around the world, including crop species, will form a symbiotic association with these beneficial fungi.

Dr. Mike Amaranthus, Mycorrhizal Applications' chief scientist, isolated and propagated spores of these naturally occurring fungi to create effective inoculants, Simpson says.

The company offers granular, powdered and liquid products containing concentrated mycorrhizae spores.

Simpson says it's important to differentiate between mycorrhizal inoculants and other inoculants used in agriculture.

"Mycorrhizae are beneficial, symbiotic fungi," he says. "*Rhizobium* bacteria are the active organism in an inoculant specifically used on legume crops. They enable legume plants to produce plant-available soil nitrogen from atmospheric nitrogen.

"Mycorrhizae perform functions that are altogether different from those of *rhizobium* bacteria. The most important functions that mycorrhizae perform are improving the host plant's ability to absorb nutrients and water and to resist infection by root-disease organisms."

No-tillers typically inoculate corn, soybean and wheat seed with the company's powder formulation or apply liquid in the furrow, Simpson says.

The powder can be applied with the seed or banded with dry fertilizer.

The powder containing the mycorrhizae spores clings to the seed, especially those of small grains like wheat that have microscopic hairs.

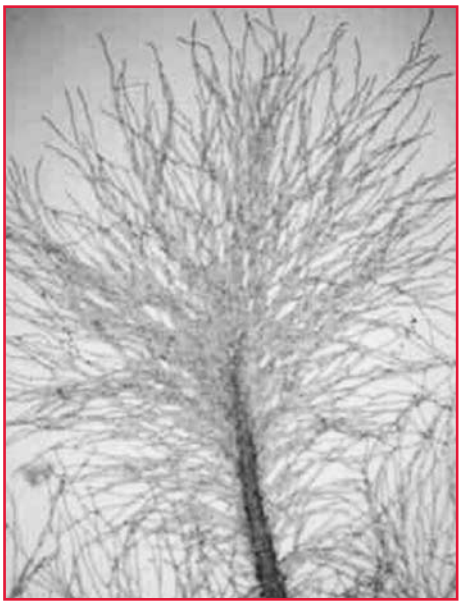
Some no-tillers apply the liquid to seed using a cement mixer or by spraying it on seed as it passes over a conveyor belt, Simpson explains.

Amherst, Wis., no-tiller Matt Hintz and Bickleton, Wash., direct-seeder Steve Matsen have both tried the mycorrhizae inoculant.

Inoculating Seed. In 2009, Hintz ran a trial, splitting his corn planter with untreated seed and corn treated with the granular mycorrhizae inoculant.

The treated corn looked healthier last summer than the untreated corn, says Hintz, who no-tills corn, soybeans and winter wheat.

Hintz was under the gun last fall to finish harvesting before snow made fields



HEALTHY HYPHAE. This microscopic photo of a wheat seedling root shows the mycorrhizal hyphae. Without mycorrhizae, the root system would be limited to the dark tapered structured in the center.

Tillage, Fallowing Fields Do Great Damage To Mycorrhizae

Tillage destroys the hyphal network, which are the abundant, microscopic fungal fibers that permeate the root zone and soil, says Larry Simpson, director of education and training for Mycorrhizal Applications, Grants Pass, Ore.

"Each colonized root cell sends out one hyphae that can branch into many others," Simpson says. "The hyphae are like spiderwebs that typically extend 18 to 24 inches beyond the root.

"Hyphae are the growing filament tissues of the fungus and are part of the mycorrhizal structure. The fungal fibers are enormously smaller than the finest root hair."

Simpson estimates these fibers can be 25 times smaller than a human hair.

While tillage destroys the hyphal network, fallowing fields is the real killer.

"The fungi are fed exclusively by the plant, which shares some of the sugars produced by photosynthesis," Simpson says. "In general, you don't have extended periods of fallow in nature."

impassable, so he didn't weigh corn treated with the inoculant and compare it with the untreated corn.

But Hintz says other no-tillers told him the inoculant increased soybean yields 10% to 15%, or about 3 to 5 bushels per acre.

That's good, he says, considering soybean yields range from 20 to 50 bushels per acre on the light ground in his area.

Hintz says no-tillers who used the inoculant on corn reported yield increases of up to 40 bushels per acre.

The corn treated with the inoculant looked healthier last summer than the untreated corn...

Matt Hintz

"It sounds like the inoculant is working," he says. "It sounds like it's paying for itself."

Treating corn with the inoculant cost about $7.50 per acre, Hintz says.

Choosing Formulations. Hintz worried last spring that the granules would hurt his vacuum planter.

"It seemed like it was a little bit abrasive," he says. "It felt gritty, like a really fine sand."

While his no-till planter didn't have any problems with the dry formulation, Hintz switched to liquid this year to avoid any potential problems.

There are two ways no-tillers can treat seed with the liquid inoculant, he says. They can use a planter box treatment or ask a distributor to treat the seed.

"I think either way will work, but you will have more even covering if someone treats the seed for you," Hintz says. "I plan on using the inoculant again this year.

"I definitely want to do some yield trials with it. I wished I had weighed it last fall."

Washington direct-seeder Steve Matsen tried the inoculant the last 2 years on hard red spring wheat.

He belongs to a group of no-tillers in Washington, Oregon and Idaho that sells its Shepherd's Grain wheat flour to artisan bakeries and university food services that value the environmental benefits of no-till.

Matsen used the granular formulation of the inoculant because it was the least expensive and easy to use.

"I just dropped it in with the seed," he says. "It doesn't activate until the seed is sprouted.

"I thought it did a great job and I think I got a yield bump. But I think I had healthier plants, especially in areas with problem soils. It was an educational process for me. I learned how much mycorrhizal activity we had."

Soil Health. Matsen says that tests on a field he planted with inoculant-treated wheat indicated the fungi had colonized 67% of the roots.

"That is a fantastic rate," he says. "Some fields indicated a presence of unknown mycorrhizae suppressing the applied inoculant. Those fields have recovered on their own."

Matsen is not sure he will need to use the inoculant every year. He may target problem areas in fields, like ridge tops that are lower in organic matter and higher in clay content or have a little higher pH measurement.

"Direct-seeders have become aware of how vital mycorrhizae are," Matsen says. "Dr. Jill Clapperton showed us how crucial they are to a wheat producer.

"No-till enhances the mycorrhizae base in the soil."

Other no-tillers in Shepherd's Grain are considering using the mycorrhizal inoculants, Matsen says.

"We feel good that no-till allows mycorrhizae to repopulate. It's crucial for us to assess the biological health in the soil," he says, adding that no-tillers need to be more sophisticated in analyzing their soil samples and need to know what organism are active in the soil.

Matsen and other no-tillers in Shepherd's Grain are becoming more interested in how soil biology and health can affect the quality and nutritional characteristics of their wheat flour.

"Can we push some nutrients through the crop from the soil?" Matsen asks. "Mycorrhizae fits right in there.

"We know it makes more phosphorus available to the plant from the soil. We believe there's a nitrogen benefit, too."

Farmer Skepticism. Simpson says he understands why many no-tillers may be skeptical about the benefits of using the inoculant containing the concentrated mycorrhizae spores.

"If I knew nothing of this, I would think it's too good to be true," he says. "Farmers tend to be a 'show me' group.

"We encourage farmers to try this on a limited scale — whatever is affordable and measurable. If they are planting a 100-acre field, we like them to try it on 10 acres and compare the results."

Mycorrhizae do much more than pull water and nutrients into a plant's roots.

Simpson says they also serve as a powerful defense against fungal root diseases and are part of the natural immune system of the plant.

"Almost all crops have some level of fungal root disease," he says. "With mycorrhizae, the incidence of fungal root disease is significantly reduced.

"You save money on fungicides."

More Than No-Till Needed For Mycorrhizae To Thrive

No-till by itself doesn't do everything needed to maintain mycorrhizae in the soil.

"In no-till, many growers believe they are perpetuating the mycorrhizae fungus by not performing tillage," says Larry Simpson, director of education and training for Mycorrhizal Applications in Grants Pass, Ore. "But harvesting a crop often precipitates the death of the plant.

"With the top growth gone, the stubble and roots soon die, eliminating the food source for the fungi. Most crop roots don't go dormant after harvest, so even in the case of no-till, you can lose the mycorrhizae."

An increasing number of no-tillers are trying cover crops to keep roots growing in the fall and winter, Simpson acknowledges. But the interval immediately after harvest to seed the cover crop to sustain mycorrhizae is quite short.

"In just 2 to 3 weeks, the roots of the harvested crop remaining in the soil often begin to die before their mycorrhizae can spread to the cover crop," Simpson says. "If you can get new seeds germinating before the roots of the old crop die, then the fungi have a chance to colonize from the existing roots.

"With sufficient mycorrhizal colonization, plants become enormously more efficient at deriving moisture and nutrients from the soil."