

Are We Shooting Ourselves In The Foot With A Silver Bullet?

Glyphosate has changed the face of crop production, but some researchers are concerned about potentially serious problems.

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NO-TILLERS SHOULD NOT be too quick to blame weather and the other usual culprits for struggling, diseased crops.

Don Huber, retired plant pathologist from Purdue University, says untreated micronutrient deficiencies may be to blame. Micronutrients are essential for small grains, soybeans, corn and other crops to tolerate stress, fight disease and produce to their potential.

Huber says the effects of micronutrient deficiencies are showing up more regularly, but it's what's he says is possibly causing those deficiencies that many no-tillers may find surprising — glyphosate.

"Glyphosate works by chelating — or tying up — micronutrients necessary for plant function. It even reduces micronutrient efficiency in glyphosate-tolerant crops," he says. "Just having the gene present reduces efficiency up to 50% for zinc and manganese.

"Add the chemical to that and you get an additive effect on plant physiology, including decreased efficiency, stress and disease resistance."

Most unexpected is that glyphosate is exuded by roots of weeds and glyphosate-resistant crops and lingers in the soil where it can impact crops in following years.

"Glyphosate is not bio-metabolized by the plant. It isn't biologically degradable and it accumulates in the soil and in perennial plants," Huber says. "It immobilizes rapidly because it's a strong chelator, but it's not removed from the system."

Huber says glyphosate can create micronutrient deficiencies in three ways:

1. It reduces micronutrient utilization in glyphosate-tolerant crops due to a combination of the gene and the added effect of the chemical.

2. It lingers in the soil and in perennial plants where it can impact micronu-

trient availability and utilization by future nontarget crops.

3. It changes soil biology by reducing populations of organisms that convert micronutrients to plant-available forms and increasing soil microbes that reduce micronutrient availability.

Because micronutrients are essential for the function of the enzymes that drive metabolism, disease defense and other critical plant functions, no-tillers can't afford to ignore deficiencies.

Glyphosate 101. To understand why glyphosate impacts micronutrients and how that can have a secondary effect on crops, look first at how it does its job.

"You can't kill a plant in sterile soil with glyphosate because it isn't the chemical that kills the plant, it's the soil organisms," Huber explains. "Glyphosate shuts down the plant's ability to utilize micronutrients necessary for enzyme function and defend against disease. Then, the soil-borne fungal or bacterial pathogens kill the plant."

Manganese is a critical micronutrient for the function of the EPSPS enzyme, which is necessary for secondary metabolism.

"There are 20 or more enzymes that require manganese to function," he says. "When glyphosate chelates that micronutrient, many of those enzymes are compromised and the plant succumbs to disease."

It's an effective system that, with the development of herbicide-resistant crops, has largely done away with cultivating

Sick And Weak. Plants with micronutrient deficiencies are more vulnerable to disease, and diseased plants often mature earlier.

"For the last 2 to 3 years, corn plants have been losing color about 7 to 10 days earlier each year," says Bob Streit, a certified crop consultant and owner of Central Iowa Agronomics in Boone, Iowa. "In 2009, we often saw corn yellowing up by August 1 even where nitrogen deficiencies weren't the problem.

"If crops continue going downhill earlier and earlier, we really put the yield potential of the Midwest corn crop at risk."

Streit adds that soils remediated with organic carbons and managed for maximum soil biology showed fewer micronutrient deficiency symptoms and disease woes.

He mentioned that growers using these techniques saw heavier test weights, healthier plants and faster-drying grain.

When plants are short of micronutrients, possibly due to glyphosate impacts, Streit says they can't fight off fungal infections.

"In 2009, there were a lot of herbicide-tolerant hybrids extensively infected with eyespot. When you looked closer, the leaves were covered with small anthracnose lesions," Streit says. "The plants lost a lot of productive leaf tissue."

Corn needs to stay green until late

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Don Huber

and the hoe. It's also helped the success of minimum-till or no-till management.

But years of leaning heavily on glyphosate may be haunting producers now and downright plaguing them in the not-so-distant future.

September for maximum grain fill, Streit says. But diseased plants don't keep green tissue late in the season, resulting in reduced yields and lighter test weights.

According to the USDA, similar effects are seen in soybeans. A 10-year study in

Missouri found that *Fusarium* root colonization was consistently higher on glyphosate-tolerant beans treated with glyphosate than glyphosate-tolerant beans or conventional beans without a glyphosate application.

What's more, the study found that where glyphosate was applied, *Fusarium spp.* was found to be two to five times more prevalent on roots when compared to plants not treated with glyphosate. This occurred 7 days after glyphosate application.

Apply Micronutrients. No plant is immune to the effects of glyphosate.

In glyphosate-resistant crops, an additional enzyme is inserted that is not blocked by the glyphosate, but Huber says there is nothing in the Roundup Ready crop that does anything to the glyphosate.

That means glyphosate is still active in the plant, chelating elements and affecting plant function.

It's an effect producers need to be aware of and manage for, he adds.

"We need to kill the weeds and then recover the crop," Huber says. "In general,



Bob Streit

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a micronutrient should be applied 8 to 10 days after every glyphosate application."

Mixing micronutrients with glyphosate for a one-trip application has not been an option because they're not compatible, Huber says.

In tank-mix trials, weed control and nutrient benefit both suffered.

He has seen promise with new micronutrient formulations for more effective tank-mixes (nutrient phosphites), but producers likely need to make a separate application.

"If you apply micronutrients during the 8-day period after a glyphosate spray, the glyphosate will immobilize the nutrients you applied and the crop will not benefit," Huber says. "A micronutrient application is essential in glyphosate-tolerant crops."

He says no-tillers should also select hybrids or varieties that show strong disease resistance and nutrient efficiency.

Lingering Impacts.

While growers likely believe glyphosate has no residual activity, Huber says it does not disappear readily in the soil.

"We see a buildup of glyphosate in the soil in part from glyphosate-tolerant crops and weeds," he says. "When we add phosphate fertilizers for corn, soybeans or wheat, for example, the phosphorus reacts to release the glyphosate back into the soil, where it's available for uptake by plants.

"We're seeing the effect of glyphosate burndown because of that buildup and because glyphosate is a strong biocide that destroys enzymes and beneficial soil organisms that make micronutrients available."

The result, Huber says, is thinner stands and struggling plants.

"We typically don't actually see plant death, but what we do see is a plant that just isn't doing as well as it should — a plant with one foot in the grave," Huber says.

Unfair Blame. Because the whole field will often react the same way, producers are more likely to blame the weather, residue conditions, soil conditions and any other usual suspects for the poor crop health.

"How much the crop reacts depends on how fertile the soil is and how long glyphosate has been used," Huber says. "In a German study, wheat planted where glyphosate had been used for 10 years yielded 46% less than wheat planted where glyphosate had been used for only 1 year.

"It may not be an instant effect, but most areas have been using glyphosate long enough that it's becoming serious and obvious that something is not right."

Huber says no-tillers may be at greater risk for secondary glyphosate issues.

"No-tillers may have more accumulation of glyphosate in the topsoil," he says. "With tillage, glyphosate is a little more diluted in the soil and stays immobilized better since it's less likely to come in contact with the phosphorus.

"Plus, no-till often relies more heavily on glyphosate for weed control."

Streit recommends no-tillers who use glyphosate do more comprehensive soil tests, including tests for micronutrients.



BROKEN MACHINE. Plants starved of micronutrients due to glyphosate effects are left unable to defend themselves from disease. Diseased leaves produce less energy, lose color earlier and result in reduced yields and lighter test weights.

He says they should apply zinc in-furrow and follow glyphosate applications with an application of manganese and other micronutrients as determined by a tissue test.

"Producers that have fields with yield, grain-maturing and stalk-quality problems need to test for more micronutrients, take proper tissue tests and make sure they can also interpret results," Streit says. "They need to make a concerted effort to rebuild soil microbe populations that are more dynamic and can form the organic acids needed for increasing nutrient availability.

"Higher soil carbon and sulfur levels also seem to lessen the problem."

Producers are reacting to the effects of glyphosate even though they may not know the reason.

"Last year, it wasn't unusual to see conventional hybrids yield with, or even out yield, the more expensive traited hybrids and have better plant health," Streit says.

Plan Corrections. He recommends growers who suspect a glyphosate-related micronutrient deficiency problem call in an alerted crop consultant to help them map out a management plan to counter effects.

"It's been promoted that glyphosate has just one effect. We've put our heads in the sand because it's effective and made weed control simple," Huber says. "What we've overlooked is the fact it's a strong micronutrient chelator and a potent microbiocide.

"For now, we can mitigate the secondary effects of glyphosate, but long-term success demands using glyphosate more judiciously. We can't keep dumping it on." 