



By Larry Reichenberger

## MISSING MICRONUTRIENTS

*Using glyphosate is complicating the uptake of some minor nutrients*

**T**he use of glyphosate herbicide and Roundup-resistant crops has made it easier to control weeds, but it may also be making it harder to manage crop nutrients. That's because this "major" herbicide doesn't fit well with many "minor" nutrients—the trace elements that are part of the delicately balanced system of crop growth.

"Glyphosate is an economical and effective herbicide, but it can have extensive non-target effects on nutrient availability, the soil environment, and agricultural sustainability," says Don Huber, professor of botany and plant pathology at Purdue University.

**Manganese deficiency.** Researchers are just beginning to understand the relationships that exist between glyphosate and micronutrients. Complications have been most evident for manganese. Manganese is the most common micronutrient deficiency in soybeans in the eastern Corn Belt and is common in other areas where

soil pH or organic matter are high, or where soils are sandy or poorly drained. A 60-bushel soybean crop removes only a handful of manganese—about .6 pound per acre.

Recent studies in Kansas and Indiana have found that some Roundup Ready soybean varieties may be even more susceptible to manganese deficiency than conventional soybean types. "We think the problem lies with the gene that was inserted into soybeans to give them resistance to glyphosate. This gene also changed the composition of a substance exuded from the roots that helps to solubilize manganese in the soil so plants can utilize it," says Barney Gordon, agronomist at Kansas State University.

In research at the North Central Kansas Experiment Station that he manages, Gordon compared the response to manganese of the conventional and Roundup Ready versions (isolines) of the same soybean variety. Results of that study are shown in the

table on the following page. With no manganese application, the conventional soybean type out-yielded the Roundup Ready type by 12 bushels per acre. Applying 5 pounds per acre of manganese to the Roundup Ready soybeans erased this yield lag. The application had no positive impact on the conventional soybeans.

"We repeated this study last season and found similar results. We got a 4 to 6 bushel per acre increase from manganese applied to Roundup Ready soybeans grown under irrigation, but no response to the application on the conventional type," he says.

**Ties that bind.** Gordon's study measured the concentration of manganese in the upper leaves of soybeans and found there was less than half as much in the resistant variety when no fertilizer was applied. This difference

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►**Above:** Manganese is a micronutrient that may be a limiting factor for growers trying to maximize the yield of Roundup Ready soybeans.

# MANGANESE BOOSTS BEANS

Variety

KS4202

KS4202 RR

Mn Applied	Yield	Concentration	Yield	Concentration
lbs./acre	bu./acre	ppm	bu./acre	ppm
0	76.9	75	64.9	32
2.5	76.1	80	72.8	72
5.0	74.9	92	77.6	87
7.5	72.6	105	77.6	95

*“Glyphosate can have extensive non-target effects on nutrient availability.”—Don Huber*

quickly narrowed with the addition of only 2.5 pounds of manganese.

Huber says the glyphosate resistance in genetically modified corn and soybeans reduces manganese uptake and efficiency by 10% to 50%. “The impact varies by variety or hybrid and the uptake of iron and other nutrients can also be reduced,” he says.

Researchers suspect several other reasons for the micronutrient uptake problems associated with Roundup Ready crops. One of those hinges around glyphosate’s role as a chelating agent—a chemical that binds tightly to other mineral elements.

**Yellow flash.** “It was first patented as a chelating agent, not as a herbicide,” reminds Kurt Thelan, agronomist at Michigan State University. “It wraps around other molecules or cations and makes them unavailable. On soybeans, an application of glyphosate can temporarily tie up manganese that is in the leaf tissue and cause the ‘yellow flash’ symptoms that are often reported by producers.”

Huber adds that glyphosate can also pose problems because it is toxic to soil microbes—tiny organisms whose job is to assist in transforming micro-

nutrients into usable forms.

“Glyphosate moves readily from plant leaves to the roots and into the soil. Once there, it immobilizes soluble manganese in the soil and can also reduce the population of organisms needed to make manganese and iron available for plant uptake,” he says.

Huber points out one study that showed the number of manganese-reducing organisms present in a gram of soil was reduced by nearly 90% following an application of glyphosate. In another, where only 2.5% of the recommended application rate of glyphosate made its way into the soil, manganese uptake was cut by 80% and iron uptake by 50%.

**U**et another conflict between micronutrients and glyphosate can exist in the spray tank. Because deficiency symptoms for micronutrients like manganese tend to appear about the time growers would be applying glyphosate on Roundup Ready soybeans, many would prefer to apply a foliar fertilizer in the same operation. However, recent research has shown that the effectiveness of both the glyphosate and some micronutrient fertilizers often are reduced when they’re tank-mixed and applied together on the crop.

“The antagonism between glyphosate and manganese fertilizer can impact weed control,” says Thelan. “Generally, there’s no problem tank-mixing most forms of manganese fer-

►**Above:** Research at Kansas State indicates Roundup Ready soybeans may benefit more from an application of manganese fertilizer.

tilizer when weeds are small (2 inches) and conditions are good. When weeds are larger and conditions less favorable, use only a chelated form of the micronutrient fertilizer to minimize the antagonism. Under tougher conditions, the herbicide and fertilizer applications should be separated. In all cases, ammonium sulfate should be used with the application.”

**Management strategies.** Researchers are finding that, not only should micronutrients and glyphosate often not be combined, their application should even be separated by more than a week. “We found that normal uptake and translocation of foliar applied manganese didn’t occur until at least eight days after glyphosate was applied,” Huber says. “In a study with zinc on corn, the highest yield wasn’t obtained until the micronutrient was applied 15 days after glyphosate.”

Huber says the greatest conflicts between glyphosate and micronutrients occur where soil fertility levels are low or other conditions limit nutrient availability. “Crop sequence, tillage, soil pH, and the form of nitrogen used are also factors. Some varieties or hybrids are also more efficient in nutrient use. However, it may be necessary to abandon glyphosate and seek alternative methods of weed control.” ■