Reducing fertilizer use with a more accurate soil test

July 11 2014, by Dennis O'brien

ARS scientists have developed a testing process that accurately measures naturally occurring nitrogen and other nutrients in soil. Credit: Peggy Greb.

Farmers face a balancing act when deciding how much fertilizer to apply. Applying too much wastes money and adds to nutrient runoff problems. Applying too little reduces yields.

Agricultural Research Service scientists in Temple, Texas, have found a

way to help get it just right, maximizing profits, minimizing costs, and saving water bodies from unwanted nutrient runoff. They have developed a test that accurately portrays soil health by determining the levels of naturally occurring nitrogen and other nutrients.

Traditional methods for determining fertilizer needs are based on soil tests developed in the 1960s, which measure the amount of nitrate in the soil. But these tests don't account for the contributions of soil microbes. The microbes play a key role because they mineralize organic nitrogen and phosphate and make them more available to the crop. As a result, farmers often apply more fertilizer than the plants actually need, adding to their costs and causing unnecessary nutrient runoff.

"The problem is that conventional tools are not measuring the right soil characteristics. They test for inorganic nitrogen in the form of nitrate, but that's just one form of nitrogen available to the plant," says Richard Haney, a soil scientist with the ARS Grassland, Soil, and Water Research Laboratory in Temple.

Haney has developed a more integrated approach. Known as the "Soil Health Tool" or "Haney test" in commercial laboratories, it involves drying and rewetting soil and analyzing it in ways that account for microbial activity and measure both nitrate and ammonium, plus an organic form of nitrogen. It also measures organic carbon and other nutrients, in part by replicating some of the natural processes that occur in a field.

The drying and rewetting mimics what happens in the field before and after a rain. Nutrients and other compounds are extracted from the soil samples with both a water-based solution and a solution known as "H3A," which has the organic acids that plant roots use to acquire nutrients from the soil. Growers who use the process receive a spreadsheet that shows the amounts of nitrogen, phosphorus, and

potassium available to plants, based on results extracted by both the water- and H3A-based solutions. Results also include measurements of water-soluble organic carbon, water-soluble organic nitrogen, and soil microbial activity, and they provide a calculation of soil health and the ratio of carbon to nitrogen (a key in how much organic nitrogen is released). Organic carbon and organic nitrogen are natural byproducts of microorganisms breaking down the soil. Growers can use the results to determine fertilizer needs.

Savings for Farmers

An ARS technician applies an organic fertilizer source on plots in a study to optimize application rates of organic and inorganic fertilizers. The study is part of efforts to evaluate a new ARS-developed tool for soil testing that can be used to help growers reduce fertilizer use without decreasing yields. Credit: Daren Harmel.

The Soil Health Tool works for any crop produced with nitrogen or other nutrient fertilizers. Haney has made it available to commercial and university soil-testing laboratories, worked with farmers to promote it, and published several papers detailing its mechanics. The research is funded in part by the Texas State Soil and Water Conservation Board and the U.S. Department of Agriculture's Natural Resources Conservation Service. This enhanced soil-testing process is now offered by laboratories in Maine, Nebraska, and Ohio. It adds to the time and costs for a soil test, but farmers have learned that in the long run it saves on fertilizer costs.

David Brandt, who farms 1,200 acres in Carroll, Ohio, started using Haney's system 3 years ago to estimate the amounts of nitrogen he needed to apply to his corn, soybeans, and wheat fields. He also used it to estimate his phosphorus and potash fertilizer needs.

"I estimate that it's saved us at least 25 percent in nutrient costs," he says. "The readings were more accurate than other soil tests we had run, and we either maintained or increased our yields."

On average, fertilizer costs are reduced by about $10 to $15 per acre by adopting the system, Haney says. With less fertilizer being applied, there is also less nutrient runoff into rivers and bays.

"This means that less of the nutrients are going into the Gulf of Mexico, Chesapeake Bay, and other waterways, where they have been contributing to algae blooms year after year," Haney says.

Works Well With No-Till, Cover Crops

Another problem with conventional soil tests is that they are based on tilled systems used from the 1940s through the 1960s, so they often fall short in providing estimates in cover-crop and no-till systems, which

create entirely different soil profiles. Haney's system is able to measure the effects of cover crops and no-till practices. "We can develop a soil health calculation and suggest a cover crop mix," Haney says.

Brandt found that the results helped him understand the contributions made by his cover crops. "We knew they were helping, but we never understood why. This new information gave us a better understanding of what was going on in terms of nutrients in the soil," Brandt says. He used the information to adjust his mix of cover crops and get a better ratio of carbon and nitrogen, a critical factor in soil health. "It's helped us to pick the right cover crops to utilize in the field," he says.

In a 4-year field study conducted with Daren Harmel, research leader of the laboratory in Temple, Haney evaluated the enhanced soil-testing method in fields of wheat, corn, oats, and grain sorghum at nine sites in Texas. They applied fertilizer at traditional rates or at the amounts dictated by the Haney soil tests, and they left some plots unfertilized. They planted and harvested on the same dates at each site and kept track of fertilizer costs, crop prices, and overall profits.

They found that the enhanced method reduced fertilizer use by 30 to 50 percent and reduced fertilizer costs by up to 39 percent. The enhanced method had little effect on corn production profits, but increased profits 7 to 18 percent in wheat, oat, and sorghum fields. The results were published in the *Open Journal of Soil Science* in June 2013.

"We're asking farmers to think about what they're putting on the soil and whether it is necessary. It involves a new way of thinking, but fertilizer costs are rising, so the idea is attracting more interest," Haney says.—By Dennis O'Brien, Agricultural Research Service Information Staff.

Provided by Agricultural Research Service