Gypsum Balances Nutrients, Builds Up Soil Structure

Proper applications of gypsum, an efficient carrier of soluble calcium, can help no-tillers improve the soil environment for plants and reclaim problematic sodic soils.

By John Dobberstein, Managing Editor

WHEN A NO-TILLER buys farm ground in some locations, such as the lake plain of northwest Ohio dominated by heavy clay, there isn't much hope of changing the soil's texture or mineralogy.

But there are properties related to how soil particles arrange and create soil structure that are sensitive to management. Soil amendments, such as gypsum, show promise for improving these difficult soils, says Dr. Jerry Bigham, a soils researcher and former director of Ohio State University's School of Environment and Natural Resources.

Open The Pores. In ideal soil, half the volume is comprised of minerals and organic matter, while the other half is pore space that serves as the ventilation and irrigation system for the soil profile.

Ideally, about half of the pore space should be water, which creates optimum conditions for growing crops. But if too much water floods the pores, there's a rapid decline in microbial activity and crop response.

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"The diffusion of oxygen needed for plant respiration is about 10,000 times slower through water as opposed to air," Bigham says. "Compaction alone can reduce this pore space by 20%."

Air-water balance is the single-most-important factor limiting U.S. production agriculture, he adds. According to a 2006 Iowa State study, the top two causes of economic loss to U.S. agriculture between 1980 and 2004 — looking at major events of $1 billion or more — were combined heat and drought stress at $130 billion and flooding and water logging at $50 billion.

If more farmers paid attention to soil structure, they would have another tool to buffer climate extremes, Bigham says.

Manage Air, Water. "The ultimate goal of air-water management is to create an environment where the plant root system meets its full genetic potential — for nutrient uptake, water transmission and exploiting the largest volume of soil possible," Bigham says. "Temperature, moisture, physical factors like tillage hardpans, chemicals like aluminum toxicity or pathogens like nematodes can influence the ability of root systems to proliferate."

A mix of soil pores is ideal, with larger pores receiving and transmitting water and smaller pores holding water during times of stress.

Pores must be connected to each other and to the soil surface, "so we can have exchange between the air in the atmosphere and what's in the pore space," he says. "There is no downside to good soil structure."

The Solution. Soil structure is enhanced not only by root and faunal activity, soil organic matter and microbial exudates, but also soluable-calcium ions.

Calcium has nutritional value in the soil and also stabilizes decayed soil-organic matter to help build soil structure, Bigham says. Gypsum, calcium sulfate dihydrate, is an efficient carrier of calcium.

Clay particles in most soils carry a negative surface charge and can repel and fly apart, or disaggregate, in water unless a no-tiller can introduce enough positive charge from exchangeable cations to balance the negative charge.

Cations like calcium, magnesium, potassium, sodium and ammonium can serve as a "flocculant" in the soil to counter these negative charges, but the efficiency of each depends on the level of positive charge and degree of hydration. Magnesium is better than sodium, but calcium is a better flocculater than both, Bigham says.

Jerry Bigham

"With sodium, because of its single charge and large hydrated radius, it's difficult to put enough of it into the soil system to balance the negative charge from clay particles," Bigham says. "Calcium has twice as much positive charge, so it's easier to put enough of it into the soil to cause clay particles to aggregate."

Helping Sodic Soils. Gypsum, with its ability to be a moderately soluble carrier for calcium, holds promise for farm fields plagued by sodic soils that have a disproportionately high concentration of sodium in their chemistry.

Sodic soils are a problem throughout the world — including the U.S., where some 24 million acres can be found, Bigham says. Sodic soils tend to have poor physical properties, with subsoils like bricks and dispersed surface soils that don't allow much water to be moved into or through them.

Sodicity has been well-documented and studied among the ag industry, particularly in Australia where experts believe as little as 6% exchangeable sodium has caused cropping problems to develop.

Water Infiltration. Gypsum has been used for many years to improve aggregation and inhibit or overcome dispersion in sodic soils, which contributes to surface sealing and crusting and problems. Bigham believes this could be alleviated with gypsum.

"You want to have air and water moving freely into the soil profile, but when sealing occurs, you get reduced infiltration, less soil water, soil and nutrient loss in runoff, off-site pollution, seedling loss, poor air exchange and probably reduced yields," he says.