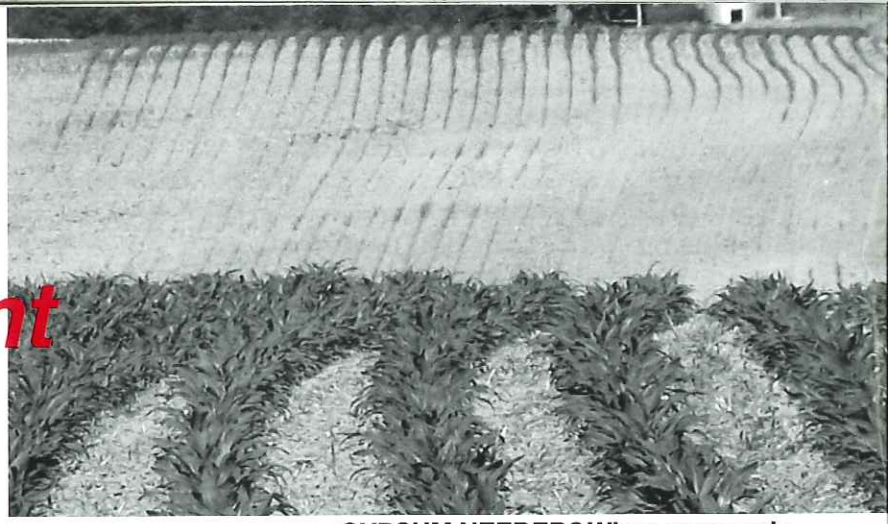
Gypsum — A Multitasking Soil Amendment

This "waste" product of power plants can help balance soil fertility, reduce erosion and improve soil structure.



GYPSUM NEEDED? When gypsum is applied at the soil surface, it reduces soil movement and soil erosion. Darrell Norton says increased soil aggregation and structure from gypsum can lead to better infiltration.

By Martha Ostendorf, Contributing Editor

CLEANER AIR MAY be good for no-tillers' health, but it's not necessarily good for the health of their crops.

Darrell Norton, a soil scientist with USDA's-Agricultural Research Service in West Lafayette, Ind., says that cleaner air standards and scrubbers on power plants mean potential deficiencies in nutrients essential for successful crop production.

"We used to not worry about sulfur because we got it for free, but we've had a considerable reduction of atmospheric sulfur deposition due to clean air standards," Norton says. "There are actually areas of the country that are experiencing sulfur deficiencies in crops, and not just in sandy soils."

Darrell Norton

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Norton says producers tend to take the calcium and sulfur freely supplied by nature for granted, but they are meso-nutrients needed in levels equal to, and even greater than, nitrogen, phosphorus and potassium.

Fortunately, the cause of the problem may also be the solution — and with even greater benefits for no-tillers in the long run.

To meet environmental standards for sulfur emissions, power plants use a scrubbing technique that produces gypsum, Norton says. The process creates high-grade gypsum, which is largely used for wallboard production, and less pure gypsum, which can be used in agriculture.

Norton says gypsum (calcium sulfate dihydrate) can supply crop-available forms of calcium and sulfur to address nutrient deficiencies, but the benefits go far beyond fertility, Norton told attendees at the 2009 National No-Tillage Conference.

Critical Calcium Needs. Calcium is necessary for proper function of cell membranes and cell walls. Norton says calcium is needed in large amounts at the tips of growing roots and shoots.

"The unusual thing about calcium is it can only be transported upward in the plant's phloem, which means the plant can't send calcium to the root tip where it's actually needed," Norton says. "We have a lot of native calcium, but it's not always soluble.

"The plant must use a lot of energy to get the calcium it needs for root elongation — energy that could be going to producing grain.

"We've found that by adding gypsum, the calcium is right where it needs to be in a soluble form that the plant can passively take up."

The result is more aggressive root growth. Norton has observed almost double below-ground biomass production on gypsum-treated soils.

"Just adding gypsum produces a much better root system," he says. "The more roots you have, the more water the plant can take up during drought, the more nutrients it can take up and your chances of success are much greater even during drought conditions."

The sulfur in gypsum also can be put to good use, especially in soybeans.

"Soybean nodules should be pink and functioning to fix nitrogen," Norton says. "Each nitrogenase molecule that is causing that pink, functioning color requires 28 sulfur atoms.

"If you don't have a sufficient amount of soluble sulfur, it doesn't matter how much inoculant you put on the seed; you're not going to get the nitrogen fixation for the following crop."

Norton says gypsum also can boost nitrogen availability when added to manure by preventing ammonia volatilization.

Erosion Management. Some benefits of no-till are decreased erosion and increased water infiltration due to less surface sealing and better soil structure. But rain and soil have a complex relationship that can result in losses to which no-tillers aren't immune.

"When low-electrolyte rain hits the soil, the soil tries to give off electrolytes in the form of soil nutrients, nitrogen, phosphorous, etc., to that rainwater at a very fast rate," Norton says. "That process, combined with the mechanical action of the raindrop, creates a seal or crust on the soil surface.

"This can even occur underneath residue in no-till. If you scrape the residue away, you'll notice you've got a compacted layer there, even if it's just a few millimeters thick."

And compaction always leads to problems. Norton says this surface compaction, or crusting, can hamper seedling emergence and initiate runoff. With runoff comes erosion, which means topsoil losses, nutrient losses and water-quality issues.

The electrolyte transfer that occurs during rainfall can even impact tiling systems.

"We tile low areas to get rid of runoff, but low-electrolyte rain takes clay with it, creating a clay-lined temporary pond in our field," Norton says. "The water can't get down to the tile and we lose production."

Norton says it doesn't take much rain to create the crusting effect.

"We can start with a very high infiltration rate, but with as little as 0.59 inches of rain, a crust can form and the infiltration rate will drop to about 0.08 inches per hour," he says.

When gypsum, an electrolyte, is applied at the soil surface, it increases the electrolyte concentration and helps to counter the chemical aspect of these issues, reducing soil movement, Norton says. On a silty-clay-loam soil at DeWitt, Iowa, a gypsum application reduced soil loss during a 2.5-inch-per-hour rain by more than 85%.

"We essentially eliminated erosion to just splash erosion under pretty intense thunder-

Treated soils are friable and loose, making seedling emergence more uniform and roots more abundant...

storm-type rain conditions," Norton says.

Part of this success is possibly due to increased soil aggregation and structure created by gypsum. A USDA-ARS National Erosion Research Lab study showed that a gypsum application increased infiltration by 500%, thus reducing water runoff.

"We have found gypsum to be very effective in reducing soil loss," Norton says. "It also helps improve water-use efficiency by getting more water into the soil."

Water Quality. Reducing erosion with gypsum helps no-tillers keep valuable topsoil and nutrients in place, which is good for them and downstream bodies of water.

"Soluble phosphorus is part of what is causing problems with algae blooms in the Gulf of Mexico and in the west end of Lake Erie," Norton says. "By adding gypsum to soil, we are able to significantly reduce the amount of soluble phosphorus in runoff."

One study Norton cited showed that a gypsum application reduced water runoff by 17%, soil loss by 60% and phosphorus losses by 67% when compared to the control.

"In some cases, gypsum has proven to work better than alum at reducing soluble phosphorus in runoff. It's a lot cheaper," he says.

Soil Properties. Gypsum can be used to help improve compacted soil and help develop better soil structure, Norton says. Just 4 months after a gypsum application, a soil with 68% clay in a Mexican no-till plot showed greatly improved soil structure.

"Untreated soils developed a crust and when wet, cuts like butter," Norton says. "Treated soils are friable and loose, making seedling emergence more uniform and roots more abundant."

These clay-type soils also can be a challenge for water management.

"Soils high in clay can have a lot of shrink-swell activity, which can open cracks deep in the soil profile," he says. "By applying gypsum, we keep soil from drying out and creating cracks. Irrigated water and rainfall go into the root zone instead of down the cracks."

Gypsum may also be a solution for producers facing highly acidic soil conditions, especially acidic subsoil.

"Very acidic soils usually have a lot of exchangeable aluminum, which is toxic to almost all plant roots," Norton says. "Lime can address acidity in topsoil, but roots feed at much deeper levels.

"We've never been able to get the calcium from our ag lime down to that layer, but gypsum will actually move down the wetting front and help at a deeper level because the sulfate in gypsum is soluble. Then it bonds with the toxic aluminum, making it insoluble."

Norton notes that gypsum is not a liming material. It's a neutral salt that only impacts pH by getting rid of the source of acidity or alkalinity.

Gypsum Sources. There are several sources of gypsum for agricultural use, including natural gypsum, synthetic gypsum created by coal-fired electricity plants and gypsum recycled from wallboard.

According to Norton, U.S. utilities produced 10 million metric tons of flue-gas desulfurization (FGD) gypsum in 2005. Only about 3% of that went to ag applications.

The bulk of the gypsum goes to produce wallboard. But, Norton says, increased production will exceed wallboard demand in most areas, creating economic opportunities for increased agricultural use.

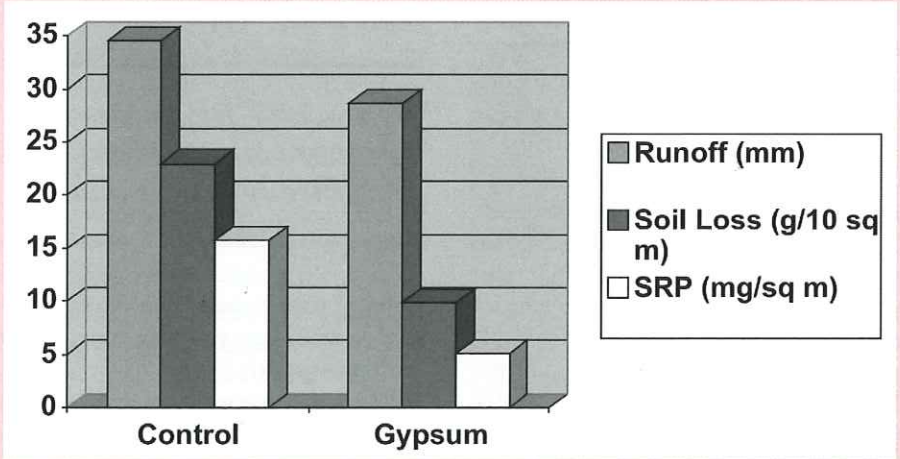
"For an individual power plant, disposal of 200,000 tons of FGD gypsum at $20 per ton represents an annual cost of $4 million. Selling it at $5 per ton would represent an annual profit of $1 million," he says.

Norton generally recommends applying 1 ton of gypsum per acre, per year. He notes, however, that regions with lower rainfall may not have enough moisture to dissolve that amount in 1 year, so applications should occur every few years as needed.

Agricultural Benefits Of Gypsum

- ❑ Improve soil structure
- ❑ Reclaim soils containing sodium
- ❑ Prevent crusting
- ❑ Aid in seedling emergence
- ❑ Improve low-solute irrigation water
- ❑ Improve compacted soils
- ❑ Prevent runoff and erosion
- ❑ Improve swelling clays
- ❑ Prevent waterlogging of soil
- ❑ Correct subsoil acidity
- ❑ Improve water-use efficiency
- ❑ Help plants absorb nutrients
- ❑ Decrease heavy-metal toxicity
- ❑ Source of sulfur
- ❑ Help prepare soil for no-till

Effects Of Gypsum On Erosion And Phosphorus Loss



WATER QUALITY. Gypsum applications increase water infiltration, which helps reduce runoff and cut soil and soluble reactive phosphorus losses by more than 60%. For no-tillers, that could mean more economical use of water and nutrients while conserving water quality downstream.