

Photo by Jana Lindley.



# Managing Sulfur in No-Till

by Ray Ward

SCIENCE

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Recently I received a phone call from a no-till farmer in east-central Nebraska asking why his corn looked yellow even though he thought his nitrogen (N) program was adequate. After asking a few questions, I drew the conclusion that the fertility problem was a sulfur (S) deficiency.

Sulfur deficiency, like N, is expressed as slow growth and general plant yellowing, often with thinner stems and a spindly appearance. The yellowing (chlorosis) starts with interveinal yellowing of new leaves and develops gradually over the entire leaf area. Yellowing of leaves occurs first on newer growth and extends to the older leaves in some crops. With time, reddening and purpling develops in many crops, especially in species of the Brassicaceae (Mustard) Family. Movement of S within the plant is not as great as that of N, so S deficiency does not cause 'firing' of the lower leaves as does N deficiency.

In many of our field crops, it is difficult to visually distinguish between N and S deficiency, although plant tissue testing can differentiate these with greater certainty.

## Sulfur in Soils

Sulfur occurs in soils in organic and inorganic forms, which are the categories used by chemists to refer to whether carbon (C) is contained in the molecule. In most soils the greatest reserve of S is in the organic form. Organic S means it is bound to the organic matter. In a previous article (March '03 *Leading Edge*), I wrote about the C:N ratio. Actually, most plant nutrients are held to some extent in the organic matter, and sulfur occurs in soil organic matter (OM) at approximately 1/8 the rate of N. So in general, the C:N:S ratio in soils is about 100:8:1. Since soil organic matter is about 58% carbon, the OM:N:S ratio is 170:8:1. This means that for

is readily converted to sulfate (SO<sub>4</sub>) ions. Sulfate is the form of S taken up by plants.

Sulfate is a soluble *anion* (negatively charged ion), just like nitrate, that can leach with soil water and be lost below the root zone. In more arid areas, sulfate may accumulate within the root zone since leaching potential is less. In

**A substantial amount of S has historically been supplied to crops by the depletion of organic matter in our soils by doing tillage.**

some cases where the root zone has water-movement restrictions, sulfate is one of the anions that combines with the (positively charged) *cations* sodium (Na), calcium (Ca), or magnesium (Mg) to form salts which can accumulate to high enough levels to create soil salinity. However, salinity is relatively rare in most of the soils of the central U.S. Plains.

Since most of the soil S is held in the organic matter, it is obvious that crops grown on soils with very low OM levels would be the most vulnerable to S deficiencies. It is well known that sandy soils have shown S deficiencies for many years. Eroded soils that have lost a lot of topsoil that was high in organic matter also show S deficiencies frequently. Now we are beginning to see S deficiencies in no-till fields where soil OM

every 170 pounds of soil OM there is 1 pound of S. This organic S becomes available to plants through microbial activity called mineralization. In the process of mineralization, H<sub>2</sub>S (hydrogen sulfide) is formed, which under aerobic (oxygen-available) conditions

Photo by Matt Hagny.



Sulfur-deficient wheat is pale green to almost yellowish, in stark contrast to the darker healthier areas in this field of second-year wheat. Sulfur deficiency often becomes quite obvious by late jointing or boot stage, although it is more difficult to pick out earlier in the plant's life cycle.