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Sulfur Fertilizer Response of Corn – Background and Research Update

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Summary

Sulfur (S) deficiency is becoming more common in Indiana crops because S emissions from coal-fired power plants have decreased over the past few decades and, thus, so has atmospheric S deposition. We conducted 11 large plot strip trials at 7 locations to examine corn yield response to S applied as ammonium thiosulfate (ATS) in starter and/or sidedress nitrogen fertilizers. Grain yield was increased by sidedress S in 6 of 11 trials. At responsive sites, yield increases ranged from 4 to 22 bu/acre and averaged 14 bu/acre. Sulfur in starter fertilizer only, increased corn grain at only one location.

Sulfur for crops from air and soil

In the past, atmospheric deposition of sulfur (S) from the burning of coal provided enough S to satisfy crop needs. Pollution controls and conversion of power plants from coal to natural gas have greatly reduced S deposition, increasing the possibility of S deficiency in crops grown in Indiana. Indeed, we have diagnosed S deficiency in corn, soybean, wheat, and alfalfa in both research fields and farmer's fields.

Figure 1. Shelby County sulfur (S) response trial in 2018. 16-row strips of light green corn can be seen where no S was applied to the corn crop. Where S was applied, the corn had darker green color.

With limited S from the atmosphere, the most important source of S in most situations is S released from organic matter

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(OM). Each percent OM in the plow layer contains about 100 lb S/acre. Organic S must be mineralized to sulfate-S (SO_4-S) to be taken up by crop plants, in much the same way that organic nitrogen (N) is made available to crop plants. At most only a few percent of the organic S is made available to the crop annually – approximately 3 lb S/acre per percent OM or less.

Since mineralization is a process carried out by living microorganisms, soil temperature and moisture largely determine when and how much of the organic S is made available to the crop. Cold and excessively wet or dry conditions reduce microbial activity and reduce S availability from soil organic matter and crop residues.

Sulfate-S is relatively mobile in most soils (similar to nitrate) because it has a double negative charge and is repelled by the negative charge of the soil, unlike nutrients such as potassium, calcium, or magnesium which are attracted to soil particles. Although SO_4-S can bind to iron and aluminum in the soil, these elements are much more likely to bind phosphate at the exclusion of SO_4-S and as a result SO_4-S is easily leached from soils, especially sandy soils.

The occurrence of S deficiency within a field may be highly variable since soil S availability varies considerably with soil OM and texture. Sulfur deficiency is often seen in sandier, lower OM, and higher elevation areas of a field while lower lying, higher OM, and heavier textured areas may have sufficient S.

Soil testing methods measure the SO_4-S form of S. Unfortunately soil testing is not particularly useful for predicting S deficiency because it does not take into account the organic S component that might become available to the crop. Additionally, the SO_4-S component that is actually measured may also be leached from the soil between the time of sampling and the time of crop need.

Fertilizer materials

There are several fertilizers available for correcting S deficiency **(Table 1)**. Adding ammonium thiosulfate to urea-ammonium nitrate solutions or blending ammonium sulfate with urea or other granular fertilizers are convenient and cost effective ways to provide S in a timely manner to corn. Otherwise, sulfate-of-potash-magnesia (sul-po-mag or K-mag) or potassium sulfate can be blended with muriate of potash to provide S and potassium (K). The inclusion of magnesium in sul-po-mag may be an extra benefit compared to potassium sulfate if soil magnesium levels are low. Generally these fertilizers are spread prior to planting therefore some of the SO_4-S might be lost from sandy soils before the time of crop need.

Naturally-occurring mined gypsum and several by-product sources of gypsum can be applied to provide S as well. Some forms of pelletized gypsum can be blended with other fertilizers or a ground gypsum can be applied with a lime spreader. Unless pelletized, however, higher than necessary rates of S will be applied with gypsum, which is difficult to spread at rates less than 500 to 1000 pounds per acre (85 to 170 pounds of S per acre assuming 17% S). If carryover of S occurs, the S will be utilized in later years. However, in sandy soils, where leaching is likely, the benefit in future years may be minimal.

Elemental S must be oxidized by soil bacteria to SO_4-S before being plant available. Warm temperatures and good moisture and aeration are required for S-oxidizing bacteria to function.

Sulfur oxidation is minimal at soil temperatures less than 50° F. Even at 75° F oxidation of S is about 15% of that at 85° F, so peak rates of S oxidation do not occur until late spring. Since the availability of elemental S may be minimal in early spring, a fertilizer containing all or at least some SO_4-S, in addition to elemental S, is preferred over a fertilizer with elemental S alone.

Table 1. Sulfur-containing fertilizers and their approximate composition. The actual nutrient concentration of any particular fertilizer should be expressed on the guarantee.

Fertilizer	%N	%K_2O	%S	%Mg	%Ca
Ammonium sulfate	21	0	24	0	0
Ammonium thiosulfate	12	0	26	0	0
Elemental sulfur	0	0	>90	0	0
Gypsum (calcium sulfate)	0	0	19	0	23
Potassium magnesium sulfate	0	22	23	11	0
Potassium sulfate	0	50	18	0	0

Summary of sulfur response trials

In 2017 and 2018 we conducted 11 trials exploring the impact of starter and/or sidedress S on corn yield (Figure 2). To provide S we mixed ammonium thiosulfate (ATS) with urea ammonium nitrate (UAN-32% or 28%) or a mixture of UAN and ammonium polyphosphate (10-34-0) as a starter fertilizer in 2x2 placement or as ATS with UAN as a sidedress application. Rates of S ranged from 5 lb/acre as starter to 25 lb S/acre as sidedress.

Sulfur application increased yield in 6 of 11 trials. Yield increases were 4, 8, 13, 18, 20, and 22 bushels per acre at the responsive sites (Fig. 2). Sidedress rates of 10 or 15 pounds of S per acre at sidedress maximized the yield response. There was no additional benefit to higher rates of S. Sulfur in the starter fertilizer at a low rate (<5 lb S/acre) increased yield (4 bu/acre) at only one location. At this one location, there was no additional benefit of sidedress S.

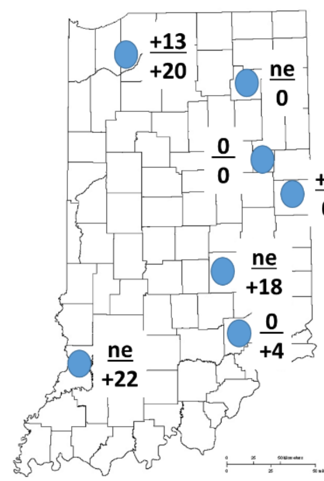

Figure 2. Yield benefit to sidedress S in Indiana in 2017 (above line) or 2018 (below line). ne = no trial that year.

We have not conducted enough experiments yet to determine the frequency and magnitude of S deficient conditions across Indiana. Nor do we know with certainty the soil and management conditions most likely to result in S deficiency. Consider conducting simple strip trials on your farm to determine whether you need additional S to maximize yield and profit. If you are interested in working with us on these trials please do not hesitate to contact us.