LOCALITY EFFECT DELAYS AVAILABILITY OF APPLIED GRANULAR ELEMENTAL SULFUR FOR CROP PRODUCTION

Farmers applying granulated elemental sulfur may be waiting an entire cropping cycle before their crops get the sulfur they need – a problem that could be costing them yield and money.

Studies in greenhouses show that elemental sulfur mixed with or without ammonium sulfate in monoammonium phosphate (MAP), diammonium phosphate (DAP) or triple superphosphate (TSP) granules – even if the particles of elemental sulfur are micronized – is not available for the first crop or in the first year after application. The same also applies to granulated elemental sulfur with bentonite. Dr. S.H. (Norman) Chien of Florence, Ala., retired principal scientist of soil chemistry with the International Fertilizer Development Center, presented data at the 2013 and 2014 American Society of Agronomy meeting illustrating his findings. In a preliminary review, he also drew the same conclusion for the results from the field trials of granular elemental sulfur reported in literature.

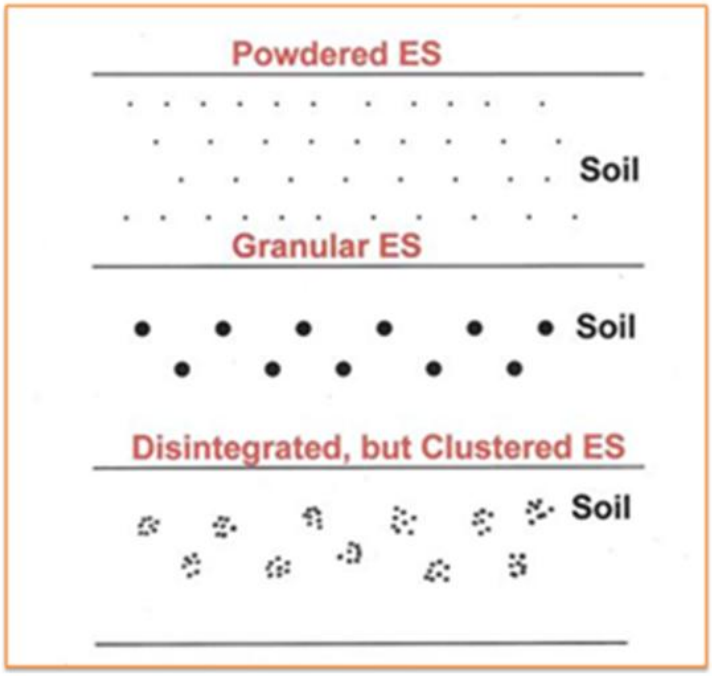
Sulfur is a vital component of chlorophyll and a wide range of amino acids, enzymes and proteins required for plant growth, but can only be taken up by plants in the sulfate sulfur form. Elemental sulfur must be oxidized into sulfate, a process carried out by soil bacteria that chemically combines sulfur atoms with oxygen and water, before it is available to crops.

The rate of oxidation of elemental sulfur into sulfate sulfur is governed by several factors, including the presence of key microbial species in the soil, as well as the soil's moisture content and temperature. Particle size is also a significant factor – smaller particles of elemental sulfur oxidize faster if they are dispersed in the soil because the interface between microbes and sulfur molecules is maximized.

Locality Effect

Chien notes that grinding elemental sulfur into even nano-sized particles does not significantly increase the rate of oxidation in the soil if the particles are then formed or incorporated into granules. The granules behave like large particles of elemental sulfur, he explains. Even as the granules disintegrate and release micronized particles in the soil, the elemental sulfur is clustered in a limited space, which minimizes the surface area available for colonization of the bacteria on the surface of the particles. He also notes that elemental sulfur is hydrophobic – water-repellent – so the elemental sulfur particles tend to coalesce to form large aggregates that reduce surface area. Chien calls this "the locality effect", as demonstrated in the following figure:

Incorporation of Elemental Sulfur in Soil



“Companies thought they could grind elemental sulfur to nanometer size and then granulate it with MAP, DAP or TSP,” Chien says. “What they forgot is that the granule disintegrates, but the micronized elemental sulfur is still clustered in the soil unless you disturb the soil to significantly disperse the micronized particles.”

That doesn’t fit with today’s no-till and reduced tillage practices, Chien notes. Even incorporating the fertilizer granules shortly after application is unlikely to reduce the locality effect, he warns. The result, Chien says, is that the elemental sulfur applied in MAP/DAP/TSP/elemental sulfur formulations, with or without ammonium sulfate, remains unavailable to plants for the entire first crop or in the year after application.

Return on Investment

Understanding the delay in availability of even micronized sulfur once it has been granulated helps farmers assess how quickly they can expect to see a return on their investment, notes Mercedes Gearhart, agronomy manager for Honeywell, which manufactures Sulf-N® ammonium sulfate.

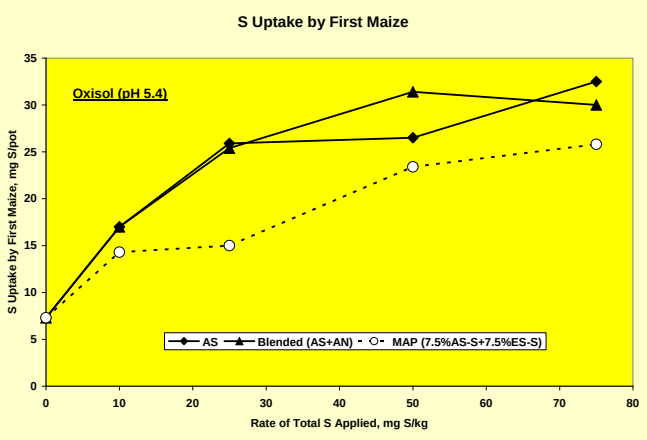
“It may be a year or more after application before micronized elemental sulfur concentrated within a granule or a pastille becomes available to the crop,” she points out. “This is simply too long for any annual crop. Sulfur in ammonium sulfate, on the other hand, is immediately available to the crop.”

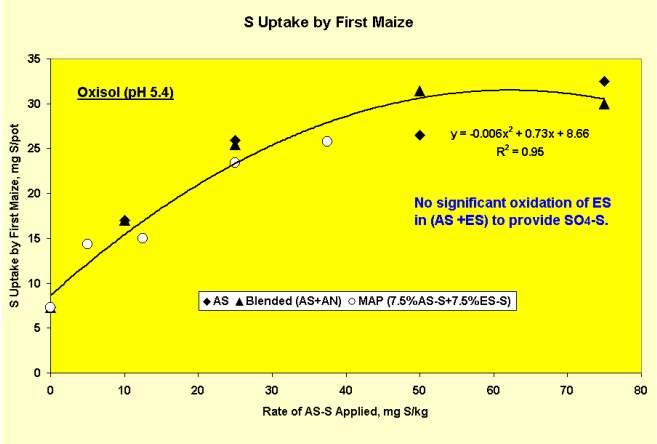
Gearhart also points out that recent University of Illinois field studies show that new corn hybrids take up half of their sulfur needs after flowering.

“Fortunately, high-capacity, high-clearance equipment is now available to make late season applications of ammonium sulfate blends possible, maximizing nitrogen and sulfur use efficiencies by reducing opportunities for loss,” she adds.

Greenhouse Study in Brazil

Chien and researchers in Brazil conducted greenhouse studies comparing the sulfur uptake in crops fertilized with ammonium sulfate (alone or blended with ammonium nitrate) and a commercial formulation of MAP, plus a combination of equal amounts of sulfur from elemental sulfur and ammonium sulfate. The scientists compared the two sulfur sources at several rates on a total-sulfur basis, from planting to six weeks of crop growth, for both a first and second maize crop, says Chien.





Source: Chien, American Society of Agronomy presentation (2014)

The first figure illustrates that the first maize crop after application took up more sulfur from ammonium sulfate or a blend of ammonium sulfate and ammonium nitrate compared to the MAP/sulfur formulation, based on the total sulfur rate applied.

“The second figure, based on the sulfate sulfur rate instead of the total sulfur rate, tells you that the contribution of elemental sulfur is zero,” explains Chien. “Otherwise, the data points of the MAP/sulfur formulation should not be fitted by the same curve as the other two sources, because the elemental sulfur would have oxidized to sulfate and contributed to additional sulfur uptake.”

Even the second maize crop in that study took up less sulfur from the MAP/sulfur application than from the ammonium sulfate formulations within the same year, Chien points out.

The bottom line, he says, is that the conventional wisdom that smaller particles of elemental sulfur oxidize quickly doesn’t apply if the micronized powder is packed into a granule. Because granulated elemental sulfur will not

convert quickly, farmers could lose yield and incur high costs by delaying the return on their fertilizer investment, says Gearhart.

“If the elemental sulfur is in a granule or clustered around the applied granule site, we have found that initial oxidation is normally nil, or insignificant for the first crop or in the year after application,” says Chien.

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