SULF-N® AMMONIUM SULFATE OUTPERFORMS ELEMENTAL SULFUR FORMULATIONS IN SOYBEAN FIELD TRIALS

In field trials conducted by Purdue University in 2016 and 2017 and recently reported in *Communications in Soil Science and Plant Analysis*[1], Sulf-N® ammonium sulfate was twice as efficient as two other commercial sulfur (S) formulations containing the same total S, but with half of it in the form of elemental S.

Results Overview

In Purdue University field trials, Sulf-N® ammonium sulfate (AS) fertilizer as S source for soybeans at planting was compared with two other commercial AS + elemental sulfur (ES) formulations containing the same total sulfur (S), but with half in the form of AS and the other half in the form of ES:

- Granular mono-ammonium phosphate plus AS and ES (MAP-10S applied as MES®-S10®)
- A blend of ES with bentonite clay (as Tiger 90CR®) plus AS

Results indicate that ES in the MAP-10S and ES+AS formulations did not experience enough oxidation to become plant-available within the season of application. Only the AS component of each fertilizer, which was already in the plant-available sulfate-S form, boosted crop growth. Soybeans showed 20 percent and 18 percent responses to AS in the 2016 and 2017 trials, respectively.

Field Trials

Because ES powder is dusty, difficult to handle and apply, and potentially explosive, formulations that include bentonite or nitrogen/phosphorus (NP) granules are typically used to provide reliable carriers for S. Recognizing that ES is not available to the crop upon application, some manufacturers have begun adding AS to their enhanced NP formulations to deliver plant-available sulfate-S as ES+AS blends. This is despite no field proof that the ES component would supply significant plant-available S during the season of application.

To evaluate the initial soybean response to AS versus NP-(ES+AS) products, Dr. Shaun Casteel, associate professor of Agronomy at Purdue University, conducted two field trials in LaPorte County, Indiana. Both fields featured sandy soil with 2.5 percent soil organic matter and a pH of 6.4, and both had been planted with corn the previous year, depleting the soil of S. The plots were supplied with all nutrients except S and balanced to ensure that S was the only limiting factor for soybean growth.

Soybeans were planted in 15-inch rows, and S treatments were applied at 0, 5, 10, 20 and 30 pounds per acre.

- In 2016, the zero-S treatment yielded 48.6 bushels of soybeans per acre. Applications of AS increased yields at every application rate, peaking at a rate of about 10 pounds of S per acre with a yield of 58.3 bushels per acre. When applied at 20 and 30 pounds per acre of S, yields were both about 57.9 bushels per acre.
- In 2017, a similar, nearly 10-bushel yield increase was observed from a 10-pound-per acre S application as AS. Yields grew from 53.7 bushels per acre (untreated), to 63.4 bushels per acre in response to AS fertilization.

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Ammonium Sulfate Made the Difference

Witnessing the impact of S on soybeans was important. So was the clear demonstration that sulfate-S—with no additional help from the ES applied in the two NP-(ES+AS) formulations described above—provided a much more pronounced yield boost.

Figures 1 and 3 below track soybean grain yields as a function of total S rate applied in 2016 and 2017. In both years, it took double the total S from MAP-10S or from the ES+AS blend to reach the same yield achieved with AS alone. Only half of the S in ES+AS formulations were found to impact soybean growth, therefore, the authors concluded that no significant amount of S from ES in the ES+AS formulation was oxidized to become plant-available S.

To prove this point, the authors graphed soybean grain yields in Figures 2 and 4 as a function of sulfate-S only. The fact that the graph lines coincide exactly

Figure 1: Soybean grain yield obtained with AS, granular MAP-10S, and bulk-blend (ES)+(AS) based on total S rate applied (2016)

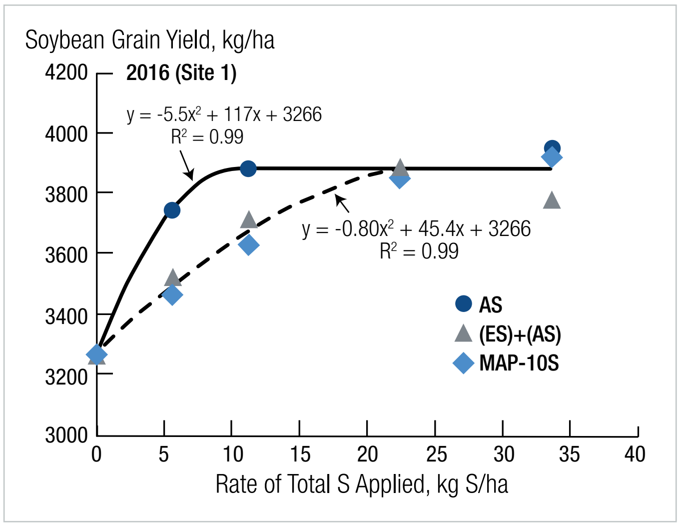


Figure 2: Soybean grain yield obtained with AS, granular MAP-10S, and bulk-blend (ES)+(AS) based on AS-S rate applied (2016)

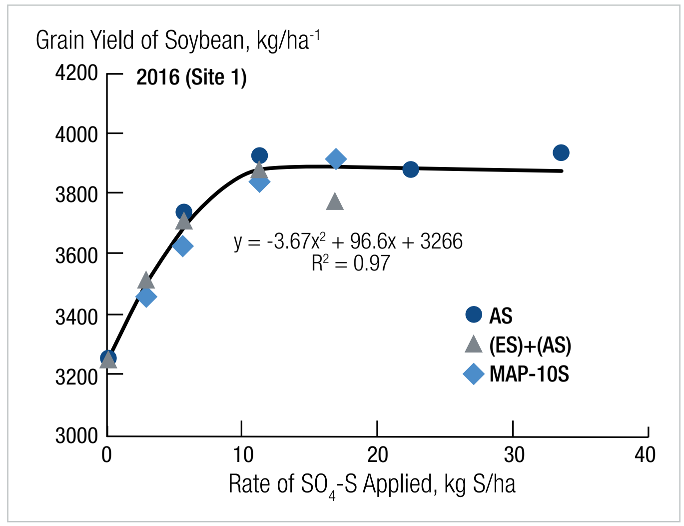


Figure 3: Soybean grain yield obtained with AS, granular MAP-10S, and bulk-blend (ES)+(AS) based on total S rate applied (2017)

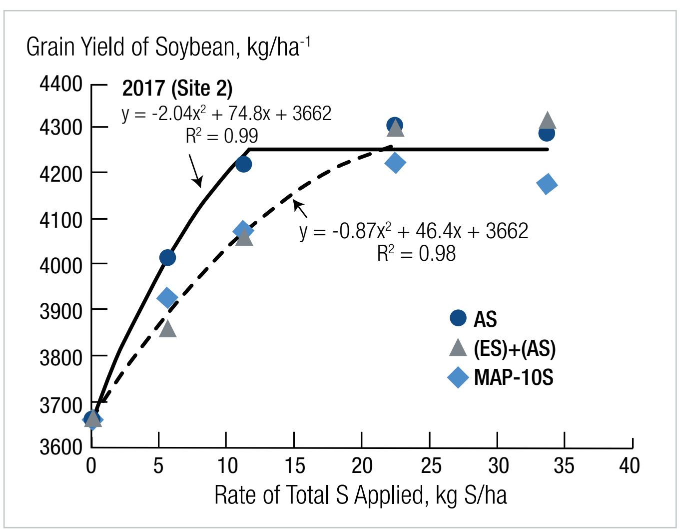
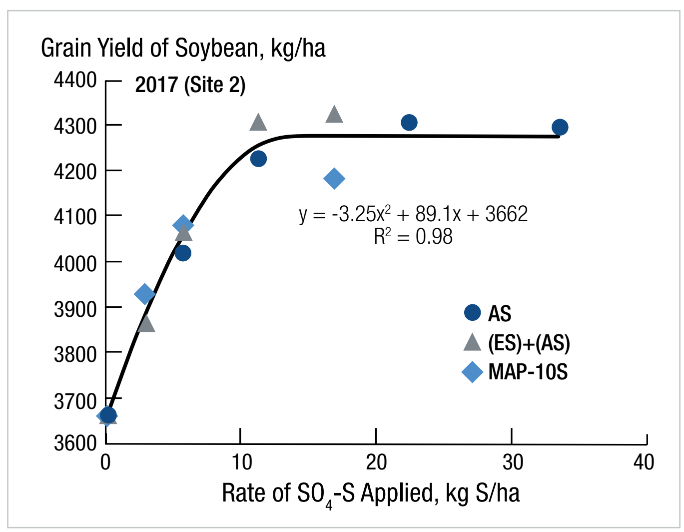


Figure 4: Soybean grain yield obtained with AS, granular MAP-10S, and bulk-blend (ES)+(AS) based on AS-S rate applied (2017)



clearly indicated that AS alone was responsible for the yield response. Had the ES portion of the ES+AS formulations contributed to the soybean growth through oxidation during the growing season, the yield curves for the two treatments containing ES would have tracked above the AS curves shown in these two figures.

Put simply, AS fertilizer was proven to be two times more efficient than either of the NP-(ES+AS) formulations.

These figures illustrate another important point to consider when comparing fertilizers: to accurately determine efficiency, products should all be tested at *multiple* S rates ranging from low to high – not just at *single* high rates which can result in misleading conclusions.

Reasons Behind Low Utilization of S from ES

The S from ES must first be oxidized by soil microbes and converted into plant-available sulfate-S before it can be used by the crop. Oxidation does not take place in cool soils. Even after the soil warms sufficiently to activate the microbial community, the oxidation process can take weeks, months and even years to complete.

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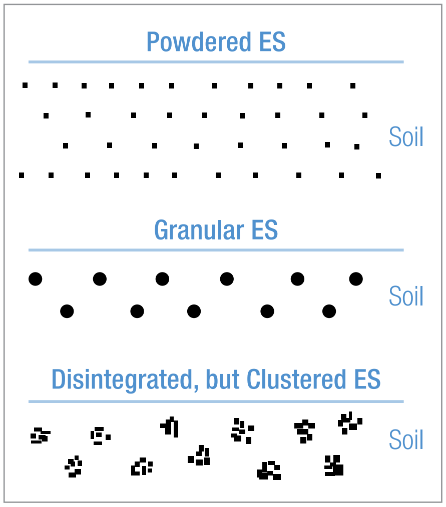
Figure 5: The "locality effect" of granular ES product incorporated in the soil



Source: Chien, 2016 American Society of Agronomy Annual Meeting

Furthermore, the presence of an active community of sulfur-oxidizing microbes alone does not necessarily lead to efficient conversion of ES to sulfate. Chien et al. (2016)[2] pointed out that application of granular ES-enhanced NP fertilizers can have a negative "locality effect" on ES oxidation. As illustrated in Figure 5, although the individual ES dust particles are small after the granules disintegrate, they are localized at the application site. This results in limited surface contact of the ES particles with the soil. Additionally, the ES particles tend to be hydrophobic (water repellent), and as such they would likely aggregate in the soil to form larger ES particles, reducing the surface areas required for ES-oxidation reactions.

Conclusion

The two Purdue University field trials clearly demonstrate, during two different growing seasons, that sulfate-S has a significant effect on soybean yield during the season of fertilizer application, while ES does not. The results also illustrate the importance of applying the right source of S at the right rate to have an impact on soybean yields that season.

Sulf-N® ammonium sulfate (21-0-0-24S) is an excellent source of plant-available sulfate-S as well as volatilization-resistant ammonium-N.

References

1. See the published article in *Communications in Soil Science and Plant Analysis*.
2. See *Chien et.al.* for details on the impact of granular ES-enhanced NP fertilizers on ES oxidation.

Contact AdvanSix
To learn more about the benefits of Sulf-N® Ammonium Sulfate, visit **AdvanSix.com** or **SulfN.com** or call:
1-844-890-8949 (toll free, U.S./Can.)
+1-973-526-1800 (international)

AdvanSix
300 Kimball Drive, Suite 101
Parsippany, NJ 07054

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