

Seven-State Soybean Sulfur Fertilization Trials 2019 Summary

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Funding provided by the soybean checkoff through the
Qualified State Soybean Board in each state.

Introduction

Many soybean growers are interested in the use of additional sulfur (S) to increase yields and profitability. However, with low profit margins, the effect of additional sulfur containing fertilizers on soybean yield and economic return is important to understand. In 2019, we began to evaluate some common sources of sulfur to help us identify environmental and soil factors where yield response to applied sulfur is most likely to occur.

Methods

Sulfur fertilization source and rate were tested in small plot trials at 19 locations in 7 states in 2019 (Figure 1). Two sources of S (AMS, ammonium sulfate, 21-0-0-24S and CaSO₄, calcium sulfate, 0-0-0-17S) at four rates (0, 10, 20, 30 lbs S/a) along with a nitrogen check (urea, 46-0-0) were tested in a randomized complete block design at all sites (Table 1). Spring fertilizer treatments were hand-applied to soybean plots immediately after planting. Measured amounts of all fertilizers were broadcast over the already-planted rows. No soil incorporation was performed. Treatments were selected for their range of S levels. Several S containing fertilizers also included N, and comparison treatments with just N fertilizers were established for proper comparison and evaluation. Soybean grain was harvested and yield and grain composition were determined. Grain protein, oil, and amino acid concentrations were measured. Only sulfur containing amino acids were included in the statistical analysis this year. Trials will be conducted again in 2020.

Results

An analysis across all locations did not show any significant differences in yield. As most states only had one or two locations, a state-specific analysis was not specified. We examined the location x treatment effect and sliced the effects by location.



Figure 1. Map of 2019 sulfur fertilization sites

Table 1. List of products, application rates, and nutrients applied.

| Treatment | Form | Product lbs/a | Supplied | Supplied |
|-----------|-------|------------------|------------|------------|
| | | | S lbs/a | N lbs/a |
| 1 | UTC | | 0 | 0 |
| 2 | AMS | 42 | 10 | 9 |
| 3 | AMS | 83 | 20 | 18 |
| 4 | AMS | 125 | 30 | 26 |
| 5 | CaSO4 | 59 | 10 | 0 |
| 6 | CaSO4 | 118 | 20 | 0 |
| 7 | CaSO4 | 176 | 30 | 0 |
| 8 | Urea | 19 | 0 | 9 |
| 9 | Urea | 39 | 0 | 18 |
| 10 | Urea | 56 | 0 | 26 |

Yield

Of the 19 locations with trials in 2019, five were significant for yield differences due to fertilization treatment (Table 2.). There was no treatment that consistently increased yield and/or protein in every location.

Table 2. Yield of soybeans at five sites with significant differences. An asterisk (*) indicates value is not different from the highest value (**bolded**) at that location.

| Product | Supplied S lbs/a | Supplied N lbs/a | Minnesota Lake MN | Starkville MS | Dunn NC | East Troy WI | Hancock WI |
|---------|---------------------|---------------------|-------------------------|------------------|---------------|--------------------|---------------|
| | | | bu/a | | | | |
| UTC | 0 | 0 | 53.6 | 29.6 * | 60.9 * | 75.4 * | 74.8 * |
| AMS | 10 | 9 | 64.7 * | 32.3 * | 64.7 * | 78.5 * | 73.8 * |
| AMS | 20 | 18 | 68.6 * | 33.2 * | 63.9 * | 74.1 * | 66.0 * |
| AMS | 30 | 26 | 64.6 * | 32.3 * | 69.1 * | 71.2 * | 61.2 |
| CaSO4 | 10 | 0 | 66.9 * | 26.1 | 67.6 * | 67.3 * | 68.6 * |
| CaSO4 | 20 | 0 | 66.3 * | 26.9 | 63.6 * | 59.2 | 60.3 |
| CaSO4 | 30 | 0 | 67.1 * | 30.7 * | 67.7 * | 71.5 * | 67.5 * |
| Urea | 0 | 9 | 62.2 * | 31.7 * | 58.1 | 64.3 | 52.0 |
| Urea | 0 | 18 | 60.1 * | 30.5 * | 64.0 * | 77.7 * | 55.5 |
| Urea | 0 | 26 | 54.5 | 29.9 * | 69.5 * | 75.0 * | 66.7 * |

Grain composition

Table 3 indicates grain protein and oil concentration and Table 4 indicates grain cysteine and methionine amino acid concentration at those locations that had significant differences. No discernable trends or differences were found across the 19 locations for any of these four values.

Table 3. Grain protein and oil concentration at the five sites that showed significant differences.

An asterisk (*) indicates value is not different from the highest value (**bolded**) at that location.

| Product | Supplied S | Supplied N | Lexington-1 | MN Lake | | Chippewa Falls | East Troy | | Hancock | |
|---------|------------|------------|---------------|---------------|---------------|----------------|---------------|---------------|---------------|---------------|
| | | | KY | MN | WI | WI | WI | | | |
| | | | Protein | Protein | Oil | Protein | Protein | Oil | Protein | Oil |
| | lbs/a | lbs/a | ----- % ----- | | | | | | | |
| UTC | 0 | 0 | 39.1 * | 37.8 | 21.7 * | 40.5 * | 37.9 * | 22.1 * | 41.6 * | 20.8 * |
| AMS | 10 | 9 | 39.0 * | 39.0 * | 21.1 * | 39.9 * | 37.7 * | 22.1 * | 40.5 | 21.1 * |
| AMS | 20 | 18 | 39.8 * | 39.3 * | 21.1 * | 39.7 | 37.0 | 22.2 * | 41.3 * | 20.7 * |
| AMS | 30 | 26 | 38.4 | 38.9 * | 21.0 | 40.9 * | 37.4 * | 22.6 * | 40.7 | 20.7 * |
| CaSO4 | 10 | 0 | 39.1 * | 38.9 * | 21.2 * | 40.2 * | 37.5 * | 22.1 * | 41.0 * | 20.6 * |
| CaSO4 | 20 | 0 | 38.9 * | 39.0 * | 21.2 * | 40.5 * | 36.8 | 22.4 * | 40.8 | 20.9 * |
| CaSO4 | 30 | 0 | 38.4 | 39.0 * | 21.2 * | 40.6 * | 36.8 | 22.5 * | 40.5 | 20.9 * |
| Urea | 0 | 9 | 38.7 * | 37.8 | 21.7 * | 40.0 * | 37.9 * | 22.0 * | 41.4 * | 20.4 * |
| Urea | 0 | 18 | 38.9 * | 37.8 | 21.7 * | 40.7 * | 38.0 * | 22.2 * | 42.0 * | 20.2 |
| Urea | 0 | 26 | 39.8 * | 37.2 | 21.7 * | 39.5 | 38.3 * | 21.8 | 41.3 * | 20.7 * |

Table 4. Grain amino acids cysteine and methionine concentration at the five sites that showed significant differences. An asterisk (*) indicates value is not different from the highest value (**bolded**) at that location.

| Product | Supplied S | Supplied N | Lexington-1 | | MN Lake | | Arlington | | Chippewa Falls | | Platteville |
|---------|------------|------------|------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| | | | KY | WI | MN | WI | WI | WI | WI | | |
| | | | Cys ⁺ | Met | Cys | Met | Cys | Met | Cys | Met | Cys |
| | lbs/a | lbs/a | ----- % ----- | | | | | | | | |
| UTC | 0 | 0 | 0.652 * | 0.570 * | 0.598 | 0.538 | 0.660 | 0.590 * | 0.662 * | 0.574 * | 0.648 * |
| AMS | 10 | 9 | 0.664 * | 0.574 * | 0.652 * | 0.572 * | 0.682 * | 0.594 * | 0.654 * | 0.564 * | 0.660 * |
| AMS | 20 | 18 | 0.670 * | 0.586 * | 0.658 * | 0.570 * | 0.672 * | 0.592 * | 0.648 | 0.562 | 0.662 * |
| AMS | 30 | 26 | 0.642 | 0.566 * | 0.660 * | 0.574 * | 0.688 * | 0.600 * | 0.670 * | 0.580 * | 0.656 * |
| CaSO4 | 10 | 0 | 0.654 * | 0.570 * | 0.642 * | 0.564 * | 0.684 * | 0.592 * | 0.648 | 0.564 * | 0.654 * |
| CaSO4 | 20 | 0 | 0.662 * | 0.574 * | 0.658 * | 0.572 * | 0.680 * | 0.596 * | 0.662 * | 0.576 * | 0.650 * |
| CaSO4 | 30 | 0 | 0.650 * | 0.570 * | 0.648 * | 0.564 * | 0.688 * | 0.600 * | 0.674 * | 0.584 * | 0.658 * |
| Urea | 0 | 9 | 0.644 | 0.564 | 0.602 | 0.538 | 0.662 | 0.580 * | 0.646 | 0.564 * | 0.650 * |
| Urea | 0 | 18 | 0.648 * | 0.564 | 0.602 | 0.538 | 0.668 * | 0.580 * | 0.660 * | 0.576 * | 0.666 * |
| Urea | 0 | 26 | 0.672 * | 0.578 * | 0.608 | 0.536 | 0.660 | 0.576 | 0.638 | 0.558 | 0.638 |

*Cys=Cysteine, Met=Methionine

Appendix 1. Soil test results for 19 locations.

| State | Location | pH | OM | P | K | Ca | Mg | B | Mn | Zn | S |
|-------|----------------|-----|-----|-----------------|-----|------|-----|-----|-----|-----|------|
| | | | % | ----- ppm ----- | | | | | | | |
| AR | Newport | 6.4 | | 116 | 125 | 767 | 129 | | 195 | 4.4 | 12.2 |
| AR | PineTree | 6.8 | | 22 | 90 | 1568 | 234 | | 106 | 2.1 | 12.5 |
| KY | Lexington-1 | 5.4 | 2.5 | 199 | 145 | 2447 | 334 | | | 8.2 | |
| KY | Lexington-2 | 5.4 | 2.5 | 100 | 181 | 1798 | 181 | | | 1.4 | |
| KY | Princeton | 5.7 | 2.2 | 39 | 293 | 3657 | 165 | | | 2.8 | |
| MN | Danvers | 7.6 | 4.3 | 1 | 308 | | | | | | |
| MN | MN Lake | 5.9 | 5.3 | 20 | 135 | | | | | | |
| MS | Starkville | 7.7 | 2.4 | 31 | 130 | 8581 | 83 | 1.2 | 44 | 1.7 | 23.0 |
| NC | Dunn | 6.0 | 0.8 | 121 | 61 | 308 | 50 | 0.3 | 16 | 5.3 | 7.0 |
| SD | South Shore | 5.9 | 3.8 | 22 | 124 | 2423 | 682 | 1.0 | 36 | 0.4 | 10.5 |
| WI | Arlington | 7.1 | 3.4 | 58 | 144 | 1816 | 513 | 0.6 | 7 | 3.8 | 3.3 |
| WI | Chippewa Falls | 6.4 | 1.5 | 50 | 172 | 658 | 163 | 0.4 | 13 | 3.0 | 2.3 |
| WI | East Troy | 6.1 | 3.5 | 94 | 137 | 1801 | 375 | 0.5 | 7 | 3.9 | 2.3 |
| WI | Fond du Lac | 6.7 | 3.6 | 16 | 118 | 1928 | 504 | 0.5 | 8 | 2.3 | 7.8 |
| WI | Galesville | 6.3 | 3.1 | 36 | 189 | 1313 | 292 | 0.5 | 12 | 3.2 | 14.4 |
| WI | Hancock | 6.0 | 0.7 | 94 | 101 | 182 | 40 | 0.2 | 11 | 1.2 | 1.0 |
| WI | Marshfield | 6.7 | 3.7 | 31 | 193 | 1150 | 347 | 0.4 | 25 | 2.3 | 6.5 |
| WI | Platteville | 6.5 | 2.8 | 26 | 117 | 1433 | 447 | 0.3 | 8 | 6.6 | 2.0 |
| WI | Seymour | 7.1 | 2.4 | 20 | 128 | 1269 | 255 | 0.4 | 10 | 1.6 | 4.2 |