**Sulfur placements' impacts on corn hybrids grown in a two-year corn-soybean rotation.**

AFREC Project Report 03/31/2026 for

AFREC Project(s) R2025-U Year 4 Report

Crop Year - 2025

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## Year 4 (2025) Summary Points

- Crop circle or SPAD readings have been shown to be impacted by hybrid at some locations with some interactions between hybrid and S application rate. Much of the hybrid interaction has been mainly a result of differences between the hybrids but only when S is not applied.
- Corn grain yield has been inconsistently impacted by sulfur rate or source during the first corn year. During the second corn year sulfur increased yield at both Rosemount and Waseca.
- Corn grain yield of the hybrids has different consistently across locations, but the differences are not attributed to one genetic source always yielding more than another nor have there been any interactions between hybrid and source or rate where the source or rate of S should be adjusted to accommodate for differing hybrid genetics.
- Soybean grain yield was not affected by the previous application of sulfur in 2023 or 2024, but what greater where S was applied ahead of corn at Waseca in 2025. Soybean grain yield did vary based on the yield of the previous corn crop with greater yield occurring for plots previously planted to the Dekalb corn which yielded less than the Pioneer in 2023, and vice versa in 2025.
- Soybean grain S concentration, seed protein concentration, and the relative proportion of cysteine and methionine increased with the application of S in 2023 but were not impacted in 2024 (2025 data is not available at this time).
- The need for sulfur is likely based on the location and specific soil conditions where crops are grown. While some of the plant tissue data have shown more interactions with the hybrids grown corn and soybean grain yield have not so there is no evidence that the source or rate of S should be adjusted based on genetics. However, the rates we are applying are well above what I would suggest for corn production in Minnesota so any differences between the hybrids might be more likely at much lower application rates of S and fertilizing corn accordingly should result in similar yield and the potential for some S to carry forward to the following soybean crop.

## Introduction

Research in Minnesota on sulfur application to corn has played an important role in understanding how much sulfur is needed by corn, how sulfur sources can impact sulfur availability, and potential options for applying sulfur. One area that has not been studied extensively is comparing placement options, band versus broadcast application of sulfur, to determine overall efficiency of placement on sulfur availability to corn. Limited data is available directly comparing band and broadcast application of sulfur in the same study. With band options becoming increasingly available more research is needed to determine whether banded sulfur is better than broadcast application of sulfur to crops.

I do not know of any current work comparing how sulfur application may affect differing hybrid genetics. Crop consultants have reported differences in how genetic sources remain green later in the season. Specifically, some genetics tend to yellow in their upper canopy late in the season which may be a result of differences in how these hybrids accumulate sulfur. There are questions about whether placement and rate of sulfur can impact this upper canopy yellowing and whether band applications are more efficient in reducing the yellowing in the upper canopy. These consultants also report substantial increases in yield levels for both corn and soybean over years with sulfur application. Most sulfur trials conducted in the past 10 years were only for one year and did not focus on the full cropping rotation and system over time to determine how much what is done in one year of a crop rotation affects subsequent years. One goal of this study is to set up a series of long-term trials to further study how sulfur impacts crop yield over time which should help to determine whether sulfur can impact overall crop productivity if used over time.

One other goal of this work will be to collect additional plant tissue data to determine whether tissue sulfur concentration can be used to predict final yield. If there are differences among hybrids, then the addition of the differing hybrids in this study will help determine whether a single critical value for total sulfur can be used or whether too much variation exists in leaf S concentration to determine an optimal S concentration across hybrids.

***Objectives***

1. Determine if sulfur placement and rate impact the response (grain yield and yield components) of longer season corn hybrids to sulfur application.
2. Determine whether sulfur accumulation varies based on hybrid genetics; specifically, do different genetic sources vary in how they accumulate sulfur in leaf tissue and does this impact critical leaf sulfur concentrations?
3. Evaluate how sulfur application method may impact soybean yield the following year corn is grown and how sulfur application rate and method affect corn and soybean yield response over time in a two-year corn soybean rotation.

## Materials and Methods

**Table 1. Soil series information and initial soil test results for samples collected before initial treatment application.**

| | 0-6" Soil Test | | | | $SO_4$-S | | | |
|---|---|---|---|---|---|---|---|---|
| Location | Bray-P1 | K | pH | OM | 0-6 | 6-12 | 12-24 | Soil Series |
| | ppm | | | % | ppm | | | |
| Rosemount | 15 | 106 | 6.7 | 3.3 | 13.4 | 9.5 | 5.2 | Tallula |
| Waseca | 29 | 226 | 6.1 | 4.7 | 11.9 | 5.6* | | Webster |
| Lamberton | 9 | 179 | 7.4 | 4.7 | 17.9 | 67.6* | | Canisteo |
| Rochester | 31 | 247 | 6.0 | 4.4 | 14.1 | 7.3* | | Mount Carroll |

**† K, Soil test potassium (K-ammonium acetate).**
*** Sulfate-S concentration was measured for the 6-24" sampling depth at Waseca.**

Two corn locations were established in 2022 (Rosemount and Waseca) with an additional two locations in 2023 (Lamberton and Rochester). Each location will consist of a two-year corn soybean rotation where all fertilizer will be applied before the corn crop then field will be rotated to soybean where not additional

fertilizer is applied. Three factors will be studied and arranged in a split- or strip plot design. Factors 1 and 2 will consist of sulfur rates (0, 18, and 36 lbs of S per acre) and two fertilizer placements by source combinations. The first placement by source combination will be pre-plant or an at planting application of ammonium sulfate [AMS (21-0-0-24)] broadcast to the soil and incorporated if possible. The second placement by source combination will be a band application of ammonium thiosulfate [ATS (12-0-0-26)] as a sub-surface band applied with the planter.

Nitrogen will be applied as urea at the time AMS is applied to balance broadcast N across all treatments at the time of AMS application (urea + NBPT may be used to lessen the risk of N volatility). In addition, 28% UAN solution will be applied with the banded treatments to balance the amount of N applied in the band. Additional N, P, and K will be applied as needed.

Two long season hybrids, 103-day relative maturity or greater, will be planted at each location. A hybrid will be sourced through Bayer and one through Corteva both with the same RM and as close to the same disease and insect resistance package as possible. Each location will be laid out using a strip plot design where strips consisting of corn hybrids will be randomized side by side planted the full length of the study over tip the rate x source and placement blocks. All treatments will be replicated four times. Soybean sites will be located at Rosemount and Waseca in 2023 which were planted to corn in 2022. No fertilizer will be applied to the soybean plots, and a single variety will be planted across both locations. Yield and other sampling data will be collected by the same sub-plot arrangement used for the corn years.

Corn leaf samples will be collected at the V8-V10 and R1 growth stage by sampling the uppermost fully developed leaf. Soybean trifoliate samples will be collected at the R1-R2 growth stage by sampling the uppermost fully developed trifoliate. All plant samples will be analyzed using dry combustion analysis for total S. The middle two rows of each plot will be harvested, and grain yield will be reported at 15.5% moisture content. Corn and soybean grain will be saved at harvest and analyzed for total S as well as seed size and weight. Whole soybean grain will be analyzed for seed protein and oil concentration by NIR> Soil samples will be collected in fall or spring post-harvest from the 0-24” depths and will be analyzed for total S.

**Table 2. Summary of cultural practices for studies conducted from 2022 to 2023.**

| Year | Location | Crop | Cultivar 1 | Cultivar 2 | Date of Spring Fert. | Date of Planting | Date of Harvest |
|---|---|---|---|---|---|---|---|
| 2022 | Rosemount | Corn | DKC 5544 | P 0598 | 6-May | 10-May | 27-Oct |
| | Waseca | Corn | DKC 5544 | P 0598 | 7-May | 16-May | 20-Oct |
| 2023 | Rosemount | Soybean | AG 21XF1 | AG 21XF1 | -- | 25-May | 9-Oct |
| | Waseca | Soybean | AG 21XF1 | AG 21XF1 | -- | 19-May | 2-Oct |
| | Lamberton | Corn | DKC 10533 | P 0598 | 8-May | 22-May | 31-Oct |
| | Rochester | Corn | DKC 10533 | P 0598 | 3-May | 19-May | 9-Nov |
| 2024 | Rosemount | Corn | DKC 10533 | P 05737V | 6-May | 17-May | 29-Oct |
| | Waseca | Corn | DKC 10533 | P 05737V | 13-May | 15-May | 3-Nov |
| | Lamberton | Soybean | P19A37E | P19A37E | -- | 17-May | 3-Oct |
| | Rochester | Soybean | P19A37E | P19A37E | -- | 15-May | 3-Oct |
| 2025 | Rosemount | Soybean | P19A37E | P19A37E | -- | 14-May | 14-Oct |
| | Waseca | Soybean | P19A37E | P19A37E | -- | 12-May | 2-Oct |
| | Lamberton | Corn | DKC 10533 | P 05737V | 8-May | 15-May | 10-Oct |
| | Rochester | Corn | DKC 10533 | P 05737V | 6-May | 13-May | 23-Oct |

† AG, Asgrow; DKC, Dekalb; P, Pioneer.

## Results and Discussion

### *Location Characteristics*

Table 1 summarizes soil series information and soil chemical properties for samples collected prior to the initial treatment application at the four locations. Sulfur trials have been established in similar soils at each location and have shown to be S responsive. Soil test P and K were Medium to Low at Rosemount and Lamberton and high at Waseca and Rochester. I am avoiding applying broadcast P as much as possible for these studies but may have to periodically apply a small rate of MAP or DAP at Rosemount and Lamberton to keep soil test P at the Medium classification. Starter was applied 2x2 and in-furrow as 6-24-6 at both locations to supplement some P to the corn crop. Total sulfate-S concentration was measured to a depth of 24 inches. There is no interpretation for sulfate-S concentration in the soil on medium to fine textured soils so the relative responsiveness of S application cannot be fully assessed using the soil test for sulfate-S.

Table 3. Summary of ANOVA analysis for measured agronomic variables for two corn trial locations studied during 2022.

| Main Effect | V5 NDRE | V10 Leaf S | V10 SPAD | R1 Ear Leaf S | R1 Up. Leaf S | R1 EL SPAD | R1 UL SPAD | Yield | Grain S | Fall $SO_4$-S |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *P*>F | | | | | |
| | | | | | Rosemount | | | | | |
| S Source | 0.22 | * | 0.20 | 0.16 | 0.71 | 0.11 | * | 0.63 | * | 0.77 |
| S Rate | 0.67 | 0.15 | 0.36 | 0.14 | 0.29 | 0.10 | 0.48 | 0.07 | 0.07 | 0.96 |
| So x R | 0.17 | 0.32 | 0.42 | 0.23 | 0.82 | 0.14 | 0.11 | 0.79 | 0.28 | 0.45 |
| Hybrid | 0.22 | 0.54 | ** | 0.10 | 0.38 | 0.81 | 0.37 | * | 0.33 | 0.36 |
| So x Hy | 0.48 | 0.87 | 0.48 | 0.76 | 0.78 | 0.86 | 0.69 | 0.79 | 0.13 | 0.91 |
| Rate x Hy | 0.84 | 0.56 | 0.49 | 0.80 | 0.67 | 0.16 | 0.32 | 0.24 | 0.98 | 0.07 |
| R x So x H | 0.86 | 0.06 | 0.16 | 0.74 | 0.22 | 0.68 | 0.19 | 0.21 | 0.36 | 0.38 |
| | | | | | Waseca | | | | | |
| S Source | 0.67 | 0.63 | 1.00 | 0.81 | 0.59 | 0.62 | 0.64 | * | 0.84 | 0.78 |
| S Rate | 0.56 | 0.10 | 0.78 | 0.71 | 0.52 | 0.77 | 0.79 | 0.92 | 0.46 | 0.22 |
| So x R | 0.51 | 0.53 | 0.77 | 0.90 | 0.54 | 0.97 | 0.68 | ** | 0.53 | 0.76 |
| Hybrid | ** | * | *** | 0.11 | 0.26 | ** | 0.07 | * | 0.33 | 0.33 |
| So x Hy | * | 0.55 | 0.38 | 0.64 | 0.55 | 0.84 | 0.25 | ** | 0.72 | 0.10 |
| Rate x Hy | 0.79 | 0.72 | 0.14 | 0.11 | 0.82 | 0.29 | 0.34 | 0.41 | 0.12 | 0.27 |
| R x So x H | 0.80 | 0.75 | 0.57 | 0.51 | 0.64 | 0.08 | 0.30 | * | 0.51 | 0.88 |

**, **, and *** represent treatment significance at P≤0,05, 0,01, and 0,001 probability levels.*

***2022 Corn trial results***

A summary table for the ANOVA for all measured variables for the growing season is given in Table 3. Individual variables will be discussed in the following tables.

Table 4. Summary of early plant vigor measured at the normalized difference red-edge (NDRE) data collected with a Crop Circle 430 active sensor collected at the corn V5 growth stage.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Rosemount | 0 | 0.245 | 0.265 | 0.273 | 0.277 | 0.265 |
| | 18 | 0.283 | 0.298 | 0.245 | 0.261 | 0.272 |
| | 36 | 0.291 | 0.304 | 0.268 | 0.267 | 0.283 |
| | So. x Hy | 0.273 | 0.289 | 0.262 | 0.268 | |
| | Source Avg. | 0.281 | | 0.265 | | |
| | Hybrid Avg. | 0.267 | 0.279 | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 0.261 | 0.280 | 0.261 | 0.287 | 0.272 |
| | 18 | 0.265 | 0.281 | 0.256 | 0.283 | 0.271 |
| | 36 | 0.264 | 0.283 | 0.261 | 0.294 | 0.275 |
| | So. x Hy | 0.263b | 0.281a | 0.260b | 0.288a | |
| | Source Avg. | 0.272 | | 0.273 | | |
| | Hybrid Avg. | 0.261b | 0.285a | -- | -- | -- |

Plant vigor was assessed at the V5 growth stage using a Crop Circle 430. A summary of the normalized difference red-edge index is given in Table 4. Early season NDRE did not differ based on sulfur source or rate at either location. Variety did vary at Wasea with higher NDRE values in the Pioneer plots. A significant source by variety interaction was found at Waseca and did indicate a potential source variation but only for only the Pioneer hybrid. The Dekalb hybrid showed no effect of sulfur source or rate.

Table 5. Summary of corn leaf S concentration measured from the uppermost fully developed corn leaf at the V10 growth stage at two Minnesota locations during the 2022 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Rosemount | 0 | 0.18 | 0.19 | 0.18 | 0.15 | 0.17 |
| | 18 | 0.22 | 0.21 | 0.18 | 0.17 | 0.19 |
| | 36 | 0.22 | 0.20 | 0.19 | 0.23 | 0.21 |
| | So. x Hy | 0.21 | 0.20 | 0.18 | 0.18 | |
| | Source Avg. | 0.20a | | 0.18b | | |
| | Hybrid Avg. | 0.20 | 0.19 | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 0.20 | 0.18 | 0.21 | 0.20 | 0.19 |
| | 18 | 0.23 | 0.20 | 0.22 | 0.21 | 0.21 |
| | 36 | 0.21 | 0.20 | 0.21 | 0.20 | 0.21 |
| | So. x Hy | 0.21 | 0.19 | 0.21 | 0.20 | |
| | Source Avg. | 0.20 | | 0.21 | | |
| | Hybrid Avg. | 0.21 | 0.20 | -- | -- | -- |

V10 leaf S concentration data was not available the time this report was written and will be included in the next year end report.

Table 6. Summary of SPAD meter reading collected from the middle of the uppermost fully developed corn leaf at the V10 growth stage at four Minnesota locations during the 2022 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Rosemount | 0 | 41.0 | 47.2 | 43.6 | 41.6 | 43.3 |
| | 18 | 44.7 | 49.5 | 39.7 | 45.9 | 44.9 |
| | 36 | 45.3 | 49.0 | 43.9 | 49.4 | 46.9 |
| | So. x Hy | 43.6 | 48.5 | 42.4 | 45.6 | |
| | Source Avg. | 46.1 | | 44.0 | | |
| | Hybrid Avg. | 43.0b | 47.1a | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 54.1 | 55.7 | 54.3 | 55.1 | 54.8 |
| | 18 | 53.7 | 56.5 | 54.4 | 56.3 | 55.2 |
| | 36 | 54.4 | 55.6 | 54.2 | 55.7 | 55.0 |
| | So. x Hy | 54.1 | 55.9 | 54.3 | 55.7 | |
| | Source Avg. | 55.0 | | 55.0 | | |
| | Hybrid Avg. | 54.2b | 55.8a | -- | -- | -- |

Corn V10 leaf SPAD meter readings were not affected by sulfur source or rate (Table 6). However, hybrid did vary at both locations with greater SPAD values for the Pioneer hybrid compared to the Dekalb indicating slightly greener upper canopy in the Pioneer plots. There was no interaction between hybrid and either S source or rate.

Table 7. Summary of leaf S concentration measured from the corn leaf opposite and below the ear at the R1 growth stage at four Minnesota locations during the 2022 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Rosemount | 0 | 0.16 | 0.15 | 0.16 | 0.14 | 0.15 |
| | 18 | 0.20 | 0.17 | 0.15 | 0.15 | 0.17 |
| | 36 | 0.20 | 0.19 | 0.18 | 0.18 | 0.19 |
| | So. x Hy | 0.19 | 0.17 | 0.16 | 0.15 | |
| | Source Avg. | 0.18 | | 0.16 | | |
| | Hybrid Avg. | 0.18a | 0.17b | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 0.18 | 0.18 | 0.18 | 0.17 | 0.18 |
| | 18 | 0.19 | 0.16 | 0.19 | 0.16 | 0.18 |
| | 36 | 0.16 | 0.16 | 0.17 | 0.16 | 0.16 |
| | So. x Hy | 0.18 | 0.17 | 0.18 | 0.16 | |
| | Source Avg. | 0.17 | | 0.17 | | |
| | Hybrid Avg. | 0.18 | 0.17 | -- | -- | -- |

R1 leaf S concentration data (ear and upper leaf) was not available at the time this report was written and will be included in the next year end report.

Table 8. Summary of leaf S concentration measured from the uppermost fully developed corn leaf at the R1 growth stage at four Minnesota locations during the 2022 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Rosemount | 0 | 0.17 | 0.17 | 0.18 | 0.15 | 0.17 |
| | 18 | 0.20 | 0.20 | 0.18 | 0.19 | 0.19 |
| | 36 | 0.20 | 0.19 | 0.20 | 0.20 | 0.20 |
| | So. x Hy | 0.19 | 0.19 | 0.19 | 0.18 | |
| | Source Avg. | 0.19 | | 0.18 | | |
| | Hybrid Avg. | 0.19 | 0.18 | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 0.17 | 0.17 | 0.17 | 0.16 | 0.17 |
| | 18 | 0.19 | 0.18 | 0.19 | 0.18 | 0.18 |
| | 36 | 0.17 | 0.17 | 0.20 | 0.20 | 0.19 |
| | So. x Hy | 0.18 | 0.17 | 0.19 | 0.18 | |
| | Source Avg. | 0.17 | | 0.18 | | |
| | Hybrid Avg. | 0.18 | 0.18 | -- | -- | -- |

Table 9. Summary of SPAD meter reading collected from the middle of the corn leaf opposite and below the ear at the R1 growth stage at four Minnesota locations during the 2022 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Rosemount | 0 | 53.8 | 52.4 | 53.2 | 51.2 | 52.6b |
| | 18 | 58.8 | 59.9 | 50.5 | 53.9 | 55.7ab |
| | 36 | 57.7 | 58.8 | 56.4 | 56.7 | 57.4a |
| | So. x Hy | 56.7 | 57.0 | 53.4 | 53.9 | |
| | Source Avg. | 56.9 | | 53.6 | | |
| | Hybrid Avg. | 55.1 | 55.5 | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 52.4 | 54.7 | 52.8 | 54.3 | 53.6 |
| | 18 | 51.7 | 54.7 | 52.4 | 54.5 | 53.3 |
| | 36 | 53.0 | 54.0 | 52.5 | 55.0 | 53.6 |
| | So. x Hy | 52.4 | 54.5 | 52.6 | 54.6 | |
| | Source Avg. | 53.4 | | 53.6 | | |
| | Hybrid Avg. | 52.5b | 54.5a | -- | -- | -- |

Table 10. Summary of SPAD meter reading collected from the uppermost fully developed corn leaf at the R1 growth stage at four Minnesota locations during the 2022 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Rosemount | 0 | 45.0 | 44.6 | 46.6 | 42.3 | 44.6 |
| | 18 | 49.0 | 48.2 | 42.3 | 43.2 | 45.7 |
| | 36 | 48.0 | 47.1 | 46.3 | 46.0 | 46.8 |
| | So. x Hy | 47.3 | 46.6 | 45.0 | 43.8 | |
| | Source Avg. | 47.0a | | 44.4b | | |
| | Hybrid Avg. | 46.2 | 45.2 | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 46.1 | 44.5 | 45.8 | 43.4 | 45.0 |
| | 18 | 45.7 | 44.0 | 45.3 | 45.2 | 45.0 |
| | 36 | 44.6 | 41.2 | 45.6 | 44.3 | 43.9 |
| | So. x Hy | 45.5 | 43.2 | 45.6 | 44.3 | |
| | Source Avg. | 44.3 | | 44.9 | | |
| | Hybrid Avg. | 45.5a | 43.8b | -- | -- | -- |

Leaf SPAD readings from the leaf opposite and below and the uppermost fully developed leaf at the R1 growth stage are summarized in Tables 9 and 10, respectively. At Rosemount, ear leaf SPAD readings were affected by S rate but not by source. SPAD readings were increased with the 18 lb S rate and did not differ between 18 and 36 lbs S per acre. Sulfur source only affected upper leaf SPAD readings at Rosemount where AMS had higher readings compared to ATS. At Waseca, source and rate did not impact ear- or upper leaf SPAD readings but variety affect both. Interestingly, SPAD values were greater for the Pioneer hybrid for the ear leaf readings, but the Pioneer SPAD values were less for the Upper leaf

readings indicating greener mid-canopy leaves but more yellow upper canopy leaves with the Pioneer hybrid. Again, there were no significant interactions between hybrid and sulfur source or rate.

Table 11. Summary of corn grain yield (reported at 15.5% moisture) response to S source and rate at four Minnesota locations during the 2022 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | bushels per acre | | |
| Rosemount | 0 | 172 | 185 | 185 | 174 | 179b |
| | 18 | 209 | 218 | 179 | 192 | 200a |
| | 36 | 196 | 205 | 196 | 213 | 203a |
| | So. x Hy | 192 | 203 | 187 | 193 | |
| | Source Avg. | 196 | | 191 | | |
| | Hybrid Avg. | 183b | 205a | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 213 | 224 | 213 | 220 | 217 |
| | 18 | 217 | 222 | 209 | 227 | 219 |
| | 36 | 212 | 213 | 219 | 232 | 219 |
| | So. x Hy | 214bc | 220b | 213c | 227a | |
| | Source Avg. | 217b | | 220a | | |
| | Hybrid Avg. | 214b | 224a | -- | -- | -- |

Corn grain yield data are summarized in Table 11. Hybrid varied at both locations with greater yield for the Pionner hybrid compared to the Dekalb. There were no significant interactions between variety and either S source or rate at Rosemount. Sulfur rate differed at Rosemount with higher yield for the 18 lb S rate compared to the control, and no additional increase in yield for the 36 lb rate over 18 lbs S per acre. At Waseca there was a significant source and variety by source interaction. The variety by source interaction indicated yield was the greatest when ATS was applied with the Pioneer hybrid. This combination of ATS with the Pioneer hybrid resulted in greater yield than either source with the Dekalb hybrid and AMS with the Pioneer hybrid. At Waseca, ATS tended to produce greater yield, but the effect was less pronounced for the Dekalb hybrid. This is only the first year of this study so more years will help to determine whether there is consistency in the effect of sources based on variety over time.

Corn grain S concentration is summarized in Table 12.

Table 12. Summary of corn grain S concentration response to S source and rate at four Minnesota locations during the 2022 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Rosemount | 0 | 0.086 | 0.093 | 0.091 | 0.078 | 0.087b |
| | 18 | 0.114 | 0.118 | 0.094 | 0.086 | 0.103a |
| | 36 | 0.115 | 0.111 | 0.107 | 0.104 | 0.109a |
| | So. x Hy | 0.105 | 0.107 | 0.097 | 0.089 | |
| | Source Avg. | 0.106a | | 0.092b | | |
| | Hybrid Avg. | 0.101 | 0.098 | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 0.106 | 0.110 | 0.100 | 0.097 | 0.103 |
| | 18 | 0.107 | 0.112 | 0.111 | 0.110 | 0.110 |
| | 36 | 0.114 | 0.101 | 0.113 | 0.106 | 0.109 |
| | So. x Hy | 0.109 | 0.107 | 0.108 | 0.105 | |
| | Source Avg. | 0.108 | | 0.106 | | |
| | Hybrid Avg. | 0.109 | 0.106 | -- | -- | -- |

Corn grain S concentration data was not available at the time this report was written and will be included in the next year end report.

Soil sulfate-S content was measured post-harvest but did not vary based on sulfur source, rate, or hybrid (Table 13).

Table 13. Summary of post-harvest two-foot soil extractable sulfate-S response to S source and rate at four Minnesota locations during the 2022 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | pounds sulfate-S per acre | | | | |
| Rosemount | 0 | 123 | 115 | 133 | 136 | 126 |
| | 18 | 139 | 148 | 116 | 117 | 130 |
| | 36 | 129 | 119 | 130 | 118 | 124 |
| | So. x Hy | 130 | 127 | 126 | 123 | |
| | Source Avg. | 129 | | 125 | | |
| | Hybrid Avg. | 128 | 125 | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 96 | 103 | 113 | 114 | 107 |
| | 18 | 94 | 95 | 97 | 86 | 93 |
| | 36 | 119 | 118 | 122 | 110 | 117 |
| | So. x Hy | 103 | 105 | 111 | 103 | |
| | Source Avg. | 104 | | 107 | | |
| | Hybrid Avg. | 107 | 104 | -- | -- | -- |

Table 14. Summary of ANOVA analysis for measured agronomic variables for two soybean trial locations studied during 2023.

| Main Effect | R1 Leaf S Conc. | Yield | Grain S Conc. | Protein | Oil | Cysteine | Methionine | Fall Soil S |
|---|---|---|---|---|---|---|---|---|
| | | | | *P*>F | | | | |
| | | | | Rosemount | | | | |
| S Source | 0.30 | 0.60 | 0.24 | 0.71 | 0.27 | 0.15 | 0.10 | 0.73 |
| S Rate | 0.92 | 0.53 | 0.58 | 0.42 | 0.47 | * | 0.19 | 0.79 |
| So x R | 0.76 | 0.19 | 0.34 | * | 0.10 | 0.82 | 0.47 | 0.51 |
| Hybrid | 0.33 | *** | 0.34 | 0.82 | 0.51 | 0.67 | 0.40 | 0.73 |
| So x Hy | 0.24 | 0.81 | 0.65 | 0.58 | 0.17 | 0.89 | 0.81 | 0.69 |
| Rate x Hy | 0.53 | 0.34 | 0.75 | * | 0.17 | 0.52 | 0.19 | 0.72 |
| R x So x H | 0.23 | 0.43 | 0.77 | 0.18 | 0.22 | 0.73 | 0.35 | 0.98 |
| | | | | Waseca | | | | |
| S Source | 0.94 | 0.60 | * | * | * | * | ** | 0.32 |
| S Rate | 0.30 | 0.12 | 0.21 | 0.07 | 0.70 | ** | * | 0.12 |
| So x R | 0.99 | 0.27 | 0.57 | 0.31 | 0.87 | 0.08 | 0.31 | * |
| Hybrid | 0.94 | * | 0.89 | 0.74 | 0.44 | 0.92 | 0.85 | 0.42 |
| So x Hy | 0.74 | 0.90 | 0.76 | 0.36 | 0.44 | 0.76 | 0.85 | 0.80 |
| Rate x Hy | 0.92 | 0.44 | 0.50 | 0.34 | * | 0.18 | 0.34 | 0.13 |
| R x So x H | 0.73 | 0.38 | 0.67 | * | 0.67 | 0.21 | 0.09 | 0.41 |

**, **, and *** represent treatment significance at P≤0,05, 0,01, and 0,001 probability levels.*

***2023 Soybean Results***

There were very few responses to sulfur at the two soybean locations in 2023. Soybean trifoliate S concentration (Table 15) and grain yield (Table 16) were not impacted by sulfur applied the previous year before corn at either location. However, soybean grain yield did vary at both locations based on the previous corn hybrid. In both cases soybean grain yield was higher for plots planted to the Dekalb hybrid in 2022. From Table 11, the Dekalb hybrid yielded less in 2022 compared to the Pioneer hybrid.

The only consistent significant impact of the previous sulfur application was on seed S concentration, protein, and cysteine and methionine content at Waseca. Seed cysteine content was also impacted by S application at Rosemount. The increase in the amount of S does indicate some carryover potential for S from the year of application to the following year. While grain yield was not impacted the benefit to protein content was somewhat surprising but the increase in seed S concentration and slightly higher S containing protein has been seen in the past.

Table 15. Summary of soybean trifoliate S concentration for the uppermost fully developed trifoliate (leaflets and petiole) at two Minnesota locations during the 2023 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | %S | | |
| Rosemount | 0 | 0.284 | 0.290 | 0.295 | 0.269 | 0.284 |
| | 18 | 0.302 | 0.283 | 0.281 | 0.276 | 0.285 |
| | 36 | 0.275 | 0.289 | 0.285 | 0.275 | 0.281 |
| | So. x Hy | 0.287 | 0.287 | 0.287 | 0.273 | |
| | Source Avg. | 0.287 | | 0.280 | | |
| | Hybrid Avg. | 0.287 | 0.280 | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 0.250 | 0.257 | 0.257 | 0.246 | 0.253 |
| | 18 | 0.245 | 0.242 | 0.246 | 0.246 | 0.245 |
| | 36 | 0.275 | 0.278 | 0.298 | 0.282 | 0.282 |
| | So. x Hy | 0.257 | 0.259 | 0.264 | 0.258 | |
| | Source Avg. | 0.258 | | 0.259 | | |
| | Hybrid Avg. | 0.258 | 0.259 | -- | -- | |

Table 16. Summary of soybean grain yield (reported at 13% moisture) response to S source and rate at two Minnesota locations during the 2023 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | bushels per acre | | |
| Rosemount | 0 | 35.7 | 33.9 | 44.9 | 40.1 | 38.7 |
| | 18 | 48.6 | 46.0 | 35.1 | 32.3 | 40.5 |
| | 36 | 37.9 | 36.3 | 38.0 | 36.7 | 37.2 |
| | So. x Hy | 40.7 | 38.7 | 39.3 | 36.3 | |
| | Source Avg. | 38.1 | | 38.6 | | |
| | Hybrid Avg. | 39.3a | 37.4b | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 62.6 | 62.5 | 61.4 | 60.5 | 61.7 |
| | 18 | 64.2 | 62.3 | 64.6 | 63.4 | 63.6 |
| | 36 | 63.1 | 61.1 | 63.9 | 62.5 | 62.6 |
| | So. x Hy | 63.3 | 62.0 | 63.3 | 62.1 | |
| | Source Avg. | 62.2 | | 61.6 | | |
| | Hybrid Avg. | 62.7a | 61.1b | -- | -- | -- |

Table 18. Summary of soybean grain S concentration response to S source and rate at two Minnesota locations during the 2023 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | %S | | |
| Rosemount | 0 | 0.335 | 0.326 | 0.291 | 0.288 | 0.310 |
| | 18 | 0.316 | 0.307 | 0.328 | 0.313 | 0.316 |
| | 36 | 0.346 | 0.354 | 0.326 | 0.318 | 0.336 |
| | So. x Hy | 0.332 | 0.329 | 0.315 | 0.306 | |
| | Source Avg. | 0.330 | | 0.311 | | |
| | Hybrid Avg. | 0.324 | 0.317 | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 0.265 | 0.258 | 0.253 | 0.248 | 0.256 |
| | 18 | 0.286 | 0.293 | 0.255 | 0.250 | 0.271 |
| | 36 | 0.291 | 0.296 | 0.266 | 0.274 | 0.282 |
| | So. x Hy | 0.281 | 0.282 | 0.258 | 0.257 | |
| | Source Avg. | 0.282a | | 0.258b | | |
| | Hybrid Avg. | 0.269 | 0.270 | -- | -- | -- |

Table 19. Summary of soybean grain protein concentration response to S source and rate at two Minnesota locations during the 2023 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | % Protein @ 13% Moisture | | | | |
| Rosemount | 0 | 34.1 | 34.9 | 33.6 | 33.7 | 34.1 |
| | 18 | 33.9 | 33.8 | 34.3 | 34.2 | 34.0 |
| | 36 | 34.4 | 34.0 | 34.5 | 34.4 | 34.4 |
| | So. x Hy | 34.1 | 34.2 | 34.1 | 34.1 | |
| | Source Avg. | 34.2 | | 34.1 | | |
| | Hybrid Avg. | 34.2 | 34.2 | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 33.3 | 33.4 | 33.1 | 33.3 | 33.3b |
| | 18 | 33.3 | 33.4 | 33.4 | 33.1 | 33.3b |
| | 36 | 33.9 | 33.6 | 33.2 | 33.6 | 33.6a |
| | So. x Hy | 33.5 | 33.5 | 33.2 | 33.3 | |
| | Source Avg. | 33.5a | | 33.3b | | |
| | Hybrid Avg. | 33.4 | 33.4 | -- | -- | -- |

Table 20. Summary of soybean grain oil concentration response to S source and rate at two Minnesota locations during the 2023 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | % Oil @ 13% Moisture | | | | |
| Rosemount | 0 | 18.7 | 18.6 | 19.1 | 19.0 | 18.9 |
| | 18 | 18.5 | 18.8 | 19.0 | 19.3 | 18.9 |
| | 36 | 18.6 | 19.1 | 18.6 | 18.4 | 18.7 |
| | So. x Hy | 18.6 | 18.8 | 18.9 | 18.9 | |
| | Source Avg. | 18.7 | | 18.9 | | |
| | Hybrid Avg. | 18.8 | 18.9 | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 18.8 | 18.8 | 19.0 | 18.8 | 18.9 |
| | 18 | 18.6 | 19.0 | 18.8 | 19.2 | 18.9 |
| | 36 | 18.6 | 18.6 | 19.0 | 18.8 | 18.8 |
| | So. x Hy | 18.7 | 18.8 | 18.9 | 18.9 | |
| | Source Avg. | 18.7b | | 18.9a | | |
| | Hybrid Avg. | 18.8 | 18.9 | -- | -- | -- |

Table 21. Summary of soybean grain cysteine response to S source and rate at two Minnesota locations during the 2023 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | Cysteine as % of total protein | | | | |
| Rosemount | 0 | 0.50 | 0.52 | 0.49 | 0.50 | 0.50b |
| | 18 | 0.52 | 0.51 | 0.50 | 0.50 | 0.51b |
| | 36 | 0.53 | 0.53 | 0.52 | 0.52 | 0.52a |
| | So. x Hy | 0.52 | 0.52 | 0.50 | 0.50 | |
| | Source Avg. | 0.50 | | 0.52 | | |
| | Hybrid Avg. | 0.51 | 0.51 | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 0.50 | 0.51 | 0.51 | 0.51 | 0.51b |
| | 18 | 0.53 | 0.53 | 0.52 | 0.50 | 0.52a |
| | 36 | 0.55 | 0.54 | 0.51 | 0.52 | 0.53a |
| | So. x Hy | 0.52 | 0.53 | 0.51 | 0.51 | |
| | Source Avg. | 0.52a | | 0.51b | | |
| | Hybrid Avg. | 0.52 | 0.52 | -- | -- | -- |

\

Table 22. Summary of soybean grain methionine concentration response to S source and rate at two Minnesota locations during the 2023 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | Methionine as % of total protein | | | | |
| Rosemount | 0 | 0.52 | 0.53 | 0.51 | 0.51 | 0.51 |
| | 18 | 0.53 | 0.52 | 0.51 | 0.51 | 0.52 |
| | 36 | 0.52 | 0.53 | 0.52 | 0.53 | 0.53 |
| | So. x Hy | 0.52 | 0.53 | 0.51 | 0.52 | |
| | Source Avg. | 0.52b | | 0.51b | | |
| | Hybrid Avg. | 0.52 | 0.52 | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 0.51 | 0.51 | 0.50 | 0.51 | 0.50b |
| | 18 | 0.51 | 0.51 | 0.51 | 0.50 | 0.50b |
| | 36 | 0.52 | 0.52 | 0.51 | 0.51 | 0.51a |
| | So. x Hy | 0.51 | 0.51 | 0.51 | 0.50 | |
| | Source Avg. | 0.51a | | 0.50b | | |
| | Hybrid Avg. | 0.51 | 0.51 | -- | -- | -- |

Table 17. Summary of soil test $SO_4$-S after harvest response to S source and rate at two Minnesota locations during the 2023 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | lb $SO_4$-S per acres in a 2-foot soil sample | | | | |
| Rosemount | 0 | 82 | 81 | 97 | 92 | 88 |
| | 18 | 96 | 94 | 85 | 77 | 88 |
| | 36 | 80 | 84 | 72 | 74 | 78 |
| | So. x Hy | 86 | 86 | 84 | 81 | |
| | Source Avg. | 86 | | 83 | | |
| | Hybrid Avg. | 85 | 84 | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 68 | 73 | 98 | 89 | 82 |
| | 18 | 71 | 70 | 70 | 84 | 74 |
| | 36 | 96 | 78 | 89 | 76 | 85 |
| | So. x Hy | 78 | 74 | 85 | 83 | |
| | Source Avg. | 76 | | 84 | | |
| | Hybrid Avg. | 82 | 78 | -- | -- | -- |

Table 18. Summary of ANOVA analysis for measured agronomic variables for two corn trial locations studied during 2023.

| Main Effect | V5 NDRE | V10 Leaf S | V10 SPAD | R1 Ear Leaf S | R1 Up. Leaf S | R1 EL SPAD | R1 UL SPAD | Yield | Grain S | Fall $SO_4$-S |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *P*>F | | | | | |
| | | | | | Lamberton | | | | | |
| S Source | 0.26 | 0.77 | 0.79 | * | 0.44 | 0.11 | 0.32 | 0.48 | 0.14 | 0.98 |
| S Rate | 0.17 | ** | *** | 0.27 | 0.36 | 0.82 | 0.55 | 0.43 | 0.10 | 0.27 |
| So x R | 0.34 | 0.10 | *** | 0.12 | * | 0.73 | 0.28 | 0.07 | 0.46 | 0.62 |
| Hybrid | 0.59 | 0.90 | * | 0.74 | 0.07 | 0.52 | ** | ** | * | * |
| So x Hy | 0.32 | 0.20 | 0.46 | 0.16 | 0.49 | 0.61 | 0.30 | 0.33 | 0.62 | 0.44 |
| Rate x Hy | 0.07 | 0.50 | 0.58 | ** | 0.09 | 0.46 | 0.07 | 0.77 | 0.80 | 0.94 |
| R x So x H | 0.84 | 0.76 | 0.95 | 0.66 | 0.63 | 0.64 | 0.74 | * | 0.08 | 0.14 |
| | | | | | Rochester | | | | | |
| S Source | 0.39 | 0.67 | 0.40 | | | | | * | 0.92 | * |
| S Rate | 0.27 | 0.11 | 0.34 | | | | | 0.74 | 0.38 | 0.42 |
| So x R | 0.81 | 0.43 | 0.73 | | | | | 0.42 | 0.90 | 0.53 |
| Hybrid | 0.16 | 0.88 | ** | | | | | 0.06 | *** | 0.94 |
| So x Hy | 0.99 | 0.54 | 0.61 | | | | | 0.77 | 0.74 | 0.34 |
| Rate x Hy | 0.35 | 0.06 | 0.82 | | | | | 0.06 | 0.29 | 0.98 |
| R x So x H | 0.62 | * | 0.96 | | | | | 0.98 | 0.16 | 0.82 |

**, **, and *** represent treatment significance at P≤0,05, 0,01, and 0,001 probability levels.*

***2023 Corn trial results***

A summary table for the ANOVA for all measured variables for the 2023 growing season is given in Table 18. Individual variables will be discussed in the following tables. No data were collected at R1 at Rochester due to a loss of leaves by a hail event that occurred in July. Yield data was collected at Rochester as planned.

Table 19. Summary of early plant vigor measured at the normalized difference red-edge (NDRE) data collected with a Crop Circle 430 active sensor collected at the corn V5 growth stage.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Lamberton | 0 | 0.197 | 0.202 | 0.204 | 0.199 | 0.201 |
| | 18 | 0.231 | 0.216 | 0.211 | 0.194 | 0.213 |
| | 36 | 0.215 | 0.224 | 0.214 | 0.213 | 0.216 |
| | So. x Hy | 0.214 | 0.214 | 0.210 | 0.202 | |
| | Source Avg. | 0.214 | | 0.206 | | |
| | Hybrid Avg. | 0.212 | 0.208 | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 0.268 | 0.270 | 0.249 | 0.244 | 0.258 |
| | 18 | 0.282 | 0.270 | 0.276 | 0.264 | 0.273 |
| | 36 | 0.292 | 0.279 | 0.284 | 0.278 | 0.283 |
| | So. x Hy | 0.281 | 0.273 | 0.270 | 0.262 | |
| | Source Avg. | 0.277 | | 0.266 | | |
| | Hybrid Avg. | 0.275 | 0.267 | -- | -- | -- |

Table 20. Summary of corn leaf S concentration measured from the uppermost fully developed corn leaf at the V10 growth stage at two Minnesota locations during the 2023 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Lamberton | 0 | 0.22 | 0.23 | 0.26 | 0.27 | 0.24b |
| | 18 | 0.32 | 0.30 | 0.30 | 0.31 | 0.31a |
| | 36 | 0.31 | 0.30 | 0.28 | 0.28 | 0.29a |
| | So. x Hy | 0.28 | 0.28 | 0.28 | 0.29 | |
| | Source Avg. | 0.28 | | 0.28 | | |
| | Hybrid Avg. | 0.28 | 0.28 | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 0.24 | 0.24 | 0.23 | 0.24 | 0.24 |
| | 18 | 0.24 | 0.22 | 0.23 | 0.23 | 0.23 |
| | 36 | 0.23 | 0.24 | 0.25 | 0.24 | 0.24 |
| | So. x Hy | 0.23 | 0.23 | 0.24 | 0.24 | |
| | Source Avg. | 0.23 | | 0.24 | | |
| | Hybrid Avg. | 0.24 | 0.23 | -- | -- | -- |

Table 21. Summary of SPAD meter reading collected from the middle of the uppermost fully developed corn leaf at the V10 growth stage at four Minnesota locations during the 2023 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Lamberton | 0 | 41.1 | 43.4 | 44.4 | 47.7 | 44.2b |
| | 18 | 46.2 | 47.8 | 43.6 | 46.0 | 45.9a |
| | 36 | 46.4 | 47.9 | 45.4 | 47.2 | 46.7a |
| | So. x Hy | 44.6 | 46.3 | 44.5 | 47.0 | |
| | Source Avg. | 45.5 | | 45.7 | | |
| | Hybrid Avg. | 44.5b | 46.7a | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 54.6 | 55.6 | 54.3 | 56.0 | 55.1 |
| | 18 | 54.0 | 55.2 | 54.8 | 56.1 | 55.0 |
| | 36 | 53.5 | 55.1 | 53.4 | 55.5 | 54.4 |
| | So. x Hy | 54.0 | 55.3 | 54.1 | 55.9 | |
| | Source Avg. | 54.6 | | 55.0 | | |
| | Hybrid Avg. | 54.1b | 55.6a | -- | -- | -- |

Early season NDRE measured at V5 was not impacted by any main effect (Table 19) Corn V10 leaf SPAD meter readings were not affected by sulfur source or rate at Rosemount but V10 SPAD was affected by rate at Lamberton (Tables 20 and 21). However, SPAD readings between hybrid did vary at both locations with greater SPAD values for the Pioneer hybrid compared to the Dekalb indicating slightly greener upper canopy in the Pioneer plots, which is similar to 2022. There was no interaction between hybrid and either S source or rate.

Table 22. Summary of leaf S concentration measured from the corn leaf opposite and below the ear at the R1 growth stage at four Minnesota locations during the 2023 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Lamberton | 0 | 0.15 | 0.13 | 0.18 | 0.17 | 0.16 |
| | 18 | 0.17 | 0.18 | 0.17 | 0.18 | 0.18 |
| | 36 | 0.16 | 0.16 | 0.17 | 0.18 | 0.17 |
| | So. x Hy | 0.16 | 0.16 | 0.17 | 0.18 | |
| | Source Avg. | 0.16b | | 0.18a | | |
| | Hybrid Avg. | 0.17 | 0.17 | -- | -- | -- |

Ear and upper leaf samples were not collected at Rochester in 2023 due to hail. Ear leaf S concentration was impacted by hybrid but not by S source or rate (Table 22). Upper leaf S concentration was not affected by source, rate or hybrid. This is like what happened in 2022 at both locations.

Table 23. Summary of leaf S concentration measured from the uppermost fully developed corn leaf at the R1 growth stage at four Minnesota locations during the 2023 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Lamberton | 0 | 0.17 | 0.17 | 0.20 | 0.20 | 0.18 |
| | 18 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| | 36 | 0.19 | 0.19 | 0.17 | 0.18 | 0.18 |
| | So. x Hy | 0.18 | 0.19 | 0.19 | 0.19 | |
| | Source Avg. | 0.19 | | 0.19 | | |
| | Hybrid Avg. | 0.18b | 0.19a | -- | -- | -- |

Table 24. Summary of SPAD meter reading collected from the middle of the corn leaf opposite and below the ear at the R1 growth stage at four Minnesota locations during the 2023 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Lamberton | 0 | 46.9 | 48.0 | 49.2 | 50.0 | 48.5 |
| | 18 | 47.1 | 48.0 | 49.4 | 50.8 | 48.8 |
| | 36 | 47.0 | 47.6 | 49.2 | 47.9 | 47.9 |
| | So. x Hy | 47.0 | 47.9 | 49.2 | 49.5 | |
| | Source Avg. | 47.4 | | 49.3 | | |
| | Hybrid Avg. | 48.1 | 48.7 | -- | -- | -- |

Table 25. Summary of SPAD meter reading collected from the uppermost fully developed corn leaf at the R1 growth stage at four Minnesota locations during the 2023 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Lamberton | 0 | 41.5 | 39.3 | 43.2 | 40.3 | 41.1 |
| | 18 | 43.7 | 40.0 | 44.7 | 39.2 | 41.9 |
| | 36 | 41.9 | 39.7 | 43.7 | 41.3 | 41.7 |
| | So. x Hy | 42.3 | 39.7 | 43.8 | 40.3 | |
| | Source Avg. | 41.0 | | 42.0 | | |
| | Hybrid Avg. | 43.1a | 40.0b | -- | -- | -- |

Leaf SPAD readings from the leaf opposite and below and the uppermost fully developed leaf at the R1 growth stage are summarized in Tables 24 and 25, respectively. Ear leaf SPAD values were not affected by source, rate, or hybrid. However, upper leaf SPAD values differed by hybrid like 2022, the Pioneer hybrid had a significantly lower SPAD values than the Dekalb. No interactions were present between source or rate and hybrid.

Table 26. Summary of corn grain yield (reported at 15.5% moisture) response to S source and rate at four Minnesota locations during the 2023 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | bushels per acre | | |
| Lamberton | 0 | 133 | 109 | 128 | 135 | 126 |
| | 18 | 145 | 134 | 133 | 118 | 132 |
| | 36 | 132 | 127 | 131 | 117 | 127 |
| | So. x Hy | 137 | 123 | 131 | 123 | |
| | Source Avg. | 130 | | 127 | | |
| | Hybrid Avg. | 134a | 123b | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 178 | 175 | 163 | 161 | 169 |
| | 18 | 181 | 168 | 175 | 162 | 172 |
| | 36 | 178 | 171 | 172 | 167 | 172 |
| | So. x Hy | 179 | 171 | 170 | 163 | |
| | Source Avg. | 175a | | 167b | | |
| | Hybrid Avg. | 175a | 167b | -- | -- | -- |

Corn grain yield data are summarized in Table 26. Hybrid varied at only at Rochester with greater yield for the Dekalb hybrid. Source or rate did not impact corn grain yield. Corn grain yield was low overall at Lamberton due to drought. The lower yield may have limited the potential for S response. Yield at Rochester was relatively high considering a significant loss of leaves due to hail. Corn grain S concentration is summarized in Table 27 and was affected by hybrid at both locations where grain S concentration was greater for the Pioneer hybrid, and grain S concentration increased with increasing S application rate.

Table 27. Summary of corn grain S concentration response to S source and rate at four Minnesota locations during the 2023 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | ---%S-- | | |
| Lamberton | 0 | 0.119 | 0.123 | 0.115 | 0.130 | 0.122b |
| | 18 | 0.122 | 0.133 | 0.130 | 0.141 | 0.131a |
| | 36 | 0.122 | 0.135 | 0.128 | 0.133 | 0.129a |
| | So. x Hy | 0.121 | 0.130 | 0.124 | 0.135 | |
| | Source Avg. | 0.126 | | 0.129 | | |
| | Hybrid Avg. | 0.123b | 0.132a | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 0.109 | 0.123 | 0.107 | 0.122 | 0.115 |
| | 18 | 0.110 | 0.119 | 0.109 | 0.123 | 0.115 |
| | 36 | 0.104 | 0.117 | 0.106 | 0.116 | 0.111 |
| | So. x Hy | 0.107 | 0.120 | 0.107 | 0.120 | |
| | Source Avg. | 0.114 | | 0.114 | | |
| | Hybrid Avg. | 0.107b | 0.120a | -- | -- | -- |

Soil sulfate-S content was measured post-harvest but did not vary based on sulfur source, rate, or hybrid (Table 28). Soil samples were collected at Lamberton, but samples were not analyzed at the time of this report.

Table 28. Summary of post-harvest two-foot soil extractable sulfate-S response to S source and rate at four Minnesota locations during the 2023 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | pounds sulfate-S per acre | | | | |
| Lamberton | 0 | 299 | 261 | 312 | 651 | 381 |
| | 18 | 711 | 799 | 437 | 702 | 662 |
| | 36 | 251 | 500 | 371 | 368 | 373 |
| | So. x Hy | 420 | 520 | 373 | 573 | |
| | Source Avg. | 470 | | 473 | | |
| | Hybrid Avg. | 397b | 547a | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 93 | 88 | 84 | 88 | 88 |
| | 18 | 95 | 92 | 84 | 87 | 90 |
| | 36 | 98 | 99 | 86 | 87 | 92 |
| | So. x Hy | 95 | 93 | 84 | 87 | |
| | Source Avg. | 94a | | 86b | | |
| | Hybrid Avg. | 90 | 90 | -- | -- | -- |

Table 29. Summary of ANOVA analysis for measured agronomic variables for two soybean trial locations studied during 2024.

| Main Effect | R1 Leaf S Conc. | Yield | Grain S Conc. | Protein | Oil | Cysteine | Methionine | Fall Soil S |
|---|---|---|---|---|---|---|---|---|
| | | | | *P*>F | | | | |
| | | | | Lamberton | | | | |
| S Source | 0.47 | 0.94 | 0.84 | 0.22 | 0.19 | 0.17 | 0.90 | * |
| S Rate | * | 0.61 | 0.18 | 0.15 | 0.51 | 0.19 | 0.14 | 0.22 |
| So x R | 0.50 | 0.32 | 0.25 | 0.65 | 0.94 | 0.37 | 0.51 | 0.47 |
| Hybrid | 0.27 | 0.72 | 0.95 | 0.79 | 0.48 | 0.57 | 0.82 | 0.19 |
| So x Hy | 0.68 | 0.78 | 0.56 | 0.54 | 0.48 | 0.39 | 0.65 | 0.06 |
| Rate x Hy | 0.76 | * | 0.58 | 0.50 | 0.94 | 0.27 | 0.28 | 0.19 |
| R x So x H | 0.97 | 0.47 | 0.68 | 0.50 | 0.64 | 0.50 | 0.26 | 0.33 |
| | | | | Rochester | | | | |
| S Source | 0.52 | 0.95 | 0.52 | 0.17 | 0.48 | 0.92 | 0.70 | 0.10 |
| S Rate | 0.50 | 0.99 | 0.77 | 0.55 | 0.35 | 0.69 | 0.34 | 0.21 |
| So x R | 0.92 | 0.84 | 0.92 | 0.43 | 0.29 | 0.11 | 0.08 | 0.76 |
| Hybrid | 0.41 | 0.44 | 0.74 | 0.79 | 0.07 | 0.16 | 0.43 | ** |
| So x Hy | 0.30 | 0.74 | 0.75 | * | 0.52 | 0.23 | 0.43 | 0.76 |
| Rate x Hy | 0.14 | 0.14 | 0.63 | 0.47 | 0.92 | 0.92 | 0.62 | 0.90 |
| R x So x H | 0.15 | 0.23 | 0.48 | 0.42 | 0.90 | 0.32 | 0.08 | 0.87 |

**, **, and *** represent treatment significance at P≤0,05, 0,01, and 0,001 probability levels.*

***2024 Soybean Results***

There were very few responses to sulfur at the two soybean locations in 2024. Soybean trifoliate S concentration (Table 30) and grain yield (Table 31) were not impacted by sulfur applied the previous year before corn at either location. Soybean Grain Yield and seed protein, oil, cysteine and methionine content were also not affected by source or rate of sulfur. The only response was found for post-harvest 2-foot soil test sulfate-S concentration which was greater when AMS was applied versus ATS. The lack of response in the soybean year was similar to what was found in 2023 for the two soybean locations at Rosemount and Waseca.

Table 30. Summary of soybean trifoliate S concentration for the uppermost fully developed trifoliate (leaflets and petiole) at two Minnesota locations during the 2024 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | %S | | |
| Lamberton | 0 | 0.179 | 0.184 | 0.190 | 0.199 | 0.188b |
| | 18 | 0.205 | 0.207 | 0.195 | 0.202 | 0.202a |
| | 36 | 0.201 | 0.201 | 0.194 | 0.194 | 0.197a |
| | So. x Hy | 0.195 | 0.197 | 0.193 | 0.198 | |
| | Source Avg. | 0.197 | | 0.194 | | |
| | Hybrid Avg. | 0.194 | 0.198 | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 0.218 | 0.219 | 0.221 | 0.233 | 0.223 |
| | 18 | 0.225 | 0.233 | 0.232 | 0.199 | 0.222 |
| | 36 | 0.229 | 0.220 | 0.238 | 0.232 | 0.230 |
| | So. x Hy | 0.224 | 0.224 | 0.230 | 0.221 | |
| | Source Avg. | 0.221 | | 0.228 | | |
| | Hybrid Avg. | 0.227 | 0.222 | -- | -- | |

Table 31. Summary of soybean grain yield (reported at 13% moisture) response to S source and rate at two Minnesota locations during the 2024 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | bushels per acre | | |
| Lamberton | 0 | 48.0 | 50.9 | 48.3 | 54.6 | 50.5 |
| | 18 | 53.1 | 54.5 | 49.3 | 48.6 | 51.4 |
| | 36 | 55.7 | 54.1 | 52.4 | 48.4 | 52.6 |
| | So. x Hy | 52.3 | 53.2 | 50.0 | 50.5 | |
| | Source Avg. | 49.5 | | 49.3 | | |
| | Hybrid Avg. | 49.2 | 49.6 | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 69.5 | 69.7 | 64.2 | 68.3 | 67.9 |
| | 18 | 68.3 | 66.5 | 68.1 | 68.1 | 67.7 |
| | 36 | 66.3 | 68.5 | 68.1 | 67.1 | 67.5 |
| | So. x Hy | 68.0 | 68.2 | 66.8 | 67.8 | |
| | Source Avg. | 68.2 | | 68.1 | | |
| | Hybrid Avg. | 67.9 | 68.5 | -- | -- | -- |

Table 32. Summary of soybean grain S concentration response to S source and rate at two Minnesota locations during the 2024 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | %S | | |
| Lamberton | 0 | 0.291 | 0.285 | 0.295 | 0.287 | 0.289 |
| | 18 | 0.295 | 0.298 | 0.309 | 0.314 | 0.304 |
| | 36 | 0.310 | 0.305 | 0.288 | 0.300 | 0.301 |
| | So. x Hy | 0.299 | 0.296 | 0.297 | 0.300 | |
| | Source Avg. | 0.297 | | 0.299 | | |
| | Hybrid Avg. | 0.298 | 0.298 | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 0.272 | 0.265 | 0.272 | 0.258 | 0.267 |
| | 18 | 0.292 | 0.278 | 0.268 | 0.273 | 0.278 |
| | 36 | 0.275 | 0.297 | 0.281 | 0.275 | 0.281 |
| | So. x Hy | 0.279 | 0.278 | 0.274 | 0.269 | |
| | Source Avg. | 0.279 | | 0.271 | | |
| | Hybrid Avg. | 0.277 | 0.274 | -- | -- | -- |

Table 33. Summary of soybean grain protein concentration response to S source and rate at two Minnesota locations during the 2024 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | % Protein @ 13% Moisture | | | | |
| Lamberton | 0 | 33.3 | 33.9 | 33.6 | 33.5 | 33.6 |
| | 18 | 33.9 | 34.1 | 34.0 | 33.9 | 34.0 |
| | 36 | 34.1 | 33.8 | 33.8 | 33.8 | 33.9 |
| | So. x Hy | 33.8 | 33.9 | 33.8 | 33.7 | |
| | Source Avg. | 33.9 | | 33.7 | | |
| | Hybrid Avg. | 33.8 | 33.8 | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 34.1 | 33.7 | 33.8 | 34.5 | 34.0 |
| | 18 | 34.1 | 33.9 | 34.0 | 34.0 | 34.0 |
| | 36 | 34.2 | 33.7 | 34.3 | 34.5 | 34.2 |
| | So. x Hy | 34.1 | 33.8 | 34.0 | 34.3 | |
| | Source Avg. | 34.0 | | 34.2 | | |
| | Hybrid Avg. | 34.1 | 34.0 | -- | -- | -- |

Table 34. Summary of soybean grain oil concentration response to S source and rate at two Minnesota locations during the 2024 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | % Oil @ 13% Moisture | | | | |
| Lamberton | 0 | 20.3 | 20.2 | 20.4 | 20.3 | 20.3 |
| | 18 | 20.2 | 20.1 | 20.3 | 20.3 | 20.2 |
| | 36 | 20.0 | 20.1 | 20.4 | 20.0 | 20.1 |
| | So. x Hy | 20.2 | 20.1 | 20.4 | 20.2 | |
| | Source Avg. | 20.1 | | 20.3 | | |
| | Hybrid Avg. | 20.3 | 20.2 | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 19.0 | 18.9 | 19.3 | 19.1 | 19.1 |
| | 18 | 19.1 | 19.1 | 19.2 | 19.0 | 19.1 |
| | 36 | 19.1 | 18.9 | 19.0 | 18.8 | 18.9 |
| | So. x Hy | 19.0 | 19.0 | 19.2 | 19.0 | |
| | Source Avg. | 19.0 | | 19.1 | | |
| | Hybrid Avg. | 19.1 | 19.0 | -- | -- | -- |

Table 35. Summary of soybean grain cysteine response to S source and rate at two Minnesota locations during the 2024 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | Cysteine as % of total protein | | | | |
| Lamberton | 0 | 0.53 | 0.57 | 0.55 | 0.56 | 0.55 |
| | 18 | 0.57 | 0.59 | 0.58 | 0.57 | 0.57 |
| | 36 | 0.58 | 0.57 | 0.56 | 0.56 | 0.57 |
| | So. x Hy | 0.56 | 0.57 | 0.56 | 0.56 | |
| | Source Avg. | 0.57 | | 0.56 | | |
| | Hybrid Avg. | 0.56 | 0.57 | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 0.58 | 0.57 | 0.57 | 0.59 | 0.58 |
| | 18 | 0.58 | 0.59 | 0.57 | 0.58 | 0.58 |
| | 36 | 0.58 | 0.58 | 0.58 | 0.59 | 0.58 |
| | So. x Hy | 0.58 | 0.58 | 0.57 | 0.58 | |
| | Source Avg. | 0.58 | | 0.58 | | |
| | Hybrid Avg. | 0.57 | 0.58 | -- | -- | -- |

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Table 36. Summary of soybean grain methionine concentration response to S source and rate at two Minnesota locations during the 2024 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | Methionine as % of total protein | | | | |
| Lamberton | 0 | 0.52 | 0.53 | 0.52 | 0.53 | 0.52 |
| | 18 | 0.53 | 0.53 | 0.54 | 0.53 | 0.53 |
| | 36 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 |
| | So. x Hy | 0.53 | 0.53 | 0.53 | 0.53 | |
| | Source Avg. | 0.53 | | 0.53 | | |
| | Hybrid Avg. | 0.53 | 0.53 | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 0.53 | 0.53 | 0.53 | 0.54 | 0.53 |
| | 18 | 0.53 | 0.55 | 0.53 | 0.53 | 0.53 |
| | 36 | 0.53 | 0.53 | 0.54 | 0.53 | 0.54 |
| | So. x Hy | 0.53 | 0.54 | 0.53 | 0.53 | |
| | Source Avg. | 0.53 | | 0.53 | | |
| | Hybrid Avg. | 0.53 | 0.54 | -- | -- | -- |

Table 37. Summary of soil test $SO_4$-S after harvest response to S source and rate at two Minnesota locations during the 2024 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | lb $SO_4$-S per acres in a 2-foot soil sample | | | | |
| Lamberton | 0 | 291 | 138 | 472 | 585 | 372 |
| | 18 | 796 | 596 | 314 | 538 | 561 |
| | 36 | 209 | 389 | 340 | 391 | 332 |
| | So. x Hy | 432 | 374 | 375 | 505 | |
| | Source Avg. | 482a | | 252b | | |
| | Hybrid Avg. | 337 | 407 | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 44 | 38 | 49 | 45 | 44 |
| | 18 | 49 | 46 | 44 | 39 | 44 |
| | 36 | 54 | 46 | 51 | 46 | 49 |
| | So. x Hy | 49 | 43 | 48 | 43 | |
| | Source Avg. | 48a | | 44b | | |
| | Hybrid Avg. | 49a | 43b | -- | -- | -- |

Table 38. Summary of ANOVA analysis for measured agronomic variables for two corn trial locations studied during 2024.

| Main Effect | V5 NDRE | V10 Leaf S | V10 SPAD | R1 Ear Leaf S | R1 Up. Leaf S | R1 EL SPAD | R1 UL SPAD | Yield | Grain S | Fall $SO_4$-S |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *P*>F | | | | | |
| | | | | | Rosemount | | | | | |
| S Source | 0.40 | 0.06 | 0.13 | 0.14 | 0.52 | 0.68 | 0.25 | 0.41 | 0.78 | * |
| S Rate | ** | *** | * | *** | ** | * | ** | ** | * | 0.95 |
| So x R | 0.26 | * | 0.13 | 0.60 | 0.90 | 0.28 | 0.09 | 0.50 | * | 0.72 |
| Hybrid | *** | *** | 0.09 | * | ** | *** | *** | 0.08 | *** | * |
| So x Hy | 0.30 | 0.16 | 0.83 | 0.46 | 0.17 | 0.38 | 0.37 | 0.83 | 0.23 | 0.73 |
| Rate x Hy | 0.06 | 0.49 | 0.66 | 0.06 | 0.12 | 0.07 | 0.85 | * | 0.30 | 0.56 |
| R x So x H | 0.66 | 0.44 | 0.37 | 0.53 | 0.76 | 0.80 | 0.33 | 0.90 | 0.37 | 0.14 |
| | | | | | Waseca | | | | | |
| S Source | * | 0.10 | 0.21 | 0.19 | * | 0.53 | 0.09 | 0.59 | 0.18 | 0.91 |
| S Rate | *** | * | *** | ** | ** | 0.17 | ** | 0.14 | * | * |
| So x R | 0.54 | * | 0.14 | 0.24 | 0.78 | 0.88 | 0.90 | 0.68 | 0.93 | 0.69 |
| Hybrid | ** | 0.65 | *** | 0.40 | *** | * | * | *** | * | * |
| So x Hy | 0.81 | 0.33 | 0.87 | 0.74 | 0.98 | 0.76 | 0.43 | 0.86 | 0.86 | 0.22 |
| Rate x Hy | *** | 0.68 | 0.94 | 0.99 | 0.41 | 0.95 | 0.25 | 0.61 | 0.87 | 0.30 |
| R x So x H | 0.70 | 0.91 | * | 0.73 | 0.83 | 0.14 | 0.69 | 0.65 | 0.84 | 0.26 |

**, **, and *** represent treatment significance at P≤0,05, 0,01, and 0,001 probability levels.*

***2024 Corn trial results***

A summary table for the ANOVA for all measured variables for the 2024 growing season is given in Table 38. Individual variables will be discussed in the following tables.

Table 39. Summary of early plant vigor measured at the normalized difference red-edge (NDRE) data collected with a Crop Circle 430 active sensor collected at the corn V5 growth stage.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Rosemount | 0 | 0.344 | 0.316 | 0.344 | 0.330 | 0.334b |
| | 18 | 0.366 | 0.359 | 0.339 | 0.332 | 0.349a |
| | 36 | 0.370 | 0.354 | 0.349 | 0.336 | 0.352a |
| | So. x Hy | 0.360 | 0.343 | 0.344 | 0.333 | |
| | Source Avg. | 0.346 | | 0.339 | | |
| | Hybrid Avg. | 0.348a | 0.337b | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 0.325 | 0.355 | 0.317 | 0.340 | 0.334b |
| | 18 | 0.379 | 0.375 | 0.367 | 0.369 | 0.373a |
| | 36 | 0.361 | 0.366 | 0.345 | 0.348 | 0.355a |
| | So. x Hy | 0.355 | 0.365 | 0.343 | 0.353 | |
| | Source Avg. | 0.354a | | 0.343b | | |
| | Hybrid Avg. | 0.344b | 0.352a | -- | -- | -- |

Table 40. Summary of corn leaf S concentration measured from the uppermost fully developed corn leaf at the V10 growth stage at two Minnesota locations during the 2024 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | ---%S-- | | |
| Rosemount | 0 | 0.187 | 0.171 | 0.176 | 0.162 | 0.174b |
| | 18 | 0.227 | 0.197 | 0.205 | 0.194 | 0.206a |
| | 36 | 0.240 | 0.216 | 0.189 | 0.185 | 0.208a |
| | So. x Hy | 0.218 | 0.194 | 0.190 | 0.180 | |
| | Source Avg. | 0.195a | | 0.183b | | |
| | Hybrid Avg. | 0.197a | 0.181b | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 0.151 | 0.151 | 0.152 | 0.161 | 0.154b |
| | 18 | 0.201 | 0.197 | 0.181 | 0.179 | 0.189a |
| | 36 | 0.192 | 0.182 | 0.163 | 0.173 | 0.178a |
| | So. x Hy | 0.182 | 0.177 | 0.165 | 0.171 | |
| | Source Avg. | 0.181a | | 0.167b | | |
| | Hybrid Avg. | 0.173 | 0.175 | -- | -- | -- |

Table 41. Summary of SPAD meter reading collected from the middle of the uppermost fully developed corn leaf at the V10 growth stage at four Minnesota locations during the 2024 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Rosemount | 0 | 47.8 | 46.8 | 51.7 | 47.6 | 48.4b |
| | 18 | 53.8 | 51.3 | 48.6 | 49.1 | 50.7a |
| | 36 | 53.4 | 51.0 | 51.2 | 48.0 | 50.9a |
| | So. x Hy | 51.6 | 49.7 | 50.5 | 48.2 | |
| | Source Avg. | 50.7 | | 49.3 | | |
| | Hybrid Avg. | 50.8a | 49.3b | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 46.4 | 49.2 | 45.1 | 46.5 | 46.8b |
| | 18 | 51.3 | 52.2 | 49.3 | 53.5 | 51.6a |
| | 36 | 49.8 | 51.9 | 49.2 | 49.5 | 50.1a |
| | So. x Hy | 49.2 | 51.1 | 47.8 | 49.9 | |
| | Source Avg. | 50.0 | | 48.8 | | |
| | Hybrid Avg. | 48.4b | 50.3a | -- | -- | -- |

Early season NDRE measured at V5 was impacted by S rate and hybrid at both locations, while source was only significant at Waseca (Table 39). The hybrid impact was not similar at both locations where NDRE was greater for the Dekalb at Rosemount while the Pioneer hybrid was greater at Waseca. There were interactions between rate and hybrid where hybrids differed at both locations but only when S was not applied. When S was applied the NDRE values were similar between hybrids at both locations.

Corn V10 leaf varied by source and rate but the source by rate interaction was also significant at both locations (Tables 40). At both locations, sources varied but only at the highest rate of S applied and, in both cases, it was ATS that produced lower V10 leaf S concentrations at the 36 lb S rate compared to AMS. Hybrid only differed at Rosemount and there were no hybrid interactions.

However, SPAD readings taken from leaves at V10 were less impacted by source (Table 41). Hybrids varied at Rosemount and Waseca like how NDRE were affected by hybrids. Application of the lowest rate of S increased V10 SPAD values and there was no further increase when 36 lbs of S was applied versus 18 lbs of S.

Table 42. Summary of leaf S concentration measured from the corn leaf opposite and below the ear at the R1 growth stage at four Minnesota locations during the 2024 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | ---%S-- | | |
| Rosemount | 0 | 0.18 | 0.15 | 0.17 | 0.14 | 0.16b |
| | 18 | 0.20 | 0.20 | 0.18 | 0.19 | 0.19a |
| | 36 | 0.22 | 0.20 | 0.17 | 0.18 | 0.19a |
| | So. x Hy | 0.20 | 0.18 | 0.18 | 0.17 | |
| | Source Avg. | 0.18 | | 0.17 | | |
| | Hybrid Avg. | 0.18a | 0.17b | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 0.13 | 0.14 | 0.13 | 0.13 | 0.13b |
| | 18 | 0.15 | 0.15 | 0.14 | 0.14 | 0.15a |
| | 36 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15a |
| | So. x Hy | 0.14 | 0.15 | 0.14 | 0.14 | |
| | Source Avg. | 0.14 | | 0.14 | | |
| | Hybrid Avg. | 0.14 | 0.14 | -- | -- | -- |

R1 leaf S concentration data (ear and upper leaf) was not available at the time this report was written and will be included in the next year end report.

Table 43. Summary of leaf S concentration measured from the uppermost fully developed corn leaf at the R1 growth stage at four Minnesota locations during the 2024 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | ---%S-- | | |
| Rosemount | 0 | 0.164 | 0.167 | 0.163 | 0.153 | 0.162b |
| | 18 | 0.181 | 0.207 | 0.177 | 0.200 | 0.191a |
| | 36 | 0.190 | 0.216 | 0.188 | 0.202 | 0.199a |
| | So. x Hy | 0.178 | 0.196 | 0.176 | 0.185 | |
| | Source Avg. | 0.188 | | 0.184 | | |
| | Hybrid Avg. | 0.178b | 0.193a | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 0.151 | 0.165 | 0.147 | 0.153 | 0.154b |
| | 18 | 0.163 | 0.183 | 0.155 | 0.179 | 0.170a |
| | 36 | 0.165 | 0.186 | 0.150 | 0.175 | 0.169a |
| | So. x Hy | 0.160 | 0.178 | 0.151 | 0.169 | |
| | Source Avg. | 0.169a | | 0.160b | | |
| | Hybrid Avg. | 0.155b | 0.174a | -- | -- | -- |

Table 44. Summary of SPAD meter reading collected from the middle of the corn leaf opposite and below the ear at the R1 growth stage at four Minnesota locations during the 2024 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Rosemount | 0 | 55.8 | 49.9 | 57.4 | 52.5 | 53.9b |
| | 18 | 59.1 | 57.1 | 57.8 | 58.3 | 58.1a |
| | 36 | 60.2 | 57.9 | 58.4 | 56.7 | 58.3a |
| | So. x Hy | 58.4 | 55.0 | 57.9 | 55.8 | |
| | Source Avg. | 54.7 | | 55.1 | | |
| | Hybrid Avg. | 56.2a | 53.6b | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 52.5 | 53.7 | 52.7 | 53.3 | 53.0 |
| | 18 | 54.8 | 55.8 | 53.7 | 54.6 | 54.7 |
| | 36 | 54.0 | 54.2 | 53.4 | 55.0 | 54.1 |
| | So. x Hy | 53.7 | 54.6 | 53.2 | 54.3 | |
| | Source Avg. | 54.1 | | 53.6 | | |
| | Hybrid Avg. | 53.3b | 54.5a | -- | -- | -- |

Table 45. Summary of SPAD meter reading collected from the uppermost fully developed corn leaf at the R1 growth stage at four Minnesota locations during the 2024 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Rosemount | 0 | 53.8 | 48.6 | 55.6 | 50.4 | 52.1b |
| | 18 | 62.0 | 56.1 | 55.3 | 53.6 | 56.7a |
| | 36 | 59.6 | 56.8 | 56.8 | 53.9 | 56.8a |
| | So. x Hy | 58.5 | 53.8 | 55.9 | 52.6 | |
| | Source Avg. | 55.6 | | 54.2 | | |
| | Hybrid Avg. | 56.8a | 52.9b | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 46.6 | 44.9 | 44.9 | 43.8 | 45.0b |
| | 18 | 51.0 | 50.2 | 49.7 | 47.3 | 49.5a |
| | 36 | 49.1 | 46.1 | 49.8 | 44.0 | 47.2a |
| | So. x Hy | 48.9 | 47.1 | 48.1 | 45.0 | |
| | Source Avg. | 48.0a | | 46.6b | | |
| | Hybrid Avg. | 48.3a | 46.2b | -- | -- | -- |

Leaf total S concentration for the ear leaf and upper leaf is summarized in Tables 42 and 42, respectively. Sulfur application rate affected ear and upper leaf S concentration but there was no difference between the two S application rates. Source only affected upper leaf S concentration at Waseca where AMS plots produced higher total S concentrations. Hybrid only varied for upper leaf S concentration at Waseca where the Pioneer hybrid had a higher total S concentration. There were few hybrid interactions for R2 leaf S concentrations.

Leaf SPAD readings from the leaf opposite and below and the uppermost fully developed leaf at the R1 growth stage are summarized in Tables 44 and 45, respectively. Ear leaf SPAD values were not affected by source but were impacted by hybrid. Upper leaf SPAD values were only impacted by Source at Waseca and were impacted by hybrid at both locations. Ear leaf SPAD values were greater for the Dekalb hybrid at Rosemount but at Waseca the Pioneer hybrid produced grater values. For upper leaf SPAD values the Dekalb hybrid produced greater values at both locations. There again were very few interactions with hybrids so when the main effects were significant the impact of the effect was similar regardless of the hybrid grown.

Table 46. Summary of corn grain yield (reported at 15.5% moisture) response to S source and rate at four Minnesota locations during the 2024 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | bushels per acre | | |
| Rosemount | 0 | 208 | 189 | 212 | 197 | 202b |
| | 18 | 223 | 226 | 216 | 213 | 219a |
| | 36 | 209 | 211 | 207 | 211 | 210b |
| | So. x Hy | 213 | 209 | 212 | 207 | |
| | Source Avg. | 200 | | 205 | | |
| | Hybrid Avg. | 206a | 199b | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 206 | 215 | 192 | 210 | 206 |
| | 18 | 227 | 238 | 218 | 223 | 227 |
| | 36 | 203 | 219 | 204 | 213 | 210 |
| | So. x Hy | 212 | 224 | 204 | 215 | |
| | Source Avg. | 214 | | 211 | | |
| | Hybrid Avg. | 206b | 218a | -- | -- | -- |

Corn grain yield data are summarized in Table 46. Hybrid varied at both locations but there was no consistent effect of one hybrid across both locations. Source did not impact corn grain yield. Rate affected corn grain yield at Rosemount and there also was an interaction between rate and hybrid where hybrid varied in yield but only when no S was applied. When at least 18 lbs of S was applied there were not significant differences among the hybrids for corn grain yield. Consistently through the study I have seen little to no difference in how the hybrids response for yield even though there have been some differences among the hybrids in some of the plant tissue factors. At this point I would not suggest changing any fertilization strategies tailoring sulfur applications to specific hybrids.

Corn grain S concentration was measured but I do not have results from the sample analysis at this time for Table 47.

Post harvest soil sulfate-S concentration was measured but was only impacted by S source at Rosemount and Hybrid at both locations with greater residual S in plots were the Dekalb hybrid were planted (Table 48).

Table 47. Summary of corn grain S concentration response to S source and rate at four Minnesota locations during the 2024 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | ---%S-- | | |
| Rosemount | 0 | 0.046 | 0.054 | 0.058 | 0.059 | 0.054b |
| | 18 | 0.067 | 0.084 | 0.059 | 0.064 | 0.069a |
| | 36 | 0.063 | 0.074 | 0.071 | 0.084 | 0.073a |
| | So. x Hy | 0.059 | 0.070 | 0.063 | 0.069 | |
| | Source Avg. | 0.065 | | 0.066 | | |
| | Hybrid Avg. | 0.061b | 0.070a | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 0.070 | 0.075 | 0.061 | 0.068 | 0.068b |
| | 18 | 0.080 | 0.093 | 0.072 | 0.078 | 0.081a |
| | 36 | 0.088 | 0.093 | 0.077 | 0.084 | 0.085a |
| | So. x Hy | 0.079 | 0.087 | 0.070 | 0.076 | |
| | Source Avg. | 0.083 | | 0.073 | | |
| | Hybrid Avg. | 0.075b | 0.082a | -- | -- | -- |

Soil sulfate-S content was measured post-harvest but did not vary based on sulfur source, rate, or hybrid (Table 28). Soil samples were collected at Lamberton, but samples were not analyzed at the time of this report.

Table 48. Summary of post-harvest two-foot soil extractable sulfate-S response to S source and rate at four Minnesota locations during the 2024 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | pounds sulfate-S per acre | | |
| Rosemount | 0 | 38 | 35 | 44 | 35 | 38 |
| | 18 | 45 | 42 | 33 | 33 | 38 |
| | 36 | 38 | 32 | 32 | 31 | 33 |
| | So. x Hy | 41 | 36 | 37 | 33 | |
| | Source Avg. | 38a | | 34b | | |
| | Hybrid Avg. | 38a | 34b | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 45 | 45 | 51 | 48 | 47n |
| | 18 | 46 | 40 | 49 | 45 | 45b |
| | 36 | 53 | 54 | 53 | 48 | 52a |
| | So. x Hy | 48 | 46 | 51 | 47 | |
| | Source Avg. | 49 | | 49 | | |
| | Hybrid Avg. | 50a | 48b | -- | -- | -- |

Table 49. Summary of ANOVA analysis for measured agronomic variables for two soybean trial locations studied during 2025.

| Main Effect | R1 Leaf S Conc. | Yield | Grain S Conc. | Protein | Oil | Cysteine | Methionine | Fall Soil S |
|---|---|---|---|---|---|---|---|---|
| | | | | ----------*P*>F---------- | | | | |
| | | | | Rosemount | | | | |
| S Source | 0.10 | 0.99 | | 0.36 | 0.92 | 0.61 | 0.41 | 0.65 |
| S Rate | 0.50 | 0.57 | | 0.93 | 0.97 | * | 0.29 | 0.98 |
| So x R | 0.98 | 0.42 | | 0.25 | 0.63 | 0.15 | 0.13 | 0.46 |
| Hybrid | 0.71 | 0.10 | | 0.56 | 0.13 | ** | 0.34 | 0.88 |
| So x Hy | 0.49 | 0.62 | | 0.25 | 0.26 | ** | 0.10 | 0.08 |
| Rate x Hy | 0.23 | 0.87 | | 0.69 | 0.45 | * | 0.22 | 0.83 |
| R x So x H | 0.41 | 0.24 | | * | 0.08 | 0.91 | 0.57 | 0.96 |
| | | | | Waseca | | | | |
| S Source | * | 0.42 | | 0.86 | 0.63 | 0.47 | 0.89 | 0.49 |
| S Rate | 0.71 | 0.08 | | * | 0.17 | 0.29 | 0.15 | 0.98 |
| So x R | 0.44 | 0.06 | | 0.12 | 0.16 | 0.59 | 0.15 | 0.07 |
| Hybrid | 0.44 | 0.21 | | 0.86 | 0.56 | 0.35 | 0.67 | 0.16 |
| So x Hy | 0.86 | 0.84 | | 0.34 | 0.20 | 0.78 | 0.88 | 0.35 |
| Rate x Hy | 0.26 | 0.78 | | 0.66 | 0.29 | 0.16 | 0.61 | 0.43 |
| R x So x H | 0.68 | 0.82 | | 0.74 | * | 0.67 | 0.98 | 0.11 |

**, **, and *** represent treatment significance at P≤0,05, 0,01, and 0,001 probability levels.*

***2025 Soybean Results***

There were very few responses to sulfur at the two soybean locations in 2025. Soybean trifoliate S concentration (Table 50) differed by sulfur source with AMS averaging a greater trifoliate S concentration at both sites. Soybean grain yield (Table 51) was not impacted by sulfur applied the previous year at Rosemount, but yield was 2 bushels per acre greater where S was applied ahead of corn (no difference between the 18 and 36 lb S rate). Soybean grain yield did vary based on the previous corn hybrid only at Rosemount. Soybean grain yield was higher for plots planted to the Dekalb hybrid in 2024 which is different from past years where soybean yield was greater following the hybrid that yielded less the previous year.

Seed S concentration was measured but I am awaiting the data at the time of this report. Seed protein concentration increased with sulfur at Waseca (Table 53). Seed oil concentration was not impacted by sulfur (Table 54). Seed cysteine content was impacted by S application at Rosemount (Table 55) but seed methionine content was not impacted by S (Table 56). Post-harvest soil test S was not affected by previous application of sulfur. The increase in soybean grain yield and the amount of S in plant tissue does indicate some carryover potential for S from the year of application to the following year. While grain yield data from Rosemount showed no impact of S, the lack of response may have been due to yield variability across the site. The west third of the trial there were sizable differences in seed size for the no-S plots versus plots with S. There was not enough consistency to see differences across sites.

Table 50. Summary of soybean trifoliate S concentration for the uppermost fully developed trifoliate (leaflets and petiole) at two Minnesota locations during the 2025 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | %S | | |
| Rosemount | 0 | 0.247 | 0.249 | 0.229 | 0.241 | 0.241 |
| | 18 | 0.248 | 0.240 | 0.228 | 0.233 | 0.237 |
| | 36 | 0.238 | 0.234 | 0.226 | 0.213 | 0.227 |
| | So. x Hy | 0.244 | 0.241 | 0.228 | 0.229 | |
| | Source Avg. | 0.242a | | 0.228b | | |
| | Hybrid Avg. | 0.235 | 0.236 | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 0.214 | 0.214 | 0.202 | 0.201 | 0.208 |
| | 18 | 0.229 | 0.207 | 0.209 | 0.197 | 0.210 |
| | 36 | 0.236 | 0.248 | 0.199 | 0.197 | 0.220 |
| | So. x Hy | 0.226 | 0.223 | 0.203 | 0.198 | |
| | Source Avg. | 0.225a | | 0.200b | | |
| | Hybrid Avg. | 0.210 | 0.215 | -- | -- | |

Table 51. Summary of soybean grain yield (reported at 13% moisture) response to S source and rate at two Minnesota locations during the 2025 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | bushels per acre | | |
| Rosemount | 0 | 49.1 | 50.6 | 51.8 | 54.5 | 51.5 |
| | 18 | 57.6 | 57.0 | 46.0 | 49.8 | 52.6 |
| | 36 | 50.8 | 55.6 | 50.6 | 53.3 | 52.6 |
| | So. x Hy | 52.5 | 54.4 | 49.5 | 52.5 | |
| | Source Avg. | 52.3 | | 52.3 | | |
| | Hybrid Avg. | 53.1a | 51.5b | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 60.3 | 61.2 | 62.8 | 62.3 | 61.6b |
| | 18 | 63.8 | 64.9 | 62.1 | 64.0 | 63.7a |
| | 36 | 64.1 | 65.5 | 61.9 | 62.9 | 63.6a |
| | So. x Hy | 62.7 | 63.8 | 62.3 | 63.1 | |
| | Source Avg. | 63.3 | | 62.7 | | |
| | Hybrid Avg. | 63.5 | 62.5 | -- | -- | -- |

Table 52. Summary of soybean grain S concentration response to S source and rate at two Minnesota locations during the 2025 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | %S | | |
| Rosemount | 0 | | | | | |
| | 18 | | | | | |
| | 36 | | | | | |
| | So. x Hy | | | | | |
| | Source Avg. | | | | | |
| | Hybrid Avg. | | | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | | | | | |
| | 18 | | | | | |
| | 36 | | | | | |
| | So. x Hy | | | | | |
| | Source Avg. | | | | | |
| | Hybrid Avg. | | | -- | -- | -- |

Table 53. Summary of soybean grain protein concentration response to S source and rate at two Minnesota locations during the 2025 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | % Protein @ 13% Moisture | | | | |
| Rosemount | 0 | 32.6 | 31.9 | 32.1 | 32.9 | 32.3 |
| | 18 | 32.8 | 33.0 | 32.0 | 31.7 | 32.4 |
| | 36 | 32.4 | 32.7 | 32.3 | 32.6 | 32.5 |
| | So. x Hy | 32.6 | 32.5 | 32.1 | 32.4 | |
| | Source Avg. | 32.6 | | 32.3 | | |
| | Hybrid Avg. | 32.4 | 32.4 | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 32.4 | 32.3 | 32.7 | 32.8 | 32.6b |
| | 18 | 33.1 | 33.0 | 32.6 | 33.0 | 32.9a |
| | 36 | 33.3 | 33.1 | 33.0 | 33.0 | 33.1a |
| | So. x Hy | 32.9 | 32.8 | 32.8 | 32.9 | |
| | Source Avg. | 32.9 | | 32.9 | | |
| | Hybrid Avg. | 32.9 | 32.9 | -- | -- | -- |

Table 54. Summary of soybean grain oil concentration response to S source and rate at two Minnesota locations during the 2025 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | % Oil @ 13% Moisture | | | | |
| Rosemount | 0 | 18.5 | 18.5 | 18.4 | 18.3 | 18.4 |
| | 18 | 18.4 | 18.4 | 18.6 | 18.2 | 18.4 |
| | 36 | 18.5 | 18.3 | 18.5 | 18.5 | 18.5 |
| | So. x Hy | 18.5 | 18.4 | 18.5 | 18.3 | |
| | Source Avg. | 18.4 | | 18.4 | | |
| | Hybrid Avg. | 18.4 | 18.5 | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 18.5 | 18.6 | 18.3 | 18.5 | 18.5 |
| | 18 | 18.2 | 18.5 | 18.6 | 18.3 | 18.4 |
| | 36 | 18.3 | 18.2 | 18.4 | 18.4 | 18.3 |
| | So. x Hy | 18.3 | 18.4 | 18.4 | 18.4 | |
| | Source Avg. | 18.4 | | 18.4 | | |
| | Hybrid Avg. | 18.4 | 18.4 | -- | -- | -- |

Table 55. Summary of soybean grain cysteine response to S source and rate at two Minnesota locations during the 2025 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | Cysteine as % of total protein | | | | |
| Rosemount | 0 | 0.51 | 0.56 | 0.55 | 0.57 | 0.54b |
| | 18 | 0.57 | 0.60 | 0.57 | 0.56 | 0.57a |
| | 36 | 0.58 | 0.60 | 0.59 | 0.57 | 0.58a |
| | So. x Hy | 0.55 | 0.59 | 0.57 | 0.56 | |
| | Source Avg. | 0.57 | | 0.56 | | |
| | Hybrid Avg. | 0.57a | 0.56b | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 0.54 | 0.53 | 0.55 | 0.56 | 0.54 |
| | 18 | 0.56 | 0.56 | 0.57 | 0.55 | 0.56 |
| | 36 | 0.55 | 0.57 | 0.55 | 0.58 | 0.56 |
| | So. x Hy | 0.55 | 0.55 | 0.55 | 0.56 | |
| | Source Avg. | 0.55 | | 0.56 | | |
| | Hybrid Avg. | 0.56 | 0.55 | -- | -- | -- |

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Table 56. Summary of soybean grain methionine concentration response to S source and rate at two Minnesota locations during the 2025 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | Methionine as % of total protein | | | | |
| Rosemount | 0 | 0.49 | 0.51 | 0.50 | 0.51 | 0.50 |
| | 18 | 0.52 | 0.53 | 0.51 | 0.50 | 0.51 |
| | 36 | 0.52 | 0.52 | 0.52 | 0.51 | 0.52 |
| | So. x Hy | 0.51 | 0.52 | 0.51 | 0.51 | |
| | Source Avg. | 0.51 | | 0.51 | | |
| | Hybrid Avg. | 0.51 | 0.51 | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 0.50 | 0.50 | 0.51 | 0.51 | 0.50 |
| | 18 | 0.51 | 0.51 | 0.51 | 0.51 | 0.51 |
| | 36 | 0.51 | 0.52 | 0.51 | 0.51 | 0.51 |
| | So. x Hy | 0.51 | 0.51 | 0.51 | 0.51 | |
| | Source Avg. | 0.51 | | 0.51 | | |
| | Hybrid Avg. | 0.51 | 0.51 | -- | -- | -- |

Table 57. Summary of soil test $SO_4$-S after harvest response to S source and rate at two Minnesota locations during the 2025 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | lb $SO_4$-S per acres in a 2-foot soil sample | | | | |
| Rosemount | 0 | 39 | 38 | 40 | 45 | 41 |
| | 18 | 52 | 49 | 33 | 37 | 43 |
| | 36 | 43 | 39 | 41 | 46 | 42 |
| | So. x Hy | 45 | 42 | 38 | 42 | |
| | Source Avg. | 43 | | 40 | | |
| | Hybrid Avg. | 42 | 42 | -- | -- | -- |
| | | | | | | |
| Waseca | 0 | 28 | 31 | 32 | 28 | 29 |
| | 18 | 28 | 22 | 28 | 41 | 30 |
| | 36 | 29 | 35 | 24 | 32 | 30 |
| | So. x Hy | 28 | 29 | 28 | 34 | |
| | Source Avg. | 38 | | 31 | | |
| | Hybrid Avg. | 31 | 28 | -- | -- | -- |

Table 58. Summary of ANOVA analysis for measured agronomic variables for two corn trial locations studied during 2025.

| Main Effect | V5 NDRE | V10 Leaf S | V10 SPAD | R1 Ear Leaf S | R1 Up. Leaf S | R1 EL SPAD | R1 UL SPAD | Yield | Grain S | Fall $SO_4$-S |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *P*>F | | | | | |
| | | | | | Lamberton | | | | | |
| S Source | 0.66 | 0.45 | 0.51 | 0.72 | 0.35 | 0.96 | 0.80 | 0.48 | | 0.48 |
| S Rate | 0.57 | 0.29 | 0.52 | 0.62 | ** | * | 0.85 | 0.19 | | 0.79 |
| So x R | 0.73 | 0.14 | 0.66 | * | 0.30 | 0.37 | 0.91 | * | | 0.66 |
| Hybrid | 0.95 | * | 0.63 | * | ** | 0.23 | 0.10 | * | | 0.08 |
| So x Hy | 0.78 | 0.71 | 0.09 | 0.57 | 0.70 | 0.08 | 0.64 | 0.18 | | 0.22 |
| Rate x Hy | 0.63 | 0.92 | 0.26 | 0.58 | ** | 0.98 | 0.17 | 0.17 | | 0.79 |
| R x So x H | 0.18 | 0.42 | 0.73 | *** | 0.14 | 0.19 | 0.51 | 0.25 | | 0.37 |
| | | | | | Rochester | | | | | |
| S Source | 0.32 | 0.92 | 0.87 | 0.29 | 0.75 | 0.80 | 0.17 | 0.44 | | 0.72 |
| S Rate | 0.45 | 0.62 | 0.24 | 0.76 | 0.69 | 0.73 | 0.58 | 0.90 | | 0.73 |
| So x R | 0.31 | 0.74 | 0.33 | 0.55 | 0.21 | 0.67 | 0.69 | 0.41 | | 0.91 |
| Hybrid | * | ** | 0.06 | 0.79 | ** | 0.06 | * | 0.09 | | 0.59 |
| So x Hy | 0.30 | 0.22 | 1.00 | 0.93 | 1.00 | 0.67 | 0.37 | 0.89 | | 0.22 |
| Rate x Hy | 0.99 | * | * | 0.70 | 0.88 | * | 0.58 | 0.58 | | 0.40 |
| R x So x H | 0.41 | 0.94 | 0.56 | 0.47 | 0.93 | 0.49 | 0.16 | 0.34 | | 0.67 |

**, **, and *** represent treatment significance at P≤0,05, 0,01, and 0,001 probability levels.*

***2025 Corn trial results***

A summary table for the ANOVA for all measured variables for the 2025 growing season is given in Table 58. Individual variables will be discussed in the following tables. Rochester yield data was relatively low due to southern rust affecting yield at the site which affected both hybrids.

Table 59. Summary of early plant vigor measured at the normalized difference red-edge (NDRE) data collected with a Crop Circle 430 active sensor collected at the corn V5 growth stage.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Lamberton | 0 | 0.302 | 0.296 | 0.301 | 0.309 | 0.302 |
| | 18 | 0.289 | 0.297 | 0.300 | 0.299 | 0.296 |
| | 36 | 0.300 | 0.302 | 0.304 | 0.296 | 0.300 |
| | So. x Hy | 0.297 | 0.298 | 0.302 | 0.301 | |
| | Source Avg. | 0.298 | | 0.302 | | |
| | Hybrid Avg. | 0.299 | 0.300 | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 0.356 | 0.360 | 0.318 | 0.333 | 0.342 |
| | 18 | 0.342 | 0.349 | 0.338 | 0.352 | 0.345 |
| | 36 | 0.328 | 0.340 | 0.325 | 0.334 | 0.332 |
| | So. x Hy | 0.342 | 0.350 | 0.327 | 0.340 | |
| | Source Avg. | 0.345 | | 0.333 | | |
| | Hybrid Avg. | 0.335b | 0.345a | -- | -- | -- |

Table 60. Summary of corn leaf S concentration measured from the uppermost fully developed corn leaf at the V10 growth stage at two Minnesota locations during the 2025 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | % | | | |
| Lamberton | 0 | 0.184 | 0.200 | 0.169 | 0.185 | 0.184 |
| | 18 | 0.184 | 0.208 | 0.193 | 0.208 | 0.198 |
| | 36 | 0.185 | 0.195 | 0.205 | 0.234 | 0.205 |
| | So. x Hy | 0.184 | 0.201 | 0.189 | 0.209 | |
| | Source Avg. | 0.193 | | 0.199 | | |
| | Hybrid Avg. | 0.187b | 0.205a | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 0.195 | 0.204 | 0.212 | 0.204 | 0.203 |
| | 18 | 0.206 | 0.224 | 0.203 | 0.209 | 0.210 |
| | 36 | 0.198 | 0.235 | 0.199 | 0.228 | 0.215 |
| | So. x Hy | 0.199 | 0.221 | 0.204 | 0.214 | |
| | Source Avg. | 0.210 | | 0.209 | | |
| | Hybrid Avg. | 0.202b | 0.217a | -- | -- | -- |

Table 61. Summary of SPAD meter reading collected from the middle of the uppermost fully developed corn leaf at the V10 growth stage at four Minnesota locations during the 2025 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Lamberton | 0 | 52.5 | 52.8 | 52.1 | 51.5 | 52.2 |
| | 18 | 51.8 | 52.1 | 51.7 | 51.6 | 51.8 |
| | 36 | 52.5 | 52.3 | 53.4 | 51.8 | 52.5 |
| | So. x Hy | 52.3 | 52.4 | 52.4 | 51.6 | |
| | Source Avg. | 52.3 | | 52.0 | | |
| | Hybrid Avg. | 52.3 | 52.0 | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 49.2 | 48.0 | 49.8 | 48.0 | 48.7 |
| | 18 | 50.6 | 46.9 | 49.6 | 46.6 | 48.4 |
| | 36 | 50.1 | 47.7 | 50.6 | 48.2 | 49.2 |
| | So. x Hy | 50.0 | 47.5 | 50.0 | 47.6 | |
| | Source Avg. | 48.7 | | 48.8 | | |
| | Hybrid Avg. | 50.0a | 47.6b | -- | -- | -- |

Early season NDRE measured at V5 was not impacted by sulfur source or rate (Table 59). Corn leaf V10 S concentration varied by hybrid but not by source or S rate (Table 60). Corn V10 leaf SPAD meter readings were not affected by sulfur source or rate at Rosemount but V10 SPAD was affected by rate at Lamberton (Table 61). There was no interaction between hybrid and either S source or rate.

Table 62. Summary of leaf S concentration measured from the corn leaf opposite and below the ear at the R1 growth stage at four Minnesota locations during the 2025 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | % | | |
| Lamberton | 0 | 0.173 | 0.205 | 0.172 | 0.179 | 0.182 |
| | 18 | 0.178 | 0.203 | 0.164 | 0.173 | 0.180 |
| | 36 | 0.176 | 0.175 | 0.174 | 0.226 | 0.188 |
| | So. x Hy | 0.176 | 0.194 | 0.170 | 0.193 | |
| | Source Avg. | 0.185 | | 0.181 | | |
| | Hybrid Avg. | 0.173b | 0.194a | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 0.155 | 0.153 | 0.158 | 0.156 | 0.155 |
| | 18 | 0.154 | 0.161 | 0.149 | 0.143 | 0.152 |
| | 36 | 0.164 | 0.164 | 0.145 | 0.157 | 0.157 |
| | So. x Hy | 0.157 | 0.159 | 0.151 | 0.152 | |
| | Source Avg. | 0.158 | | 0.151 | | |
| | Hybrid Avg. | 0.154 | 0.156 | -- | -- | -- |

Ear leaf S concentration was impacted by hybrid only at Rosemount but was not affected by source or rate outside of the significant source x rate interaction at Rosemount which could not be clearly explained by

an increase in leaf S at Lamberton but only when ATS was the source applied (Table 62). Upper leaf S concentration was impacted by S rate at Lamberton and hybrid and there was an interaction between rate and hybrid due to S rate only impacting the pioneer hybrid and not the Dekalb (Table 63). Ear leaf (Table 64) and upper leaf (Table 65) SPAD readings were seldom impacted by main effects at the two corn locations.

Table 63. Summary of leaf S concentration measured from the uppermost fully developed corn leaf at the R1 growth stage at four Minnesota locations during the 2025 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | % | | |
| Lamberton | 0 | 0.194 | 0.216 | 0.213 | 0.261 | 0.221b |
| | 18 | 0.197 | 0.245 | 0.205 | 0.229 | 0.219b |
| | 36 | 0.225 | 0.296 | 0.221 | 0.301 | 0.261a |
| | So. x Hy | 0.205 | 0.252 | 0.213 | 0.264 | |
| | Source Avg. | 0.229 | | 0.238 | | |
| | Hybrid Avg. | 0.209b | 0.258a | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 0.169 | 0.204 | 0.194 | 0.231 | 0.199 |
| | 18 | 0.183 | 0.216 | 0.169 | 0.198 | 0.191 |
| | 36 | 0.187 | 0.219 | 0.186 | 0.220 | 0.203 |
| | So. x Hy | 0.180 | 0.213 | 0.183 | 0.216 | |
| | Source Avg. | 0.196 | | 0.199 | | |
| | Hybrid Avg. | 0.181b | 0.215a | -- | -- | -- |

Table 64. Summary of SPAD meter reading collected from the middle of the corn leaf opposite and below the ear at the R1 growth stage at four Minnesota locations during the 2025 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Lamberton | 0 | 55.4 | 54.5 | 54.8 | 53.9 | 54.6b |
| | 18 | 56.9 | 54.8 | 55.2 | 55.7 | 55.6a |
| | 36 | 56.2 | 55.0 | 56.7 | 56.2 | 56.0a |
| | So. x Hy | 56.2 | 54.7 | 55.5 | 55.3 | |
| | Source Avg. | 55.5 | | 55.4 | | |
| | Hybrid Avg. | 55.9 | 55.0 | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 54.4 | 58.1 | 54.9 | 58.1 | 56.4 |
| | 18 | 56.1 | 56.5 | 55.9 | 57.8 | 56.6 |
| | 36 | 56.8 | 57.3 | 56.4 | 56.8 | 56.8 |
| | So. x Hy | 55.8 | 57.3 | 55.7 | 57.6 | |
| | Source Avg. | 56.5 | | 56.6 | | |
| | Hybrid Avg. | 55.7b | 57.4a | -- | -- | -- |

Table 65. Summary of SPAD meter reading collected from the uppermost fully developed corn leaf at the R1 growth stage at four Minnesota locations during the 2025 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| Lamberton | 0 | 42.6 | 39.7 | 41.8 | 40.1 | 41.0 |
| | 18 | 42.0 | 39.0 | 42.7 | 39.0 | 40.7 |
| | 36 | 42.8 | 38.9 | 44.3 | 38.2 | 41.1 |
| | So. x Hy | 42.5 | 39.2 | 42.9 | 39.1 | |
| | Source Avg. | 40.8 | | 41.0 | | |
| | Hybrid Avg. | 42.7a | 39.1b | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 47.9 | 43.1 | 44.2 | 43.2 | 44.6 |
| | 18 | 46.5 | 43.8 | 45.8 | 43.8 | 45.0 |
| | 36 | 44.8 | 44.2 | 44.9 | 42.6 | 44.1 |
| | So. x Hy | 46.4 | 43.7 | 44.9 | 43.2 | |
| | Source Avg. | 45.1 | | 44.1 | | |
| | Hybrid Avg. | 45.7a | 43.4b | -- | -- | -- |

Table 66. Summary of corn grain yield (reported at 15.5% moisture) response to S source and rate at four Minnesota locations during the 2025 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | bushels per acre | | |
| Lamberton | 0 | 218 | 249 | 253 | 256 | 244 |
| | 18 | 244 | 245 | 240 | 239 | 242 |
| | 36 | 255 | 262 | 247 | 254 | 255 |
| | So. x Hy | 239 | 252 | 247 | 250 | |
| | Source Avg. | 245 | | 248 | | |
| | Hybrid Avg. | 243b | 251a | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 168 | 171 | 156 | 166 | 165 |
| | 18 | 160 | 171 | 167 | 170 | 167 |
| | 36 | 162 | 172 | 158 | 172 | 166 |
| | So. x Hy | 164 | 171 | 161 | 169 | |
| | Source Avg. | 168 | | 165 | | |
| | Hybrid Avg. | 162b | 170a | -- | -- | -- |

Corn grain yield data are summarized in Table 66. Hybrid varied at both locations and at both locations the Pioneer hybrid outyielded the Dekalb (results have been inconsistent and there has been no statistical advantage of either hybrid across all locations). Source or rate main effects did not impact corn grain yield. There was a significant source by rate interaction at Lamberton but that was due to greater yield for the Pioneer hybrid but only when no sulfur was applied. Yield of both hybrids was similar when at least 18 lbs of S was applied regardless of S source. Corn grain samples were collected from both locations but at the time of the report the data are not available. There was no effect of sulfur source or rate on post-

harvest soil $SO_4$-S concentration (Table 68). Soil $SO_4$-S was higher at Lamberton and there was a significant difference between hybrids at this location.

Table 67. Summary of corn grain S concentration response to S source and rate at four Minnesota locations during the 2025 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | ---%S-- | | |
| Lamberton | 0 | | | | | |
| | 18 | | | | | |
| | 36 | | | | | |
| | So. x Hy | | | | | |
| | Source Avg. | | | | | |
| | Hybrid Avg. | | | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | | | | | |
| | 18 | | | | | |
| | 36 | | | | | |
| | So. x Hy | | | | | |
| | Source Avg. | | | | | |
| | Hybrid Avg. | | | -- | -- | -- |

Soil sulfate-S content was measured post-harvest but did not vary based on sulfur source, rate, or hybrid (Table 28). Soil samples were collected at Lamberton, but samples were not analyzed at the time of this report.

Table 68. Summary of post-harvest two-foot soil extractable sulfate-S response to S source and rate at four Minnesota locations during the 2025 growing season.

| | | Sulfur Source x Hybrid | | | | |
|---|---|---|---|---|---|---|
| | | AMS | | ATS | | |
| Location | S Rate (lb/ac) | Dekalb | Pioneer | Dekalb | Pioneer | Rate Avg |
| | | | | pounds sulfate-S per acre | | |
| Lamberton | 0 | 251 | 215 | 463 | 807 | 434 |
| | 18 | 539 | 604 | 501 | 719 | 591 |
| | 36 | 460 | 546 | 525 | 555 | 522 |
| | So. x Hy | 416 | 455 | 496 | 693 | |
| | Source Avg. | 436 | | 595 | | |
| | Hybrid Avg. | 456b | 574a | -- | -- | -- |
| | | | | | | |
| Rochester | 0 | 39 | 37 | 37 | 35 | 37 |
| | 18 | 40 | 37 | 38 | 39 | 39 |
| | 36 | 40 | 39 | 36 | 39 | 38 |
| | So. x Hy | 39 | 38 | 37 | 38 | 38 |
| | Source Avg. | 38 | | 37 | | |
| | Hybrid Avg. | 38 | 38 | -- | -- | -- |

***Predicting Corn Grain Yield with Tissue S Concentration***

Sufficiency ranges exist for leaf tissue S concentrations to predict final yield and the requirements for sulfur. Most data have focused on leaf tissue samples collected during the early reproductive period. There was a significant relationship between relative corn grain yield (% of maximum yield of each hybrid at each location) and leaf S concentration at V10 and R1-R2. At V10, corn grain yield was at maximum when the concentration of S in the uppermost fully developed leaf was 0.20% (Figure 1). At R1 to R2, corn grain yield was at maximum when S concentration in the leaf opposite and below the ear was 0.18% (Figure 2) and when the S concentration was 0.16% in the uppermost fully developed leaf (Figure 3). The most predictive sample was the leaf opposite and below the ear where the $R^2$ value (coefficient of correlation) was 0.18. The poorest was the uppermost fully developed leaf at R1-R2 ($R^2$=0.08). It should be noted that the S concentration was determined with a sulfur combustion analyzer and not by ICP which is commonly used by private soil testing labs. I have noted differences between the combustion versus ICP results, but I have favored using the combustion analyzer as I have found ICP does not perform well and does not show significant differences when sulfur fertilizer is applied. Soybean data has not been correlated with tissue S concentration at this time.

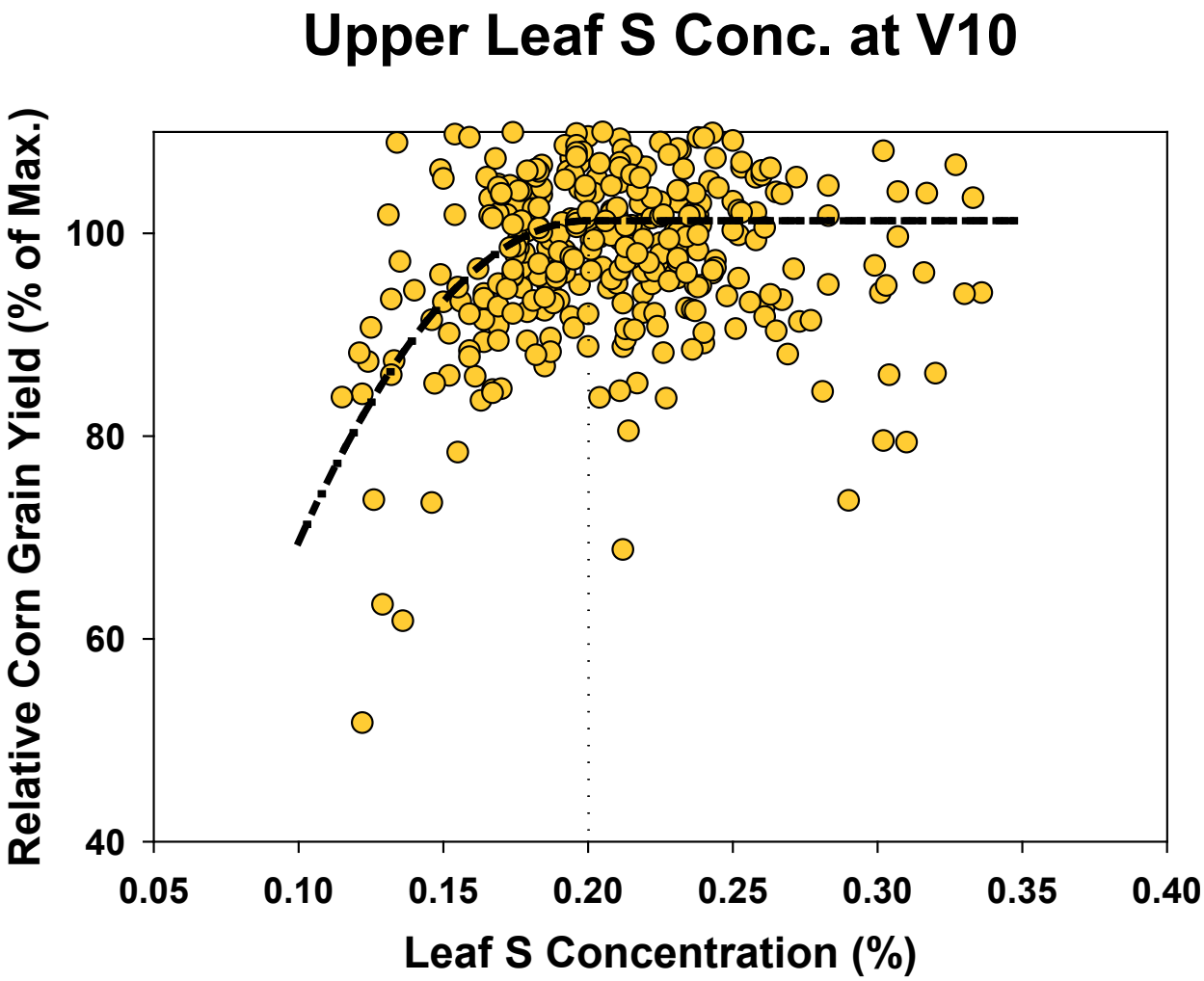


Figure 1. Relationship between relative corn yield (% of maximum) and corn leaf S concentration for the uppermost fully developed leaf sampled at the V10 growth stage.

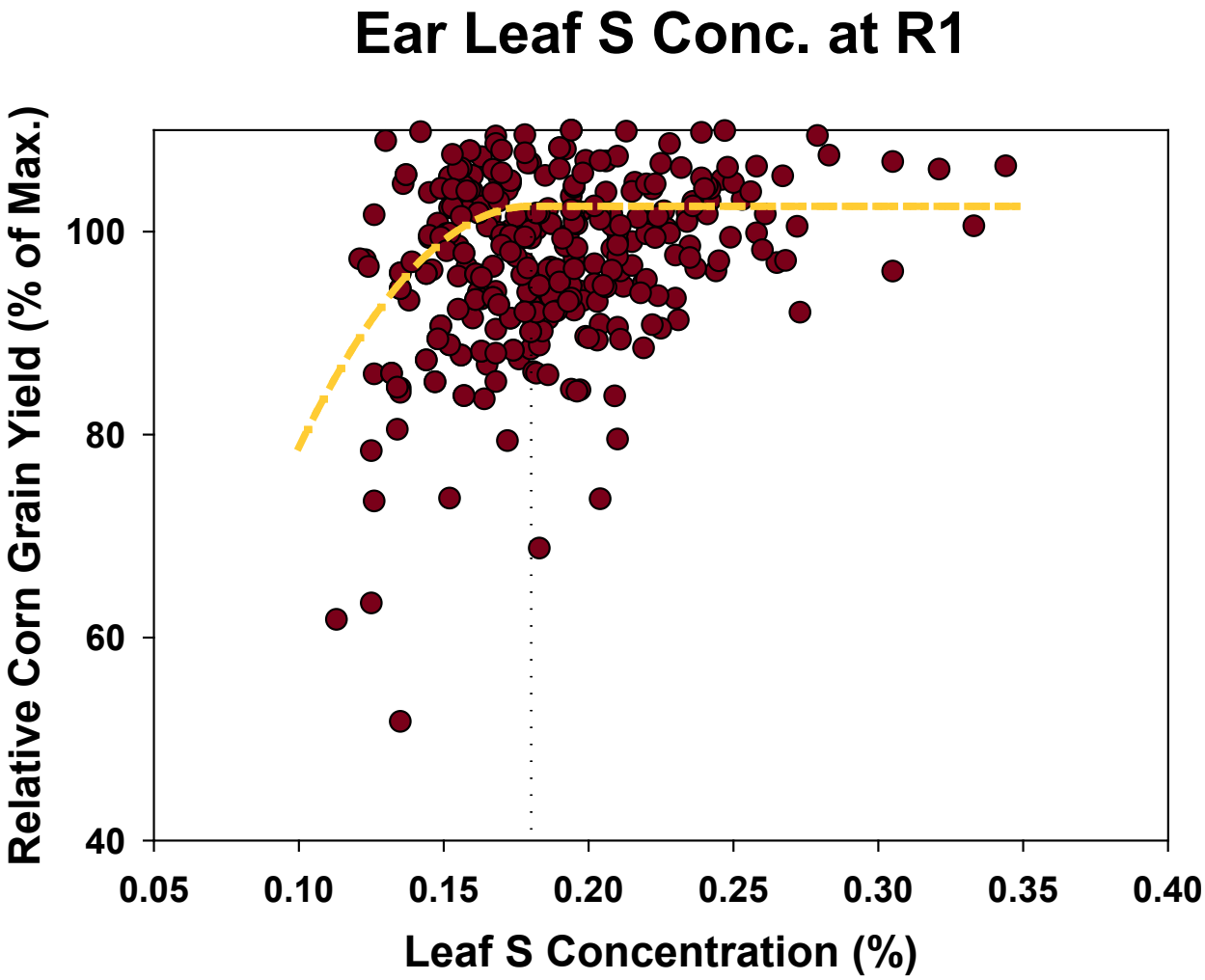


Figure 2. Relationship between relative corn yield (% of maximum) and corn leaf S concentration for leaf opposite and below the ear sampled at the R1-R2 growth stage.

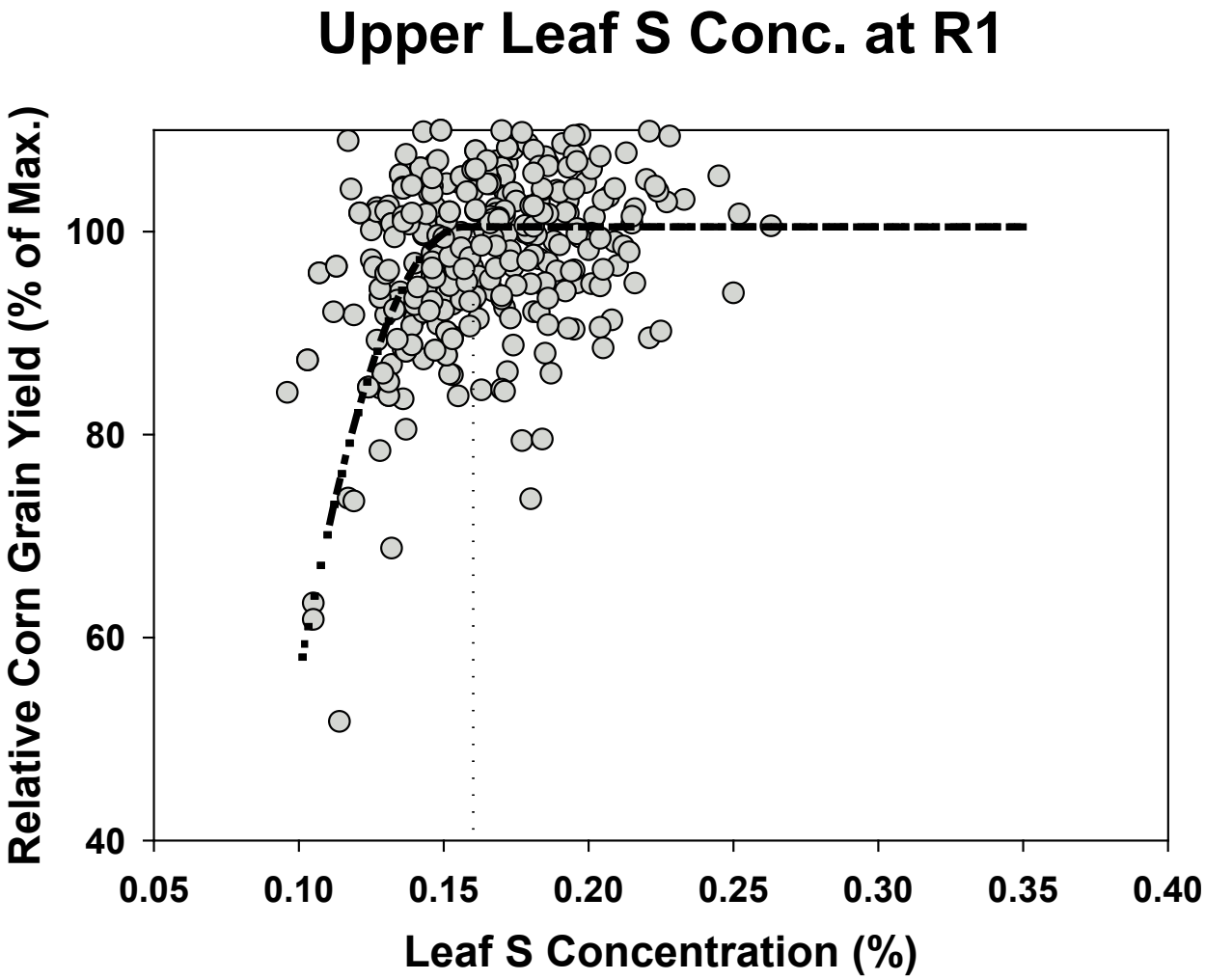


Figure 3. Relationship between relative corn yield (% of maximum) and corn leaf S concentration for the uppermost fully developed leaf sampled at the R1-R2 growth stage.