

Soybean Nitrogen fixation under Nitrogen and Sulfur fertilization

Objectives:

- 1) Estimate BNF and N budgets in soybean considering N and sulfur (S) fertilization rates.
- 2) Build a predictive model for BNF in the United States using environmental data.
- 3) Extend the results to soybean growers using local and national extension networks.

Objective 1: Estimate BNF and N budgets in soybean considering N and sulfur (S) fertilization rates.

In 2021, this study was performed at 27 locations in 13 states with Dr. Ignacio Ciampitti of Kansas State University (KSU) serving as the lead PI. Every effort was made to select a site in each state that was likely to be 1) responsive, and 1) non-responsive to soybean S fertilization.

In South Dakota, the studies were planted in Aurora (theoretical responsive environment) and Brookings (theoretical non-responsive environment). Plots were planted at both locations in mid-May. Soil samples were collected prior to planting and N and S fertilizer treatments were surface applied immediately following planting. Plant and soil samples were collected at the R2, R4, and R6 growth stages. The soil samples were frozen and sent to AgVise Labs in Benson, MN as there was a problem at the KSU lab that was initially meant to perform the analysis. Soybean whole-plant and stem samples were weighed, dried and course-ground, and sent to Dr. Ciampitti's laboratory at KSU for analysis (The R6 plant samples are still in the grinding process). Plots were harvested with a Kincaid plot combine in early October and grain samples were sent to the University of Minnesota (c/o Dr. Seth Naeve) for analysis.

The Aurora location was selected as a 'responsive' environment because the soils are 'lighter' and considered to be potentially more responsive to fertilizer applications. However, soils at both locations had similar fertility, CEC values, and soil OM (Table 1) A list of fertilizer treatments is summarized in Table 2. A visual representation of the data distribution/yields by treatment for the sulfur study is shown as boxplots in Figure 1. While it appears there may have been a numerical response to sulfur and nitrogen at the Aurora location, statistical analysis showed no differences in any fertilizer treatments at either Aurora ($Pr(> F) = 0.185$) or Brookings ($Pr(>F) = 0.347$). Data variability was higher than normal ($CV\% = 11.7$) at the Aurora location due to extremely dry conditions.

Table 1. Soil test values for soybean BNF study locations in SD.

Location	Soil texture	OM (%)	P (ppm)	K (ppm)	pH	CEC (meq/100g)
Aurora	silty clay loam	4.4	13	176	6.4	28.5
Brookings	silty clay loam	4.8	22	176	7.3	25.9

Table 2. List of fertilizer treatments used in the soybean BNF study.

Treatment Number	Planting		R3 Growth Stage		Total Nutrients Applied	
	N Source (lb/a)	S Source (lb/a)	N Source (lb/a)	S Source (lb/a)	N Rate (lb/a)	S Rate (lb/a)
1					0	0
2	Urea-N (16) AMS-N (8)	AMS-S (9)			24	9
3	Urea-N (0) AMS-N (24)	AMS-S (27)			24	27
4	Urea-N (17) AMS-N (4)	AMS-S (5)	AMS-N (4)	AMS-S (5)	24	10
5	Urea-N (1) AMS-N (12)	AMS-S (12)	AMS-N (12)	AMS-S (15)	24	27
6	Urea-N (24)				24	0
7	Urea (135)	AMS-S (13)	Urea (135)	AMS-S (13)	270	26
8	Unfertilized corn (without nitrogen application)					

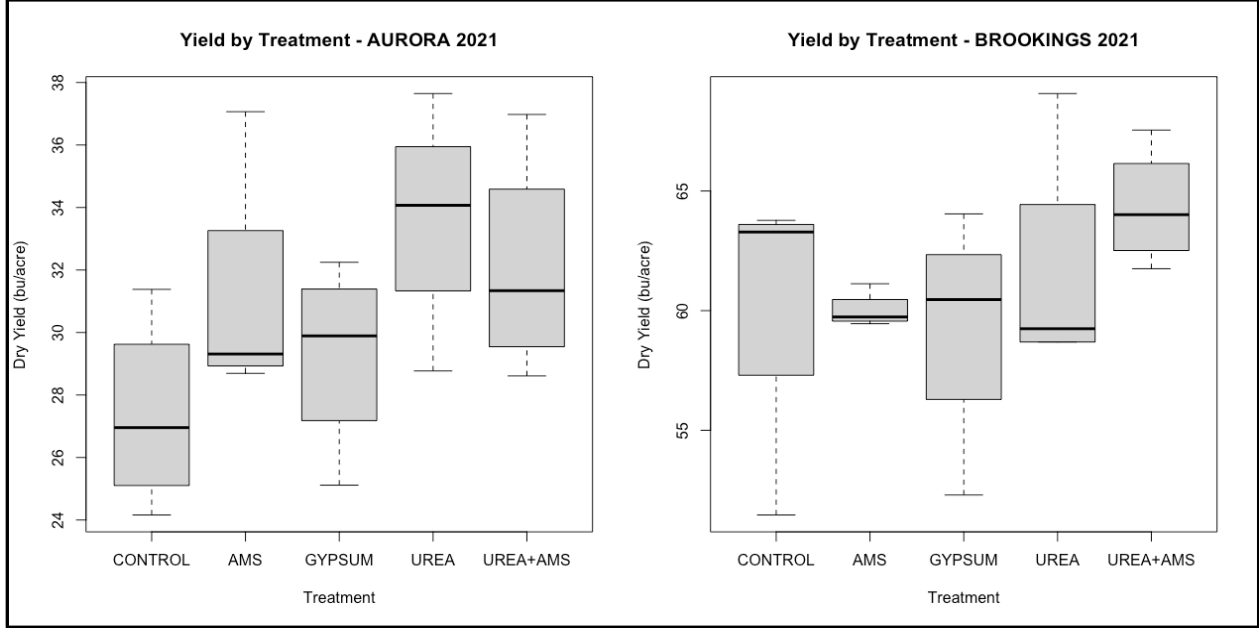


Figure 1. Boxplots showing soybean yields by fertilizer treatment for Aurora and Brookings, SD.

Soil sample results seem to indicate that the fertilizer treatments were performing in an expected manner. At the time of this report, we have not seen any results from KSU regarding the N analysis in the soybean tissue samples or anything from the U of M regarding soybean grain quality samples. A more detailed analysis will be shared in subsequent reports. Economic analysis for SD will likely not be performed due to the lack of significant treatment differences.

Objective 2: Build a predictive model for BNF in the United States using environmental data.

Dr. Ciampitti and his group at KSU will be conducting meta-analysis and attempting to build a predictive model once all the data has been compiled. Prediction models will likely be national in scope with regional considerations.

Objective 3. Extend results to soybean growers through extension networks.

To date, I have discussed the results of this study on the SDSU Extension Crop Hour on 1/18/2022 (https://www.youtube.com/watch?v=rueshEZDT_Y) and in a seminar at the Sioux Empire Farm Show on 1/28/2022. I also discussed the project on a TV interview with Michelle Rook on 1/28/2022. I also plan to discuss the project at SDSU Extension Road Show events on 2/04/2022 and 2/09/2022. I plan to continue to share with growers through winter talks (virtual and in-person), radio interviews, SDSU extension website publications, and social media during the January - June 2022 timeframe. A national summary fact sheet will be published for the study. A timeline has not been shared for the fact sheet and any peer-reviewed publications.