



MinnesotaCorn

RESEARCH & PROMOTION COUNCIL

INNOVATION GRANT PROGRESS REPORT

PROJECT TITLE: On-farm Evaluation of Variable Rate Sulfur Application

REPORTING PERIOD: April 1, 2024 – September 4, 2024.

FARMER INNOVATOR: Kirk Stueve – Stueve Ag Enterprises Inc

COLLABORATING ORGANIZATION/PERSON: Precision Ag. Center (U of MN) – Dr. Yuxin Miao.

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1.) PROJECT ACTIVITIES COMPLETED DURING THE REPORTING PERIOD. (Describe project progress specific to goals, objectives, and deliverables identified in your project proposal.)

During this reporting period, we achieved significant progress in the "On-farm Evaluation of Variable Rate Sulfur Application for Corn" project. Key activities included:

1. Establishing field trials across multiple locations in Minnesota, each with at least 40 acres and equipped with GPS yield monitors and variable rate technology for fertilizer application.
 - a. 2022: 3 corn fields. Two fields used Ammonium sulfate (AMS), and one used gypsum.
 - b. 2023: 6 corn fields. AMS was used in two fields, and the gypsum in the rest (7).
 - c. 2024: 5 corn fields. AMS was used in one field and gypsum in others (5).
2. Applying five distinct sulfur rates (0, 10, 20, 30, and 40 lb S/ac) across the on-farm trials with the Precision Ag. Center team providing the fertilizer prescriptions. We used a randomized block design for the 2022 and 2023 trials. However, we've changed to a Latin square design in 2024 based on other on-farm research results across the US. We will compare the outcomes of both design methods to check their differences and see potential improvements for the next ones.
3. Collecting and analyzing essential on-farm data such as yield maps, as-planted and as-applied fertilizer maps, and doing in-season monitoring using remote sensing imagery.
4. Conducting soil/plant sampling to understand better sulfur and other limiting factors, such as organic matter, and their within-field spatial variability.
5. Engaging farmers and consultants for trial implementations and establishing an on-farm research network in Minnesota. The idea is to work closer to them so we can learn the most from their experience, create practical solutions for their needs, and, using the on-farm network, increase collaboration in the state. This will also help farmers and crop consultants increase the adoption of precision agriculture tools and methods.
6. Presenting the research findings at national and international conferences and in the stakeholders' meeting organized annually by Precision Ag. Center.
7. Writing scientific papers about research findings to contribute to the scientific community. As of now, graduate student Renzo Negrini has 2 upcoming journal papers on on-farm precision sulfur management.
8. Preliminary yield, profitability, and sulfur response data analysis has been performed, focusing on the variability in agronomic and economic optimum sulfur rates, their sustainable benefits, and identifying key influencing factors.

These activities align with the project's goals of evaluating within-field sulfur response variability and the potential benefits of variable-rate sulfur applications. In addition, we've been working hard to develop a practical, profitable, and sustainable precision sulfur management system for farmers.

2.) IDENTIFY ANY SIGNIFICANT FINDINGS AND RESULTS OF THE PROJECT TO DATE.
(There may be none to report at some stages of the project)

The project has provided critical insights into the agronomic, economic, and sustainable impacts of variable-rate sulfur application on corn and soybean production across multiple fields during the 2022 and 2023 growing seasons.

Agronomic Findings:

- Corn yield ranged from 150 bu/ac to 294 bu/ac across fields, years, and S rates.
- Soybean yield ranged from 55 bu/ac to 79 bu/ac across fields and S rates.
- Overall, yield response to sulfur rates was generally positive, with many fields showing improved yield at higher sulfur rates in both years.

Economic Findings:

- Profit: Economic returns varied across fields, with specific sulfur rates providing more significant increases in profit.
- Soybeans: The potential profit increase due to variable rate S application at site-specific economic optimum S rate was \$30-75/ac.
- Corn: The potential profit increase due to variable rate S application at site-specific economic optimum S rate was \$29-110/ac.

Sulfur Use Efficiency (SUE):

- SUE ranged from a minimum of 1 bu /lb to a maximum of 26 bu /lb.

Agronomic and Economic Optimum Sulfur Rates (AOSR and EOSR):

- The Agronomic Optimum Sulfur Rate (AOSR) and Economic Optimum Sulfur Rate (EOSR) varied from 0 to 40 lb S/ac across all fields, indicating the importance of site-specific management and the development of precision sulfur management.
- These results highlight the importance of better understanding the factors impacting the agronomic and economic optimum sulfur rates and developing precision S management strategies.

These findings will be further refined after the 2024 growing season, when additional data will be collected and analyzed to assess the long-term impacts of variable-rate sulfur applications on corn and soybean production in Minnesota.

3.) CHALLENGES ENCOUNTERED. (Describe any challenges you encountered related to project progress specific to goals, objectives, and deliverables identified in the project proposal.)

We had data problems in 3 fields (2023), applying the correct prescribed rates and extracting the as-applied data from the machines. This issue probably happened due to a lack of knowledge in calibrating, setting up the variable-rate technology, and adequately retrieving the data from the monitor after the application. Unfortunately, we can't utilize the data when that happens.

All farmers and consultants were very supportive and believed in the project's ideas and methods.

4.) EDUCATION AND OUTREACH ACTIVITIES. (Describe any opportunities to engage with farmers, influencers, or the media about your project.)

1. Conference presentations: Tri-societies annual meetings in 2023 and 2024; International Conference On-Farm Precision Experimentation (ICOFPE) Texas 2024; International Conference In Precision Agriculture (ICPA) 2024. At the ICPA, the graduate student leading the sulfur research, Renzo Negrini, won the outstanding graduate student award in precision agriculture.
2. Regional Meetings: ASABE North Central 2024, Brookings, South Dakota.
3. Stakeholder's meeting 2023 and 2024: farmers, crop consultants, UMN, USDA, and MDA researchers.
4. Shared the knowledge, impact, and importance of on-farm research in lectures for undergraduate and graduate students at UMN lectures and trainings, such as for the Mandela Washington Program from UMN (2024).

5.) HOW CAN WE HELP? (Please let us know how we can improve the experience or assist in your project if possible.)

1. It Would be great to have more funding for outreach activities, such as:
 - a. Professional and personal development of the graduate student focused on the project. So, he can enhance his skills and help farmers to achieve better results.
 - b. National/international conferences, meetings, and workshop presentations to showcase our innovative on-farm research outcomes.
2. Advertise more of the work we've been doing with farmers and consultants and the name of Precision Ag. Center. Include more photos, videos, and texts of the farmers who believe in on-farm research and the connection between their side, the private sector, and the university on-farm researchers. Spreading the knowledge will help to increase precision agriculture tools and on-farm research adoption in Minnesota. We can think about that together and see the best way to proceed and favor all sides.