PRACTICAL FARMERS OF IOWA
COOPERATORS' PROGRAM Farmer-Led Research

EXPERIMENT

2024

Sulfur Fertilizer and Humic Acid Amendment for Soybeans

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In a Nutshell:

- Many farmers are interested in expanding their fertilizer and amendment applications beyond standard NPK in order to address nutrient deficiencies, promote plant growth and resilience and ultimately boost crop yields.
- Sulfur deficiency in soil has been common in Iowa for several decades due to decreased atmospheric S deposition. Fertilization with sulfate fertilizers, which provide plant-accessible sulfur, can sometimes increase yields in soybeans, though yield increases are often larger in corn [1],[2].
- Humic acid is a widely available biostimulant that can promote root growth, vegetative growth and potentially yield increases in crops including soybeans when applied at low concentrations [3],[4].
- Keaton Krueger conducted two trials in 2024 to determine whether applying humic acid + ammonium thiosulfate (ATS) or humic acid alone to his strip-tilled soybeans affected yield compared to applying nothing.

Key Findings:

- In Krueger's humic acid + ATS vs. no products trial, soybeans planted 23 days after humic acid and ATS were applied with strip tillage (79 bu/ac) yielded the same as soybeans planted without these amendments (78 bu/ac).
- In Krueger's humic acid vs. no humic acid trial, soybeans planted with in-furrow humic acid (77 bu/ac) yielded slightly but significantly less than soybeans planted without humic acid (80 bu/ac).

Cooperators

Keaton Krueger — Ogden, IA

Funding

Walton and Cargill

BACKGROUND

Many Iowa farmers are aware that applying soil macro- and micro-nutrients beyond NPK or applying biostimulants may significantly increase crop vigor and yields in a cost-effective way. Sulfur is one macronutrient essential for plant growth and plant uptake of other nutrients that has become deficient in many Iowa soils in recent decades. Sulfur fertilization can be a cost-effective method for increasing yields of alfalfa and corn, but soybean yield responses, while seen sometimes, are not as common [2],[5]. Sulfur deficiency, while common, is difficult to identify as there are no reliable soil tests for midwestern soils and it can look like nitrogen deficiency in foliage. Tissue sampling to identify deficiencies in alfalfa or strip-trials in corn-soybean rotations are recommended for any farmers who are not already applying sulfur incidentally through manure, existing fertilizers or irrigation water [1].

In addition to applying macro- and micro-nutrients directly, many farmers have also tried applying biostimulant products such as humic acid to stimulate plant growth. Humic acid is derived for organic matter and is operationally defined as the fraction of decomposed biomass that is water-soluble at neutral or alkaline

Keaton Krueger applying humic acid in-furrow with his planter at soybean planting. Krueger applied humic acid at planting in his humic acid vs. no humic acid trial and applied humic acid + ATS while strip-tilling, 23 days prior to planting, in his humic acid + ATS trial. Photo taken May 12, 2024.

pH [1],[2]. When applied at low concentrations in field settings to corn, soybean, and other crops, humic acid can increase crop root and vegetative growth, increasing plant tolerance to stress [3]. However, research has frequently shown that this increased growth does not generally result in significant yield increases [4].

Keaton Krueger is interested in expanding his fertilizer and amendment regimen to more uncommon products if they show promise in improving his yields in a cost-effective way. This year, he completed two trials testing whether adding sulfur as ATS (quickly plant-available) and/or humic acid to his soybeans affected his yields. He reports that his soybean rotation is an easy place to add products like ATS because "I have been strip tilling prior to soybeans so adding in some liquid product with that application adds no extra cost."

METHODS

Design

Krueger planted two trials in separate fields. In the first, he established two treatments:

1) Strip-till soybeans with humic acid and ammonium thiosulfate (ATS) applied with the strip-till bar 23 days prior to planting
2) Strip-till soybeans

In the second trial, he established two different treatments:

1) Strip-till soybeans with humic acid applied in furrow at planting
2) Strip-till soybeans

Application rates and other management details are shown in **Table 1.**

Krueger planted four randomized replicates of each treatment (**Figure A1**). Replication and treatment randomization allow for statistical analysis and conclusions about the effect of treatments on yield. To avoid edge-effects of decreased yields on the edges of fields, Krueger established his treatments several rows into the field. Krueger recorded soybean yield at harvest using a yield monitor.

Data analysis

We used an analysis of variance (ANOVA) followed by Tukey's HSD at a 95% confidence level to determine if there were significant differences between treatments within each experiment. The difference between the two treatments is compared with the HSD. A difference greater than or equal to the HSD indicates that one treatment significantly outperformed the other and the farmer can expect the same results to occur 95 out of 100 times under the same conditions. A difference smaller than the HSD indicates the difference is not statistically significant and the treatment had no effect. We can perform this analysis because Krueger established completely randomized and replicated experimental designs (**Figure A1**).

TABLE 1. Management of both trials at Keaton Krueger's in 2024.

	HUMIC ACID AND SULFUR	HUMIC ACID
Cash crop	Soybean	Soybean
Treatment strip size	950 ft x 60 ft	1050 ft x 60 ft (35 ft harvested)
Cover crop planting	Sept. 11, 2023 Cereal rye 53 lb/ac, radish 3 lb/ac interseeded into standing corn	Sept. 11, 2023 Cereal rye 53 lb/ac, radish 3 lb/ac interseeded into standing corn
Tillage	Apr. 19, 2024 Strip-till	Apr. 19, 2024 Strip-till
Cash crop planting	May 12, 2024 140,000 seeds/ac, 30 in. rows	May 12, 2024 140,000 seeds/ac, 30 in. rows
Treatment application	4 gal/ac ATS and 0.5 gal/ac humic acid solution (24%) applied with strip till bar	0.5 gal/ac humic acid solution (24%) applied in furrow at planting
Cover crop termination	May 15, 2024 Zidua and glyphosate	May 15, 2024 Zidua and glyphosate
Weed control	June 10, 2024 Glufosinate, S-Metholachlor, Enlist, Clethodim	June 10, 2024 Glufosinate, S-Metholachlor, Enlist, Clethodim, Max In Boron
Harvest	Sept. 27, 2024	Oct. 2, 2024

RESULTS AND DISCUSSION

Humic Acid + ATS

In Krueger's humic acid + ATS vs. no products trial, soybeans planted 23 days after humic acid and ATS were applied with strip tillage yielded the same as soybeans planted without these amendments (**Figure 1**). Krueger reports that he was surprised by this finding and expected to see a yield impact from the sulfur application (ATS) based on the response in soybean growth and vigor that he saw in field. Previous academic research has shown that sulfate or available sulfur fertilization only sometimes increases soybean yields [1],[2]. Krueger says "I will probably want another year of data on a different field before I decide if this treatment is worth it or not.

Humic Acid

In Krueger's humic acid vs. no humic acid trial, soybeans planted with in-furrow humic acid (77 bu/ac) yielded slightly but significantly less than soybeans planted without humic acid (80 bu/ac) (**Figure 2**). Krueger reports that "I am very surprised to see a negative response to humic acid in furrow. I'm not sure what to make of that." Decreased plant root and shoot growth caused by humic acid application at high concentrations have previously been documented in academic literature. Though there is little consistency about concentrations that are considered high, recommended application rates including those that Krueger used are included in that range [3].

CONCLUSIONS AND NEXT STEPS

Krueger is not sure whether he will continue trying humic acid as an amendment intended to increase soybean yield, but he does plan to continue trialing sulfur. He knows that results might be different on a different field or in a different year as soil and other growing conditions change. As a frequent participant in PFI trials, Krueger reports that trials are useful to him because they "help me to confirm on my own farm if practices that are shown to elicit a response in the literature hold up."

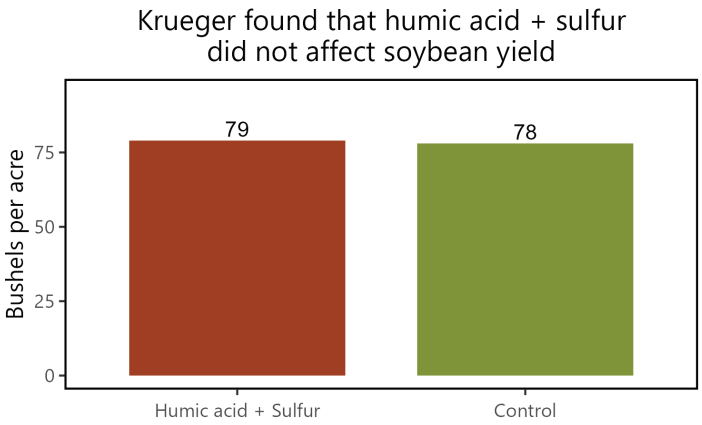

FIGURE 1: Soybean yield by treatment in Krueger's humic acid + ATS (sulfur) vs. no product (control) trial. There was no statistically significant difference in soybean yield between the two treatments (HSD = 1.2 bu/ac) at the 95% confidence level.

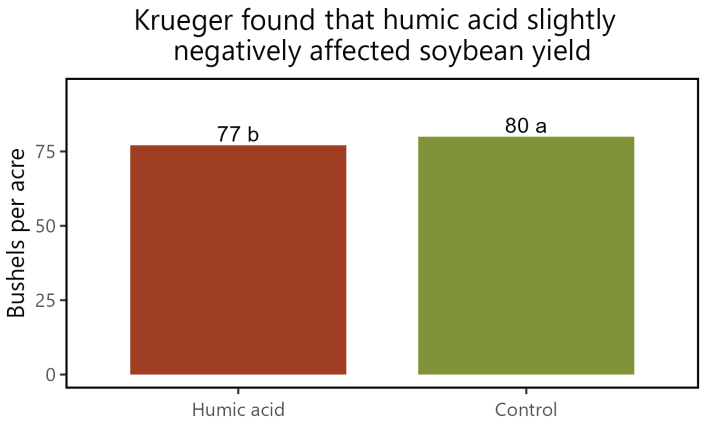

FIGURE 2: Soybean yield by treatment in Keaton Krueger's humic acid vs. no humic acid (control) trial. We use different letters beside yield values to indicate soybeans treated with humic acid yielded significantly less than soybeans that were not treated (HSD = 2.5 bu/ac) at the 95% confidence level.

APPENDIX – TRIAL DESIGN AND WEATHER CONDITIONS

	Control	Humic Acid	Humic Acid	Control	Control	Humic Acid	Humic Acid	Control
STRIP	1	2	3	4	5	6	7	8
REP	1		2		3		4	

FIGURE A1. Example experimental design used by Keaton Krueger

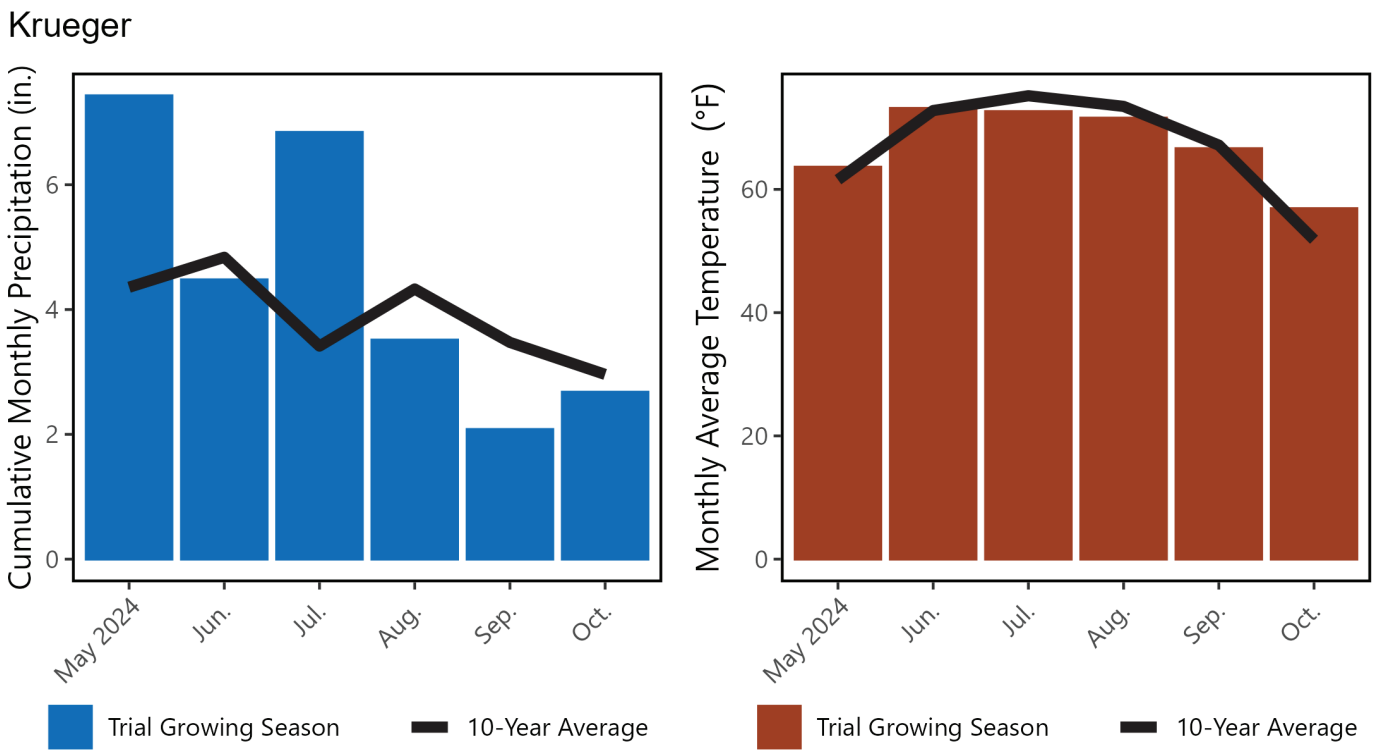

FIGURE A2. Modeled mean monthly temperature and rainfall at each trial site during the study period and the ten-year historic averages. Data is from the NasaPOWER climate dataset [6], [7].

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PRACTICAL FARMERS of Iowa

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