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| *Investigating if Sulfur is a Limiting Nutrient in New York Soybean Production* |
| Image result for soybean pictures |

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# aBSTRACT

Soybean acreage continues to grow throughout New York State. According to the 2016 New York State Agriculture overview, 320,000 acres of soybeans were harvested with an average yield of 41 bushel/acre. Soybean response to nutrients depend on growth and yield potential, availability and weather. In recent years sulfur has become an important limiting nutrient to crop production for several reasons. These reasons are as followed: higher yielding varieties require more sulfur, reduced sulfur returns with farm manure, less use of sulfur containing pesticides, reduced industrial sulfur emissions to the atmosphere due to stricter emission regulations, insufficient soil organic matter levels and increased awareness of crop sulfur needs. Due to the decrease in atmospheric sulfur deposition over the last few decades, questions about fertilizer sulfur needs in forages and soil and tissue sampling tools for sulfur management have arose. Recent research in New York on alfalfa has shown a significant yield increase with additional sulfur fertilization, it is clear that sulfur deficiencies do exist in New York soils. The goal of this on-farm research is to identify if sulfur deficiencies do exist in soybean crop rotations and test if additional sulfur fertilization will result in increased yields. Producers will be able to identify if sulfur is a limiting nutrient on farm production, identify key factors that lead to sulfur deficiencies (crop rotations, reduced manure application), and understand how to identify fields with the potential to become sulfur deficient. The experiment will focus on testing the accuracy of current management tools and practices for making decisions on sulfur management in soybeans. In addition, the experiment will re-examine a higher standardized rate of 30 lbs. S/acre for different products and forms (gypsum and ammonium sulfate) to determine if sulfur uptake is impacted with Nitrogen availability.

## Background and Justification

Since the passing of the Clean Air Act in 1970 and the introduction to sulfur free phosphorus fertilizers and pesticides, secondary addition of sulfur to fields through atmospheric deposition and fertilizer application has significantly decreased in New York (Kettering, 2012). With the diminishing use of sulfur containing fertilizers and pesticides, the decrease in atmospheric sulfur deposition, and increase in yield through improved management practices and crop genetics, we have to question the sulfur status of New York soils and sulfur management options. Recent research in New York on alfalfa has shown a significant yield increase with additional sulfur fertilization, clearly exhibiting sulfur deficiencies do exist in New York soils. The question we want to answer is do sulfur deficiencies exist in soybean crop rotations? Sulfur is an essential nutrient for plant growth and development. Inadequate sulfur supply can heavily affect yield and crop quality. Similar to phosphorus, this element received little attention for many years because fertilizers and atmospheric inputs supplied the soils with adequate amounts (Scherer, 2001). In recent years, areas of sulfur deficiencies have become more common throughout the world. Due to the decrease in atmospheric sulfur deposition over the last few decades, questions about sulfur fertilizer needs in forages and soil, and tissue sampling tools for sulfur management have arose throughout western New York. Producers want to know if they should be adding additional sulfur fertilizer to their production systems in order to increase yield and quality.

Soybean production is common to most NY field crop and dairy farms and critical to their economic viability. Despite improved management practices and crop genetics, many opportunities remain to improve soil health, crop quality and yield to enhance farm net profitability. The proposed research project is designed to help soybean producers identify and address if nutrient deficiencies, specifically sulfur, exist in their soils and if their current management tools and practices for making decisions on sulfur are accurate. The proposed research project will help producers identify if sulfur is a limiting nutrient in on-farm production, identify key factors that lead to sulfur deficiencies (crop rotations, reduced manure applications, soil health), and understand how to identify fields with the potential to become sulfur deficient. A multitude of research shows that improving soil heath can boost crop yield, enhance water quality and infiltration, and increases resilience to abiotic and biotic factors. The proposed research will teach soybean producers innovative techniques to better manage their crop production, increase yields/quality and profitability, while improving field conditions. The long range goal of this research project is to improve operational practices on-farm and foster industry wide innovation.

### Objectives

The primary goal of this research project is to identify if sulfur is a limiting nutrient in soil and New York soybean production. Interest in the use of gypsum is increasing in New York. Gypsum is an excellent source of calcium and sulfur, both of which are essential crop nutrients. In recent years, sulfur deficiencies have become increasingly common in field crops throughout the world. Sulfur can be low in coarse-textured soils low in organic matter. The purpose of this trial was to evaluate the short-term and long-term effects of broadcast pelletized gypsum on crop yields in New York rotations.

Project Objectives:

1. Determine if sulfur is a limiting nutrient in soil and New York soybean production
2. Test the accuracy of the current management tools and practices for making decisions on sulfur management in soybeans.
3. Identify if there’s a need to examine other crops for sulfur needs in New York.

### Procedure:

### In 2017, an on-farm research project was conducted in western New York, to evaluate gypsum as a source of sulfur for soybean production. To determine the immediate effect of broadcast gypsum on soybean yields, a broadcast gypsum application was compared to an untreated control at two locations in 2017. Gypsum was applied in the spring at both locations prior to planting. The gypsum application rate for each location was based on a standard rate of 30 pounds of sulfur per acre. An application of 20-40 pounds of sulfur per acre will generally correct a sulfur deficiency. This rate was selected to highlight gypsum’s reported advantages as a soil amendment capable of improving soil tilth and water infiltration. Location 1 was a 7.5 acre plot with variety, DF 242-2.4 soybeans drilled in 15” rows at 153,000 seeds per acre. The two treatments were replicated six times. The trial was planted May 19, 2017. The soil was primarily Odessa with some Schoharie silt loam. The previous crop was grain corn.

### Location 2 was a 17.96 acre plot with variety, Asgrow S20-J5x soybeans drilled in 15” rows at 150,000 seeds per acre. The two treatments were replicated three times. The trial was planted on June 3, 2017. The soil was primarily aeric fragicquepts with wallington silt loam. The previous crop was grain corn.

### Uppermost fully developed trifoliate leaves were sampled during pre-bloom at location 1, July 11 (Chart 1) and early bloom at location 2 July 24 (Chart 2) for nutrient analysis and soybeans were harvested at location 1 October 14, 2017 and location 2 October 15, 2017.

### Chart 1-Branton. Effects of gypsum on leaf nutrient concentrations at pre-bloom for location 1, Western New York, 2017.

### Chart 2 -Lockpit Farm. Effects of gypsum on leaf nutrient concentrations at early bloom for location 2, Western New York, 2017.

**Chart 3. Effects of gypsum on soybean yield at location 1, Western New York, 2017.**

**Chart 4. Effects of gypsum on soybean yield at location 2, Western New York, 2017.**

\*Soybean yields were not significantly different.

For soybeans, the sulfur sufficiency range is between 0.20 to 0.40 percent. The gypsum treatment did not affect the nutrient concentration levels of sulfur within the leaf. The control and treated were at optimum sulfur sufficiency levels. Our gypsum treatment also had no effect on other secondary and micronutrient concentration levels within the leaf and all were within optimum ranges. Plants treated with gypsum showed no visible difference throughout the growing season. The yield difference between the gypsum treatment and untreated control was negligible.

Most soil sources of sulfur are found in the organic matter and are therefore concentrated in the topsoil or plow layer. Elemental sulfur and other forms as found in soil organic matter and some fertilizers, are not available to crops. They must be converted to the sulfate SO4 form to become available to the crop. This conversion is performed by soil microbes and therefore require soil conditions that are warm, moist, and well drained to convert quickly into its available form. The sulfate form of sulfur is an anion causing it to become leachable. In soils with abundant and restrictive clay layers in the sub-soil, you’ll commonly find the sulfate has leached over time and become suspended on the clay layer. In return the sulfate is only available when the roots grow out to this area of the soil. It is my belief that due to the soil type, extensive rainfall and saturated soil conditions at each plot site, cooler temperatures, and below average growing degree days we may have experienced issue regarding nutrient availability and leach-ability. It is my conclusion that the experiment needs to be repeated and spread out over several sites and include other sources of sulfur.