Beneficial Use Case Study

Correcting Sulfur Deficiency with FGD Gypsum to Boost Alfalfa Yield

Coal Combustion Product Type
FGD Gypsum

Project Name
Correcting Sulfur Deficiency with FGD Gypsum to Boost Alfalfa Yield

Project Location
Onaway, Michigan

Project Participants
Presque Isle County Michigan State University Extension, Charah Solutions

Project Completion Date
2017

Project Summary
Sulfur and boron are essential to alfalfa's quality, yield, and regrowth. Alfalfa utilizes approximately five to six pounds of sulfur per harvested ton. A 2015 survey of tissue sulfur levels in Michigan alfalfa fields found that 58 percent of those sampled in the northern regions of the state were deficient, likely the result of lower atmospheric sulfur deposition resulting from regulatory efforts to minimize power plants' sulfur emissions. Boron is commonly deficient in alfalfa grown in high-pH, sandy loam soils, such as those found in northeast lower Michigan. To address these deficiencies, Presque Isle County Michigan State University Extension tested the use of two Sul4R PLUS gypsum products from Charah Solutions on alfalfa hay quality and yield.

Project Description
A two-year-old alfalfa stand near Onaway, Michigan, was selected for testing based on soil analysis that revealed sulfur and boron deficiencies. Approximately 300 pounds per acre of 3-14-42 dry fertilizer was applied to all fields to control for potential nitrogen, phosphorous, and/or potassium deficiencies. Two different treatments were then applied to the alfalfa fields at a rate of 147 pounds per acre—the first SUL4R-PLUS gypsum, comprising 21% Ca and 17% S, and the second SUL4R-PLUS B+Z, comprising 18% Ca, 16% S, 0.50% B, and 1.5% Zn. The other plots were left untreated to act as a control group. Each treatment was replicated four times in a randomized pattern.

Alfalfa yield varied significantly between the gypsum and control treatments at first cutting (P=0.008), second cutting (P=0.05), and overall (P=0.02), with the SUL4R-PLUS and SUL4R-PLUS B+Z treatments out-yielding the control treatment by 1,321 and 1,537 pounds dry matter per acre, respectively. Yield was higher for the SUL4R-PLUS treated fields at first cutting, and in the SUL4R-PLUS B+Z treated fields at second cutting.

Further, alfalfa yield was significantly correlated with tissue sulfur concentration (R2=0.26, P=0.10). Alfalfa tissue sulfur concentrations varied significantly between the SUL4R-PLUS treatment and the control treatment (P=0.10). However, the SUL4R-PLUS B+Z treatment produced intermediate tissue sulfur concentrations not significantly different from the SUL4R-PLUS treatment or the control. Tissue boron levels, however, were significantly higher in both the SUL4R-PLUS B+Z and control treatments

Photo: GNU FDL/Gary D. Robson

relative to the SUL4R-PLUS treatment, although all treatments produced sufficient tissue boron levels.

These differences in nutrition status between treatments did not translate into significant differences in forage quality at first cutting—likely the result of the alfalfa being overmature and damaged by alfalfa weevil prior to first cutting, making quality poor overall. However, crude protein and relative feed value were both higher in the SUL4R-PLUS B+Z treatment at second cutting.

Collectively, the data suggest SUL4R-PLUS products are capable of addressing sulfur, and possibly boron, deficiency in alfalfa to significantly increase both forage yield and net economic return. The addition of boron to gypsum (i.e., the SUL4R-PLUS B+Z treatment) produced somewhat unexpected results, apparently counteracting the negative effect of added calcium on boron uptake by the alfalfa in the SUL4R-PLUS treatment.

The addition of boron to SUL4R-PLUS also appears to have a possible effect on the rate of sulfur uptake and utilization by alfalfa. Tissue sulfur and first cutting yields were less in forage treated with SUL4R-PLUS B+Z compared to SUL4R-PLUS. Yet regrowth after first cutting in the boron-treated fields outpaced even the standard SUL4R-PLUS treatment, and forage quality was also better at second cutting where boron was added.

The researchers hypothesize that the addition of boron as a coating to the gypsum pellets may physically limit the availability of sulfur initially. However, the additional boron appears to be important eventually in counteracting reduced boron uptake caused by the large amount of calcium in gypsum—and may also interact synergistically with added sulfur to improve forage yield and quality by mid-season.

This case study was adapted from "Increase alfalfa hay yields by addressing sulfur deficiency," published January 15, 2018, by James DeDecker and Christian Tollini of Michigan State University Extension. To read the full synopsis of their research, please visit: https://www.canr.msu.edu/news/increase_alfalfa_hay_yields_by_addressing_sulfur_deficiency