

Use of FGD Gypsum on a Bermudagrass Pasture in the Appalachian Plateau Region

Dexter B. Watts and H. Allen Torbert

United States Department of Agricultural Research Service, National Soil Dynamics Laboratory, 411 S Donahue Drive, Auburn, AL 36832

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ABSTRACT

Addition of industrial by-products from coal fired power plants (FGD gypsum and FGD gypsum + fly ash) are thought to increase plant production. Thus, a study was conducted to evaluate the effects of industrial by-products as a soil amendment on bermudagrass (*Cynodon dactylon* L.) yield. The study was conducted on an established bermudagrass pasture. Poultry litter was applied to the pasture as the nutrient source at a rate of 8.8 Mg ha⁻¹. After poultry litter addition, commercial gypsum, and FGD-gypsum, FGD-gypsum + fly ash was applied at three different rates (2, 10, and 20 Mg ha⁻¹). Addition of gypsum, whether it was commercial gypsum, FGD-gypsum, or FGD-gypsum + fly ash impacted plant yield the same, suggesting that FGD-gypsum and FGD-gypsum + fly ash could be an alternative for commercial gypsum. During the 2008 growing season, the three gypsum sources at 10 Mg ha⁻¹ produced the greatest plant response. However, during the 2009 growing season, the three gypsum sources at 2 Mg ha⁻¹ produced the greatest plant response. Differences in growth response between the two growing seasons could be attributed to increased rainfall observed during the 2009 growing season. This study shows that gypsum addition to soil can potentially influence bermudagrass pasture systems, but in order to understand the full potential of gypsum addition to soil a long term evaluation is needed.

INTRODUCTION

Use of gypsum as a soil amendment could potentially increase the yield of agricultural crops. Gypsum can be used as a source of both Ca and S for plant nutrition. Gypsum amendments can also improve the physical and chemical properties of soils by promoting better soil aggregation, increasing water infiltration and movement through the soil profile, and mitigating subsoil acidity and Al toxicity.¹

Mined Gypsum has been used as a calcium additive for years for peanuts, but is not commonly used in hay and other row crop production systems due to its high cost. Flue gas desulfurization (FGD) gypsum may be an alternative to mined gypsum. Use of FGD scrubbers to remove sulfur from the flue gas of coal-burning power plants for electricity production yields gypsum as a

byproduct of the scrubber process. Presently, FGD gypsum is used primarily by the wallboard industries. However, installation of FGD scrubbers is expected to increase significantly in response to new and existing air pollution regulations, with a concomitant increase in FGD gypsum. The current markets are not expected to be able to utilize all of the FGD gypsum produced. The beneficial uses of gypsum on agricultural land could provide an additional use for FGD gypsum, which represents a low cost alternative to commercial mined gypsum. Also, FGD gypsum has a higher $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ content and fewer impurities than commercially mined gypsum and contains much smaller, finer, more uniform sized particles.^{2,3,4} Thus research is needed to evaluate gypsum's impact on reducing soluble P in surface water runoff, its effect on yield production, the rate needed for maximum yield, and the potential environmental impact of over application. Therefore the objective of this study was to evaluate FGD gypsum use as a soil amendment to increase the yield of bermudagrass in a hay production system.

MATERIALS AND METHODS

Site Description

A field experiment was conducted during 2008 and 2009 growing seasons at the Sand Mountain Research and Extension Center located in the Appalachian Plateau region of Northeast Alabama on a Hartselle fine sandy loam. The study was in an established bermudagrass pasture utilized for hay production. The soil was a Hartsells fine sandy loam (fine-loamy, siliceous, subactive, thermic Typic Hapludults), which consists of moderately deep, well drained moderately permeable soil that is formed from acid sandstone. The surface 0-15 cm (6 inches) of soil at the time of study initiation was characterized as 11.9 % clay, 28.9 % silt, and 59.6% sand with an average bulk density of 1.5 g cm^{-3} . Climate in this region is subtropical with no dry season; mean annual rainfall is 1325 mm (52 inches), and mean annual temperature is 16°C (61°F).⁵ Prior to initiation of the field study, no known history of fertilization had occurred since the establishment of the Research station in 1929.

Cultural Practices and Treatments

The bermudagrass pasture was cleared of any weeds or senesced plant material prior to establishment of plots. Experimental plots 3.05 m wide by 6.10 m long (12 ft wide and 20 ft long) were arranged in a randomized complete block design with four replications. The experimental treatments consisted of three gypsum sources (commercially available bag gypsum, FGD-gypsum from TVA, and FGD-gypsum + fly ash from TVA) applied on May 21, 2008 at rates of 2, 10 and 20 Mg ha^{-1} (1, 5, and 10 tons acre⁻¹) for the gypsum source, and compared to lime at 10 Mg ha^{-1} (5 tons acre⁻¹), mixture of commercial gypsum at 10 Mg ha^{-1} + lime at an equivalent Ca content, and a control (fertilized with poultry litter only). Poultry litter was applied as the nitrogen source at a rate of 8.8 Mg ha^{-1} (4 tons acre⁻¹; maximum 1 time application rate for Alabama) on all plots. Poultry litter was surface broadcasted using a pull behind John Deere Manure Spreader. Poultry litter used in this study was collected from a local poultry production

facility and consisted of poultry manure and a bedding material mixture. Following the application of poultry litter, surface broadcast application of the gypsum sources and lime treatments were applied on top of the poultry litter by hand. The bermudagrass was managed as a pasture used for hay production.

Forage yield

Beginning in early June of each year plots were harvested every 6 wk for approximately 3 or 4 cuttings. Biomass yield was determined by harvesting a 1.52 by 6.1 m area within each plot using a Lawn-Genie plot forage harvester (Matthews Co., Crystal Lake, IL) retrofitted with a weighing basket. Harvesting was performed by cutting a swath through the center of each plot at a 7 cm stubble height. The total wet biomass was determined and sub-samples were taken and from each yield sample to determine dry matter content.

Statistics

The experimental design was a randomized complete block design, with the four blocks representing replicates. Statistical analysis was performed using a GLM procedure of SAS (SAS Institute, 1985). Statistical comparisons were made at a significance level of $\alpha < 0.10$ established *a priori*.

RESULTS AND DISCUSSION

The bermudagrass was harvested for a total of 3 cutting in 2008 and 4 cutting in 2009. Cuttings in 2009 resulted in significantly higher yields ($P < 0.0001$) compared to 2008. Rainfall totals from May to November in 2008 was 341 mm (13.42 inches) and 2009 rainfall totals was 823 mm (32.41 inches). Rainfall totals during the 2009 growing season was almost double that observed during 2008. Thus, differences in the number of bermudagrass cutting were attributed to increase plant biomass production resulting from greater rainfall total observed during the 2009 growing season.

The influence of gypsum on bermudagrass yield during the 2008 and 2009 growing seasons was minimal. No significant differences were observed between the control and gypsum treatments regardless of rates during both years (Figure 1 and Figure 2). Although no significant, during the 2008 growing season, the commercial gypsum, FGD gypsum, and FGD gypsum + fly ash at rate of 10 mg ha⁻¹ tended to have the highest yield compared to the other treatments. During the 2009 growing season, the commercial gypsum, FGD gypsum, and FGD gypsum + fly ash at rate of 2 mg ha⁻¹ had the highest yield compared to the other treatments. These differences between years observed in bermudagrass yield response to gypsum addition were probably attributed to the amount of rainfall observed during the growing seasons. For instance, the bermudagrass during the 2009 growing season received higher than normal rainfall. There was no difference between the commercial gypsum, FGD gypsum, and FGD gypsum + fly ash, thus suggesting that all of the gypsum sources respond similar to each other. The important thing to note from this

study is that gypsum addition to bermudagrass pastures, whether it is commercial gypsum, FGD gypsum or FGD gypsum + fly ash did not have a negative impact on yield. Thus, FGD gypsum or FGD gypsum + fly ash could potentially be used as a low cost alternative to commercial gypsum when gypsum is needed, such as a binding agent to reduced potential loss of soluble P⁶ or as a calcium and sulfur additives. Use of th This was a short term study (2 years), thus, the long-term impact that gypsum has on plant yield remains to be investigated. Also, poultry litter was used as the fertilizer source which contains macro and micro nutrients that are beneficial for plant growth. Thus, additions of poultry litter may have masked the beneficial effects that gypsum may have on bermudagrass. Therefore, more research is also needed on gypsums influence on bermudagrass yield without the addition of an organic fertilizer source.

CONCLUSIONS

Commercial gypsum, FGD gypsum, and FGD gypsum + fly ash impact on yield bermudagrass yield was minimal. Flue gas desulfurization gypsum, FGD gypsum, and commercial gypsum provided similar yields. No decreases in yield were observed with the addition of any gypsum source. More research is needed on the long-term impact that gypsum production has on yield response in forages with and without the addition of organic nutrient sources such as poultry litter.

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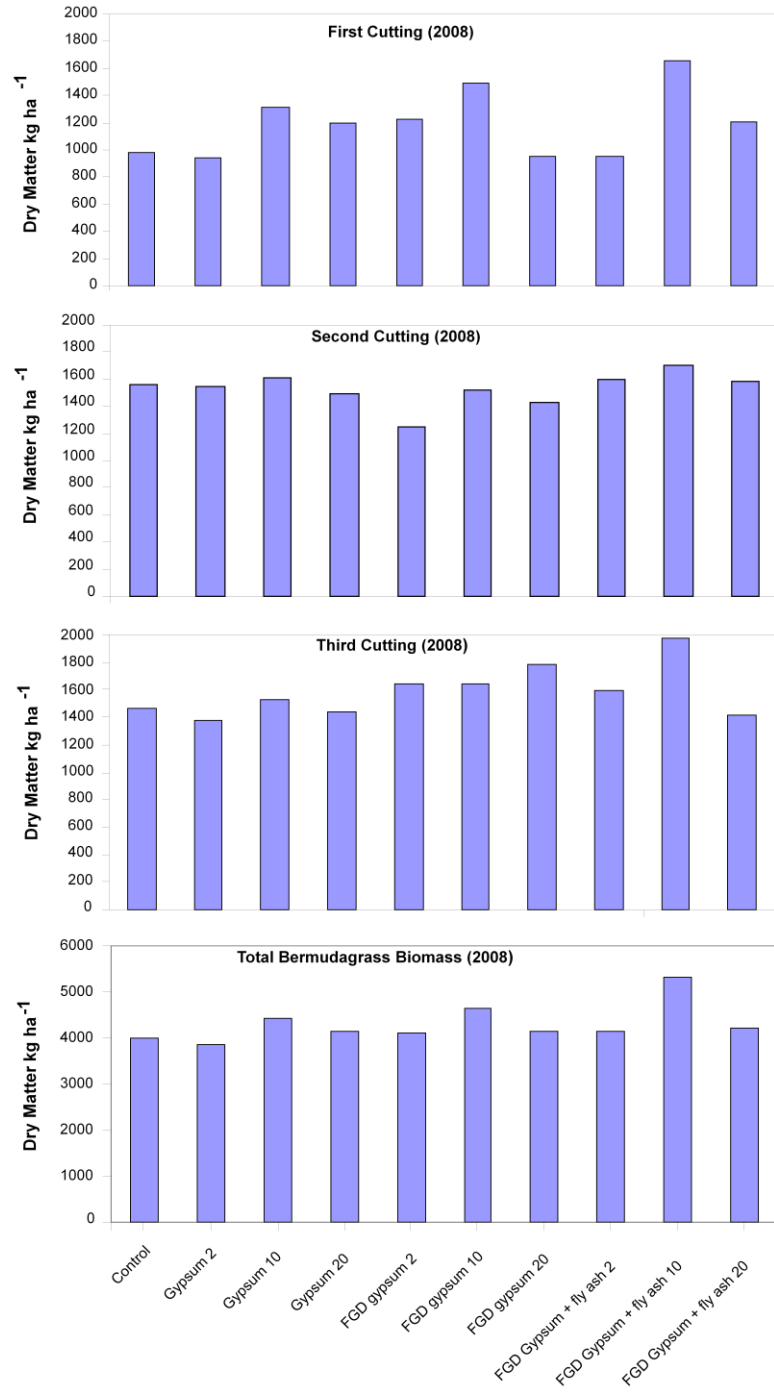


Figure 1. Bermudagrass yields for the 2008 growing season for the control, commercial gypsum (gypsum), flue gas desulfurization (FGD) gypsum, and FGD gypsum + fly ash at rate of 2, 10, 20 Mg ha⁻¹.

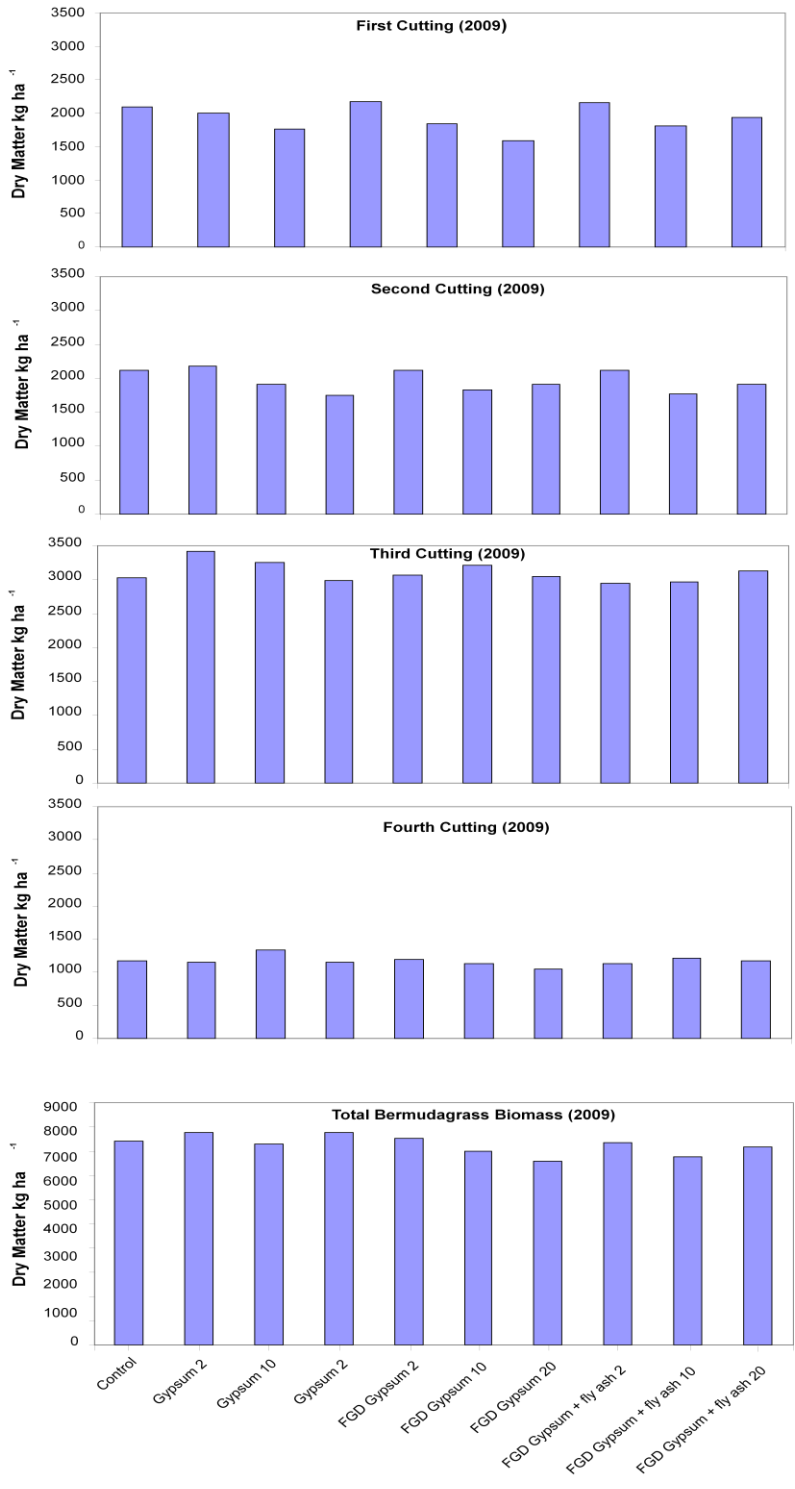


Figure 2. Bermudagrass yields for the 2009 growing season for the control, commercial gypsum (gypsum), flue gas desulfurization (FGD) gypsum, and FGD gypsum + fly ash at rate of 2, 10, 20 Mg ha⁻¹.