PHOSPHOGYPSUM AS A SOURCE OF NUTRIENTS FOR BAHIAGRASS

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ABSTRACT
Phosphogypsum is a by-product of the manufacture of phosphoric acid from phosphate rock and is a potential source of sulfur and calcium for crops. There are currently more than 700 million Mg of phosphogypsum in Florida alone stacked in waste piles and an additional 30 million Mg produced annually. A 3-year study was conducted to determine whether addition of phosphogypsum to bahiagrass would increase production and quality. Results indicate that addition of up to 4.0 Mg/ha phosphogypsum increased bahiagrass yields, protein content, and *in vitro* digestibility of forage. This study has demonstrated that phosphogypsum can be used as an alternative source of sulfur and calcium for forage crops.

KEYWORDS
Phosphogypsum, sulfur, calcium, forage, bahiagrass.

INTRODUCTION
Sulfur deficiencies in plants have been reported in more than 45 states, including Florida. Although sulfur is usually considered a secondary plant nutrient, it still needs to be viewed as one of the major nutrients essential for crop growth along with nitrogen, phosphorus, and potassium. Sulfur is required by plants for the synthesis of certain amino acids which are required for protein production. If sulfur is limiting, forage quality, as well as quantity, will be reduced. In fact, sulfur deficiencies are often confused with nitrogen deficiency. While in less severe cases of sulfur deficiency visual symptoms may not always show up, crop yield and quality can be adversely affected.

Until recently, little attention has been given to the need for sulfur fertilization in Florida and other parts of the country. This is understandable since in the past low analysis fertilizers contained sulfur impurities sufficient to meet the nutrient requirements for crop production. However, fertilizer manufacturing technology has now become highly advanced and consequently high analysis fertilizers, such as triple superphosphate and diammonium phosphate, are free of sulfur impurities. As a result, sulfur deficiencies are becoming more pronounced and widespread throughout the world. Coarse textured soils, such as those commonly found in Florida, may also exhibit sulfur deficiencies because of their very low nutrient holding capacity.

It is important to note that sulfur fertilization will increase yields and improve the quality of crops only if the plants are deficient in sulfur. The sulfur status of a crop is best determined by having plant tissue samples analyzed for sulfur. Tissue analysis is better correlated to crop yield than soil tests for sulfur. For grasses, the level of sulfur in plant tissue should range from 0.2 to 0.5 percent. If the level of sulfur falls below 0.2 percent, sulfur deficiency is indicated and the grass should respond to sulfur fertilization.

Over the years, we have demonstrated that addition of sulfur can increase production of harvested forages, such as bahiagrass (*Paspalum notatum* Flugge), by as much as 25 percent and protein by 1.2 percent. In these studies, the sources of sulfur were ammonium sulfate and potassium sulfate which are relatively expensive. Bahiagrass, which is an important forage crop in Florida, is grown on nearly five million ha, exceeding production of all other improved grasses combined. To provide sulfur for this land area would be a considerable expense.

There is a need to find an alternative economic source of sulfur which would be more affordable to growers than traditional sulfur fm ($CaSO_4.2H_2O$), is a by-product of the wet-acid production of phosphoric acid from rock phosphate, is a potential low cost source of sulfur and calcium for forages and other crops. In Florida alone, there are more than 700 million Mg of phosphogypsum stored in waste stacks, with 30 million tons being added to the stacks annually. In the entire country the total amount of phosphogypsum in stacks is estimated at seven billion tons. Until now, phosphogypsum has had little commercial use because it contains low levels of radium (8-30 pCi Ra-226/g), raising concern over its potential harmful effects.

This paper presents the results of the agronomic effects of phosphogypsum, applied at agronomic rates, on bahiagrass.

METHODS
Over the past six years, we have evaluated the agronomic and the environmental impact of phosphogypsum use on pastures in Florida. The studies were conducted at the University of Florida Range Cattle Research and Education Center at Ona, Florida.

Yearly phosphogypsum rate of 0.4 Mg/ha and one-time rates of 2.0 and 4.0 Mg/ha were applied to long-established bahiagrass plots located on a Myakka fine sand soil. No-phosphogypsum plots serve as controls. Bahiagrass forage was harvested monthly from May until December in order to assess the influence of phosphogypsum on forage production and quality. Soil samples were collected annually to a depth of 1 meter. Water samples were collected after each heavy rain to a depth of 1.5 meter. Forage, soil samples , and groundwater samples were analyzed for various plant nutrients. Fluorides were also determined in forage and groundwater samples.

RESULTS AND DISCUSSION
Forage Yield. Regardless of the rate or time of application, phosphogypsum tended to increase regrowth and mature (hay) bahiagrass yields by approximately 20 percent (Figure 1) over the 3-year period. Significant increases in regrowth and hay yields were noted for the 0.4 Mg/ha as well as at higher rates, for at least two years, and over the 3-year period for all rates. Other studies have also shown that addition of phosphogypsum, mined gypsum, or other sources of sulfur can increase forage production when sulfur is deficient (Alcordo and Rechcigl, 1993).

Forage Quality. Phosphogypsum tended to increase crude protein content of the mature bahiagrass forage, by as much as 1% in all years and over the 3-year period, and the digestibility, by as much as eight percentage units (Figure 2) in some individual harvests during the first year (1990). This is in agreement with other studies showing that addition of sulfur will increase the nutritive value of forages on sulfur deficient soils. Increases in both digestibility and protein content of forage are known to increase the weight gains in livestock. Phosphogypsum increased the sulfur and calcium content of the bahiagrass tissue. The calcium content ranged from 0.42 to 0.60%. Sulfur content ranged from 0.18 to 0.40% for the 0 and 4.0 Mg phosphogypsum/ha treatments, respectively.

Phosphogypsum also slightly increased the fluoride content of the bahiagrass tissue from 7.2 mg/kg for the control to 8.6 mg/kg for the 4.0 Mg phosphogypsum/ha (data not shown). However the content was well below the 30 ppm maximum acceptable level for livestock

intake. The low levels of tissue fluoride found in this study are of some importance since high levels of fluoride may bring about the loss of teeth in cattle.

This study demonstrates that phosphogypsum can increase both the yield and quality of bahiagrass, and possibly other forage grasses. This can, in turn, lead to greater livestock weight gains and increased stocking rates, resulting in increased profits of ranchers. Phosphogypsum may, thus, be a viable and an economical source of sulfur and calcium for forage production.

REFERENCES

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Figure 1
Influence of phosphogypsum on bahiagrass yields.

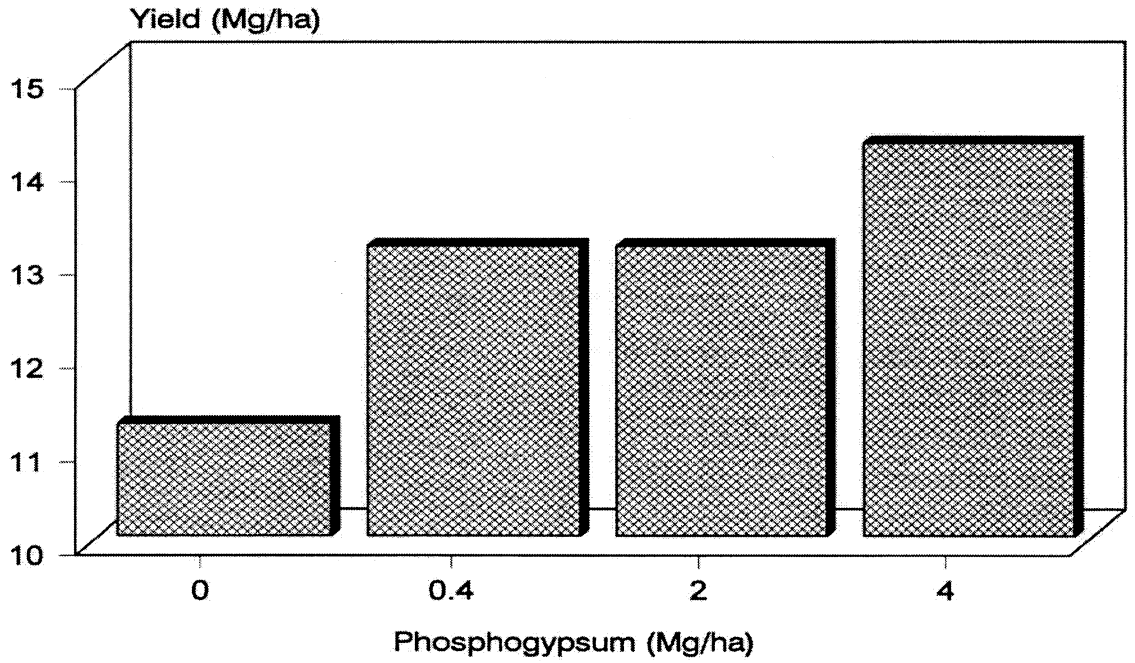

Figure 2
Influence of phosphogypsum on bahiagrass digestibility.