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Lime and Nitrogen for Bahiagrass Production

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The coastal area of Mississippi is basically a rolling landscape with highly erodible sandy soils. The climate is mild, growing season is nearly year round, and annual precipitation averages almost 60 inches. Soils in this area are characterized by low fertility, low organic matter, low cation exchange capacity, and low pH. The predominant vegetation is pine trees and native grasses. These characteristics, coupled with the present interest in ecology, make this type of soil undesirable for row crop production. This area is basically adapted for the production of pine trees, grass, and cattle. This type of agriculture is ecologically attractive.

There are many types of grasses, both introduced and native, which produce good pastures, but Pensacola bahiagrass (*Paspalum notatum* Flugge) has become an important forage grass because of its ability to perform under low manangement, fertility, and pH (4). This grass was collected from vacant lots and docks in Pensacola, Florida in 1941 (1). It forms a dense, low-growing sod, which produces abundant forage near the ground.

Lime and fertilizer are major expenses in an intensive pasture production program. In Florida, researchers determined that when ammonium nitrate was applied at a rate of 150 lb/A in March and September, a pH range of 4.8 to 6.0 had no effect on yield of Pensacola bahiagrass (2).

The objective of this study was to determine the effect of rate and date of ammonium nitrate application under two pH regimes on bahiagrass production.

Procedures

Ammonium nitrate and lime were surface applied to established Pensacola bahiagrass using a 2 x 4 randomized complete block factorial design with four replications. There was no rerandomization between years. Initial pH of the field was 5.2, dolomitic limestone was applied at 0 and 3,000 lb/A. At the beginning of the experiment, fertility of the plot area was tested and found to be uniform. Phosphorous and potassium were applied uniformly across the plot area at 72 lb/A of P_2O_5 and K_2O in April of each year for the duration of the experiment. Nitrogen was applied as ammonium nitrate at three rates: 200 lb/A in April and again in June

(AJ200); 100 lb/A per application in April, May, June, and July (AMJJ100); and 400 lb/A in April and again in June (AJ400). A no-nitrogen check was included.

Plots were harvested with a rotary lawn mower to a height of 3 inches, and dry matter yield determined four times during the 1990 and 1991 growing seasons and six times during the 1992 growing season. Soil pH and fertility status were determined at the end of the study by the Mississippi State University Soil Testing Laboratory.

Crude protein (CP), acid detergent fiber (ADF), and neutral detergent fiber (NDF) were determined by the Louisiana Agricultural Center Southeast Research Station by Near Infrared Spectrophotometry. Percent total digestible nutrient (TDN) was calculated using the formula (((87.46 + (0.2 x CP)) x 0.816) - 2.38) - (0.91 x ADF).

Pounds of TDN per acre were calculated by multiplying dry matter yield by percent TDN. Hay value was calculated with a Mississippi State University developed Linear Programming Package (DHLLP) using the prices of corn ($6.00 cwt) and cottonseed meal ($200.00 ton) as the input prices for energy and protein sources. Daily rainfall data were collected at Poplarville and summed for 2-week intervals.

Results

In 1990, averaged over nitrogen rate, 3,000 lb/A of dolomitic limestone did not increase dry matter, CP, ADF, NDF, or TDN. There was no interaction between lime and nitrogen rate. No ammonium nitrate resulted in a total dry matter yield of 2,867 lb/A, while the AMJJ100 treatment resulted in a total yield of 4,557 lb/A (Table 1). Yield of the AJ400 and AMJJ100 treatments were not different. The AJ200 treatment yielded significantly less (3,541 lb/A) than the AMJJ100 treatment (4,557 lb/A) even though the total amount of ammonium nitrate used was the same.

Averaged over all cutting dates, CP and TDN increased and ADF and NDF decreased as the total amount of nitrogen applied increased (Tables 2, 3, 4, and 5). When averaged over all cutting dates, even though the same amount of total N was applied, AMJJ100 had significantly higher CP and TDN and lower ADF than the AJ200 treatment. TDN/A of the AMJJ100 treatment was not different from the AJ400 treatment, but the AMJJ100 treatment had lower CP. As nitrogen rate increased, NDF decreased, but there was no difference between the AMJJ100 and AJ200 treatments.

In 1991, averaged over cutting dates, 3,000 lb/A of dolomitic limestone applied in 1990 did not increase dry matter, CP, ADF, NDF, or TDN. In the lime treatment, there was an increase in dry matter and TDN yield as nitrogen increased, but in unlimed treatment the effect of nitrogen was extremely variable (data not shown).

No nitrogen resulted in a dry matter yield of 3,612 lb/A, which was lower than AMJJ100 and AJ400 nitrogen treatments (Table 6). The AJ400 treatment yielded 4,324 lb/A, and the AJ200 and AMJJ100 treatments yielded approximately 4,000 lb/A.

Averaged over all cutting dates, as nitrogen rate increased, percent CP and TDN increased and NDF decreased. There was no difference between the AJ200 and AMJJ100 treatment as there was in 1990 (Tables 7, 8, and 9). Total TDN and CP were highest in the AJ400 treatment. Nitrogen rate had no effect on ADF (Table 10).

In 1992, 3,000 lb/A of dolomitic limestone applied in 1990 did not increase forage yield. There was no interaction between lime and nitrogen rate. No nitrogen resulted in a dry matter yield of 4,046 lb/A, which was less than any of the N treatments. There was no significant difference among the three N treatments (Table 11).

As N rate increased, CP and TDN increased and ADF and NDF decreased, but there was no difference between the AJ200 and AMJJ100 treatments (Tables 12, 13, 14, and 15). In all instances, there was a difference between the 0 and the AJ400 treatment, but no difference between the AMJJ100 and AJ200 treatments.

Averaged over all N rates for 3 years, adding 3,000 lb/A of lime at the inception of the experiment had no effect on bahiagrass yield over the 3 years of the experiment (Table 16). Over the 3 years of this experiment, total dry matter and TDN yield per acre was higher in the AJ400 and AMJJ100 treatments and lowest in the 0 nitrogen treatments (Table 17 and 18). The AJ200 treatment resulted in yields higher than the 0 nitrogen but lower than the AMJJ100 and AJ400 treatments. The AMJJ100 treatment yielded more than the AJ200 treatment but was not different from the AJ400 treatment, even though twice as much nitrogen was applied.

Assuming an ammonium nitrate cost of $190 per ton, this increased nitrogen cost from $38 to $76/A without a significant yield increase.

Averaged over 3 years, crude protein increased as nitrogen rate increased (Table 19). There was a significant difference between the 0 nitrogen and all other treatments. The AMJJ100 and AJ200 treatments were not significantly different, but both were less than the AJ400 treatments.

Neither nitrogen rate nor timing of application had an effect on NDF; however, as nitrogen rate increased, ADF decreased (Tables 20 and 21). AJ400 had a lower ADF than the 0 and AJ200 treatments but was not different from the AMJJ100 treatment.

At the end of the 3 years, each plot was soil tested and analyzed. The pH of unlimed plots was 5.4 and the limed plots 6.0 (Table 22). There was no interaction between nitrogen treatment and lime for P, K, Ca, Mg, or Zn. As the amount of ammonium nitrate increased, pH decreased (Table 23).

There was no difference in residual nutrient availability between the AJ200 and AMJJ100 treatments even though total dry matter yield of the AMJJ100 treatment was significantly higher (Table 23).

Across lime rates, there were significantly more residual nutrients in the 0 nitrogen than in the AJ400 plot. Such findings would be expected because of the significantly lower dry matter production. There was significantly more Ca and Mg in the limed plots, which again would be expected because of the addition of dolomitic limestone.

Conclusions

This experiment was initiated to evaluate the effect of nitrogen rate and soil pH on dry matter yield of bahiagrass in southern Mississippi. Hay removal to a 3-inch stubble was the vehicle used to measure yield. Visual observations indicate that bahiagrass produces a significant amount of forage below the 3-inch cutting height. Grazing research has shown bahiagrass to be equivalent to bermudagrass in animal carrying capacity and animal performance, but lower in hay production from pasture clippings (3).

The efficient use of high-cost inputs is one of the most important aspects of any enterprise. This paper does not consider all input costs but deals only with lime and nitrogen. These data indicate that if soil pH in a bahiagrass pasture is above 5.4, liming to a pH of 6.0 will not significantly increase yield.

Additionally, smaller frequent applications of nitrogen are more efficient in terms of plant uptake and yield than large applications spaced further apart. When totaled over the 3 years of this experiment, 100 pounds of ammonium nitrate applied in April, May, June, and July produced as much dry matter and TDN per acre as 400 pounds of ammonium nitrate applied in April and June. As nitrogen rate increased, percent CP increased, ADF decreased, however there was no effect on NDF. Other considerations include loss of nitrogen by leaching when large amounts are applied. This is more prevalent in sandy soils and is detrimental to water quality.

In 1990, 1991, and 1992, the difference in value of bahiagrass forage between the 0 and AJ400 treatment was $71.78, $37.57, and $50.70/A, respectively, which was not enough to cover nitrogen cost of $78.00. In 1990, 1991, and 1992 the difference in value between 0 and AMJJ100 treatments was $57.24, $23.55, and $44.78, respectively, which was in excess of nitrogen cost ($38.00) 2 out of 3 years (Table 24). These data indicate that, under the conditions of this experiment, high nitrogen rates are not economically feasible.

There were differences in dry matter yield, CP, and ADF between years (Tables 17, 19, and 20). This is attributed to differences in rainfall between years (Figures 1, 2, and 3). Bahiagrass yield was similar for 1990 and 1991 and significantly higher in 1992. This appears to be a function of moisture availability. In 1990 and 1991, moisture patterns were similar, but in 1992, there was more moisture available from mid-July until December.

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