Tifton 85 Bermudagrass Response to Fertilization on Two Coastal Plain Soils

By William Anderson and Mike Stewart

Among the forage bermudagrasses, Tifton-85 is recognized for several positive attributes that led to it being the cultivar of choice in many regions of the world.

Given its greater yield potential and improved quality characteristics compared to other bermudagrasses, a more tailored approach to nutrient management would benefit Tifton-85 producers ...which was the goal of the work reported here.

Bermudagrass [*Cynodon dactylon* (L.) Pers.] is grown for pasture or hay on approximately 15 million acres in the southern U.S., and is the leading warm season perennial forage species. Forage bermudagrass improvement began with the USDA-ARS in Tifton, GA with Dr. Glenn Burton in 1937. 'Coastal' was released in 1943 as the first of many improved forage bermudagrass cultivars. Nearly 50 years later 'Tifton 85' (PI 672166) was released, which is darker green, taller, and was found to produce up to 25% more dry matter and was 11% more digestible than Coastal. Though Coastal is a true bermudagrass (*Cynodon dactylon*), Tifton 85 is a cross between Tifton 68 stargrass (*C. nlemfuensis* Vanderyst) and a *C. dactylon* introduction, PI 290884. For this reason Tifton 85 has very distinct phenotypic (observable) traits including few rhizomes and very aggressive stolons.

Hybrid forage bermudagrasses, including Tifton 85, are generally grouped together for fertilizer and lime recommendations, based on soil test values. However, bermudagrass cultivars may not have the same nutrient needs. For example, Brink et al. (2004) found that Tifton 85 bermudagrass contained about 11% more P than Coastal in a four-year study on a fine sandy loam where high rates of N, P, and K were applied as broiler litter. Tifton 85 is different from other hybrids in growth habit, yielding ability, nutritive value, concentration of some nutrients, and seasonal growth, but there is very limited information on the fertilizer requirements of this grass. This article examines research that was designed to 1) determine the yield response of Tifton-85 to N at low, medium, and high levels of PK input; 2) measure nutrient uptake in forage for each harvest; 3) determine the effects of the fertilizer treatments on forage quality; and 4) determine the most economical N rate to maximize the rate of return.

Study Description

Established sods were utilized to conduct two experiments with Tifton 85 bermudagrass from 2004 to 2007 on the University of Georgia Coastal Plain Experiment Station at Tifton, GA. One Tifton 85 sod was established on a Carnegie sandy loam soil ten years prior to the beginning of this trial, and had been left idle without any fertilization. This sod was maintained by multiple mowings each year. The second location was on a Fuquay loamy sand soil, and was also established ten years prior to the test, but had been grazed and well managed with yearly addition of 300 lb N/A and 120 lb K_2O/A for five years before the initiation of the study. Soil test levels (0 to 10-in. depth, Mehlich I) at the Carnegie site were 8 ppm P (low) and 37 ppm K (medium), and at the Fuquay site levels were 28 ppm for both P (medium) and K (low). Levels of these nutrients below this depth declined significantly in both soils.

Abbreviations and notes: N = Nitrogen; P = phosphorus; K = potassium; S = sulfur; Ca = calcium; Mg = magnesium; ppm = parts per million.

Harvesting Tifton 85 research plots. The bermudagrass cultivar has become the choice forage among many ranchers and hay producers in the southern U.S. as well as other countries such as Brazil, Mexico, and Venezuela.

Treatments for the experiments were annual N rates of 200, 300, 400, 500, 600, and 700 lb N/A as the main plots and low, medium, and high rates of P and K as subplots. Low, medium, and high rates of P and K represented approximately 50, 100, and 150%, respectively, of the two elements taken up in the forage for the 18 treatments (six main plots × three subplots). As P and K were extracted during harvests and measured for each growing season and over years, the amount of P and K applied for a particular treatment was adjusted to meet the goals of the study. While specific rates for each treatment are not presented here, note that across both soils rates ranged from approximately 40 to 145 lb P_2O_5/A, and 205 to 655 lb K_2O/A.

The sources of N, P, and K were ammonium nitrate, triple superphosphate, and potassium chloride, respectively. Gypsum ($CaSO_4$) was included to supply 13 lb S/A per application. Dolomitic limestone, applied at the ratio of 4:1, limestone:N rate, regulated the soil pH and provided Mg for the grass. Ingredients for each subplot treatment were mixed and applied four times each year except the last year when only three applications were made. This required 15 total applications during the study. Each year the first application was made the last week in March and succeeding applications following the first, second, and third harvests. The last harvest each year measured residual effects from previous applications of treatments.

Forage was harvested six times during the growing season (May to October) in 2004, 2005, and 2006; however, in 2007 there were only four harvests from July to October due to a May-June drought.

Yield Response to Fertilizer Treatments

Since year x N and year x PK interactions were not significant, results are presented as an average over four years. Yield significantly increased from the lowest N application rate to 400 lb N/A then leveled off with higher rates at the Fuquay location, but continued to increase at the Carnegie soil location to the 500 lb N/A treatment (**Figure 1**). On the Carnegie soil, PK replacement had no effect at lower N rates, but at 500 lb N/A and above, greater replacement of P and K resulted in higher yields. On the Fuquay soil, higher fertilizer replacement of P and K resulted in slightly higher yields, but the effect was only significant at N rates of 400 and 500 lb N/A.

Overall, the Carnegie soil location responded to N fertilization rates to a greater extent than the Fuquay location. This is likely because the Carnegie location had been depleted by lack of maintenance prior to the trial, while the Fuquay soil location had been fertilized and well maintained. But the Fuquay soil is sandier than the Carnegie soil, so it is expected that the nutrient holding capacity of the Fuquay soil would be slightly lower. The late June to early July harvests (second in the first three years, and first in 2007) tended to have the highest yields, while the midsummer (late July to early August) and final harvests tended to have lower yields (data not shown), though there was some variation across years due in part to differences in rainfall. The majority of the yield responses to N rate occurred during the first and last harvest at each location (data not shown). Fertilizer timing strategies for this grass may require further refinement.

Nitrogen Recovery and Nutrient Uptake

Figure 2 shows an approximation of the balance between N removed in harvested forage and N fertilizer applied (i.e., removal to use or partial N balance) across years and sites. This N balance tended to decline at higher application rates, except in 2007 (drought year) at the Carnegie site where it was low (52% average) and flat across N rates. In the first two years the N balance was close to or exceeded 100% of the amount applied at lower application rates, particularly at the Fuquay site. Even at the highest fertilization rate (700 lb N/A), greater than 70% of the applied N was recovered in 2004 and 2005. As the study progressed, the average N balance declined presumably as native supplies of N were depleted, although rainfall also appears to have been a factor.

A common general range of yearly N fertilizer application for Tifton 85 bermudagrass is 300 to 400 lb/A. The 4-year average partial N balance for the 300 and 400 lb N rates at the Carnegie site was 84 and 77%, and at the Fuquay site it was 109 and 102%, respectively. If the 2007 drought year is removed, then the 3-year average N balance from the Carnegie site increases to 95 and 87%, and for the Fuquay site 119 and 110%. These data illustrate the exceptional ability of forage bermudagrass to intercept and utilize N fertilizer.

The P and K treatments had a small effect on the N balance at the Fuquay site; across years and N rates, the high PK rate increased N recovery by about 6% over the low PK rate (data not shown). It should be noted though that there was no zero

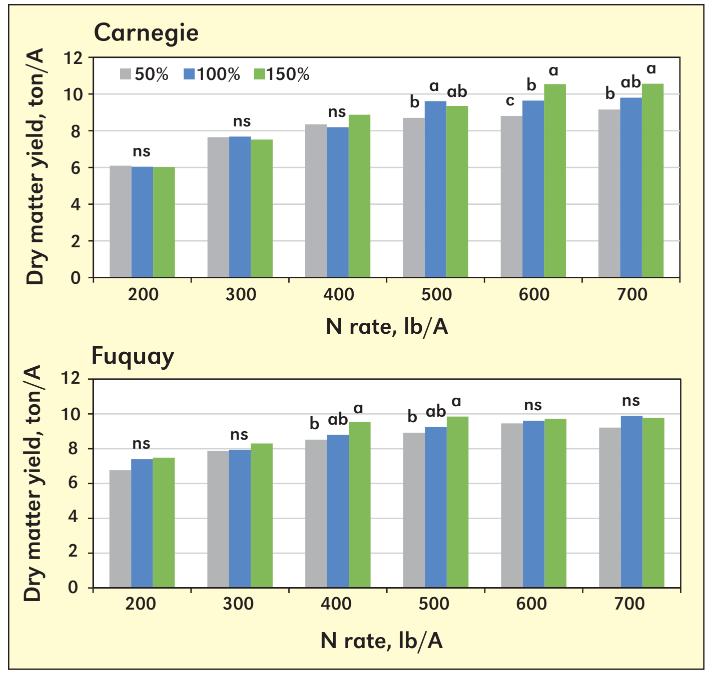

Figure 1. Average (2004 to 2007) dry matter yield response of Tifton 85 bermudagrass at 50%, 100%, and 150% replacement of P and K within six N fertilization rates on Carnegie soil (top) and Fuquay soil (bottom) in Tifton, GA. Within N fertilizer treatments, means with the same letter are not different. The PK treatment was not significant within N treatments marked with 'ns.'

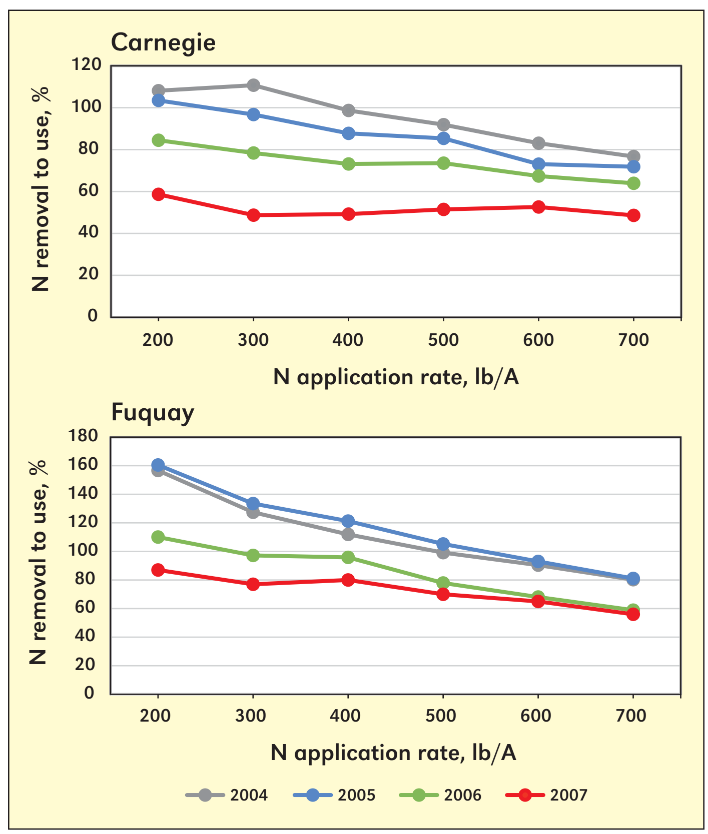

Figure 2. Removal to use for applied N in harvested forage of Tifton 85 bermudagrass grown between 2004 and 2007 at six N application rates near Tifton, GA at (top) Carnegie and (bottom) Fuquay soil locations.

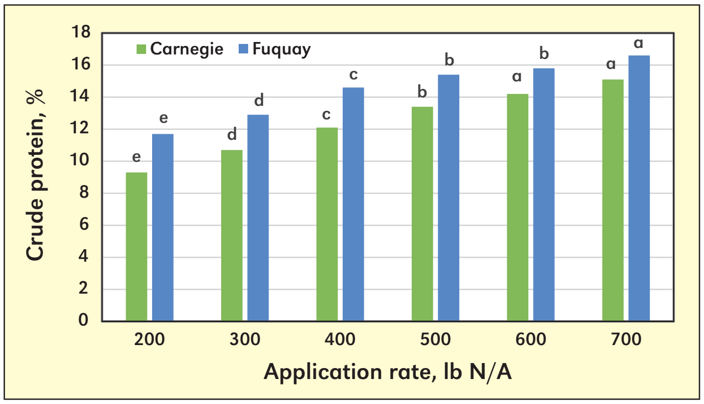

Figure 3. Crude protein content of Tifton 85 bermudagrass forage grown between 2004 and 2007 at six N application rates at two locations (Carnegie soil and Fuquay soil) near Tifton, GA. Within locations, means with the same letter are not different.

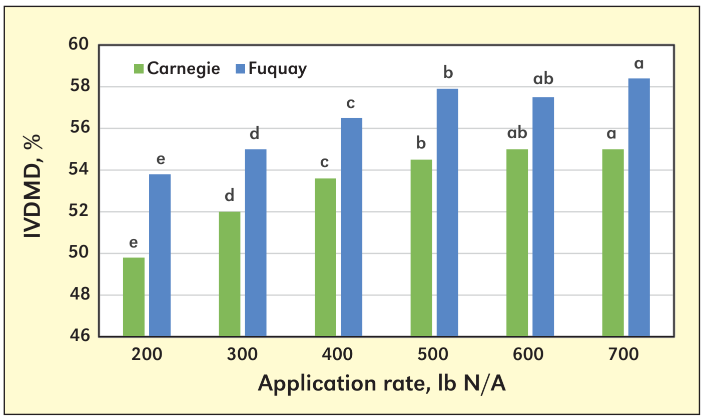

Figure 4. Percent *in-vitro* dry matter digestibility (IVDMD) of Tifton 85 bermudagrass forage grown between 2004 and 2007 at six N application rates at two locations (Carnegie soil and Fuquay soil) near Tifton, GA. Within locations, means with the same letter are not different.

PK treatment, so a measure of the full impact of these nutrients on N recovery was not possible.

While more detailed nutrient uptake information is not presented here, it is available in the source article (Anderson et al., 2016), and results suggest that the N-P_2O_5-K_2O fertilizer ratio for Tifton 85 bermudagrass should be about 3:1:4 at the lowest N rate (200 lb N/A), 4:1:5 at the moderate N rates (300 and 400 lb N/A), and 5:1:5 at the high N rates (500 to 700 lb N/A).

Forage Quality

Crude protein (CP) content of the forage tended to increase with N application rate (**Figure 3**). Application rate of P and K did not affect CP content, although P and K contents of the forage were both correlated with N content. Across all years and harvests, CP content increased at both sites as N application progressed from 200 to 700 lb N/A. Also, % in-vitro dry matter digestibility (IVDMD) increased in a similar pattern over the range of N applications: from 50% to 56% at the Carnegie location, and from 54% to 58% at the Fuquay location (**Figure 4**). Nitrogen content and % IVDMD were highly correlated (r = 0.684 at Carnegie, and r = 0.553 at Fuquay); however, the effect of N fertilizer rate on IVDMD was not as consistent as with CP content. Percent IVDMD was negatively correlated with neutral detergent fiber (NDF) content, but was not correlated with acid detergent fiber (ADF) content. Even in the absence of yield differences, the higher CP content and higher digestibility enhances the quality of Tifton 85 hay at higher N application rates. Improvement in these quality parameters is especially important for the performance of growing calves and lactating cows.

Economic Analysis

A detailed economic analysis was conducted to determine the optimum N rate, and is reported in detail in the original paper (Anderson et al., 2016); however, in the interest of space only a brief summary is provided here. It was assumed that profit-maximizing producers will increase the amount of N fertilizer applied up until the application of one more unit of N will cost more than the value of the additional hay produced. Rates used for P and K in the analysis were 100% of removal. Profits on the Carnegie soil were maximized at 300 lb N/A with net returns (NR) of US$360/A. For the Fuquay soil, profits were maximized at 200 lb N/A for NR of $407/A. Adding an additional 100 lb N/A resulted in losing $9 and $16/A, respectively.

Changing hay or fertilizer prices to reflect historic price variations resulted in significant changes to the optimum levels of N fertilization. With an optimistic scenario (high hay price and low fertilizer prices) optimum levels of N on the Carnegie soil increased to 600 lb N/A with NR of $732/A, and on the Fuquay soil 500 lb N/A with NR of $740/A. A pessimistic scenario (low hay and high fertilizer prices) reduces optimum levels of N to 200 lb N/A for both soil types with NR of $11 and $47/A for the Carnegie and Fuquay soils, respectively.

These results are consistent with generally recommended rates of 300 to 400 lb N/A. However, the variation in NR due to price changes highlights the importance of producers accounting for input and hay price fluctuations.

Summary

This four-year study was conducted to determine the response of rain-fed Tifton 85 bermudagrass to six rates of N, and three rates of PK fertilization at two Georgia (U.S.) locations. Application of 200 to 400 lb N/A along with P and K applied at replacement (removal) levels resulted in maximum economic return. Nutrient uptake results indicate that N-P_2O_5-K_2O ratio varies with N fertilization rate, and that forage bermudagrass is very efficient at recovering applied N fertilizer, with average recovery (partial N balance) reaching over 100% at the 300 lb N rate. Also, crude protein and IVDMD of forage responded positively to increasing rates of N fertilization. BC

Acknowledgment

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