SL-237

UF UNIVERSITY of FLORIDA
IFAS Extension

Development of Bahiagrass Fertilization Recommendations: 1990-2008[1]

E.A. Hanlon, Rao Mylavarapu, C.L. Mackowiak, and M.L. Silveira[2]

Introduction and Intent

The intent of this document is to record changes in bahiagrass fertilization and liming recommendations from 1990 through 2008, and to summarize efforts of the various work groups and committees. Because bahiagrass is the dominant grass used throughout Florida for both improved pasture and hay production, UF/IFAS' nutrient recommendations have played a substantial role in the creation of sustainable management strategies. This document records modifications that are based mostly on scientific discovery and, in part, on best professional judgment regarding the management of bahiagrass using diagnostic nutrient testing. Ranchers, forage producers, and other interested parties may also use the information in this document to understand the basis for current UF/IFAS bahiagrass liming and fertilization recommendations.

In 1990, an *ad hoc* committee reviewed the bahiagrass recommendations for both liming and fertilization. The committee included faculty members from the Soil & Water Science and Agronomy departments, as well as selected state and county extension faculty members. In 1994, UF/IFAS' administration formed the Bahiagrass Fertilization Working Group to complete a more formal review of bahiagrass liming and fertilization recommendations including soil testing results reported to producers by the Extension Soil Testing Laboratory (ESTL). The working group reviewed the literature and, based on best professional judgment, devised appropriate liming and fertilization recommendations for bahiagrass to be used by the ESTL and in statewide extension programs. The working group completed its task in 1996 with a white paper that was approved by UF/IFAS administration through the Plant Nutrient Oversight Committee, a representative committee represented by all levels of UF/IFAS.

In 2000, as an activity of the Suwannee River Partnership, the Florida Department of Agriculture and Consumer Service (FDACS) led an effort to develop *Interim Measures for Nitrogen for Hay Production*. With UF/IFAS as a crucial member, the Suwannee Fertilizer Work Group (SFWG), a

1. This document is SL-237, one of a series of the Soil and Water Science Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Original publication date January 2006. Revised August 2008. Visit the EDIS Web Site at http://edis.ifas.ufl.edu.

2. E. A. Hanlon, professor, Soil and Water Science Department, Southwest Florida Research and Education Center (REC)--Immokalee, FL; R. Mylavarapu, associate professor, Soil and Water Science Department; C.L. Mackowiak, assistant professor, North Florida REC--Quincy, FL; M.L. Silveira, assistant professor, Range Cattle REC--Ona; Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL 32611.

technical subcommittee, evaluated nutrient management practices in the Suwannee River Basin. This group focused on properly calibrating soil testing, documenting environmental outcome, and ensuring that crops would be commercially viable.

In 2003, IFAS researchers and extension specialists developed new footnotes, modified some of the previous footnotes, and created a new crop code for Hay crops to enable processing of the soil samples and reports through the ESTL (Mylavarapu, 2003).

In 2004, UF/IFAS administration formed the Forage Fertilization Working Group to review all UF/IFAS fertilization and liming recommendations for grass and forage production throughout the state. This working group specifically reviewed UF/IFAS recommendations for bahiagrass to address include recent research developments.

In 2007, in response to continuing low phosphorus (P) measured by soil testing, and concern expressed by both researchers and forage producers about bahiagrass stand sustainability, the UF/IFAS administration created the Pasture Fertilization Standards Task Force to review and update P recommendations for established bahiagrass pastures.

Based upon the fertilizer recommendations from 1996, forage producers had not been fertilizing bahiagrass pastures in south Florida with P for the past 10 to 15 years. Using spring and fall bahiagrass pasture soil samples and corresponding bahiagrass tissue samples from 27 sites located within ranches in the Okeechobee basin, soil-test P values were interpreted as LOW (Table 1). Tissue samples were at or slightly greater than 0.15% P. This tissue-P concentration threshold was accepted by the Pasture Fertilization Standards Task Force.

Because of these initial results, the Pasture Fertilization Standards Task Force produced an interim recommendation change, which requires both a soil and a tissue sample from the same pasture to obtain a meaningful P recommendation for Bahiagrass.

The committee also recommended that the north-south dividing line for bahiagrass recommendations (discussed below in more detail, Fig. 1) be removed. The ESTL implemented both changes in December 2007 after approval by the Plant Nutrient Oversight Committee. An updated version of UF/IFAS Standardized Fertilization Recommendations for Agronomic Crops, SL129 (http://edis.ifas.ufl.edu/SS163 , Mylavarapu et al., 2007) contains the updated recommendations made by the Pasture Fertilization Standards Task Force.

Bahiagrass Fertilization Recommendations established in 1990

Target Soil pH

The target soil pH for Bahiagrass production was 5.5. A lime requirement test was completed whenever the observed soil pH was 5.3 or less. A lime requirement recommendation was made to the nearest 0.5 ton/acre. These practices fit the literature available in 1990 and were implemented by the ESTL in that year.

Phosphorus and Potassium

The agronomic interpretation scale for both P and K (Table 1) is used throughout Florida and 5 other states and was implemented by the ESTL in 1990. The following recommendations and soil-test interpretation ranges were coupled with grower-selected bahiagrass production of High, Medium, and Low N options (Table 1). The rates of P and K adopted at that time were modifications of still older rates. Changing P and K rates with increasing N use represented a consensus of the *ad hoc* Working group, and was an attempt to balance field observations and limited research with a desire to insure adequate plant nutrition until additional research findings were available to confirm or refute these decisions.

Fertilization Management Footnotes, 1990 to 1996

The following footnotes were printed with all bahiagrass ESTL soil-test reports from 1990 to 1996.

Footnote 124: IFAS recommendations emphasize efficient fertilizer use without losses of

Table 1. Mehlich-1 (double acid) soil-test interpretations and bahiagrass fertilization recommendations, 1990 to 1996

N Option	Phosphorus Interpretation					Potassium Interpretation				
	Very Low	Low	Med.	High	Very High	Very Low	Low	Med.	High	Very High
	pounds P_2O_5/acre					pounds K_2O/acre				
High	40	40	0	0	0	80	80	40	0	0
Med.	25	25	0	0	0	50	50	0	0	0
Low	0	0	0	0	0	0	0	0	0	0
High = 160 lb N/acre/yr; Med. = 100 lb N/acre/yr; Low = 50 lb N/acre/yr.										

yield or of crop quality. Efficient fertilizer use results in high production with minimum impact to our environment. Since fertilizer use and management are only two aspects of crop production, growers are encouraged to consider IFAS recommendations in light of their entire management strategy, including financial considerations.

Footnote 131: Fertilization Management Notes for Bahiagrass Pastures

For new plantings, apply only 100 lb N/A split as follows: apply 30 lb N/A, all of the P_2O_5, and 50% of the K_2O as soon as plants have emerged. Apply 70 lb N/A and the remaining K_2O 30 to 50 days later.

For established stands of bahiagrass, apply all of the fertilizer in the early spring to maximize much-needed spring forage. Bahiagrass is a very efficient forager and recovers nutrients from deeper in the soil profile than other popular forage grasses so danger of leaching losses is low. Three fertilization options are presented below. Choose the option which most closely fits your fertilizer budget, management objectives, and land capability.

High-N Option Apply 160 lb N/A and the soil-test-based recommended rates of P_2O_5 and K_2O for each of your pastures. The fertilization rates suggested in this option are high enough to allow bahiagrass pasture to achieve well above average production. Management and environmental factors will determine how much of the potential production is achieved and how much of the forage is utilized.

Medium-Nitrogen Option Apply around 100 lb N/A this year. At that level of N fertilization, P and K may be limiting if your soil tested low in these nutrients. Apply 25 lb P_2O_5/A if you soil tested low in P and none if it tested medium. Apply 50 lb K_2O/A if your soil tested low in K and none if it tested medium. Re-test you soil every second or third year to verify P and K levels. If you plan to make a late-season cutting of hay, apply 80 lb N/A between August 1 and 15 (about 6 weeks before the growing season ends).

Low-Nitrogen Option (for Grazed Pastures Only) Apply around 50 lb N/A this year, recognizing that N will be the limiting nutrient. Thus, do not apply P or K. If you follow this practice of applying only N to your pasture for more than one year, apply the P and K recommended by soil test every third or fourth year to avoid excessive depletion of those nutrients. Do not use this option if you cut hay since nutrient removal by hay is much greater than by grazing animals.

1996 Discussion and Recommendations from the Bahiagrass Fertilization Working Group

Bahiagrass liming, management, and fertilization recommendations were updated based upon published research documents. Some of the research findings appeared to be contradictory, so recommendation changes were made to best fit the available data.

Bahiagrass Fertilization Working Group Committee Members and Participants, 1994 to 1996

E.A. Hanlon, Chair	F.M. Rhoads
F. Pate	C.G. Chambliss
G.H. Snyder	D. Townsend
J. Rechcigl	J.F. Selph
P. Mislevy	M.E. Griggs
R. Stanley	S.L. Sumner (retired)
D.L. Wright	J.B. Sartain

Target Soil pH

The Working group expressed strong feelings concerning target pH. Some members believed that bahiagrass should be limed to 5.5, while others favored the 5.0 target pH.

Replicated field trials (Rechcigl et al., 1993; Rechcigl et al., 1995) showed that the addition of dolomitic lime increased bahiagrass production up to a soil pH of 5.0. However, no yield increases were seen with calcitic limestone. This apparent disagreement could have been caused by a response to Mg from the dolomite. Two additional papers, both from north Florida (Teare et al., 1987; Blue, 1974), also reported no bahiagrass yield response above a soil pH of 5.0.

In a review of soil-test results from the ESTL, approximately 6% of the 1,400 soil samples for bahiagrass production received by the ESTL per year (1994 through 1996) had a soil pH between 5.0 and 5.5. The response curves from research in central and south Florida were relatively flat from 4.7 through 5.3.

The following compromise was approved. The state would be divided into NORTH and SOUTH designations. The NORTH and SOUTH designations (with a dividing line near Orlando, Figure 1) had already been used for turf recommendations for 15 years. Additionally, USDA-Natural Resources and Conservation Service classify soils above this line as Thermic and soils below this line as Hyperthermic. This approach allowed the liming recommendation to be changed for central and south Florida, matching the research findings from that area. The 1990 liming recommendations were kept for NORTH Florida.

The NORTH target pH was maintained at 5.5. The SOUTH target pH was set to 5.0. Additionally, footnote changes clarified the decision to lime (see the following Footnotes section).

1996 Liming and Fertilization Management Footnotes

Footnote 803 was printed for any soil sample from the SOUTH zone with a lime requirement using a Target pH of 5.0.

Figure 1.

Footnote 803: Lime soil with either dolomite or dolomitic limestone.

Footnote 810 was added to instruct growers about the relatively minimum need for lime for bahiagrass pasture production.

Footnote 810: In central and south Florida, bahiagrass pasture production has been modestly increased only with dolomitic limestone and only to a soil pH of 5.0. If your soil pH is between 4.8 and 5.3, you should base your need for lime on the economics of your production system.

Fertilization Management: Phosphorus and Potassium

Considerable discussion addressed whether or not soil testing assists with fertilizer management decisions for bahiagrass. The literature in 1996 suggested:

1.That the Mehlich-1 (M-1) extractant values changed with additions of P or K to bahiagrass pastures;
2.That the M-1 extractant was calibrated to yield responses from other improved grasses with the addition of fertilizers; and
3.That the M-1 did not accurately predict bahiagrass response to P and K additions in some replicated and unreplicated field trials on Alfisols or Spodosols in central and south Florida. The reason for this inaccurate prediction is that bahiagrass roots obtain P and K from soil horizons below the depth of soil sampling.

No soil testing calibrations for P and K fertilizer recommendations for bahiagrass had been conducted on the Entisols and Ultisols in north Florida. Traditionally, soil-test based recommendations have been used to improve production and/or quality of the immediate crop (bahiagrass). In pasture situations, bahiagrass is grown as a means for the production of cattle. Since cattle are the money-generating product, the profitability of cattle production actually controls the economics of bahiagrass fertilization.

The responsibility for the economics of fertilization, while traditionally mentioned in management footnotes, has always been deferred to the grower. UF/IFAS could then avoid making general economic statements without knowing the specific economic conditions facing the rancher. The Working group was divided on the issue of making bahiagrass fertilization recommendations for the crop or the cattle. In the 1996 cattle market, bahiagrass fertilization for pasture production was questionable, according to some knowledgeable Working group members. At that time, there were no studies that fertilize bahiagrass and then measure changes in beef production to resolve this dilemma.

In pasture situations, the Working group also could not agree on the usefulness of soil testing for fertilizer management decisions. Most members agreed that, for central and south Florida data, soil testing had done a poor job as a fertilizer management tool. However, these same members expressed doubts about the length of time that pastures would persist without additions of P and/or K. Soil testing every 3 years may provide a nutrient history for the surface soil, and may prove useful in detecting problems if a decline in plant persistence is noted. However, so long as there is a nutrient supply coming from the lower horizons, soil testing is unlikely to improve fertilizer management decisions.

Bahiagrass growth characteristics include the fact that its roots can actively grow in the Spodic (Bh) horizon (highly acidic soil, often containing elevated levels of Aluminum). To do so, bahiagrass must be tolerant of normally toxic levels of Al3+ found in Bh horizons in Florida. Work (Rechcigl et al., 1992) using tracers demonstrated that roots within the Bh horizon are active. Additional work showed that the Bh horizon is also considerably enriched in Mehlich-1 extractable P, but that not all of this P is available for bahiagrass uptake, since a large fraction exists in organic P forms. However, this additional P source was adequate to sustain bahiagrass, permitting growth, but at somewhat deficient P plant-tissue concentrations.

Traditional soil testing for forages includes soil from the 0- to 6-inch depth. The Bh horizon is often well below this sampling depth. Thus, traditional soil testing will not consider nutrients in the Bh horizon and could potentially over-predict the need for fertilization.

In the end, compromises were reached so that recommendations were based as much as possible on results from the literature. The recommendations from the Working group included the following changes:

1. The bahiagrass pasture (Crop code = 24) entry was expanded with the following statement:

"Bahiagrass pasture NOTE: In central and south Florida, recent field research has shown that soil testing is not a reliable tool for bahiagrass pasture fertilizer management decisions, and is not recommended. Fertilizer decisions for bahiagrass pastures should be based on the economics of your operations."

2. For soil samples originating from the NORTH zone:

a)Footnote 124 (see Bahiagrass Fertilization Recommendations Established in 1990) was used for bahiagrass pasture soil samples.

3. A new footnote, Footnote 132, based in part upon Footnote 124, was created for all bahiagrass pasture soil samples from the SOUTH zone.

Footnote 132: IFAS recommendations emphasize efficient fertilizer use without losses of yield or of crop quality. Efficient fertilizer use results in high production with minimum impact to our environment. Since fertilizer use and management are only two aspects of crop production, growers are encouraged to consider IFAS recommendations in light of their entire management strategy, including

financial considerations. In central and south Florida, soil-test based recommendations for bahiagrass pasture fertilization should be evaluated on an economic basis using the rate of N fertilization, cattle productivity, and cattle prices.

4. The 1990 version of Footnote 131 was reworded to include bahiagrass fertilization recommendations for both NORTH and SOUTH zones:

Footnote 131: Fertilization Management Notes for Bahiagrass Pastures:

For new plantings, apply only 100 lb N/A split as follows: apply 30 lb N/A, all of the P1. The bahiagrass pasture (Crop code = 24) entry was expanded with the following statement:

"Bahiagrass pasture NOTE: In central and south Florida, recent field research has shown that soil testing is not a reliable tool for bahiagrass pasture fertilizer management decisions, and is not recommended. Fertilizer decisions for bahiagrass pastures should be based on the economics of your operations."

2. For soil samples originating from the NORTH zone:

a)Footnote 124 (see Bahiagrass Fertilization Recommendations Established in 1990) was used for bahiagrass pasture soil samples.

3. A new footnote, Footnote 132, based in part upon Footnote 124, was created for all bahiagrass pasture soil samples from the SOUTH zone.

Footnote 132: IFAS recommendations emphasize efficient fertilizer use without losses of yield or of crop quality. Efficient fertilizer use results in high production with minimum impact to our environment. Since fertilizer use and management are only two aspects of crop production, growers are encouraged to consider IFAS recommendations in light of their entire management strategy, including financial considerations. In central and south Florida, soil-test based recommendations for bahiagrass pasture fertilization should be evaluated on an economic basis using the rate of N fertilization, cattle productivity, and cattle prices.

4. The 1990 version of Footnote 131 was reworded to include bahiagrass fertilization recommendations for both NORTH and SOUTH zones:

Footnote 131: Fertilization Management Notes for Bahiagrass Pastures:

For new plantings, apply only 100 lb N/A split as follows: apply 30 lb N/A, all of the P_2O_5, and 50% of the K_2O as soon as plants have emerged. Apply 70 lb N/A and the remaining K_2O 30 to 50 days later.

For bahiagrass pastures in central and south Florida, recent research has shown that P and K fertilization may not be economical. Furthermore, soil-test results may underestimate the soil supply of P. Choose to add P and K based upon economic considerations for your production system.

For established stands of bahiagrass, apply all of the fertilizer in the early spring to maximize much-needed spring forage. bahiagrass is a very efficient forager and recovers nutrients from deeper in the soil profile than other popular forage grasses so danger of leaching losses is low. Three fertilization options are presented below. Choose the option which most closely fits your fertilizer budget, management objectives, and land capability.

High-N Option Apply 160 lb N/A and the soil-test-based recommended rates of P_2O_5 and K_2O for each of your pastures. The fertilization rates suggested in this option are high enough to allow bahiagrass pasture to achieve well above average production. Management and environmental factors will determine how much of the potential production is achieved and how much of the forage is utilized.

Medium-Nitrogen Option Apply around 100 lb N/A this year. At that level of N fertilization, P and K may be limiting if your soil tested low in these nutrients. Apply 25 lb P_2O_5/A if your soil tested low in P and none if it tested medium. Apply 50 lb K_2O/A if your soil tested low in K and none if it tested medium. Re-test your soil every second or third year to verify P and K levels. If you plan to make a late-season cutting of hay, apply 80 lb N/A between August 1 and 15 (about 6 weeks before the growing season ends).

Low-Nitrogen Option (for Grazed Pastures Only) Apply around 50 lb N/A this year, recognizing that N will be the limiting nutrient. Thus, do not apply P or K. If you follow this practice of applying only N to your pasture for more than one year, apply the P and K recommended by soil test every third or fourth year to avoid excessive depletion of those nutrients. Do not use this option if you cut hay since nutrient removal by hay is much greater than by grazing animals.

Recommendation Changes made in 2003 sponsored by the Suwannee Fertilizer Work Group

Using the approved recommendations in 1996 as a starting point, the Suwannee Fertilizer Work Group updated bahiagrass recommendation in 2003 using new research findings. If new information was not available, the content of the previously-approved footnotes was retained. Wording, while primarily from the 1996-approved footnotes, was modified to emphasize topics that the work group felt was important. The following information indicates only those portions of the recommendations that were changed in 2003. Current management guidelines accompanying IFAS soil test reports have been described in EDIS Document SL 129 (Kidder et al., 2002) . These footnotes address all types of management for bahiagrass. Some footnotes also apply to other grasses as well.

Footnote 124: UF/IFAS fertilization and liming recommendations are advisory in nature and emphasize efficient fertilizer use and environmentally sound nutrient management without losses of yield or crop quality. It is generally assumed the nutrients will be supplied from purchased, commercial fertilizer and the expected crop yields and quality will be typical of economically viable production. Growers should consider IFAS recommendations in the context of their entire management strategy, such as return on investment in fertilizer and the benefits of applying manure or biosolids (sewage sludge) to their land.

There is insufficient research available to support the use of UF/IFAS soil test results for environmental nutrient management purposes. Such use is discouraged until correlation is proven.

Footnote 131: Fertilization Management Notes for Bahiagrass

Bahiagrass is probably the most widely-used improved forage grass in Florida. It responds well to grazing management and inputs such as fertilization. However, it also can persist and give satisfactory yields under little or no management. Bahiagrass is a very efficient forager and recovers nutrients from deeper in the soil than other popular forage grasses. Because of the wide range of possible use and management levels, recommendations for its fertilization differ with the level of management and the economic inputs. Management decisions concerning liming and fertilization of bahiagrass pastures are very sensitive to cattle productivity and prices.

Recent field research has shown no yield benefit to P or K fertilization of **grazed bahiagrass pastures** in central and south Florida, so soil testing for P & K is not necessary in this part of the state. For purposes of this recommendation, central and south Florida is the region south of a line drawn approximately east-west through Orlando (Figure 1). If you are a producer from that region who has chosen to soil test and wish to follow the standardized recommendations for north Florida, those options are discussed below.

Establishment of New Plantings For new plantings, apply 80 lb N/A split as follows: apply 30 lb N/A, all of the P_2O_5, and 50% of the K_2O as soon as plants have emerged. Apply the remaining K_2O and 50 lb N/A 30 to 50 days later. If manure or biosolids are used as the main source of nutrients, apply the entire annual application once the plants are large enough to withstand physical damage from the application.

Maintenance Fertilization of Established Bahiagrass Pasture Four fertilization options are presented below for bahiagrass pastures. Choose the option which most closely fits your fertilizer budget, management objectives, and land capability.

If you will be only grazing your bahiagrass, you should carefully consider the potential for economical return on your investment in fertilizer before using the Medium-Nitrogen or High-Nitrogen options

described below. The added forage produced for the grazing animals may not be worth the added cost.

Low-Nitrogen Option (for Grazed Pastures Only) Do not use this option if you cut hay since nutrient removal by hay is much greater than by grazing animals. This option results in the lowest cost of purchased fertilizer. Apply around 50 lb N/A in the early spring to maximize much-needed forage. Do not apply P or K recognizing that N will be the limiting nutrient in this low-cost option.

Medium-Nitrogen Option Apply 100 lb N/A in the early spring to provide much-needed forage. At this level of N fertilization, P and K may be limiting if your soil tested low in these nutrients. Apply 25 lb P_2O_5/A if your soil tested very low or low in P and none if it tested medium or high. Apply 50 lb K_2O/A if your soil tested very low or low in K and none if it tested medium or high. Retest your soil every second or third year to verify P and K levels.

High-Nitrogen Option Apply 160 lb N/A and the soil-test recommended rates of P_2O_5 and K_2O for each of your pastures. Split the N into two applications of 80 lb N/A each, applying in early spring and early summer. The fertilization rates suggested in this option are high enough to allow bahiagrass pasture to achieve well above average production. Management and environmental factors will determine how much of the potential production is achieved and how much of the forage is utilized. A single cutting of hay can be made without need for additional fertilization.

Fertilization of Pastures with Biosolids or Manure Apply no more than 160 lb of total N/A per application and no more than 320 lb of total N/A per year. (Note: In areas designated as phosphorus sensitive, the rate of application will be determined by other criteria).

Special Note if Applying Manure or Biosolids A different set of economic factors is usually considered when waste materials rather than purchased fertilizer are supplying the nutrients. Additionally, it is often impractical to follow the application timings discussed in this footnote when using waste materials from other operations.

Bahiagrass Cut Sometimes for Hay

For a Single Cut Per Year from Pastures If you used the Low-N option of pasture fertilization, apply 80 lb N/A and the soil-test recommended amount of P_2O_5 and K_2O no later than six weeks before the growing season ends. If you used the Medium-N option of pasture fertilization, apply 80 lb N and 40 lb K_2O/A no later than six weeks before the growing season ends. If you used the High-N option of pasture fertilization, you do not need any additional fertilization to make one cut of hay.

Bahiagrass Grown Only for Hay

For Multiple Cuts of Hay Apply 80 lb N/A and the soil-test recommended rates of P_2O_5 and K_2O in early spring. Apply an additional 80 lb N and 40 lb K_2O/A after each cutting, except the last in the fall. Include 20 lb of P_2O_5/A in the supplemental fertilizer if the soil tested low or medium in P.

Bahiagrass for Seed Production Apply 60 to 80 lb N/A and the soil-test recommended P and K in February or March. Graze until May, June, or July, depending on variety. Remove cattle before seed heads start to emerge and apply an additional 60 to 80 lb N/A.

If the bahiagrass is not grazed, do not apply fertilizer in February or March since this may stimulate excessive top growth. Mowing from February to April may be needed to remove excessive top growth. Apply the soil test recommended P and K and 60 to 80 lb N/A before seed heads first appear. Fertilize Pensacola in March/April and Argentine and Paraguay in May/June.

Footnote 132: HAY OR SILAGE (ALL PERENNIAL GRASSES)

For Multiple Cuts Apply 80 lb N/A and all of the recommended P_2O_5 and K_2O in early spring. Apply an additional 80 lb N and 40 lb K_2O/A after each cutting, except the last in the fall. Include 20 lb of P_2O_5/A in the supplemental fertilizer if the soil tested low or medium in P.

For a Single, Late Season Cut from Pastures If you have not applied N in the past two months, apply 80 lb N/A and the soil-test recommended amount of P_2O_5 and K_2O. If you have applied N in the past two

months, do not apply any N now, but do apply the soil-test recommended amount of P_2O_5 and K_2O. Any application of fertilizer should be made no later than six weeks before the growing season ends.

Special Note if Applying Manure or Biosolids A different set of economic factors are usually considered when waste materials rather than purchased fertilizer are supplying the nutrients. Additionally, it is often impractical to follow the application timings discussed in this footnote when using waste materials from other operations.

Recommendation Changes made in 2007 sponsored by the Pasture Fertilization Standards Task Force, 2007 to current

J.D. Arthington, Chair	M.L. Silveira
C.L. Mackowiak	P.J. Hogue
D.E. Mayo	R. Mylavarapu
J.M. Vendramini	Y. Newman
L.E. Sollenberger	

This section contains the latest recommendations for bahiagrass. While much of the wording of this footnote was carried forward from previous versions, this version contains information regarding the coupling of soil P samples with plant tissue P samples. This approach not only measures the extractable concentration of P from the surface soil but also measures plant-tissue P concentration. These two measurements in combination should result in appropriate P fertilization recommendations for established bahiagrass.

131. FERTILIZATION MANAGEMENT NOTES FOR GRAZED BAHIAGRASS

Bahiagrass is one of the most widely-used planted forage grasses in Florida. It responds well to grazing management and inputs such as fertilization. However, it also persists and give satisfactory yields under low inputs. Because of the wide range of uses and management levels, recommendations for bahiagrass fertilization differ with the level of management and the economic inputs. Management decisions concerning bahiagrass pasture liming and fertilization are sensitive to cattle productivity and prices.

This section contains the latest recommendations for bahiagrass. While much of the wording of this footnote was carried forward from previous versions, this version contains information regarding the coupling of soil P samples with plant tissue P samples. This approach not only measures the extractable concentration of P from the surface soil but also measures plant-tissue P concentration. These two measurements in combination should result in appropriate P fertilization recommendations for established bahiagrass.

131. FERTILIZATION MANAGEMENT NOTES FOR GRAZED BAHIAGRASS

Bahiagrass is one of the most widely-used planted forage grasses in Florida. It responds well to grazing management and inputs such as fertilization. However, it also persists and give satisfactory yields under low inputs. Because of the wide range of uses and management levels, recommendations for bahiagrass fertilization differ with the level of management and the economic inputs. Management decisions concerning bahiagrass pasture liming and fertilization are sensitive to cattle productivity and prices.

LIMING

In order to obtain maximum fertilization efficiency, soil pH should be maintained at 5.5 or higher. If soil pH tests 5.3 or lower, a lime requirement test will be conducted and a recommendation for lime application will be made. Optimal use of lime is to apply at least 3 to 6 months prior to fertilization to provide adequate time for the lime reaction to occur and the soil pH to adjust to the desired level.

Soils should be tested for pH every 2-3 years

PHOSPHORUS FERTILIZATION

In order to receive phosphorus fertilizer recommendations for established bahiagrass, soil AND tissue samples should be submitted to the ESTL

at the same time. As per the preliminary research findings, soil tests alone are not adequate to determine bahiagrass P needs. A companion tissue test has, therefore, been added to the testing procedures along with the soil test to determine the P fertilization needs. Producers are strongly encouraged to simultaneously test soil and tissue samples if bahiagrass pastures have not received P fertilization for long periods. Phosphorus should not be applied if tissue P concentrations are at or above 0.15%, even if soil tested Very Low or Low in P. For Medium and High soil P levels, P application is not recommended since there is no added benefit of P fertilization on bahiagrass yields.

If P recommendations are not desired and the producer is only interested in soil pH, lime requirement, and/or K, Mg, and Ca recommendations and soil P concentration, a soil sample alone can be submitted to the ESTL. In this case, the soil-test report will not include P fertilizer recommendations. (Please choose the appropriate test from the Producer Sample Submission Form).

Both the consolidated representative soil and the tissue samples should be collected simultaneously from each field of **up to** 40 acres.

The testing procedures and the P recommendations for bahiagrass may be adjusted as field research data become available.

INTERPRETATION FOR BAHIAGRASS SOIL AND TISSUE TEST

SOILTEST	TISSUE TEST	RECOMMENDATIONS
P MEDIUM/HIGH	NO TISSUE TEST	0
P LOW/VLOW	P >=0.15%	0
P LOW/VLOW	P<0.15%	25 or 40 lbs P_2O_5/acre†

†Recommended amount of P_2O_5 depends upon nitrogen option chosen.

MAINTENANCE FERTILIZATION OF ESTABLISHED BAHIAGRASS PASTURE

Four fertilization options are presented below for bahiagrass pastures. Choose the option which most closely fits your fertilizer budget, management objectives, and land capability. If you will only be grazing your bahiagrass, you should carefully consider the potential for economical return on your investment in fertilizer before using the Medium-Nitrogen or High-Nitrogen options described below. The added forage produced for grazing animals may not be worth the added cost.

•Low-Nitrogen Option. Do not use this option if you cut hay since nutrient removal by hay is much greater than by grazing animals. This option results in the lowest cost of purchased fertilizer. Apply 50 to 60 lb N/A in the early spring. Do not apply K, recognizing that N will be the limiting nutrient in this low-cost option. Apply 25 lb P_2O_5/A if your soil tests Very Low or Low in P and tissue P concentration is below 0.15%. Do not apply P if tissue P concentration is at or above 0.15%, even if the soil tests Very Low or Low in P. For Medium and High soil P levels, neither P application nor tissue analysis is recommended since there will be no added benefit of P fertilization on bahiagrass yields.

•Medium-Nitrogen Option. Apply 100 lb N/A in the early spring. Apply 25 lb P_2O_5/A if your soil tests Very Low or Low in P and tissue P concentration is below 0.15%. Do not apply P if tissue P concentration is at or above 0.15%, even if the soil tests Very Low or Low in P. For Medium and High soil P levels, neither P application nor tissue analysis is recommended since there will be no added benefit of P fertilization on bahiagrass yields. Apply 50 lb K_2O/A if your soil tests Very Low or Low in K and none if it tests Medium or High.

•High-Nitrogen Option. Apply 160 lb N/A in two applications of 80 lb N/A in early spring and early summer. Apply 40 lb P_2O_5/A if your soil tests Very Low or Low in P and tissue P concentration is below 0.15%. Do not apply P if tissue P concentration is at or above 0.15%, even if the soil tests Very Low or Low in P. For Medium and High soil P levels, neither P application nor tissue analysis

is recommended since there will be no added benefit of P fertilization on bahiagrass yields. Apply 80 lb K_2O/A if your soil tests Very Low or Low in K and 40 lb K_2O/A if it tests Medium. No K should be applied if your soil tests High or Very High in K. The fertilization rates suggested in this option are high enough to allow bahiagrass pasture to achieve well above average production. Management and environmental factors will determine how much of the potential production is achieved and how much of the forage is utilized. A single cutting of hay can be made without need for additional fertilization.

Bahiagrass Cut Sometimes for Hay

For a Single Cut Per Year from Pastures. If you used the Low-N option of pasture fertilization, apply 80 lb N/A no later than six weeks before the growing season ends. Apply 50 lb K_2O/A if your soil tests Very Low or Low in K and none if it tests Medium or High. Apply 25 lb P_2O_5/A if your soil tests Very Low or Low in P and tissue P concentration is below 0.15%. Do not apply P if tissue P concentration is at or above 0.15%, even if the soil tests Very Low or Low in P. If you used the Medium-N option of pasture fertilization, apply an additional 80 lb N no later than six weeks before the growing season ends. Apply 50 lb K_2O/A if your soil tests Very Low or Low in K and none if it tests Medium or High. Apply 25 lb P_2O_5/A if your soil tests Very Low or Low in P and tissue P concentration is below 0.15%. If you used the High-N option of pasture fertilization, you do not need any additional N fertilization to make one cut of hay. Apply 80 lb K_2O/A if your soil tests Very Low or Low in K and 40 lb K_2O/A if it tests Medium. Apply 40 lb P_2O_5/A if your soil tests Very Low or Low in P and tissue P concentration is below 0.15%.

Bahiagrass Grown Only for Hay

For Multiple Cuts of Hay. Apply 80 lb N/A in early spring. Also in spring, apply 80 lb K_2O/A if your soil tests Very Low or Low in K and 40 lb K_2O/A if it tests Medium. Apply 40 lb P_2O_5/A if your soil tests Very Low or Low in P and tissue P concentration is below 0.15%. Apply an additional 80 lb N and 40 lb K_2O/A after each cutting, except the last in the fall. Include 20 lb of P_2O_5/A after each cutting if the soil tested Very Low or Low in P.

Bahiagrass for Seed Production

Apply 60 to 80 lb N/A in February or March. At the same time, apply 80 lb K_2O/A if your soil tests Very Low or Low in K and 40 lb K_2O/A if it tests Medium. Apply 40 lb P_2O_5/A if your soil tests Very Low or Low in P and tissue P concentration is below 0.15%. Graze until May, June, or July, depending on variety. Remove cattle before seed heads start to emerge and apply an additional 60 to 80 lb N/A.

If the bahiagrass is not grazed, do not apply fertilizer in February or March since this may stimulate excessive top growth. Mowing from February to April may be needed to remove excessive top growth. Apply 60 to 80 lb N/A before seed heads first appear. Apply 25 lb P_2O_5/A if your soil tests Very Low or Low in P and tissue P concentration is below 0.15%. Do not apply P if tissue P concentration is at or above 0.15%, even if the soil tests Very Low or Low in P. For Medium and High soil P levels, neither P application nor tissue analysis is recommended. Apply 50 lb K_2O/A if your soil tests Very Low or Low in K and none if it tests Medium or High. Fertilize Pensacola bahiagrass in March/April and Argentine and Paraguay varieties in May/June

Summary

The UF/IFAS recommendations for bahiagrass have gone through several refinements from 1990 through 2008. These recommendations are founded upon experimental evidence that has been published in a number of venues (see Bibliography section). Recommendations have changed considerably, affecting soil pH management, as well as appropriate P and K fertilization for hay, sod, and pasture management scenarios. High quality bahiagrass production can be achieved in Florida if these recommendations are followed.

Development of appropriate liming and fertilization recommendations is a continuing process. As the Pasture Fertilization Standards Task Force continues to explore current issues involving bahiagrass production and more long-term soil and plant-tissue data are collected, this document shall be updated to reflect new findings.

Bibliography

1.Allen, R.J., Jr., and F.T. Boyd. 1959. Pasture development in the Everglades. Soil Crop Sci. Soc. Fla. Proc. 19:154-161.

2.Blue, W.G. 1966. The effect of nitrogen sources, rates and application frequencies on Pensacola bahiagrass forage yields and nitrogen utilization. Soil Crop Sci. Soc. Fla. Proc. 26:105-109.

3.Blue, W.G. 1970. The recovery of autumn and winter applied potassium by a warm-season grass from Leon fine sand. Soil Crop Sci. Soc. Fla. Proc. 31:75-77.

4.Blue, W.G. 1971. Nitrogen fertilization in relation to seasonal Pensacola bahiagrass (Paspalum notatum Flugge) forage nitrogen and production distribution on Leon fine sand. Soil Crop Sci. Soc. Fla. Proc. 30:9-15.

5.Blue, W.G. 1973. Role of Pensacola bahiagrass stolon-root systems in fertilizer nitrogen utilization on Leon fine sand. Agron. J 65:88-90.

6.Blue, W.G. 1988. Response of Pensacola bahiagrass on a Florida Spodosol to nitrogen sources and times of application. Soil Crop Sci. Soc. Fla. Proc. 47:135-139.

7.Blue, W.G. 1974. Efficiency of five nitrogen sources for Pensacola bahiagrass on Leon fine sand as affected by lime treatments. Soil Crop Soc. Fla. Proc. 33:176-180.

8.Blue, W.G. 1977. Comparison of sulfur-coated urea and ammonium nitrate as fertilizers for Pensacola bahiagrass on a Spodosol. Soil Sci. Soc. Am. J. 41:1191-1193.

9.Blue, W.G. 1979. Forage production and N contents, and soil changes during 25 years of continuous white clover: Pensacola growth on a Florida Spodosol. Agron. J. 71:795-798.

10.Blue, W.G. 1980. Soil fertility management for improved pastures. Soil Crop Sci. Soc. Fla. Proc. 39:5-8.

11.Blue, W.G. 1988. Response of Pensacola bahiagrass (Paspalum notatum Flugge) to fertilizer nitrogen on an Entisol and a Spodosol in north Florida. Soil Crop Sci. Soc. Fla. Proc. 24:20-26.

12.Blue, W.G., and N. Gammon, Jr. 1963. Differences in nutrient requirements of experimental pasture plots managed by grazing and clipping techniques. Soil Crop Sci. Soc. Fla. Proc. 23:152-161.

13.Blue, W.G., C.L. Dantzman, and V. Impithuksa. 1980. The response of the three perennial warm-season grasses to fertilizer nitrogen on Eaugallie fine sand (Alfic Haplaquod) in Central Florida. Soil Crop Sci. Soc. Fla. Proc. 39:44-47.

14.Blue, W.G., D.W. Jones, and J.B. Sartain. 1976. Interpretation of soil and forage tissue analytical data. Memorandum.

15.Blue, W.G., N. Gammon, Jr., and H.W. Winsor. 1961. Accumulation of organic matter and nitrogen on flatwoods soils planted to white clover-grass pastures. Soil Crop Sci. Soc. Fla. Proc. 21:74-81.

16.Boyd, F.T. 1961. Fertility responses of St. Augustine, Pangola, and Pensacola bahia grasses on south Florida sandy soils. Soil Crop Sci. Soc. Fla. Proc. 19:172-178.

17.Carvalho, M.M., V. Freitas, A.B. Da Cruz Filho. 1994. Phosphorus requirements for the establishment of two forage grasses in an acid soil. Pesq. agropec. bras., Brasilia. 29(2):199-209.

18.Dantzman, C.L., J.E. McCaleb, and E.M. Hodges. 1967. Influence of fertilization rate and grass variety on extractable potassium and phosphorus in Flatwoods soils. Soil Crop Sci. Soc. Fla. Proc. 27:30-34.

19.Department of Agriculture and Consumer Services (DACS). 2005. Office of Agricultural Water Policy - Overview. 5E-1.023 Procedures for Landowners and Leaseholders to Submit a Notice of Intent to Implement Nitrogen Best Management Practices (BMPs). State of Florida, DACS, Tallahassee, FL. Available at:http://www.floridaagwaterpolicy.com/rules/

Rule_5E_1_023.html. Accessed: November 28, 2005.

20.Dunavin, L.S., Jr., and O.C. Ruelke. 1959. The evaluation of cold hardiness in Florida pasture grasses. Soil Crop Sci. Soc. Fla. Proc. 47:139-142.

21.Gammon, N., Jr., and W.G. Blue. 1961. Nitrogen in pasture and field crop production. Soil Crop Sci. Soc. Fla. Proc. 21:283-287.

22.Gonzalez, J.S., W.G. Blue, and C.L. Dantzman. 1973. Availability of native subsoil phosphorus in flatwoods soil from Central Florida. Soil Crop Sci. Soc. Fla. Proc. 32:138-141.

23.Hanlon, E.A. 1995. Current UF/IFAS recommendations regarding pasture fertilization. p.57-64 In W. Kunkle (ed.) 1995 Beef Cattle Shortcourse, Gainesville, FL.

24.Hodges, E.M, and J.E. McCaleb. 1959. Pasture development at the Range Cattle Station. Soil Crop Sci. Soc. Fla. Proc. 19:150-154.

25.Hodges, E.M., and F.G. Martin. 1975. Forage production of Perennial grasses as affected by fertilizer rate and season. Soil Crop Sci. Soc. Fla. Proc. 34:158-161.

26.Hodges, E.M., W.G. Kirk, F.M. Peacock and J.E. McCaleb. 1970. Supplemental feeding of steers on Pangolagrass and Pensacola bahiagrass warm season pastures (Series II). Soil Crop Sci. Soc. Fla. Proc. 30:337-341.

27. Ibrikci, H., E.A. Hanlon, and J.E. Rechcigl. 1992. Initial calibration and correlation of inorganic-phosphorus soil test methods with a bahiagrass field trial. Commun. Soil Sci. Plant Anal. 23(17-20):2569-2579.

28.Impithuksa, V., and W.G. Blue. 1977. The fate of fertilizer nitrogen applied to Pensacola bahiagrass on sandy soils as indicated by Nitrogen-15. Soil Crop Sci. Soc. Fla. Proc. 37:213-217.

29.Impithuksa, V., and W.G. Blue. 1985. Fertilizer nitrogen and nitrogen-15 in three warm-season grasses grown on a Florida Spodosol. Soil Sci. Soc. Am. J. 49:1201-1204.

30.Impithuksa, V., C.L. Dantzman, and W.G. Blue. 1979. Fertilizer nitrogen utilization by three warm-season grasses on an Alfic Haplaquod as indicated by nitrogen-15. Soil Crop Sci. Soc. Fla. Proc. 38:93-97.

31.Impithuksa, V., W.G. Blue, and D.A. Graetz. 1984. Distribution of applied nitrogen in soil--Pensacola bahiagrass components as indicated by nitrogen-15. Soil Sci. Soc. Am. J. 48:1280-1284.

32.Jones, V. 1991. Set stocking recommended for spring pasture. The Stockman Grass Farmer. p. 8-9.

33.Kidder, G., S.L. Sumner, E.W. Jennings, and M. Ramsey. 1992. Save energy, resources, and money with IFAS bahiagrass pasture fertilization recommendations. Fla. Coop. Ext. Serv.

34.Kidder, G., C.G. Chambliss, and R. Mylavarapu. 2002. UF/IFAS Standardized Fertilization Recommendations for Agronomic Crops SL129, Soil & Water Science, Cooperative Extension Service, IFAS. p9.

35.Killinger, G.B. 1959. Pasture herbage changes in Florida during the past two decades (1939-1959). Soil Crop Sci. Soc. Fla. Proc. 19:162-165.

36.McCaleb, J.E., C.L. Dantzman, and E.M. Hodges. 1966. Response of panolagrass and Pensacola bahiagrass to different amounts of phosphorus and potassium. Soil Crop Sci. Soc. Fla. Proc. 26:248-256.

37.Monson, W.G., and G.W. Burton. 1984. Forage research at Tifton, Georgia. Soil Crop Sci. Soc. Fla. Proc. 43:1-2.

38.Monteiro, F.A., and W.G. Blue. 1990. Effects of sulfur and molybdenum applied to Spodosol on White Clover-Pensacola bahiagrass growth and composition. Soil Crop Sci. Soc. Fla. Proc. 49:72-77.

39.Mylavarapu, R.S. 2003. Role of an Extension Soil Testing Program in the Development of Best Management Practices: A Florida Case Study. Journal of Extension, 45(4) pp9.

40.Mylavarapu, R., D. Wright, G. Kidder, C.G. Chambliss. 2007. UF/IFAS Standardized Fertilization Recommendations for Agronomic Crops. EDIS: SL129/SS163. http://edis.ifas.ufl.edu/SS163 .

41.Neller, J.R. 1963. Comparisons of phosphorus fertilizers for pastures on flatwoods soils in Florida. Soil Crop Sci. Soc. Fla. Proc. 4:55-60.

42. Newman, Y.C., C.L Mackowiak, R. Mylavarapu, and M.L. Silveira. 2007. Fertilizing and liming forage crops. EDIS: SS-AGR-176. http://edis.ifas.ufl.edu/AG179.

43.O'Donnell, J.J., J.E. Rechcigl, W.D. Pitman, and D.M. Sylvia 1991. Establishment and growth of Vigna parkeri on an acid Florida Spodosol in response to lime and phosphorus. p. 491-500. In R.J. Wright et al. (Eds.) Plant-soil interactions at low pH. Kluwer Academic Pub., Dordrecht, The Netherlands.

44.Pate, F.M. 1993. Mineral supplement is more important with new fertilizer recommendations. Florida Cattleman 57,11:32,50.

45.Phillips, J.M., and C.S. Snyder. 1988. Effect of limestone and magnesium on bahiagrass yield, quality, nutrient concentration and uptake and soil test levels. Arkansas Agr. Exp. Sta. Bull. 914, 23 p.

46.Rechcigl, J.E., G.G. Payne, A.B. Bottcher, and P.S. Porter. 1992. Reduced phosphorus application on bahiagrass and water quality. Agron. J. 84:463-468.

47.Rechcigl, J.E., P. Mislevy, and A.K. Alva. 1993. Influence of limestone and phosphogypsum on bahiagrass growth and development. Soil Sci. Soc. Am. J. 57:96-102.

48.Rechcigl, J.E., P. Mislevy, and F.M. Pate. 1991. Influence of limestone and phosphogypsum on bahiagrass growth and development. Ona A.R.E.C. Res. Rep. RC-1991-3:1-9.

49.Rechcigl, J.E., P. Mislevy, and H. Ibrikci. 1995. Response of established bahiagrass to broadcast lime and phosphorus. J. Prod. Agric. 8(2):249-253.

50.Rodriguez-Kabana, R., D.B. Weaver, R. Garcia, D.F. Robertson, and E.L. Carden 1989. Bahiagrass for the management of root-knot and cyst nematodes in soybean. Nematropica. 19:185-193.

51.Rodulfo, S., and W.G. Blue. 1970. The availability to forage plants of accumulated phosphorus in Leon fine sand. Soil Crop Sci. Soc. Fla. Proc. 30:167-173.

52.Ruelke, O.C. 1960. Fertility, as a limiting factor for pastures in Florida. Soil Crop Sci. Soc. Fla. Proc. 20:23-27.

53.Ruelke, O.C., and G.M. Prine. 1971. Performance of six hybrid Bermudagrasses, Pangola digitgrass, and Pensacola bahiagrass at three fertility levels in north central Florida. Soil Crop Sci. Soc. Fla. Proc. 31:67-71.

54.Saturnino, R., and W.G. Blue. 1967. The availability to forage plants of accumulated phosphorus in Leon fine sand. Soil Crop Sci. Soc. Fla. Proc. 30:167-173.

55.Schroder, V.N., and O.C. Ruelke. 1968. Nutritional studies of root and shoot development of yellowed Bahiagrass. Soil Crop Sci. Soc. Fla. Proc. 28:35-43.

56.Silveira, M.L., J.M. Vendramini, L.E. Sollenberger, C.L. Mackowiak, Y.C. Newman. 2007. Tissue Analysis as a Nutrient Management Tool for Bahiagrass Pastures. EDIS: SL252/SS475. http://edis.ifas.ufl.edu/SS475 .

57.Snyder, G.H., and A.E. Kretschmer, Jr. 1988. A DRIS Analysis for Bahiagrass Pastures. Fla. Agric. Exp. Stn. Journal Series N. 8726.

58.Stanley, R.L., Jr., and R.W. Wallace. 1970. Crimson clover and Argentina bahiagrass yields as related to fertilizer rate and time of application. Soil Crop Sci. Soc. Fla. Proc. 30:90-99.

59.Sumner, S., W. Wade, J. Selph, J. Southwell, V. Hoge, P. Hogue, E. Jennings, P. Miller, and T. Seawright 1991. Fertilization of established Bahiagrass pasture in Florida. Univ. Fla., Fla. Coop. Extn. Serv. Circ. 916, Gainesville, FL.

60.Teare, I.D., D.L. Wright, R.L. Stanley, and B.T. Kidd. 1986. The economics of fertilizing Bahiagrass under pines. Field Day handout.

61.Teare, I.D., D.L. Wright, R.L. Stanley, Jr., and B.T. Kidd. 1987. Bahiagrass response to lime and nitrogen under pines. Agron. J. 79:1-4.

62.Van Buren, N. 1991. Forage Fertility Management/Improving Quality Can Open New Customer Markets. Solutions p. 48-49, 58-59.

63.Weiser, G.C., and R.L. Smith. 1988. Nitrogen related characteristics of Switchgrass and Bahiagrass in Florida. Soil Crop Sci. Soc. Fla. Proc. 47:161-164.

E.A. Hanlon, Chair	F.M. Rhoads
F. Pate	C.G. Chambliss
G.H. Snyder	D. Townsend
J. Rechcigl	J.F. Selph
P. Mislevy	M.E. Griggs
R. Stanley	S.L. Sumner (retired)
D.L. Wright	J.B. Sartain
A.E. Kretschmer	