SS-AGR-176

Fertilizing and Liming Forage Crops[1]

Y.C. Newman, C. Mackowiak, R. Mylavaparu, and M. Silveira[2]

Plants require many essential nutrients for growth. Those nutrients required by plants in large quantities are called macronutrients, and they are nitrogen (N), phosphorus (P), and potassium (K). Those required in moderate quantities are called secondary nutrients, and they are calcium (Ca), magnesium (Mg), and sulfur (S). There are also nutrients that are needed in very little amounts but are as essential for plant growth as the macro and secondary nutrients, and they are called micronutrients (iron, copper, zinc, manganese, boron, molybdenum, and chlorine). The soil can supply the plant with most, if not all, of the macro, secondary, and micronutrients, but often the supply of one or more of the nutrients is insufficient for optimum growth.

Nitrogen is the nutrient that grass pastures use the most, and when used in a balanced fertilization, it often results in increased forage quality and production. Phosphorus may be deficient in some soils, but other Florida soils are high in native P. Some forage crops may extract sufficient P from the subsoil, even when the P level in the surface soil is low. Potassium (K) may be needed by some forage crops. Under intensive hay or silage production where nutrients are removed from the land, annual applications of P and K are typically required. Potassium is fairly mobile in sandy soils and can quickly become deficient. Calcium, magnesium, sulfur, and some micronutrients may also become deficient in the soil if soil fertility is overlooked.

While routine soil tests do not include a micronutrient analysis, it is suspected that in some areas of Florida S deficiency may be seen in some years and on some crops. Sulfur deficiency may be seen under intensive hay or silage production. Sulfur deficiency symptoms are pale green leaves mainly in young leaves, similar to nitrogen deficiency, but nitrogen deficiency symptoms show pale leaves in older and new leaves. If a producer is concerned or suspects a sulfur deficiency, some sulfur may be added by using ammonium sulfate as the nitrogen source in the first spring application (just be aware that ammonium sulfate is an acidifying fertilizer). Use of other S fertilizers such as sulpomag or gypsum is another option when no additional N is needed or if your pH is moderately acidic.

Under most circumstances, micronutrients are not deficient in pastures and therefore should not be applied until a deficiency of a specific nutrient is confirmed. A suggestion for new plantings of forages on unplanted and unfertilized flatwood soils is to apply 3 lb/acre of copper with the initial fertilization.

Only the nutrients that are needed by the crop should be included in the fertilizer. For example, if a soil test indicates that phosphorous is adequate, no phosphorus should be included in the fertilizer. Banking fertilizer in the soil is not a profitable method for managing the nutrition of crops, plus there is a high risk of environmental pollution.

1. This document is SS-AGR-176, one of a series of the Agronomy Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. This publication is also part of the *Florida Forage Handbook*, an electronic publication of the Agronomy Department, originally written by C.G. Chambliss; revised by Yoana Newman. For more information you may contact the editor of the *Florida Forage Handbook*, Y. C. Newman (ycnew@ufl.edu). Revised January 2008. Reviewed April 2011. Please visit the EDIS website at http://edis.ifas.ufl.edu.

2. Y.C. Newman, assistant professor, Agronomy Department; C. Mackowiak, assistant professor, Soil and Water Science Department; R. Mylavaparu, associate professor, Soil and Water Science Department; M. Silveira, assistant professor, Soil and Water Science Department. Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL 32611.

How does a manager decide if fertilizer or lime should be applied to a pasture or forage crop? Fertilizer and/or lime should be applied (1) if an increase in forage growth can be expected, (2) if the extra forage is needed, and (3) if a return on the investment can be expected. The experience of the forage manager, along with soil testing for pH, P, and K, can be used in making a decision about liming and fertilizing with P and K, especially for hay or silage production. There is no point in fertilizing to reach maximum yields if the extra forage produced is not used. To make a profit on the investment, the forage must be utilized or harvested, and the product (animal weight gain, milk, hay, or silage) must be marketed.

Fertilizer should usually be applied at the beginning of the growing season. Warm-season perennial grasses should be fertilized in the early spring (February to March). Spring fertilization stimulates production at a critical time. Some pasture grasses may be given an additional application of N in June if extra forage is needed, but this is usually not the case for a beef cow/calf operation. Although bahiagrass gives little, if any, response to a late-summer/fall application, limpograss, rhodesgrass, and stargrass do. These grasses can be fertilized in the late summer or early fall to extend the grazing season or, in the case of limpograss, for stockpiling. Timely application of fertilizer can be used to increase forage yield and quality, improve stand persistence, and provide for better distribution of forage across the growing season. The producer should consider that the response obtained from an application of fertilizer is influenced by other factors such as solar radiation, temperature, soil moisture, and grazing management. For example, overgrazing or excessive defoliation limits the ability of the plant to respond to the added nutrients and thereby reduces potential yield.

Some grasses, such as the stargrasses and some of the hybrid bermudagrasses, need to be fertilized annually or maintained in a high-fertility environment in order to keep a good stand. On the other hand, some ranch managers with large, extensive operations may only fertilize their bahiagrass or limpograss once every three years. These grasses can persist under minimum fertility if they are not overgrazed or mismanaged.

Fertilization Recommendations for Specific Forages

Fertilizing for Establishment of Perennial Grasses

Applying nutrients on a clean-tilled seedbed before plant roots are present increases the risk of losing some or all of the nutrients through leaching. Heavy rainfall events on the sandy soils of Florida can move N and K downward in the soil profile and out of reach of plant roots that will be developing later. Therefore, it is suggested that, where possible, nutrients (fertilizer) not be applied until plant roots are present to take them up. On the other hand, biosolids, poultry litter, manures, and composts can be lightly incorporated into the seedbed. They have a slower nutrient release than mineral fertilizers and the organic matter may provide some additional tilth and moisture retention to the soil.

For establishment of new plantings, apply 100 lb N/acre and split application as follows: apply 30 lb N/acre, all of the soil test recommended P_2O_5, and 50% of the K_2O as soon as plants emerge. Apply the remaining K_2O and 60–70 lb N/acre 30–50 days later.

When the new plants are small, only a limited amount of N and K_2O are applied, with additional N and K_2O being applied later to encourage the new plants to continue growing, spreading, and developing into a full and complete stand of grass.

Fertilizing Bahiagrass

GRAZED BAHIAGRASS

Phosphorus Fertilization

In order to receive phosphorus fertilizer recommendations for established bahiagrass, soil AND tissue samples should be submitted to the Extension Soil Testing Lab (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 either the test for soil pH and lime requirement recommendations, or the test for soil pH, lime requirement, K, Mg, and Ca recommendations, the 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.

ESTL testing procedures and recommendations for P for bahiagrass may be adjusted as and when field research data becomes available.

MAINTENANCE FERTILIZATION

Four fertilization options are presented below for established bahiagrass pastures. Choose the option which most closely fits your fertilizer budget, management objectives, and land capability. If you will be grazing only 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 50–60 lb N/acre 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/acre 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/acre in the early spring. Apply 25 lb P_2O_5/acre 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/acre 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/acre in two applications of 80 lb N/acre in early spring and early summer. Apply 40 lb P_2O_5/acre 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/acre if your soil tests Very Low or Low in K and 40 lb K_2O/acre 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/acre 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/acre 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.

Interpretation for Bahiagrass Soil and Tissue Test		
SOIL TEST	TISSUE TEST	RECOMMENDATIONS
P MEDIUM/HIGH	NO TISSUE TEST	0
P LOW/VLOW	P= or >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.		

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/acre if your soil tests Very Low or Low in K, and none if it tests Medium or High. Apply 25 lb P_2O_5/acre 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/acre if your soil tests Very Low or Low in K and 40 lb K_2O/acre if it tests Medium. Apply 40 lb P_2O_5/acre 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/acre in early spring. Also in spring, apply 80 lb K_2O/acre if your soil tests Very Low or Low in K, and 40 lb K_2O/acre if it tests Medium. Apply 40 lb P_2O_5/acre 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/acre after each cutting, except the last in the fall. Include 20 lb of P_2O_5/acre after each cutting if the soil tested Very Low or Low in P.

BAHIAGRASS FOR SEED PRODUCTION

Apply 60–80 lb N/acre in February or March. At the same time, apply 80 lb K_2O/acre if your soil tests Very Low or Low in K, and 40 lb K_2O/acre if it tests Medium. Apply 40 lb P_2O_5/acre 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 60–80 lb N/acre.

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 60–80 lb N/A before seed heads first appear. Apply 25 lb P_2O_5/acre 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/acre if your soil tests Very Low or Low in K and none if it tests Medium or High. Fertilize Pensacola in March/April and Argentine and Paraguay in May/June.

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 publication when using waste materials from other operations.

Fertilizing Established Pastures of Bermudagrass, Stargrass, Digitgrass (Pangola), Rhodesgrass, and Suerte

For grazed stands, apply 80 lb N/acre, all of the soil test recommended P_2O_5, and 50% of the K_2O in early spring. Apply an additional 60–80 lb N/acre and the remaining K_2O at midseason. In central and south Florida, the midseason application can be delayed and applied in September to early October for fall production on stargrass, hybrid bermudagrasses, and rhodesgrass. Under intensive management in central and south Florida, up to 200 lb N/acre/year may be economically viable for stargrass and bermudagrass. In this situation, apply 80 lb N/acre, all of the P_2O_5, and 50% of the K_2O in early spring. Follow with 50 lb N/acre in midseason, and 70 lb N/acre and the other 50% of the K_2O in mid-to-late September.

Fertilizing Established Pastures of Limpograss

For grazed stands, apply 60 lb N/acre and the entire soil test recommended P_2O_5 and K_2O in late winter or early spring. Apply an additional 60 lb N/acre in late summer or early fall. For a minimum fertilization alternative, ignore the P and K recommendation and apply only 60 lb N/acre/year.

Fertilizing for Hay or Silage Production from Perennial Grasses (excluding bahiagrass)

For multiple cuts: Apply 80 lb N/acre 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/acre after each cutting, except the last in the fall. Include 20 lb of P_2O_5/acre in the supplemental fertilizer if the soil tested low or medium in P.

For a single, late season cut from pasture: Apply 80 lb N/acre if you have not applied N in the past two months, and apply 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 nitrogen 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.

Summer Annual Grasses

Species included are sorghum-sudan hybrids, pearl millet, brown top millet, and Japanese millet.

Apply 30 lb N/acre, 50% of the soil test recommended K_2O, and all of the P_2O_5 fertilizer in a preplant or at-planting application. Apply 50 lb N/acre and the remaining K_2O after the first grazing period. Apply an additional 50 lb N/acre after each subsequent grazing period, except the last.

Warm-Season Legumes or Legume-Grass Mixtures

Species included are aeschynomene, alyceclover, desmodiums, hairy indigo, stylo, perennial peanut, and other tropical legumes. Apply all of the soil-test-recommended P_2O_5 and K_2O in spring or early summer when seedlings or regrowth are 3–4 inches tall.

Perennial Peanut Hay Production

Apply all of the soil test recommended P_2O_5 and K_2O in early spring. Make an annual application of 20–30 lb sulfur/acre applied as a sulfate (e.g., gypsum, ammonium sulfate, magnesium sulfate, potassium sulfate, potassium magnesium sulfate). After each hay harvest, apply an additional 15 pounds of P_2O_5 and 40 pounds of K_2O per ton of hay removed, unless the soil tests high or very high.

Cool-Season Annual Grasses

When planting on a prepared seedbed, apply 30 lb N/acre, 50% of the soil test recommended K_2O, and all of the P_2O_5 fertilizer in a preplant or at-planting application. Apply 50 lb N/acre and the remaining K_2O after the first grazing period. Apply an additional 50 lb N/acre after each subsequent grazing period. When overseeding established perennial grasses with cool-season annual grasses, apply 50 lb N/acre plus all of the P_2O_5 and K_2O after emergence. Apply an additional 50 lb N/acre after each subsequent grazing period.

Cool-Season Legumes or Legume-Grass Mixtures

Species included are all true clovers (white, red, arrowleaf, crimson, subterranean), vetches, lupines, and sweet clover. If legumes such as white clover are already established, or if reseeding annual legumes such as crimson clover are re-establishing from natural seed, apply all of the soil test recommended P_2O_5 and K_2O fertilizer in late fall. For new plantings, apply the recommended P_2O_5 and K_2O in a preplant or at-planting application. If legumes are planted in combination with oat, rye, wheat, and/or ryegrass, apply 30 lb N/acre in a preplant or at-planting application plus one additional 50 lb N/acre application after the grass is well established. These recommendations are made assuming adequate soil moisture is available either from rainfall or irrigation. In southern Florida, lack of adequate rainfall during the cool season frequently causes stand failure or limits growth. Under nonirrigated conditions in southern Florida, the probability of inadequate moisture is high and the likelihood that the crop will benefit from applied fertilizer is low, especially on the drier soils.

Alfalfa

Apply all of the soil-test-recommended P_2O_5 and 50% of the K_2O fertilizer in late fall. Apply the remaining K_2O in early spring. If the alfalfa is mechanically harvested rather than grazed, apply an additional 30 lb P_2O_5 and 60 lb K_2O/acre after each harvest. An additional application of 100 lb K_2O/acre in June or July may increase summer survival of alfalfa. Apply 3 lb boron/acre per year to alfalfa in three 1 lb/acre applications. Copper and zinc fertilizer may be needed if soil pH is above 6.5. The lime requirement shown on the soil test report is adequate for established alfalfa. However, if the alfalfa has not yet been planted, apply and incorporate one ton of lime/acre if the soil pH is below 6.6. Lime is especially important for alfalfa establishment. It is not practical to incorporate lime once the alfalfa is planted. Fertilizer should contain 15–20 lb sulfur/acre; apply as a sulfate (e.g., gypsum, ammonium sulfate, magnesium sulfate, potassium sulfate, potassium magnesium sulfate) since elemental sulfur reacts too slowly to supply the sulfur needs of the current crop and elemental sulfur may decrease soil pH.

Liming

The primary reasons for liming acidic soils are to increase crop yield and to enhance fertilizer efficiency. Lime also affects the solubility of other elements; therefore, some plant nutrients are made more available by liming, while toxicities caused by excessive concentrations of other plant nutrients are reduced. In addition to neutralizing soil acidity, calcitic limestone supplies the plant nutrient calcium, and dolomitic limestone supplies both calcium and magnesium. While a correct liming program is beneficial for plant growth, excessive liming can be detrimental. Deficiencies and imbalances of certain plant nutrients may result from excessive lime application.

To obtain maximum benefit from liming and to determine the type and quantity of lime to apply, soil and plant factors must be taken into account. The first step is to properly collect a soil sample from the area to be limed. Samples are normally taken to a depth of 4–6 inches. The soil sample should be sent to a reputable soil testing laboratory for determination of pH and lime requirements.

Lime should be incorporated into the soil whenever possible since lime reacts with soil that it comes in contact with. However, it has little immediate effect on the soil pH below the top inch or so. Therefore, lime should be applied and incorporated 3–6 months prior to planting. The frequency of lime application will depend on many factors, including fertilization program, soil type, and crop. Typically, lime application should seldom be more frequent than every 3 years, with the exception of intensive hay fields that receive high ammonium-nitrogen fertilizer application rates.

If the soil is at or above the target pH, soil calcium in the soil should be sufficient for optimum plant growth. If the soil pH needs to be increased and the level of magnesium is low, liming with dolomitic limestone is a relatively inexpensive method for adjusting the pH and supplying magnesium. Magnesium can be added to the fertilizer.

The target pH for various forage crops is listed in Table 1. All of the recommendations shown in Table 1 are part of the standardized fertilization recommendation system of the UF/IFAS Extension Soil Testing Laboratory. Cool-season legumes are pH specific and most of them require high pH of 6 or higher. Warm-season perennial grasses, on the other hand, perform well at a lower pH. Appropriate lime recommendations are automatically recorded as part of the soil test report.

Other Important Considerations

When applying manure, biosolids, and waste materials, producers may apply higher rates than those recommended for mineral fertilizers since the nutrients present in the waste materials need to be converted into forms that the plants can use. However, the producer should not go above rates that are environmentally acceptable. Additionally, timing of nutrient application may be different than those previously recommended.

When applying lime-stabilized biosolids, attention should be given to the liming effect of this material. Soil pH should be carefully monitored to avoid pH conditions above 6.5. It has been demonstrated that bahiagrass growing in soil conditions of pH 7.0 or above will, very likely, perform poorly compared to bahiagrass growing at lower pH conditions.

For additional information see:

EDIS IFAS fact sheet SL179 *Using Waste Products in Forage Production*.

EDIS IFAS fact sheet SS-AGR-152 *Fertilization of Agronomic Crops* for a more extensive discussion of micronutrients.

For additional information on this and other forage topics, please visit the Forages of Florida website at http://agronomy.ifas.ufl.edu/ForagesofFlorida/index.php.

Table 1. Target pH for different forage crops grown on mineral soils.

Crop Category	Crops Included	Target pH
Bahiagrass	bahiagrass	5.5
Other improved perennial grasses	bermuda, star, rhodes, suerte, and digitgrass	5.5
	limpograss	5.0
Warm-season annual grasses	corn, sorghum, sorghum-sudans, and millets	6.0
Cool-season annual grasses	small grains and ryegrass	6.0
Warm-season legumes or legume-grass mixtures	perennial peanut, stylo, desmodiums, aeschynomene, alyceclover, hairy indigo, and other tropical legumes	6.0
Cool-season legumes or legume-grass mixtures	All true clovers (white, red, arrowleaf, crimson, subterranean), vetches, lupines, and sweet clover	6.0 – 7.0
Alfalfa	Alfalfa	7.0