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Rising Nitrogen Prices Puts Focus Back on Efficiency for Hay Production

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Mississippi forage producers use a wide range of practices to supply nitrogen (N) to their forage crops, especially warm-season grasses. The nitrogen source, rate, time, and place of application as well the use of additives vary greatly throughout the state. Thus under certain weather conditions, nitrogen can be lost from the soil between application and crop uptake if the soil is either too wet or too dry. This publication is intended to address fertilization practices that have the greatest potential for success in dealing with fertilizer use efficiency. The best management practices (BMPs) presented here are identified as sound practices from economic production and environmental stewardship.

Everyone wants the nitrogen to end up in the forage. Successful fertility practices deliver enough nitrogen to the forage crop to optimize yield and profitability while minimizing losses. Before starting any fertility program there are several questions that a producer should ask him/herself: (1) What nutrients do my forage crops need? (2) What are the plant available forms (commercial vs. manure)? (3) What kind of field conditions are present? (4) In what balance should these fertilizers be applied? (4) Can nitrogen increase dry matter yields and by how much? (5) How will nitrogen affect forage nutritive characteristics? To answer these questions and provide a complete fertility program, a soil sample should be obtained. Contact your local County Extension Office to obtain the necessary information or obtain the Information Sheet 346 at MSUCares.

Nitrogen Fertilizer Sources

Ammonium nitrate [AN (34-0-0)], urea [U (46-0-0)], urea-ammonium sulfate [UAS (33-0-0-S)], and urea-ammonium nitrate [UAN, 28-32% N] solution are the main N sources used by Mississippi forage producers. Although all these sources are excellent N sources, most BPM in choosing a fertilizer source relates to timing, application method and placement. It is recommended to avoid early applications of ammonium nitrate as well as urea and UAN solution. Surface applications of AN, U, and UAS are usually effective, but environmental conditions could affect efficiency especially with U and UAS.

It is always important to select a nitrogen fertilizer source with low volatility rate. Urea and urea-ammonium sulfate can be broadcast and not left on the surface for extended periods of time when air temperatures are below 65. They have higher volatilization rates under hot and humid conditions or if the soil pH is greater than 7.3. It is recommended to apply them close as possible to a good chance of rain in the forecast. Do not apply immediately after a rain period since water evapotranspiration could increase the rate of nitrogen loses. Urea and UAS could be treated with volatilization inhibitors, but the data related to the effects of these products on forage production is limited. A study at University of Georgia has revealed little advantage of these products on hay production. Urea-ammonium nitrate solution should not be broadcast on high-residue surfaces and the same management practices applied to urea applies to UAN. Extensive use of urea-ammonium sulfate as an N source will lead to twice as much soil acidification as any other N source. Monitoring soil pH becomes more important when ammonium sulfate is used.

Nitrogen Application Rates

How much nutrient is required by a forage crop will depend on the yield targeted and the quality. Some forage crops such as hybrid bermudagrass will require high N inputs (200 to 240 lb N/ac) to sustain yields. It is important to emphasize that soil testing is the number one tool to obtain the basic information of which nutrients are available and allow balanced nutrient management. While nitrogen is not measured by the Mississippi Soil Test, inadequate soil phosphorus or potassium, or acid soils may decrease the use efficiency of applied nitrogen. Hay production in Mississippi could provide 4 to 5 cuts depending on the region. It is recommended to split the nitrogen applications throughout the growing season. Split-applications will improve nutrient uptake, increase total yields (**Table 1**) and improve the economic yield (**Table 2**).

It is recommended to use ammonium nitrate on pastures and hay production after Mid-May to reduce N loses. Urea, UAS and UAN fertilizer sources can be used, but a minimum of one-quarter inch of rainfall is required within three to five days of application to minimize the risk of nitrogen loss. Prior to Mid-May, any nitrogen source can be used since rainfall is more likely. Generally urea is cheaper than ammonium nitrate per unit nitrogen (not per ton fertilizer) and is the best buy for late April to early May application.

Table 1. Response of Sumrall007 bermudagrass to nitrogen fertilizer. Data is a two year average.

Application Rate[1]	Number of Applications[2]	Actual N per Application	Total Actual N Applied	Total Yield	Yield Increase	
		lb/ac				%
0	0	0.0	0	4136	0	0
200	1x	68.0	68	5914	1777.5	43
200	2x	68.0	136	8500	4363.5	106
200	3x	68.0	204	10602	6465.5	156
200	4x	68.0	272	13064	8928.0	216
200	5x	68.0	340	14350	10213.5	247
240	5x	81.6	408	17217	13081.0	316
280	5x	95.2	476	17520	13383.5	324
320	5x	108.8	544	18988	14851.5	359
360	5x	122.4	612	20106	15969.5	386

[1]Ammonium Nitrate (34-0-0) was the fertilizer source for all application rates.
[2]1x = April, 2x = April, May, 3x = April, May, June, 4x = April, May, June, July, 5x = April, May, June, July, August.
Source: Lang and Broome. 2002. Mississippi State University.

Application rate determinations may also take nutrient crop uptake into consideration, especially when nutrients removed on hay production will not be returned to the same field (**Table 3**). If forages are grown without fertilizer, they will remove nutrients from the soil and soil test values will decrease. Over a period of time forage productivity will also decline. The decline in forage yields depends on the initial nutrients in the soil as indicated by soil test results, the nutrients removed in the harvested crop, the soil's reserve nutrients, the release rate of those reserve nutrients, and the length of time from the last application of fertilizer. A ton of grass will remove approximately 30-35 lb of nitrogen, 10 lb of phosphate (P_2O_5), and 50 lb of potash (K_2O).

Timing of Nitrogen Application

Although there is no one answer that will pinpoint the right time for N application, applications should be synchronized with the highest nutrient requirement. Loading the soil too early in the spring when plants are still breaking up from dormancy might not be beneficial for hay production and can increase potential loses. Early broadcast applications (late February to early march) can sometimes be lost before the main uptake period in April and May. Risk is especially high if N is applied when there is a high rainfall period. Forage producers also have the tendency to cut the hay very short and then apply nitrogen. This practice can also increase the chances for nitrogen losses. It is advised to maintain a stubble height of at least 3 inches to allow plants to recover fast. Allow plants to recover for at least 3-5 days after cutting before applying any nitrogen, which will allow for faster nutrient uptake by the new growth. It is important to keep in mind that these benefits must be balanced against the risks associated with a smaller time window for N application, and against other time-sensitive farm operations that may be necessary at the same time that N applications would be most efficient.

Table 2. Cost of nitrogen application and economic yield for Sumrall007 bermudagrass.

N Applied (lb/ac)[1]	Cost ($/ac) per lb DM Yield Increase[2]	Cost ($/ac) from Nitrogen Application[2,3]	Lbs of DM per lb of Nitrogen Applied	Economic Yield ($/ac)[3]
0	0.000	0.00	0.0	137.87
68	0.025	36.74	26.1	197.12
136	0.020	90.85	32.1	283.32
204	0.020	134.56	31.7	353.38
272	0.020	186.02	32.8	435.47
340	0.021	212.18	30.0	478.32
408	0.020	272.35	32.1	573.90
476	0.023	277.38	28.1	583.98
544	0.024	307.47	27.3	632.92
612	0.025	330.04	26.1	670.18

[1]Ammonium Nitrate (34-0-0) was the fertilizer source for all application rates.
[2]Include a fertilizer price of $0.64/lb (it includes a $0.13 application cost).
[3]It assumes a hay value of $67.00 per ton dry matter.

Place of Nitrogen Application

The placement decision of the fertilizer depends on the mobility of the fertilizer. Nitrogen needs water to mobilize through the soil profile. Most fertilizer sources used in forage production are in a dry pelletized form and they are broadcast on permanent pasture or perennial hayfields making incorporation difficult and perhaps impractical. Ensuring uniformity at the time of application is very important. Fertilizer sources such as UAN solution and poultry litter will have greater utilization when incorporated. The availability of N in manure increases once the organic matter start to decompose.

Application Methods and Placement

Nitrogen fertilizer materials lend themselves to a range of application methods, including broadcast application and incorporating the fertilizer. Choice of method and placement is related to the source of N. Broadcast applications can be used with urea, ammonium nitrate and UAN solution. However, broadcast applications of urea can result in substantial loss of fertilizer N to the air. Research shows that N loss from surface-applied urea can range from 0 to 60%, and 30% appear

to be the average loss. The amount of loss depends on weather conditions; volatilization loss is greatest with warm, dry windy weather and if pH is greater than 7.3 but is slowed or stopped by rain that moves the urea into the soil. Treatment of urea with urease inhibitors before broadcasting, or incorporating the urea into the soil with tillage or irrigation within three or four days, will reduce or prevent N loss. Broadcasting UAN is not recommended when residue levels are high because of the potential for the N in the droplets to become tied up on the residue. Broadcast UAN solution is also susceptible to volatile loss of N to the air in the same way as urea, but only half as much will be lost. No special management considerations are needed for broadcast applications of ammonium nitrate.

Managing Nitrogen from Poultry Litter

Table 3. Amount of nutrient removed per ton of forage dry matter.

Forage Crop	Nutrient Removed		
	N	P_2O_5	K_2O
	lb /ton DM		
Annual Ryegrass	39	16	54
Bahiagrass	31	8	34
Bermudagrass	39	12	44
Clover	43[1]	12	44
Dallisgrass	34	14	44
Legume/grass mix	39[1]	12	43
Sorghum/sudangrass	37	14	47
Tall Fescue	36	14	50

[1]Nitrogen comes from nitrogen fixation.
Source: Univ. of Arkansas Coop. Ext. Serv. 2010. Self-Study Guide Guide 8: Soil Fertility Management in Pastures Essential Nutrients for Plant Growth. Online.

Poultry litter is commonly used as a fertilizer on pastures and hayfields in Mississippi. The biggest challenge that forage producers face when using poultry litter as an N fertilizer source is determining the amount of manure to apply to provide a target rate of N. Organic nitrogen ranges from 5 to 90 percent of the total N in the litter. It is very important to get the poultry litter tested to determine the actual nutrient content. Approximately 50% of the N in the poultry litter is available to the plant in the first six months of application and organic nitrogen is released over time. The rest of the nitrogen in the poultry litter could be lost through volatilization if applied on the surface. It is recommended to apply the poultry litter close to the crop need and ensure uniform spread patterns.

Poultry litter N can act as a slow-release N source, providing benefit in some situations. It is a good N source for fall application on pastures when compared with commercial fertilizers such as ammonium nitrate. If conditions are good for fall forage growth, they will also be good for N release from the litter. However, in dry conditions, litter N will stay in a form that is more likely to contribute to spring growth than the more mobile ammonium nitrate. For best utilization of poultry litter in the fall, applications should be done before soil temperatures fall below 40 ºF. Remember to calibrate the manure spreader to ensure that you are able to apply the target rate of manure. Mississippi State fertilizer calculator for pastures (Publication P2562) will allow calculating the amount of manure needed based on soil test recommendations.

Strategic Use of Nitrogen in Pastures

Nitrogen can also be used strategically in grazing situations. A light application of nitrogen (25-50 N lb/ac) in March will jump-start spring growth and allow for earlier grazing. The amount of acreage for spring application should be limited because the seasonal distribution of grasses would be out of balance and the potential for grass tetany is increased. Generally one acre of pasture per two cows should be fertilized and never more than a third of the total pasture acreage. The most universally beneficial use of nitrogen in grazing situations is during late summer. Grasses fertilized in August can be stockpiled and grazed in late fall or early winter. The general recommendation is 30-60 lb/ac for most warm-season grasses and 50-60 lb/ac for tall fescue when choosing to stockpile for winter grazing. When the decision is made to apply fertilizer, consider the field that would make the best utilization of applied nutrients.

There are three main strategies that are usually followed in pasture production. They include:

- **No N application**: this is suited to maintain dry cows and is suited for low stocking rates as maximum forage growth will never achieved under this system, particularly during the winter grazing.
- **Total N application:** apply N after every grazing period as long as moisture allows pasture growth. This strategy ensures that the pasture is never short of N but can also be more vulnerable to high N loses that makes such system environmentally quest bale. This system is suited for high stocking rates.
- **Strategic N application:** apply N strategically and to more productive pastures when additional forage growth is required, especially during the cooler months. In this case, a nitrogen application is considered more of a supplementation.

Summary

One of the main goals of managing nitrogen applications in forage systems is to achieve economic and environmental sustainability. There are 4 major steps toward achieving sustainability and those are applying the recommended N source, at the recommended rate, at the recommended time and place. These four components form the nucleus of a forage fertility program. Besides fertility, there also some sound general crop management practices that are essential

to produce forage crops capable of efficient nitrogen uptake. Decreasing soil compaction will allow root growth which is critical of efficient nitrogen uptake. Manage soil P, K and pH to ensure optimum levels for forage production. Soil sample each field at least every other year to guide P, K and lime applications. Prevent weeds from getting too large. Large weeds can remove substantial amounts of N away from the forage crop, even if they are successfully controlled later.

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