Forage News

MISSISSIPPI STATE UNIVERSITY EXTENSION SERVICE

Enhancing Utilization of Urea-based Fertilizers in Forage Production

Volume 4, Issue 3

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March 2011

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As we approach the spring, many producers in Mississippi and in the southeast start thinking about getting ready for fertilizing their pastures. With the increase in fuel and oil prices, fertilizer [nitrogen (N), phosphorus (P), and potassium (K)] prices have also increased significantly in the last five years (**Fig. 1**). Many producers still follow the tradition that applications of fertilizers such Triple 13, Triple 17 or DAP might be sufficient and the economic approach to fertilizer their hay fields. This is not usually the case because producers might under fertilizing and therefore, the expected forage yield is below its potential. On the other hand, over-fertilization might cause luxury consumption and waste of money.

The best approach to determine what is really needed by the plant to reach optimum production would be through soil testing. Following fertility recommendations will have more cost-effective and it will have greater benefits in the long-run.

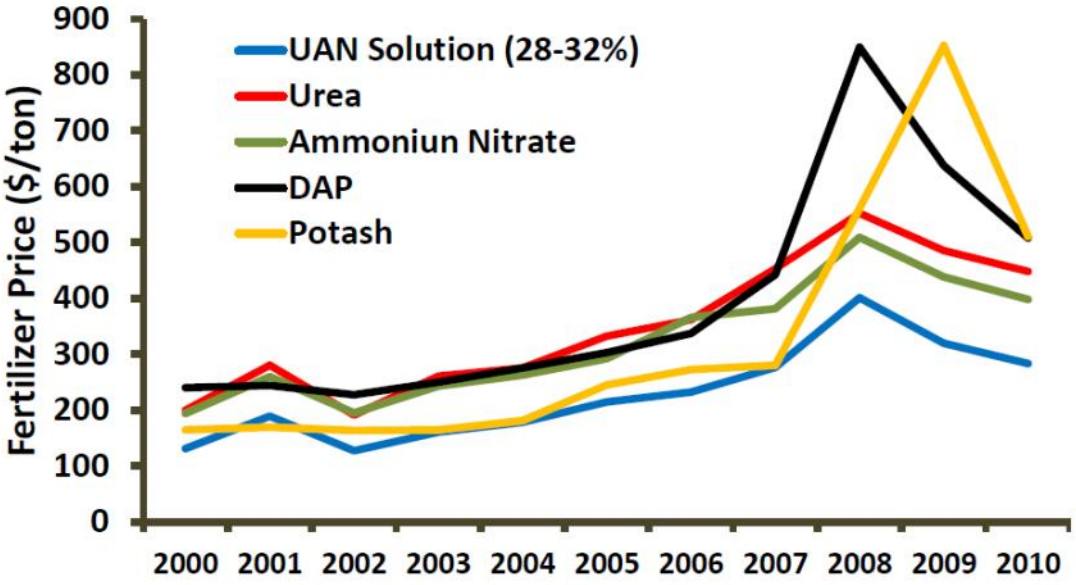

Figure 1. Average U.S. farm prices for selected fertilizer. Source: USDA, 2011.

Due to the increasing problems with the handling of ammonium nitrate (storage and transport), urea –based products such as urea (46-0-0), urea ammonium nitrate solution (UAN) (28-32%) and urea ammonium sulfate (33-0-0S) are becoming more popular among forage production systems. It is important to understand how these urea-based products are broken down at the time of application. For urea to be used by forages, it has to be broken into ammonia (NH_3) and then it react with water in the soil to form ammonium (NH_4^+), the most common form of nitrogen taken by plants. This process happens in the soil through an enzyme called urease. Urease is a naturally occurring enzyme that will break urea in the soil. If the ammonia does not react with water in the soil surface, it will escape to the atmosphere. This process produces hydroxide ions (OH^-), which may cause the soil around the applied urea granules to have a pH around 9.0. This soil pH increase causes ammonia volatilization. Because this zone is very toxic due to elevated ammonia concentration for several hours, it is recommended that urea-based fertilizers not be mixed with seed or not be applied at planting at rates that exceeds 15 to 20 lb/ac.

The rate of ammonia volatilization is affected by several environmental conditions including the amount of surface residue, soil water content, temperature, and soil pH. Soils that have high organic matter content also tend to have higher urease concentrations. High concentrations of soil organic matter and crop residues increase urea hydrolysis rates and volatilization. This is largely because the urease enzyme is produced by microorganisms that are more active in the presence of organic material than in mineral soil. As a result, forage system may have higher surface hydrolysis rates than bare soil and conventional tillage systems.

Ammonia volatilization reduces the economic efficiency of forage production systems especially in hay. Either yield will be reduced or additional costs will be incurred from additional application of nitrogen fertilizer. The time between urea application and precipitation are also critical. When doing urea applications, it is important that there is adequate moisture because up to thirty percent of the available nitrogen can be lost through atmospheric volatilization within seventy-two hours of application. Urea based products are more efficient when applied in cold, dry soils at the time of application and/or the occurrence of significant precipitation (> 0.1") within the first 3 to 6 days of urea application. Under these conditions, the use of a urease inhibitor could act as an insurance policy in case rainfall does not come quickly enough. This is also a reason why urea might be a better fertilizer choice for cool-season forage production later in the fall, late winter, or early spring (March to mid-May) when soil temperatures are still below 65 °F.

One of the major risks of using urea-based products and having major losses is in mid-summer when air temperatures and humidity are very high. Volatilization of urea increase when soil temperatures are above 65 °F and humidity is above 60%. The soil's pH also has a strong effect on the amount of volatilization, especially high pH soils (>7.0). High pH has proven to increase urea hydrolysis. Studies have shown that urea hydrolysis in high pH soils occurs within two days of application while in acidic soils (low pH) the urea hydrolysis took as twice as long to hydrolyze. One approach to reducing nitrogen loss is splitting nitrogen application throughout the growing season.

Table 1. Commercially available urea fertilizer enhancers.

		Fertilizer Application Rates		
Product Name	**Company**	**Dry**	**Liquid**	**Approx. Avg. Retail Price ($/gallon)**
		Amount per ton of fertilizer		
Agrotain Ultra	Agrotain	3.0 qt	1.5 qt	72.00
Environment Smart Nitrogen	Agrium	--	--	$0.18 to $0.20 lb per N unit
Nutrisphere-N	Special Fertilizer Products	2.0 qt	--	125.00
NZone	AgXplore	4.0 qt	2.0 qt 18-24 oz for liquid manure	50.00
Upgrade	Atlantic-Pacific Ag	3.0 qt	--	35.00

Disclaimer: The mention of these products is for educational purposes only. Reference to commercial products or trade names does not imply discrimination or endorsement by the Mississippi State University Extension Service. These products have not been tested on forage production systems in Mississippi by the Mississippi University State University Forage Extension Program and utilization of these products by producers is at their own risk. Rate and prices (2011) are based on company's direct information and they may vary by region or fertilizer dealer.

When field conditions are not optimal, nitrogen loss could be reduced when a urease inhibitors or coats are applied to fertilizers. They are commonly known as "fertilizer enhancer or urease inhibitor." A fertilizer enhancer is an additive that

could be applied to dry or liquid urea-based fertilizers to prevent losses caused by volatilization by creating an active shield or coat that prevents catalytic reactions caused by urease and allowing plants uptake of stable forms of nitrogen for a longer period of time. These fertilizer enhancers prevent the urease enzyme from breaking down the urea for up to fourteen days and decrease volatilization for up to 90%. This increases the probability that urea will be absorbed into the soil after a rain event rather than volatilized into the atmosphere. There are several urease inhibitors in the market. These urease inhibitors cause urea hydrolization to occur below the soil surface and decrease atmospheric losses. They also decrease the localized zones or pockets of high pH commonly created with the application of uncoated or untreated urea. **Table 1** provides more detailed information about their composition, rate of application, and average retail price.

The use of fertilizer enhancers might be more beneficial during the summer than early season application. Early season application of fertilizer enhancers will reduce N availability and might prevent warm-season grasses from obtaining adequate amount of nutrient to provide early growth after breaking dormancy. Products such as ESN that is already precoated should be used in a small ratio (coated to uncoated urea) early in the season to assure that plants will have the necessary available nitrogen. Study conducted at the University of Georgia on 'Russell' bermudagrass has indicated that Agrotain reduced ammonia volatilization by over 63% and produced 11% more forage yield when compared to urea applied in the same way. There was also a 19% increase in recovering applied nitrogen. A study conducted in 2010 at Mississippi State University has shown no advantage of Nutrisphere-N coated urea products in annual ryegrass production. This is an indication that fertilizer enhancers will not give a yield advantage in the spring and they should be used mainly in the summer and early fall when temperature and humidity are high and higher volatilization loss potential exist. When trying some of the available products, do so cautiously. Use them on a small area and leave untreated check (uncoated urea application vs. urea with enhancers) strips for comparison of results. Do not judge results solely on plant appearance, but on forage yield and quality.

Fertilizer enhancers are intended to treat urea-based fertilizers (granular or liquid) (**not the soil**) to retard the volatilization or loss of nitrogen in pasture or hay field situations where fertilizer will be broadcast. It is important to evaluate your hay production systems before investing in these products and deciding if they will fit into your management system. It is difficult to cut forage production without compromising yield, but investing in fertilizers in a more efficient way could help reduce fertilizer expenses. Application of high N rates or the entire amount at the beginning of the season does not provide any economic advantage and could lead to unnecessary environmental risks such as leaching, volatilization, or nitrate toxicity. Splitting nitrogen applications could help increase yields by 5 to 10% and N use efficiency by 20 to 30% higher when N applications are split among 2 to 4 applications during the season. Another important approach is to apply nitrogen, phosphorus, and potassium to hay fields where soil pH is in the optimum range and there is an indication of an economic yield response. Always follow the 4R's of nutrient stewardship: use the **right product**, use the **right rate**, use it in the **right place**, and apply at the **right time**.