

# Nitrogen Sources for Pasture and Hay

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## INTRODUCTION

Nitrogen is one of the major nutrients required by forage grasses for proper growth and development. Yield and forage quality response to added nitrogen can be dramatic. Unlike the other two major nutrients, phosphorus and potassium, nitrogen is not retained in the soil from year to year in a form that forage plants can readily use. Nitrogen applied to the soil is rapidly converted to nitrate-N and is then often incorporated into organic materials, leached out of the rooting zone by rainfall or lost back to the atmosphere. Nitrate-N is rapidly available to the forage plant but, especially in lighter soils, moves with the soil water out of the crop-rooting zone. In wet or poorly drained soils, the nitrate-N can be converted back to gaseous forms and lost to the atmosphere. Urea nitrogen on the soil surface is subject to volatilization loss as ammonia.

Nitrogen can be supplied to forage grasses by accompanying legumes such as clovers or alfalfa, which can fix nitrogen directly from the atmosphere. In



forage systems without legumes and in some legume grass management schemes, nitrogen must be added as a fertilizer material to achieve the best forage grass production and quality. Several types of nitrogen fertilizer materials are available. The best one for you will depend on factors such as fertilizer material availability, price, equipment available, time of year and tillage practice.

## UREA-CONTAINING SOURCES

### Urea

Urea is perhaps the most commonly available and utilized nitrogen source in Tennessee. It contains 45 percent actual N or 45 pounds of N per 100 pounds of fertilizer material. Urea has good handling and storage properties because it does not absorb water as quickly as ammonium nitrate. These properties enable fertilizer dealers to store and process this material during humid weather, making it a material of choice for bulk storage and blending operations. Urea is generally one of the lower-priced nitrogen fertilizer materials.

To minimize potential for nitrogen loss, all inorganic nitrogen fertilizer materials should be applied close to the time of expected forage production. Volatilization loss (loss as ammonia gas from surface-applied and non-incorporated urea) is of particular consideration for urea-containing fertilizer materials. Research shows that the potential for nitrogen loss as ammonia gas increases as temperature, soil pH and moisture increase, and as rate of application increases<sup>1</sup>.

The percent of surface-applied nitrogen from urea volatilized can increase about four-fold as the soil temperature increases from 45 to 90 degrees F. This



information suggests that fertilization of cool-season forages in March would result in lower potential for nitrogen loss than might be realized for fertilization of warm-season forages or for fertilization of fescue in August. Addition of the urease inhibitor to urea is especially important for these warm-season forages or for fertilization of fescue for stockpiling in August or early September.

High soil pH or free lime on the soil surface can enhance nitrogen loss from surface-applied urea when the urease inhibitor is not used. Research has demonstrated an 11-fold increase in amount of nitrogen loss as the surface soil pH increased from 5.0 to 7.0. Urea itself has an alkaline effect upon the soil initially, so the higher the rate of application, the higher the soil pH change in the zone around the urea particles. A surface application of 200 pounds of nitrogen per acre as urea (about 444 pounds of actual urea per acre) has been shown to increase surface soil pH from 6.5 to above 8.5 within the zone of application. The surface soil pH returned to 6.5 in about 30 days after application. This suggests that surface application of lime (without subsequent incorporation) in fall or spring should follow nitrogen application (especially when urea is used and not incorporated) whenever it is practical to manage. This allows for rainfall to incorporate the nitrogen into the soil before lime is applied.

Volatilization loss can be avoided by addition of a urease inhibitor to the fertilizer material. This increases the price of the material, but the cost is usually still lower than or equal to that of ammonium nitrate.

Potential for foliage burn with urea materials is low, and when incorporated into the soil by rainfall or tillage, it is as efficient a source of nitrogen as any source, even without the use of a urease inhibitor. Although burn potential is low, application of the material when the forage is dry should reduce the amount of fertilizer sticking to foliage where it is more susceptible to volatilization loss than if it makes contact with the soil.

### **Urea Ammonium Nitrate Solutions (UAN)**

Interest in liquid nitrogen materials is increasing. UAN usually contains 32 percent nitrogen and weighs 11.06 pounds per gallon (3.54 pounds of nitrogen per

gallon). Price is competitive per pound of nitrogen and often somewhat lower than ammonium nitrate or urea. Availability of the material or equipment for application is a problem in some areas. Potential for volatilization loss of N is somewhat lower than with urea, because about one-half of the nitrogen in UAN comes from ammonium nitrate, with the remainder supplied by urea. Addition of a urease inhibitor should be strongly considered prior to surface application without incorporation.

Research<sup>2,3,4,5</sup> suggests that application of UAN in a band (coarse stream) can often but not consistently result in more efficient use of that material than what may be achieved when the material is broadcast. UAN may be broadcast by spraying through a flat-fan spray nozzle or in a band application by dribbling in a coarse narrow stream (remove nozzle tips).

In rhizome-forming forage like bermudagrass, distance between bands<sup>6</sup> (up to about 24 inches) does not appear to be as critical as for fescue. In clump-forming sod such as fescue, best results appear to be with narrow band spacings<sup>3</sup> (about 10 inches).

Potential for burn and/or irreparable destruction of sod appears to be greater when using liquid nitrogen solutions than for solid materials, especially at nitrogen rates above about 50 pounds of N per acre. When application rates much higher than this are needed, a split application would be needed to avoid excessive destruction of forage grass. Even at low nitrogen rates, some yellowing and burn of forage is often noted after application, and when banded at wide spacings, some streaking occurs. The streaking may later disappear in rhizome-forming grasses as nitrogen is moved to the growing points of the forage. The wider the band spacing, the longer it takes for the streaking effect to go away.

## **NON-UREA SOURCES**

### **Ammonium Nitrate**

Ammonium nitrate is the primary non-urea source used in hay and pasture systems. It contains 34 pounds of N per 100 pounds of fertilizer material (34 percent nitrogen). It is usually the most expensive of the commonly used nitrogen sources. Availability may become a problem in some areas due to regulatory issues and storage problems.



Ammonium nitrate is usually applied in a broadcast application. There is little potential for volatilization loss of nitrogen from this material. The fertilizer material should be applied when forage is dry to minimize potential for burn.

The main problem with storage of ammonium nitrate is its tendency to take up water. Because of this problem, many farm supply stores are unable to carry it in bulk supply, especially during the humid summer months. Bagged material is usually available, but often more costly and time-consuming to apply and handle.

## **OTHER SOURCES OF NITROGEN**

### **Animal Manures**

Animal manures have a long history of use in our farming systems. In fact, when inorganic fertilizers first came into use, they were sometimes called “those chemical manures.” In recent years, the low cost, ease of spreading and widespread availability of the “chemical manures” has resulted in most producers paying little or no attention to the fertilizer potential of animal manures. Indeed, in recent years, animal manures are probably most often regarded as a waste to be disposed of rather than a valuable fertilizer resource. Extension literature<sup>7,8</sup> is available to assist producers in determining the most appropriate rates of animal manures to use in various cropping systems.

The larger bulk that must be handled and spread is a definite disadvantage of animal manures over commercial fertilizer materials. Also, special equipment for spreading is not always available, making even spreading of the material a difficult chore. In Kentucky<sup>9</sup>, research indicates that use of broiler litter may result in building of soil phosphorus and potassium levels. An increase in soil pH was observed in the Kentucky studies and is attributed to the high base content of the broiler litter. For the short term, this is a very desirable effect, as many of our pasture/hay systems suffer from the effects of low soil pH.

In Tennessee, broiler litter is one of the more widely available manures, having a rather high nutrient content. Short-term application<sup>7,8,9,10</sup> (when broiler litter tests about 60 pounds of total N per ton of material) on cool-season pasture/hay systems needs to be about 4 to 5 tons per acre per year when P and K soil tests are in

the low range. Apply 2 to 3 tons per acre in early March and about 2 tons per acre in late July to early August for stockpiling of fescue. Fall nitrogen application for fescue stockpiling is done even in grass/clover systems, as clovers generally make little growth (therefore no nitrogen contribution) during the hot summer months. Once P and K soil test levels build to the high or very high range, application rates should be reduced to about 2 tons per year and only applied about every other year. Use conventional fertilizer materials to meet nitrogen needs when manures can not be used because of high P and/or K.

In Virginia, application at or greater than about 10 tons of broiler litter per acre in a single application resulted in temporary depression of fescue forage production. Application at rates higher than suggested in the previous paragraph should be avoided because of potential for environmental harm and yield or forage quality problems (high nitrate content of forage, enhancement of grass tetany problems).

For bermuda pastures, apply 3 tons in early May and July. For improved bermuda hay fields, apply 4 to 6 tons in early May and again in July. Over the long term, as phosphorus and potassium fertility builds and soil pH increases, application rates may need to be lowered, with inorganic nitrogen sources making up the difference.

## **SUMMARY**

Selection of nitrogen source materials is a primary consideration in our pasture/hay systems, because nitrogen has a consistent and dramatic effect on forage yield and quality. Generally, for surface applications that are not incorporated by tillage or rainfall, ammonium nitrate performs better than UAN, which performs better than urea. When possible, apply nitrogen in advance of lime application, especially when using urea-containing nitrogen sources. Broiler litter has been shown to equal or better the performance of inorganic nitrogen fertilizer sources in pasture/hay systems and to build soil test levels of phosphorus, potassium and raise soil pH.

When fertilizer nitrogen is incorporated by tillage or rainfall (within two days of surface application) there is no difference in performance among the sources discussed in this publication. Use of material coated with a urease inhibitor is strongly suggested with non-incorporated



urea-containing materials in Tennessee forage systems. Banding of UAN can increase the efficiency with which the nitrogen from that material is utilized in our pasture/hay systems. UAN is more likely to burn forage grasses than solid fertilizers and application rates should be under about 50 pounds of nitrogen per acre in any one application, especially in non-rhizome-forming forage like fescue.

All inorganic nitrogen sources should be applied as close to the time of anticipated forage plant growth as possible. Animal manures should be applied about two weeks ahead of anticipated forage production where possible. For spring application, the amount of N needed for multiple harvests of hay systems can be applied in one application when using animal manures as the fertilizer source.

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