EFFECT OF NITROGEN SOURCE AND RATE ON YIELD AND QUALITY OF STOCKPILED FESCUE

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Introduction

Tall fescue is grown on more than 24 million acres in the east-central and southeastern United States. It is the primary forage base for more than 9 million beef cows in this region. One of tall fescue's strongest and most under-utilized attributes is its ability to be stockpiled for winter grazing.

Stockpiling tall fescue for winter grazing is accomplished by clipping pastures in late summer, applying 60 to 80 lb nitrogen/acre, and allowing the growth to accumulate until December (NRCS, 2007). Recent research in Virginia found that the type of nitrogen applied for stockpiling can dramatically affect yield (Teutsch et al., 2005). Ammonium nitrate was shown to be the most effective nitrogen source for stockpiling. However, the future availability of this source is uncertain. Global use of ammonium nitrate has decreased and many agricultural suppliers are reluctant to sell ammonium nitrate due to security concerns. Although newly available nitrogen sources and additives (Table 1) may provide a suitable replacement for ammonium nitrate, currently the effectiveness of these nitrogen sources for stockpiling tall fescue is unknown. This study was designed to determine the effect of N source and rate on the yield and nutritive value of stockpiled tall fescue.

Methods and Materials

Small plot experiments were established near Blacksburg, Steeles Tavern and Blackstone, VA to evaluate the effectiveness of nine nitrogen sources (Table 1) applied at five nitrogen rates (0, 25, 50, 75, and 100 lb nitrogen/A). Prior to fertilization, the experimental area was soil sampled and clipped to stubble height of 3 to 4 inches. Nitrogen treatments were applied in mid-August to mid-September depending on the location. Forage growth was allowed to accumulate until mid-December, at Blacksburg and Steeles Tavern location and mid-January at the Blackstone site.
Table 1. Description of nitrogen sources to be used for the stockpiled tall fescue experiments conducted at three locations in Virginia.

<table>
<thead>
<tr>
<th>Nitrogen Source</th>
<th>Analysis (N-P-K)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium Nitrate</td>
<td>34-0-0</td>
<td>Normally contains 34% N, half as $\text{NH}_4^+$ and half as $\text{NO}_3^-$. Not susceptible to volatilization when surface applied to pastures in late summer.</td>
</tr>
<tr>
<td>Ammonium Sulfate</td>
<td>21-0-0-24S</td>
<td>In addition to 21% N, also contains 24% S making it a good N source when S is needed. Low risk of volatilization when applied in late summer. Results in greater soil acidification, requiring more lime per unit N applied.</td>
</tr>
<tr>
<td>Urea (granular)</td>
<td>46-0-0</td>
<td>Contains a relatively high concentration of N. Susceptible to volatilization when surface applied to pastures in late summer.</td>
</tr>
<tr>
<td>Urea (granular) + Agrotain</td>
<td>46-0-0</td>
<td>See above. The addition of Agrotain reduces N losses via volatilization.</td>
</tr>
<tr>
<td>Environmentally Smart Nitrogen</td>
<td>44-0-0</td>
<td>Urea N that is encapsulated in polymer coating that results in a slow release N Source.</td>
</tr>
<tr>
<td>Nitamin</td>
<td>42-0-0</td>
<td>Slow release N source. This source is degraded to a plant available form by soil microbes over a 60-90 day period.</td>
</tr>
<tr>
<td>Pelleted Biosolid</td>
<td>6-3.5-0.5</td>
<td>Pelletized biosolids product that can be spread with conventional equipment. Approximately 60% of the total N is plant available (Teutsch and Tilson, 2006).</td>
</tr>
<tr>
<td>Microstart60</td>
<td>4-2-3</td>
<td>Granular/pelletized poultry litter product produced by Perdue AgriRecycle, LLC, Seafood, DE. This product can be spread with conventional equipment. First-year N availability is not known.</td>
</tr>
<tr>
<td>Broiler Litter</td>
<td>5-3-1.5</td>
<td>Widely available organic N source in poultry producing areas of the state. First-year N availability is approximately 60% (VDCR, 1995).</td>
</tr>
</tbody>
</table>

In mid-December, the yield and nutritive value of the stockpiled forage was determined by clipping a swath through the center of each plot using a mechanical forage harvester. A subsample of fresh forage was collected from each plot for dry matter, nutritive value, and nitrogen uptake determinations. Subsamples were dried in a forced-air oven at 60°C for 3 to 5 days and ground to pass through a 2 and 1 mm screen using a Wiley (Thomas Scientific, Swedesboro, NJ) and Cyclone (Udy Corporation, Fort Collins, CO) sample mills, respectively.

Samples were analyzed for acid and neutral detergent fiber (ADF and NDF), total digestible nutrients (TDN) and crude protein (CP) using near infrared spectroscopy. WINISI II software was used to develop a calibration data set for wet chemistry determination values to use for (Infrasoft International, Port Matilda, PA). Levels of ADF, NDF and TDN for calibration set were
determined using the ANKOM filter bag system (ANKOM Technology, 2007). Total N was determined using a modified Kjeldahl procedure (Technicon Auto Analyzer II, Industrial Method 334-74W/B, Tarrytown, NY). Crude protein was calculated as total N x 6.25. Total N removal was estimated by multiplying TKN x DM Yield.

2006 Results

Rainfall during the fall 2006 stockpiling period was 12, 17, and 19 inches for the Blacksburg, Blackstone and Steeles Tavern locations, respectively. The Blackstone and Blacksburg location received rainfall greater than 0.1 inches within 5 days of N application, which is sufficient for incorporation (Havlin et. al., 2005). The first killing frost occurred on 4 Nov 2006 at the Blackstone location and 3 Nov 2006 at both the Blacksburg and Steeles Tavern locations.

There were significant N rate x location (P < 0.001) and N source x location (P < 0.03) interactions for the DM yield. Therefore, data is presented by location. For each of the three locations, N rate x N source interactions were not present for the DM yield. Consequently, the main effect of N rate and N source are presented for the yield data.

Yield ranged from 1300 to 2900, 1700 to 3000, and 2600 to 3300 lb DM/A for the Blacksburg, Steeles Tavern and Blackstone locations, respectively, and increased with N fertilization in a linear manner (Fig. 1 and 2). The higher yield for the no N control at the Blackstone location was likely due to a higher clipping height prior to stockpiling (6 in vs 3 in). Stockpile yield increased at a rate of 16.2, 7.6, and 14.2 lb DM/lb N applied for the Blacksburg, Blackstone, and Steeles Tavern location, respectively. The lower N response observed at the Blackstone location was likely related to the shorter stockpiling period. At this location, N was applied approximately one month later. Due to this shorter period, the forage did not have as many growing degree days for growth before the first killing frost.

There were no significant differences among N sources at any of the three locations (Fig. 3). This was likely due to timely rainfall occurring during the early stockpiling period. Rainfall shortly after N application helps to move N into the soil where it can be rapidly assimilated to nitrate, reducing losses via volatilization. A recent study on the effects of N sources on stockpiled tall fescue reported that N rate increased linearly; however, the rate of increase varied among N sources (Teutsch et. al, 2005). Teutsch et al found significant differences among the N sources due to the lack of rainfall following the application; this favored volatilization.

The results of the current study were influenced by adequate rainfall during the early stockpiling period. In years with below normal rainfall, high volatilization from urea-based N sources would be expected. N loss from non urea-based fertilizers typically occurs via the conversion of NO$_3^-$ to N$_2$ gas through denitrification or leaching of NO$_3^-$. These are not a concern in the late summer due to the dry conditions. Rainfall was not higher than normal this year so N loss from the fertilizers such as ammonium nitrate and ammonium sulfate were not a concern. The conditions following N application allowed all fertilizers to be incorporated efficiently with little N loss. More work is needed to evaluate the effectiveness of the alternative N sources used in this study during years with normal or below normal rainfall. In addition, the effect of N rates and sources on economics of stockpiling will be examined.
Crude protein differed significantly among locations. At the Blacksburg location, there were differences among N sources. Each source increased linearly (Fig. 4). ESN is significantly different from the urea and urea + Agrotain. Ammonium sulfate is significantly different from urea. The crude protein levels ranged from 11 to 15%, which are all within the acceptable range for livestock. At the Steeles Tavern location, all crude protein levels were within the acceptable range of 10-15%. As Figure 5 shows ESN is significantly different from ammonium sulfate, poultry litter urea and urea + Agrotain. Ammonium nitrate is also significantly different from urea. The Blackstone location had much different results for crude protein than the other two locations. As Figure 6 shows, the crude protein levels ranged from 6 to 9.5%, which is not within the acceptable range for most livestock. If cattle were grazing this fescue, a supplement would be needed to maintain growth for the cattle. At this location, ESN and urea + Agrotain were significantly different from the pelleted biosolid but there was no difference among the other sources. All of the N sources increase linearly except the pelleted biosolid. At the 75 lb/A rate, the crude protein level is less than the 50 lb/A rate. This difference may be due to application or sample collection errors, as there is no biological explanation for this result.

Total digestible nutrients (TDN) also differed among locations. In Figure 7, N sources are averaged over rate and then grouped by location. At the Blacksburg location, ESN and ammonium sulfate were not significantly different however; both did differ from the urea TDN levels. The TDN levels at the Steeles Tavern location were not significantly different. The pelleted biosolid used at the Blackstone location was significantly different from urea and the ammonium sulfate TDN amounts. These differences in TDN among some of the N sources cannot be explained at this time. The ammonium sulfate does contribute sulfur to the forage that may cause the increase at the Blacksburg and Blackstone locations. We will examine all forage samples for S content to determine if sulfur might have been limiting for the other N sources.

**Preliminary 2007 Yield Data**

Rainfall during the 2007 stockpiling period was much lower than the 2006 period. Currently only Blacksburg and Steeles Tavern data are available. Rainfall amounts were 5.30” and 7.60” during the stockpiling period (August – December) in Blacksburg and Steeles Tavern, respectively. Steeles Tavern received great than a 0.1” of rainfall within 5 days of application and Blacksburg received exactly 0.1” rainfall during the five days after treatment application. The first killing frost occurred at both locations on 29 October 2007.

Data is presented by location due to significant differences in yields from locations. At the Blacksburg location, there are no significant differences among N sources. Yields ranged from 740 lb/A to 4820 lb/A. At the Steeles Tavern, yields were significantly lower. Yields ranged from 20 lb/A to 415 lb/A. Prior to N application the Steeles Tavern pasture had been heavily grazed and was showing moisture stress. In Blacksburg, the pastures had not been grazed recently, and had more initial growth than the Steeles Tavern pastures. There were significant differences among some sources at the Steeles Tavern location. Poultry litter and urea were significantly different from any of the other N sources. A more thorough analysis on the 2007 yield data is currently in progress. Currently the quality and nutritive values for samples collected in December 2007 are being determined.
References


Figure 1. Nitrogen rate and location effects on the yield of stockpiled tall fescue averaged over N sources over the 2006 growing season at Blacksburg and Steeles Tavern locations. PAN is the plant available-N.
Figure 2. Nitrogen rate and location effects on the yield of stockpiled tall fescue averaged over N sources over the 2006 growing season at Blackstone location. PAN is the plant available-N.

Figure 3. Nitrogen source effect, by location on the yield of stockpiled fescue averaged over the N rates.
Figure 4 Blacksburg Crude Protein by source

Figure 5 Steeles Tavern Crude Protein, by source
Figure 6 Blackstone Crude Protein, by source

Total Digestible Nutrients

Figure 7 Total Digestible Nutrient, by location, averaged over N rate