Finding alternatives to ammonium nitrate as a nitrogen source for tall fescue pastures

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Tall fescue grows on more than 12 million acres and provides forage for more than 4 million beef cattle in Missouri. About one-half of all tall fescue acres receive some nitrogen fertilizer in spring. Most of these applications are made in March or early April. Another time in which tall fescue acres are fertilized with nitrogen is in late-summer for stockpiling. Stockpiling tall fescue allows producers to extend the grazing season into winter and thereby cut winter feeding costs up to 70%.

In past years, ammonium nitrate and urea have been the most popular sources of N for spring and late-summer fertilization. Ammonium nitrate is widely considered the "safest" source of N for forage production, particularly for late-summer applications, as the N in ammonium nitrate is much less likely to be lost to volatilization than is urea. However, ammonium nitrate has become a homeland security issue for the fertilizer industry because it can be used as an explosive. Additionally, few new ammonium nitrate plants have been constructed in the United States over the last 20 years, and given the current economic and security climate, domestic production is likely to decline over the next 10 to 20 years. These factors make ammonium nitrate more expensive than other N sources.

Given the pricing structure and potential problems with ammonium nitrate, urea is becoming more widely used as a N source for forage production. This is due to urea's wider availability and lower cost per N unit when compared to ammonium nitrate. In fact, in many rural parts of Missouri, the only source of N available for pastures is urea. While urea is a common source of N fertilizer for row crop applications in spring, its use for fertilization of pastures is problematic due to excessive nitrogen volatilization. Up to 40% of the N applied to pastures as urea can be lost due to volatilization if rainfall does not occur within 48 hours of an application. Given these problems, farmers are looking for a reliable and inexpensive source of N for pastures.

Some old and new technologies might help alleviate these problems. The most promising solutions are to use a non-volatilizing N source such as ammonium sulfate or to treat urea fertilizer with a volatilization inhibitor. Ammonium sulfate is a sulfur rich (24% S), cost competitive, non-volatilizing source of nitrogen. In addition, several companies have developed products reported to reduce or eliminate volatilization of urea under field conditions. While the technology behind these "urea stabilization products" varies, there has been little "head-to-head" testing under typical field conditions. Technologies that allow safe application of urea would alleviate concerns from farmers and the fertilizer industry, but research is needed to determine which of these products would be most useful for fertilizing pastures in Missouri.

The **overall objective** is to develop research-based recommendations that help industry personnel and farmers determine the best alternative to ammonium nitrate fertilizer for tall fescue pastures. Specific objectives are:

Objective 1: Compare ammonium nitrate to ammonium sulfate, urea, coated urea products, and mixtures of ammonium sulfate with urea and ammonium sulfate with ESN polymer coated urea as a source of nitrogen for tall fescue.

Objective 2: Determine the optimum rate and use efficiency for each source of N tested.

Procedures:
Treatments: Established tall fescue was fertilized with 75 lb/acre of N on 17 and 18 March 2005 at the Forage Systems Research Center near Linneus, MO and the Southwest Research and Education Center near Mount Vernon, MO. The sources of N are listed in Table 1 and include several urea based products already on the market, mixtures of some of these products, as well as untreated urea, ammonium sulfate, and ammonium nitrate as checks. The 75 lb/acre N rate was selected because it is a common fertilization rate for producers. Soil P and K levels are maintained at levels recommended by the University of Missouri Soil Testing Laboratory.

Table 1. Nitrogen fertilization treatments being tested at the Southwest Research and Education Center near Mount and the Forage Systems Research Center near Linneus, MO. Each source is applied to deliver 75 lb/acre N. In addition, rate mixtures of ammonium sulfate/ESN, ammonium sulfate/urea and urea/ammonium sulfate/ESN are included.

Fertilizer Source	For mixture treatments	
	Rate applied (lb/acre of S)	% N derived from ESN and/or Urea
Ammonium Nitrate		
Urea	-	-
Ammonium Sulfate	-	-
Urea treated with Agrotain	-	-
ESN polymer coated Urea	-	-
Nurea	-	-
Nurea with 10% NITAMIN	-	-
Ammonium Sulfate (10S)/Urea	10	88
Ammonium Sulfate (20S)/Urea	20	75
Ammonium Sulfate (40S)/Urea	40	53
Ammonium Sulfate (10S)/ESN	10	88
Ammonium Sulfate (20S)/ESN	20	75
Ammonium Sulfate (40S)/ESN	40	53
1/3 each Ammonium Sulfate + ESN + Urea	28.6	67
Unfertilized Control	-	-

Design: Each treatment in both experiments is replicated five times in a randomized complete block design. Individual plots are 10 ft. x 35 ft.

Measurements:
Forage yield was measured in late May, late July and early October in 2005, and will be measured three times again in 2006 and 2007. Forage yield was determined by clipping a 4-ft. x 25-ft. strip in each plot using a Hege sickle bar harvester.

At each date, sub-samples of forage harvested from each plot were retained for forage quality analyses {crude protein, acid detergent fiber (ADF), neutral detergent fiber (NDF), and indigestible NDF (iNDF)}. Samples were dried at 122° F in a forced-air oven before being ground to pass a 1-mm screen. Crude protein, ADF, NDF, and iNDF will be measured using near infrared reflectance spectroscopy. None of this data is available at present, but will be included in future reports.

Preliminary Results:
Our preliminary data indicate that only the spring harvests responded to N applied in March. This fact was true for both locations (Tables 2 and 3). We hypothesized that the "coated urea" products might have yielded greater in the summer and perhaps fall because of their slow N release activity. But this was not the case. Additionally, no one product was overwhelmingly consistent in producing high yields.

We noted that ammonium sulfate ranked in the top producing group at nearly all harvests and locations and its performance is perhaps the most surprising data from this experiment. Conventional thinking is that we do not get a response to fertilizing tall fescue with sulfur in Missouri. Another somewhat surprising result was that ammonium nitrate provided no better yields than urea in this first year. We acknowledge that each location received nearly 1.0 inch of rain within 5 days of the fertilizer application. Most likely, this precipitation was sufficient to get urea into the soil solution. An extended dry period after application of these products may have resulted in more volitization of urea and thus better performance of the "coated urea" products.

The total yield of the unfertilized control was the least at SWC while at FSRC, it was the same as 11 other products. This discrepancy is likely attributable to a pure tall fescue stand at SWC while at FSRC, the pasture contained approximately 30% red clover. Thus, the rhizobia of red clover were fixing atmospheric N and supplying plant available N to the system. At the SWC, 75 lbs N/acre produced on average 3600 lb/acre of forage. This high ratio of dry matter to N input was well worth the cost and would be ideal for producers focused on their haymaking enterprise.

Table 2. Yield from the 26 May, 29 July, and 11 October 2005 harvests of tall fescue fertilized with different nitrogen sources at the Southwest Research and Education Center near Mount Vernon, MO. Nitrogen was applied at 75 lb/acre for each fertilizer source.

Fertilizer Source	5/26/2005	7/29/2005	10/11/2005	Total yield
	---------------------------- lb/acre ----------------------------			
Ammonium Nitrate	8081	928	1224	10232
Urea	7780	759	1244	9784
Ammonium Sulfate	8834	892	1067	10793
Urea treated with Agrotain	8300	858	1359	10518
ESN polymer coated Urea	7134	772	1077	8983
Nurea	8142	867	1096	10104
Nurea with 10% NITAMIN	7368	891	1117	9376
Ammonium Sulfate (10S)/Urea	7927	969	1091	9987
Ammonium Sulfate (20S)/Urea	7574	999	1076	9649
Ammonium Sulfate (40S)/Urea	7810	886	1236	9931
Ammonium Sulfate (10S)/ESN	7044	780	1032	8856
Ammonium Sulfate (20S)/ESN	6675	746	1091	8513
Ammonium Sulfate (40S)/ESN	7613	867	1013	9492
AS + ESN + Urea at 1/3 each	7500	861	1253	9613
Unfertilized Control	4231	591	1121	5943
$LSD_{(0.05)}$	916	NS	NS	1228

Table 3. Yield from the 27 May, 27 July, and 12 October 2005 harvests of tall fescue fertilized with different nitrogen sources at the Forage Systems Research Center near Linneus, MO. Nitrogen was applied at 75 lb/acre for each fertilizer source.

Fertilizer source	5/27/2005	7/27/2005	10/12/2005	Total yield
	----------------------------	---------------------------- lb/acre	----------------------------	
Ammonium Nitrate	3723	1864	2304	7892
Urea	4157	1958	2310	8425
Ammonium Sulfate	5217	2733	2361	10580
Urea treated with Agrotain	3916	2333	2095	8611
ESN polymer coated Urea	4271	2413	2002	8685
Nurea	3846	2106	2055	8135
Nurea with 10% NITAMIN	3692	2152	2101	7945
Ammonium Sulfate (10S)/Urea	5190	2605	2120	9915
Ammonium Sulfate (20S)/Urea	3750	1757	1989	7395
Ammonium Sulfate (40S)/Urea	3754	1768	1954	7476
Ammonium Sulfate (10S)/ESN	3617	1691	2397	7692
Ammonium Sulfate (20S)/ESN	4232	1947	2200	8380
Ammonium Sulfate (40S)/ESN	4854	2401	2055	9310
AS + ESN + Urea at 1/3 each	4835	2416	1957	9208
Unfertilized Control	2997	2305	1967	7269
$LSD_{(0.05)}$	1154	NS	NS	NS

Budget for Year 2

Salary and Benefits	
Research Specialist (25% of $38,850)	$ 9,713
Benefits for Research Specialist	$ 3,059
Student labor for grinding, etc	$ 1,000
Benefits for student labor	$ 100
Total Salary and Benefits	$13,872
Operating Expenses	
Fertilizer, bags, repair parts for harvester and other field supplies	$ 1,000
NIR charges for forage quality (255 samples @ $10 each)	$ 2,550
Soil N analysis (510 samples @ $8 each)	$ 4,080
Travel to FSRC and SWC (mileage, lodging, and meals)	$ 1,700
Total Operating Expenses	$ 9,330

Total Proposal Request for Year #2 ***$23,202***