Project Title: The influence of nitrogen rate and pasture composition on the toxicity, quality and yield of stockpiled tall fescue

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Accomplishments:

- A three-year field trial studying the effects of nitrogen rate and pasture composition on the toxicity, quality, and yield of stockpiled tall fescue began in August, 2002. The study has 10 treatments; five rates (0, 50, 100, 150 and 300 lb. per acre) of N applied in August and two pasture types (tall fescue with or without red clover). The study is replicated six times.

- We established the study in an existing endophyte-infected tall fescue/red clover pasture at the Forage Systems Research Center (FSRC) near Linneus, MO. Before the treatments were applied, the stand was approximately 30% red clover and 70% tall fescue. For the tall fescue treatments without red clover, existing red clover plants were controlled by spraying 2,4-D and Remedy.

- Soil samples were taken to a 40-inch depth prior to applying fertilizer treatments in 2002 and in March and August of 2003 and 2004. Samples were split into three depth classes (0-10, 10-20, and 20-40 inches) and then analyzed for NH_4 and NO_3 content. Initial results showed that plots had equal ($P>0.05$) levels of pre-experiment NH_4 and NO_3. Subsequent results are shown later in this report.

- Forage was harvested on a monthly basis starting in mid-November of 2002 and 2003. Forage harvests continued monthly during winter (November to March). In addition, all plots were harvested in May and July of 2003 and 2004 to measure any residual effects from the fertilizer treatments.

- Because this project examines forage yield, quality and toxicity of stockpiled tall fescue over winter, we are only part-way through the third year. Some preliminary results are:

- Stockpiled forage yield:

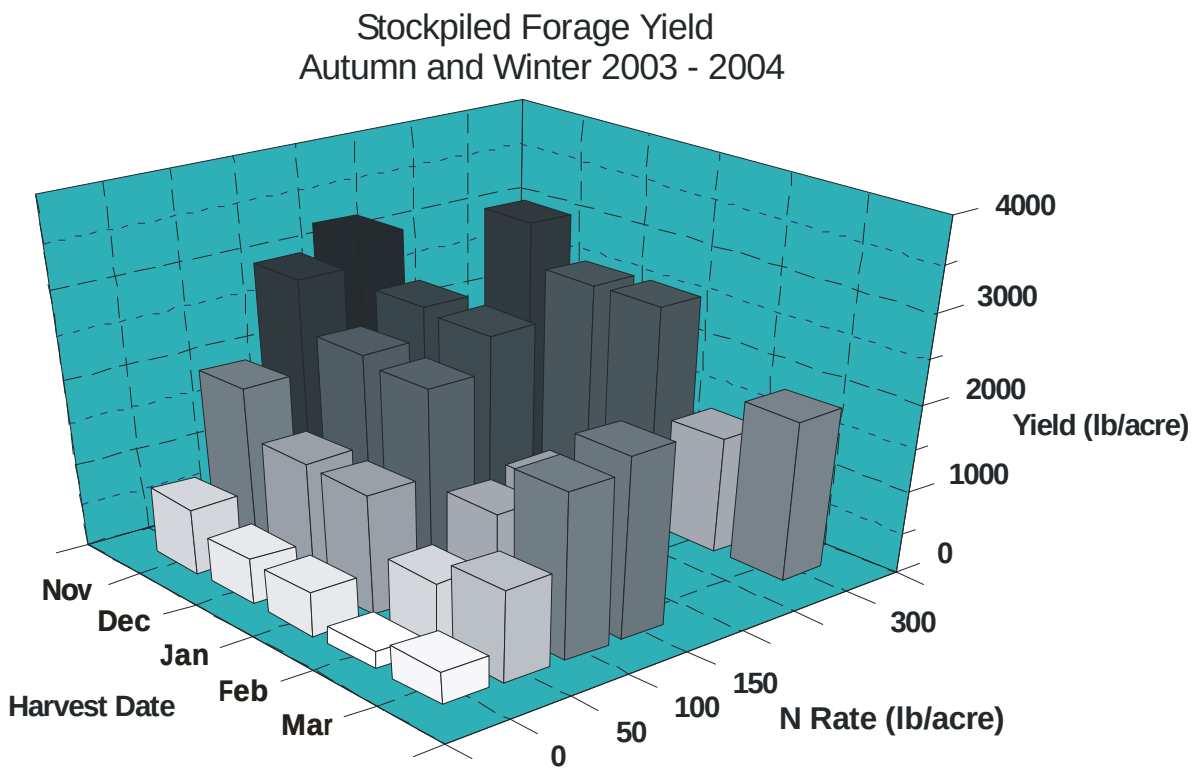
    - Stockpiled forage yields increased substantially when N was applied in August, despite the dry growing conditions in the autumn of 2003 (Fig. 1). Regardless of whether plots contained red clover, a nearly linear response to N rates up to 100 lb. per acre was observed. Rates above 100 lb. per acre showed little increase in stockpiled forage yield. These data suggest at least two things:

        1. Having red clover in stands of tall fescue does not decrease forage yield in autumn, but neither does it improve yields for stockpiling. The amount of red clover in the mixed plots is about 30% in the 0, 50, and 100 lb. per acre N-treatments which is considered ideal for a grazing system. Much less red clover was present in the 150 and 300 lb. per acre N treatments, likely due to competition from the tall fescue. If red clover contributes any nitrogen to improve grass growth in autumn, then it is

likely that the competition from the red clover or the space that the red clover uses offsets any N contribution. Red clover does not maintain its dry matter as well in winter as does tall fescue, and the red clover plants themselves contribute little to yield, especially after mid-December.

2. Although many producers limit late-summer or fall applications of N to 50 or 60 lb. per acre, our data show that even in dry years N rates up to 100 lb. per acre give acceptable yield responses. A preliminary economic analysis for this appears later in this report.

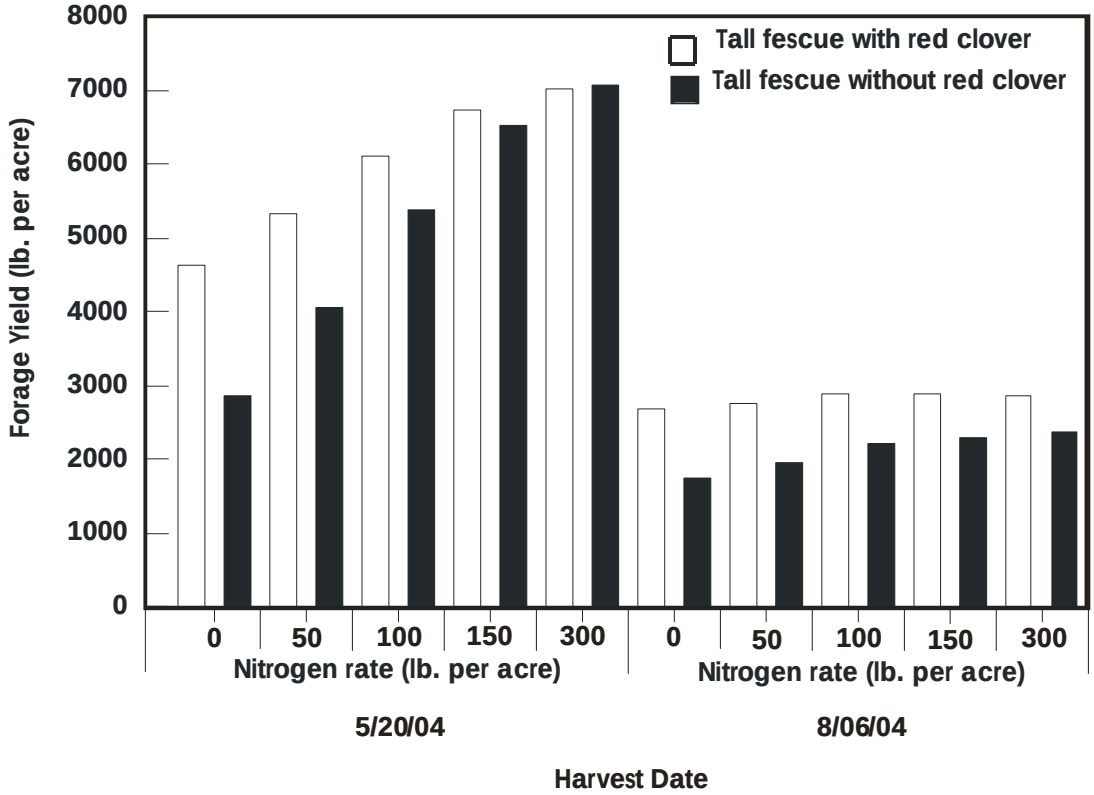
Fig. 1. Stockpiled forage yield in autumn and winter 2003 – 2004. Forage yields for plots with red clover were the same (P>0.05) as those without red clover so data were averaged across pasture types.



- Forage yields in spring and summer:

    - While the tall fescue responded in autumn to N, there were large carry over effects the following spring (Fig. 2). Yields taken in May of 2004 showed a nearly linear increase in forage yield in response to N applied in autumn although the response was greater for tall fescue without red clover that for tall fescue with red clover. At the three lowest N rates (0, 50, and 100 lb. per acre N) tall fescue with red clover yielded more than plots without red clover but at the two highest N rates the differences were not significant (P>0.05). In July, yields were lower than in spring for all treatments. The addition of red clover improved yields at all N rates for the July harvest.

Fig. 2. Forage yields in May and July of 2004 from tall fescue with and without red clover and fertilized with 0, 50, 100, 150 or 300 lb. per acre of N the previous August.

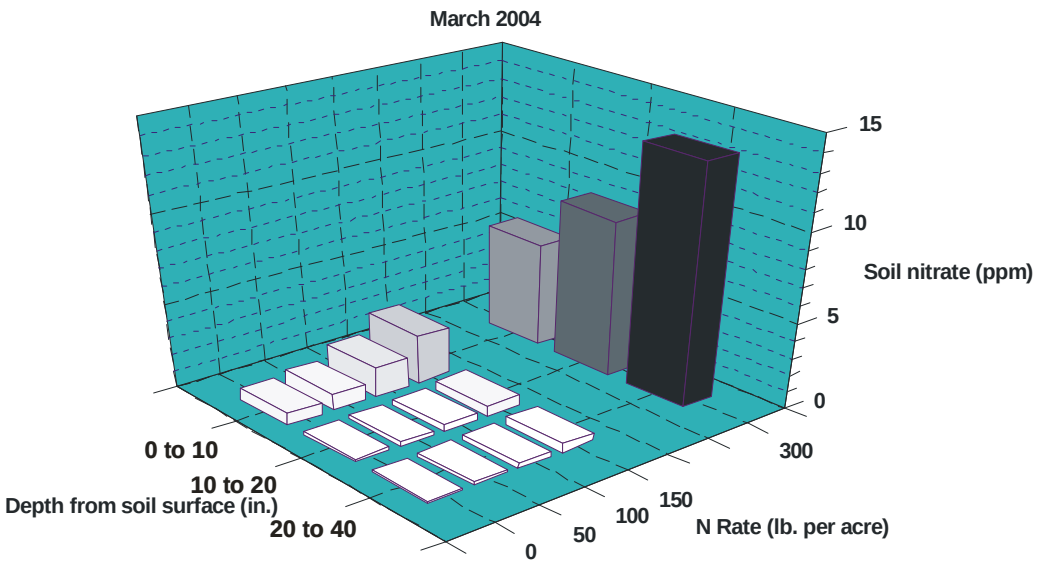


- Red clover stands:
    - Red clover stands were impacted by autumn applied N but red clover stands in all but the 150 and 300 lb. of N per acre treatments were at or above the ideal density of 5 plants per square foot in spring. This along with the yield data discussed above suggests that mixed tall fescue/red clover pastures can benefit from modest rates of autumn applied N without the red clover component being lost. When applying N fertilizer in late summer, rates of 150 or more lb. per acre should be avoided if red clover stands are desired.

- Soil nitrate levels:
    - As expected, soil nitrate levels in March of 2004 were highest in the 300 lb. per acre N treatment (Fig. 3). Soil nitrate levels in the 0 to 10 inch layer were 5 ppm for the 300 lb. per acre N treatment but only 1 ppm or less for all the other treatments. In the 10 to 20 inch layer and the 20 to 40 inch layer, soil nitrate levels were 40 to 70% lower than for the 0 to 10 inch layer for all treatments except the 300 lb. per acre N treatment. For the 300 lb. per acre treatment, soil nitrate levels increased with depth of sampling. In the 20 to 40 inch layer, soil nitrate levels were 13 ppm for the 300 lb. per acre treatment, which is about 3 times more nitrate than was found in the top 10 inches of the soil profile.

- This suggests that annual applications of 300 lb. per acre of N in August could allow some leaching of nitrogen. We have noted that the grass stands in the 300 lb. per acre treatment have thinned over the course of the experiment. We believe that the abundant growth in this treatment caused excessive shading which in turn caused the stand to thin. This thinner stand was less able to take up N in autumn leaving the potential for unused N to move lower into the soil profile.

Fig. 3. Soil nitrate levels in March 2004 when fertilized with 0, 50, 100, 150 or 300 lb. per acre of N the previous August.

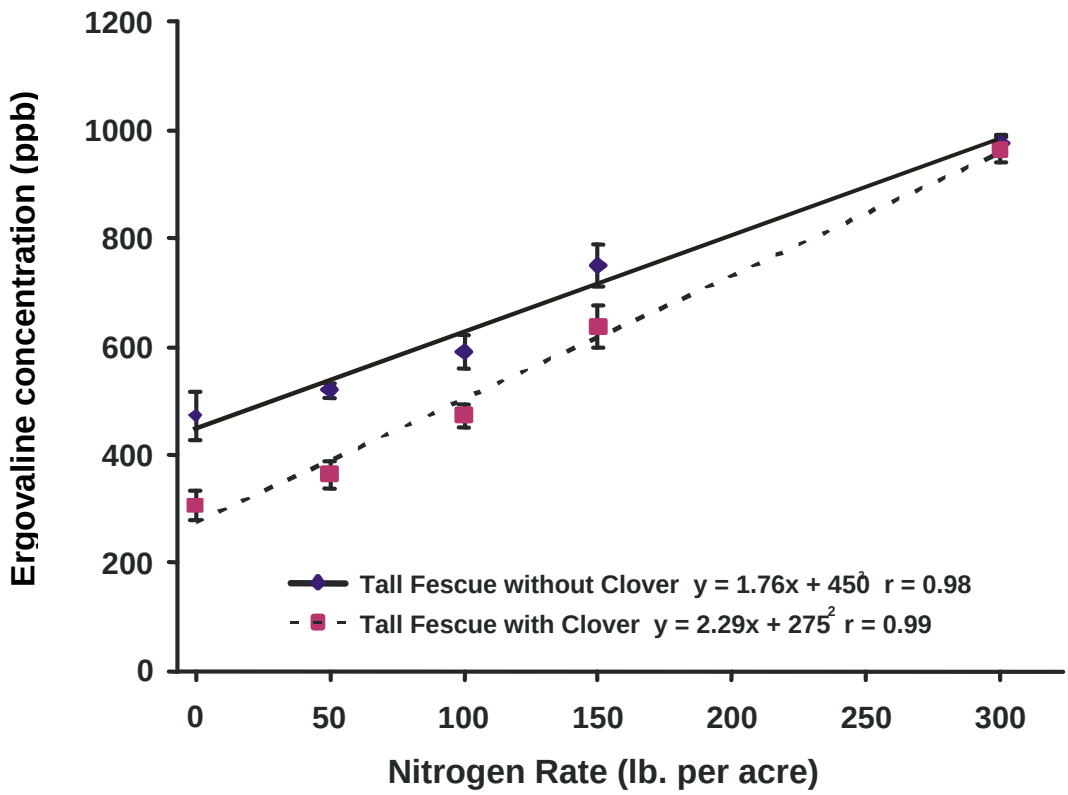


- These data show that in a healthy grassland system, little nitrate is lost from the system except when 300 lb. per acre of N is applied. Although economic considerations make it unlikely that commercial fertilizer would applied at such a high rate, it does suggest that high N levels from other sources such as manure could pose a nitrate leaching problem.

- Ergovaline concentrations in forage:

  - The ergovaline concentrations we found in stockpiled forage are approximately 25 to 50% lower than those reported by Rottinghaus et al. (1991) for spring-grown tall fescue. However, the ergovaline concentration in all treatments was in excess of the 150 ppb threshold for livestock reported by Stamm et al. (1994). This suggests that while stockpiled forage has lower ergovaline levels than tall fescue during the growing season, it still is a potential problem for livestock owners in winter and that N fertilizer management plays an important role (Fig. 4).

Fig. 4. Ergovaline concentrations in stockpiled tall fescue with and without red clover and fertilized with 0, 50, 100, 150 or 300 lb. per acre of N in August 2002. Samples were collected in November 2002.



- Preliminary economic analysis:

  - When previous moisture conditions cause limited on-farm hay supplies, a late summer N application might be more cost effective than previously thought. A basic economic analysis shows that if ammonia nitrate costs $0.40 per N unit, plus $3 per acre spreading cost and fair quality grass hay is valued at $50.00 per ton that the optimum N fertilization rate in autumn is over 100 lb. per acre (Table 1).

Table 1. Preliminary economic analysis showing the cost and benefit of nitrogen applied in August to tall fescue pastures that are stockpiled. Yields used in the analysis are the average of all winter harvest dates.

N rate applied in Aug.	Stockpiled forage yield	Fertilizer Cost †	Additional cost per ton of forage ‡
-------- lb. per acre --------		$ per acre	$ per ton
0	623	0	-
50	1668	23.00	44.04
100	2761	43.00	40.23
150	3094	63.00	50.99
300	2842	123.00	110.85

† Fertilizer costs include ammonia nitrate @ $0.40 per N unit plus $3 per acre for spreading.
‡ Cost compared to 0 N rate.

- More than 500 people have seen this research as part of various extension education programs conducted at the Forage Systems Research Center. In addition, the research plots have been used as part of Dr. McGraw's *Forages* class at the University of Missouri.

Objectives left to finish:

- Over the next year we will continue our research on the impact of N on stockpiled tall fescue. As outlined in our original proposal, the tasks in the table below will be conducted over the next year.

Continue to harvest appropriate sub-subplots for forage yield and retain subsamples for forage quality and ergovaline analysis (Year 3)	1/15/05, 2/15/05 and 3/15/05
Seed 5 lb/a of red clover on appropriate plots to maintain grass/legume mix.	3/1/05
Take soil cores from each sub-plot to determine residual soil N.	3/19/05
Harvest all sub-subplots for forage yield and retain subsamples for forage quality and ergovaline analysis. (This should measure the residual effects)	5/19/05 and 7/24/05
Count the legume plants in six, 1.0 ft.^{2} quadrats in each plot	5/25/05 and 8/12/05
Analyze samples taken to date for forage quality & ergovaline content	8/30/05
Prepare final report to Missouri Fertilizer and Lime Council	12/15/05
Prepare a guidesheet on N fertilization of stockpiled tall fescue	12/15/05
Work with publications office on articles for the popular press	12/15/05

- In addition to completing the tasks outlined above, we will be analyzing our field data more fully. Specifically, we are interested in determining the rate and extent of forage degradation over winter, with a special focus on ergovaline concentrations. Based on previous data published by Kallenbach et al. (2003), ergovaline levels are expected to drop over winter in stockpiled tall fescue. Although the influence of N rate on this process is

unknown, we would like to develop prediction equations that could guide producers, fertilizer dealers, crop consultants and other about the potential toxicity and use of stockpiled tall fescue in winter.

- We will continue to integrate our findings into the curriculum of the Missouri Grazing Schools and the annual Winter Grazing Workshops at Linneus and Mt. Vernon. These outreach efforts can be expected to reach more than 1,000 producers, agency staff, and agri-business personnel. Additionally, as more comprehensive data are collected, we will prepare a new guidesheet about stockpiling tall fescue as well as prepare articles to be published in statewide and national magazines such as Missouri Ruralist, Graze, Stockman Grass Farmer and scientific journals.

References

Kallenbach, R.L., G.J. Bishop-Hurley, M.D. Massie, G.E. Rottinghaus, and C.P. West. 2003. Herbage mass, nutritive value, and ergovaline concentration of stockpiled tall fescue. Crop Sci. 43:1001-1005.

Rottinghaus, G.E., G.B. Garner, C.N. Cornell, and J.L. Ellis. 1991. HPLC method for quantitating ergovaline in endophyte-infested tall fescue: Seasonal variation of ergovaline levels in stems with leaf sheaths, leaf blades, and seed heads. J. Agric. Food. Chem. 39:112-115.

Stamm, M.M., T. Delcurto, M.R. Horney, S.D. Brandyberry, and R.K. Barton. 1994. Influence of alkaloid concentration of tall fescue straw on the nutrition, physiology, and subsequent performance of beef steers. J. Ani. Sci. 72:1068-1075.

Budget: **$0**

No additional budget is requested for this year. Since this project starts in August and continues through July of each year, we still have about six more months of data to collect before the project is completed. We only request that we be allowed to carry over the funding already allocated for this project so that we can complete it.