Paper ID: 1321
Theme 2. Grassland production and utilization
Sub-theme 2.3. Soil-plant-animal-human interrelationships

Tall fescue (*Festuca arundinacea*) stockpiling response to N fertilizer in southern Virginia as affected by biological soil quality

Chris Teutsch[1], Robert Shoemaker[2]*, Alan Franzluebbers[3]
[1]Virginia Tech, Blackstone, Virginia, United States
[2]Virginia Department of Conservation and Recreation, Warrenton, Virginia, United States
[3]USDA-Agricultural Research Service, Raleigh, North Carolina, United States
*Corresponding author e-mail: robert.shoemaker@dcr.virginia.gov

Keywords: Carbon, Nitrogen, Tall fescue

Introduction

Cattlemen in the eastern USA profitably utilize endophyte-infected tall fescue (*Festuca arundinacea*) for fall-stockpiled winter grazing. Ergot alkaloid concentration in fescue tends to decline in winter. This improves the quality of fescue for grazing when the supply of other forage becomes limited on most farms. Tall fescue dry matter yields generally respond favorably to nitrogen (N) inputs, but response can be limited with summer application due to accumulation of biologically available N in soil. Research is needed to characterize a diversity of pastures for response to N fertilizer during fall stockpiling.

Biological soil quality can be estimated with a simple measure of soil respiration following rewetting of dried soil (Franzluebbers *et al*., 2000). The flush of CO_2 following rewetting of dried soil has been related to the quantity of N mineralized during longer term incubations (Franzluebbers and Haney, 2006) and to N uptake in field studies of forage growth (Haney *et al*., 2001).

Soil was collected from a set of pastures in southern Virginia to characterize biological soil quality and determine dry matter yield response to fertilizer N inputs.

Materials and Methods

In 2014, three tall fescue pastures owned by cattlemen in southern Virginia near Blackstone were selected, as they were thought to represent a gradient in overall productivity from medium to high. In each pasture, a randomized complete block design was laid out in 64 plots measuring 3 m x 6 m each. Soil was sampled at 0-10 cm depth in August 2014 by compositing 8 cores from each of four replicate blocks at each site. The composite soil samples were analyzed for the flush of CO_2 during 3 days following rewetting of dried soil at the USDA-ARS laboratory in Raleigh, North Carolina. Nitrogen fertilizer treatments were applied at 0, 45, 90, and 134 kg N ha^{-1} in early September. Nitrogen sources were ammonium nitrate, urea + agrotain @ 2 L Mg^{-1}, urea + agrotain @ 4 L Mg^{-1}, urea + agrotain @ 6 L Mg^{-1}, and urea alone. The experimental area was fenced to not allow grazing. Plots were harvested from 1.5 m x 6 m sections in early January 2015. Reported yields are the average for the various N sources. An economic analysis compared stockpiling fescue versus purchasing hay with different price structures for hay and commercial nitrogen fertilizer.

Results and Discussion

Tall fescue biomass accumulated in a mostly linear manner at all three sites (Figure 1). With application of 90 kg N ha^{-1}, dry matter (DM) accumulation was 10.4 $\pm$ 4.6 kg DM kg^{-1} N on the Harrison pasture, 16.5 $\pm$ 12.9 kg DM kg^{-1} N on the Morris pasture, and 7.8 $\pm$ 4.8 kg DM kg^{-1} N on the Roberts pasture. Yield response, compared to purchasing adequate quality hay, was marginally profitable at two of the three sites, assuming \$USD 170 Mg^{-1} of hay (15% moisture) and cost of N fertilizer at \$USD 2.20 kg^{-1} N (equivalent response of 10.0 kg DM kg^{-1} N). If hay cost only \$USD 100 Mg^{-1}, then the break-even response would be 17.0 kg DM kg^{-1} N and none of the observed responses would have been profitable. If, however, fertilizer N cost only \$USD 1.10 kg^{-1} N and hay was worth \$USD 170 Mg^{-1}, then the break-even response would be 5.0, and fertilizing all fields would have been profitable.

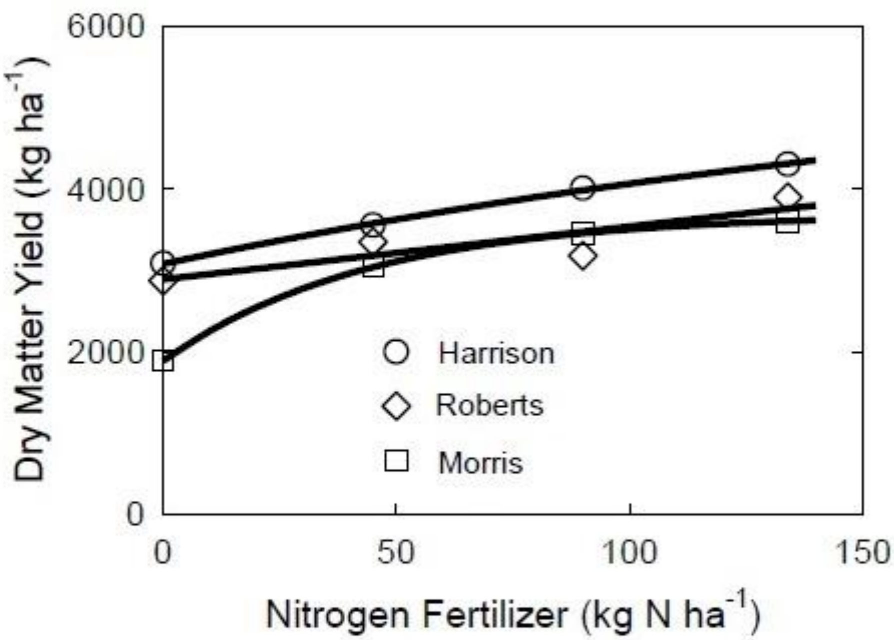

Fig. 1: Tall fescue stockpile yield in response to late summer N fertilizer application on the three farms in southern Virginia

As a measure of soil biologically quality (and hence a measure of biologically available N), the flush of CO_2 following rewetting of dried soil indicated an optimum condition at ~300 mg C kg^{-1} soil (3 days)$^{-1}$(Figure 2). 60% of the variation among the four replicates at each of the three pastures was explained by the flush of CO_2. The low yield with low flush of CO_2 was expected, as it was highly consistent with previous data collected (Franzluebbers and Brock, 2007). However, the decline in yield response with flush of CO_2 values exceeding (300 mg C kg^{-1} soil)$_{0\text{-}3\ days}$ was not expected to be as strong as observed, so further investigation is warranted to verify this relationship. The decline in yield with high flush of CO_2 is hypothesized to be from a large accumulation of C-rich and N-poor surface residues under certain pasture conditions (Franzluebbers, 1999). These results also do not account for residual inorganic N in surface soil. These data will be collected but not yet available. As a predictive tool for N availability, the flush of CO_2 following rewetting of dried soil needs to be used in conjunction with residual inorganic N concentration.

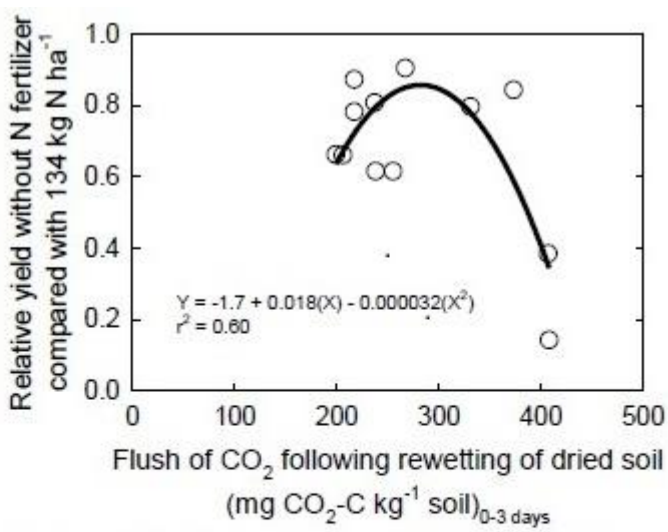

Fig. 2: Relative tall fescue yield without N compared with full N application in relationship to the flush of CO_2 as a biological soil quality indicator

Conclusion

Tall fescue yield minimally increased with fertilizer N application at all sites. The cost to to obtain more dry matter for the beef herd, either through stockpiling or supplemental hay purchases, needs to be carefully considered. Other costs also need to be considered because increased N fertilization may inhibit clover growth, reduce soil pH, and increase long-term lime costs. The cost to feed stockpiled fescue is likely less labor and equipment intensive compared to feeding hay.

However imported hay contains significant amounts of phosphorus and potassium and may improve soil fertility compared to stockpiled fescue.

Further research is needed to categorize pastures as to their expected biomass yield response to late summer fertilization for stockpiled tall fescue based upon soil CO_2 levels. Refined N fertilizer recommendations for tall fescue should be possible based upon the parameters of livestock prices, local hay prices, N fertilizer prices, and expected N mineralization determined by the flush of CO_2 test.

References

Franzluebbers, A. J. 1999. Potential C and N mineralization and microbial biomass from intact and increasingly disturbed soils of varying texture. *Soil Biol. Biochem*. 31: 1083-1090.

Franzluebbers, A. J. and B. G. Brock. 2007. Surface soil responses to silage cropping intensity on a Typic Kanhapludult in the piedmont of North Carolina. *Soil Tillage Res*. 93: 126-137.

Franzluebbers, A. J. and R. L. Haney. 2006. Flush of CO_2 as a soil biological quality indicator. Proc. Int. Soil Tillage Res. Org., Kiel, Germany.

Franzluebbers, A. J., R. L. Haney, C. W. Honeycutt, H. H. Schomberg and F.M. Hons. 2000. Flush of carbon dioxide following rewetting of dried soil relates to active organic pools. *Soil Biol. Biochem*. 64: 613-623.

Haney, R. L, F. M. Hons, M. A. Sanderson and A. J. Franzluebbers. 2001. A rapid procedure for estimating nitrogen mineralization in manured soil. *Biol Fert Soils* 33: 100-104.