

**Management of Cattle to Reduce Vulnerability to Heat Stress
Following Grazing of Toxic Tall Fescue**

Glen Aiken

USDA-ARS-Forage-Animal Production Research Unit; Lexington, KY

Introduction

Tall fescue [*Schedonorus arundinaceus* (Schreb.) Dumort] is a cool-season perennial grass that covers approximately 15 million ha (Thompson et al., 2001) in a region referred to as the “fescue belt”, which is between the temperate northeast and subtropical south. An endophytic fungus inhabits plants in greater than 90% of tall fescue pastures (Sleper and West, 1996) and produces alkaloid toxins that induce the fescue toxicosis malady. Toxicosis has symptoms in cattle that include poor weight gain, retention of rough hair coat, elevated body temperature, labored respiration, and decreased serum prolactin (Schmidt and Osborn, 1993). Ergot alkaloids bind biogenic amine receptors in peripheral vasculature (Oliver, 2005) and may reduce the animal’s ability to dissipate body heat and cause severe heat stress at the onset of high ambient temperature (Hemken et al., 1981; Spiers et al., 2005).

Tall fescue is primarily utilized for cow-calf production because poor weight gain efficiency of calves exhibiting fescue toxicosis has prevented the wide use of tall fescue for stocker production (Hoveland, 1993). Most calves weaned on tall fescue pastures and not retained for herd replacement are typically sold and transported to other regions for pasture backgrounding while some are retained for shipment to feedyards. Fescue toxicosis exacerbates the stress from shipping and these combined stresses can increase morbidity and mortality, and the length of feedyard adjustment. Management strategies, such as preconditioning, could reduce stress levels of fescue cattle that are transported long distances. This paper reviews physiological changes in steers following the removal of steers from toxic tall fescue and placement on non-toxic diets.

Can Recovery from Fescue Toxicosis be Achieved in the Short Term?

To minimize toxicosis, Aiken and Piper (1999) moved steers grazing endophyte-infected tall fescue in the spring to eastern gamagrass (*Tripsacum dactyloides* L.) pastures in Booneville, AR in the summer. Serum prolactin concentrations had increased from ~20 ng/mL to ~100 ng/mL by 28 d of being moved to eastern gamagrass. At the conclusion of summer grazing, 60% of the steers that remained on tall fescue had rough haircoats, but only 20% of the steers grazed on eastern gamagrass had rough haircoats. Severity of toxicosis had been substantially reduced by removing the steers from tall fescue at the onset of warm ambient temperatures; however, symptoms of toxicosis were seen in a few calves at the conclusion of grazing eastern gamagrass.

In another experiment, Stuedemann et al. (1998) reported that urinary alkaloid concentrations declined 67% in steers within 24 hr after being switched from endophyte-infected tall fescue to endophyte non-infected tall pastures. These experiments indicated there is short-term flushing of high concentrations of ergot alkaloids once cattle are removed from toxic tall fescue, but tight binding of alkaloids in certain animal tissues (i.e., vascular tissue, adipose, etc.) may cause some retention of alkaloids in vascular circulation.

Complete recovery from fescue toxicosis is not likely in the short term. However, there appears to be an easing of both vasoconstriction and dopinergic activities of ergot alkaloids shortly after fescue cattle are placed on non-toxic diets to improve health and stability, and reduce the vulnerability to heat stress.

Changes in Rectal Temperature and Prolactin Following Grazing of Toxic Tall Fescue

Aiken et al. (2002) grazed forty-five steers on toxic tall fescue for 66 d to evaluate effects of post-graze steroid hormone implantation and protein supplementation on temporal changes in rectal temperature and serum prolactin following placement on non-toxic diets. There was no effect of implantation or supplementation on changes in the responses. Mean rectal temperatures of 39.9°C at 10 h following removal from E+ fescue pastures declined to less than 39.2°C in 82 h. Although the monitoring was conducted in late June, ambient temperatures were below 25°C and likely contributed to the decline in rectal temperature. Initial serum prolactin was approximately 25 ng/ml, but increased and stabilized at 75 ng/ml serum in 58 hours following placement on non-toxic diets.

Aiken et al. (2006) compared changes in rectal temperatures and serum prolactin following grazing of toxic tall fescue in west-central Arkansas between steers that were implanted with progesterone and estradiol or non-implanted. Steers were grazed on toxic tall fescue for 84 d from late March to late June and subsequently moved to bermudagrass pasture. Rectal temperatures of implanted steers were approximately 0.2°C higher than those of non-implanted over the monitoring period. Rectal temperatures over both treatments averaged 40.4°C at the conclusion of grazing and declined to 39.7°C in 10 d (Fig. 2A). Ambient temperatures during monitoring were moderate, ranging from 22.8 to 26.1°C (Fig. 1) and may have contributed to higher rectal temperatures for the first 6 d. Based on the rate of decrease, rectal temperatures may have fallen to 39.2°C if temperatures had been monitored for an additional 2 days. There were no differences in serum prolactin concentrations between implant treatments. Serum prolactin concentrations increased curvilinearly as days on the non-toxic diet increased (Fig. 3A). Prolactin concentrations rose quickly between 0 and 3 d and the rate of increase slowed between 3 and 10 d. Similar to the rectal temperature response, serum prolactin did not reach a plateau concentration, which may indicate that the monitoring phase was not conducted for a long enough period of time.

Aiken and others (unpublished) in a 2-yr study compared changes in rectal temperatures and serum prolactin of unfed steers grazing toxic tall fescue in north-central Kentucky with steers that were fed soybean hulls (2.3 kg/steer/day). Steers were grazed from early June to middle September and subsequently moved to small pens and fed corn silage and a concentrate

to represent a finishing phase. Ambient temperatures during the monitoring phase were below 25°C in both years (Fig. 1). Post-graze rectal temperatures of steers fed on pastures were approximately 0.1°C higher ($P < 0.01$) than those that were not fed. Rectal temperatures averaged over both years and treatments were 40.3°C at the conclusion of grazing and declined to 39.1°C in 9 to 10 d (Fig. 2B). There were no differences in serum prolactin concentrations between feeding treatments ($P > 0.10$), but serum prolactin increased ($P < 0.01$) rapidly and stabilized in approximately 20 d (Fig. 3B).

Aiken and others (unpublished) compared rectal temperatures and serum prolactin of pregnant heifers grazed on toxic (KY-31) with those grazed on non-toxic (MaxQ) tall fescue. In the first year of this 2-yr experiment, when mean ambient temperature was 26°C, initial post-graze rectal temperatures were higher ($P < 0.01$) in heifers on toxic (40.6°C) tall fescue than those on non-toxic (39.7°C) pastures (Fig. 4A). Rectal temperatures declined ($P < 0.01$) in heifers on both fescues and stabilized in 12 d at 39.4°C for heifers removed from toxic pastures and approximately 39.1°C for those removed from non-toxic pastures (Fig. 4B). Temperatures remained stable for the remainder of the 21-d monitoring period. Therefore, vasoconstriction in heifers grazed on toxic tall fescue was eased but not alleviated. Serum prolactin in pregnant heifers grazed on non-toxic tall fescue was initially high (~230 ng/mL) and in those grazed on toxic tall fescue was initially low (~90 ng/mL) (Fig. 5). Prolactin concentrations decreased ($P < 0.05$) in heifers grazed on non-toxic and increased ($P < 0.05$) in those grazed on toxic tall fescue, and both stabilized at similar concentrations ($P > 0.10$) in 6 d. Increased serum prolactin concentrations in those grazed on toxic tall fescue may indicate a reduction of dopinergic activity caused by ergot alkaloids. It is uncertain why serum prolactin concentrations decreased in heifers grazed on MaxQ.

Final Thoughts

Thus far, experiments have indicated that cattle can be removed from toxic tall fescue pastures to lower elevated body temperatures in 3 to 12 d. Number of days needed for rectal temperatures to decline to those of a healthy and stable condition will depend on ambient temperatures. Longer recoveries from elevated body temperature appear to be required if ambient temperatures are above 25°C. Serum prolactin increases and stabilizes in 2 to 20 days after toxins are removed from the diet. Time for prolactin concentrations to increase and stabilize may also depend on ambient temperature. Other factors are the extent of time on toxic tall fescue pasture, pasture infection of stands, and alkaloid concentrations in grazed fescue. Changes in physiology of cattle as they switch from toxic to non-toxic diets appear associated with the excretion of alkaloids and the reduction of alkaloid concentrations in vascular circulation. High affinities of alkaloids at receptors likely slows their diffusion. More research is needed to determine possible storage and release of ergot alkaloids in organs and other tissues and evaluate long-term carryover effects of alkaloids on cattle physiology.

References

- Aiken, G. E., M. L. Looper, S. F. Tabler, D. K. Brauer, J. R. Strickland, and F. N. Schrick. 2006. Influence of stocking rate and steroidal implants on growth rate of steers grazing toxic tall fescue and subsequent physiological responses. *J. Anim. Sci.* 84:1626-1632.

- Aiken, G. E., and E. L. Piper. 1999. Stoking rate effects on steer performance for two methods of alleviating fescue toxicosis. *Prof. Anim. Sci.* 15:245-252.
- Aiken, G.E., Piper, E.L., and Meisner, C.R. 2001. Influence of protein supplementation and implant status on alleviation of fescue toxicosis. *J. Anim. Sci.* 79:818-823.
- Hemken, R. W., J. A. Boling, and L. S. Bull, R. H. Hatton, R. C. Buckner, and L. P. Bush. 1981. Interaction of environmental temperature and anti-quality factors on the severity of summer fescue toxicosis. *J. Anim. Sci.* 52:710-714.
- Hoveland, C.S. 1993. Importance and economic significance of the *Acremonium* endophytes to performance of animals and grass plant. *Agric. Ecosys. Environ.* 44:3-12.
- Oliver, J. W. 2005. Pathophysiologic response to endophyte toxins. Pages 291-301 in *Neotyphodium in Cool-Season Grasses*. C. A. Roberts, C. P. West, and D. E. Spiers (Eds.). Blackwell Publishing, Ames, IA.
- Schmidt, S. P., and T. G. Osborn. 1993. Effects of endophyte-infected tall fescue on animal performance. *Agric. Ecosys. and Environ.* 44:233-262.
- Sleper, D.A., and C.P. West. 1996. Tall fescue. p. 471-502. *In* L.E. Moser et al. (ed.) *Cool-Season Forage Grasses*. Agron. Monogr. No. 34. ASA, CSSA, and SSSA, Madison, WI.
- Spiers, D. E., T. J. Evans, and G. E. Rottinghaus. 2005. Interaction between thermal stress and fescue toxicosis: Animal models and new perspectives. Pages 243-270 in C.A. Roberts, C.P. West, and D.E. Spiers (Eds.). *Neotyphodium in Cool-Season Grasses*. Blackwell Publishing, Ames, IA.
- Stuedemann, J. A., N. S. Hill, F. N. Thompson, R. A. Fayer-Hosken, W. P. Hay, D. L. Dawe, D. H. Seman, and S. A. Martin. 1998. Urinary and biliary excretion of ergot alkaloids from steers that grazed endophyte-infected tall fescue. *J. Anim. Sci.* 76:2146-2154.

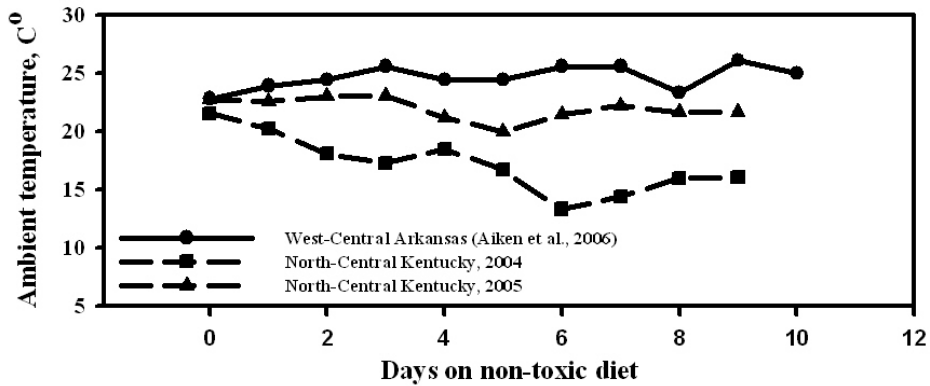


Figure 1. Ambient temperatures over monitoring periods following grazing of toxic tall fescue and placement on non-toxic diets in west-central Arkansas (Aiken et al., 2006) and north-central Kentucky (Aiken, unpublished).

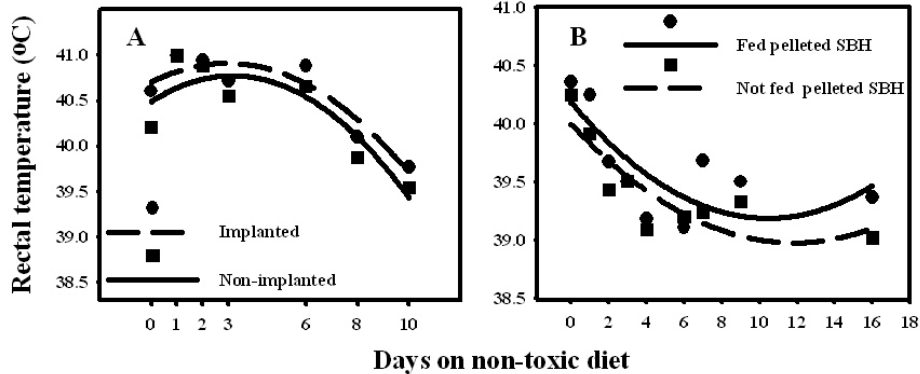


Figure 2. Rectal temperatures monitored following grazing of toxic tall fescue and placement on non-toxic diets for: A) implanted and non-implanted steers in west-central Arkansas (Aiken et al., 2006), and B) steers fed or not fed soybean hulls on pasture in north-central Kentucky (Aiken, unpublished).

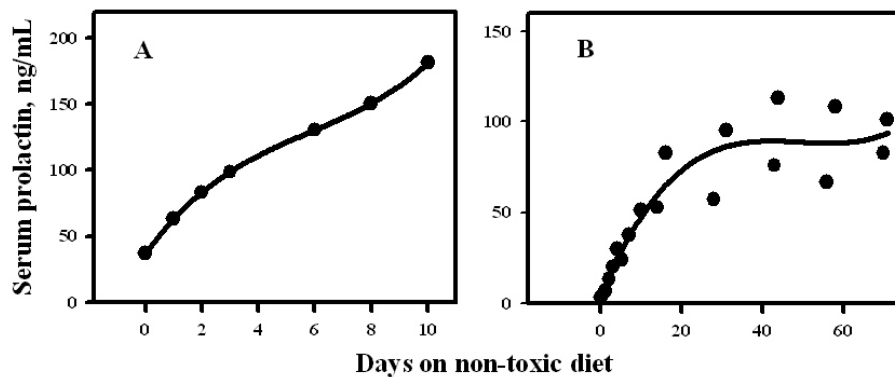


Figure 3. Serum prolactin concentrations monitored in steers following grazing of toxic tall fescue and placement on non-toxic diets for: A) implanted and non-implanted steers in west-central Arkansas (Aiken et al., 2006), and B) steers fed or not fed soybean hulls on pasture in north-central Kentucky (Aiken, unpublished)

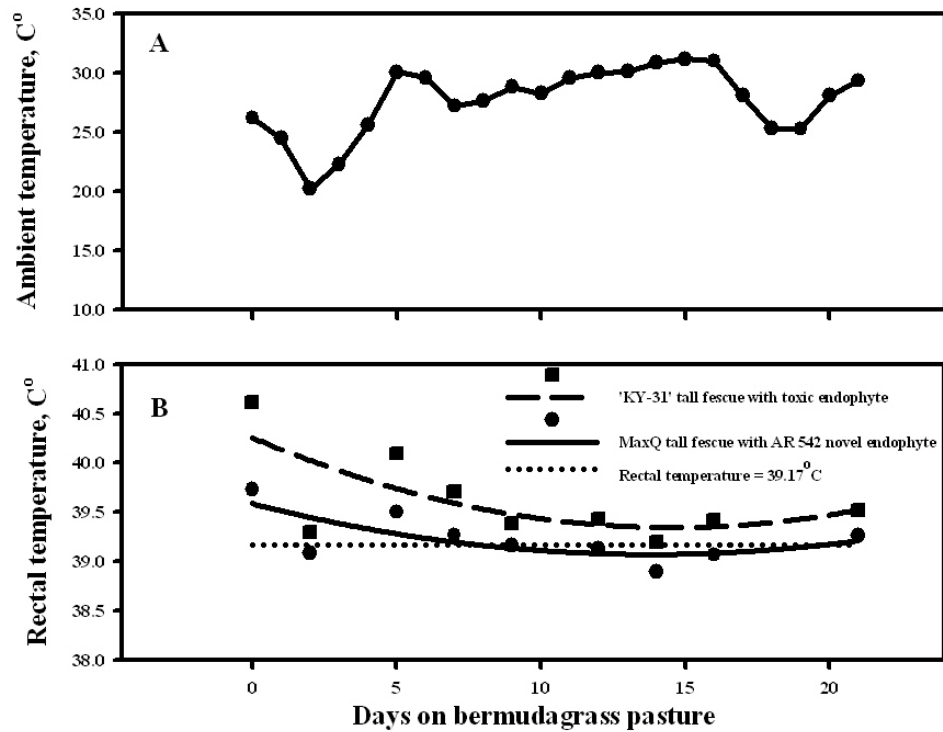


Figure 4. Ambient temperatures (A) and rectal temperatures (B) monitored for steers following grazing of Kentucky-31 with the toxic endophyte or MaxQ tall fescue with the non-toxic endophyte and placement on bermudagrass pastures (Aiken and Loper, unpublished).

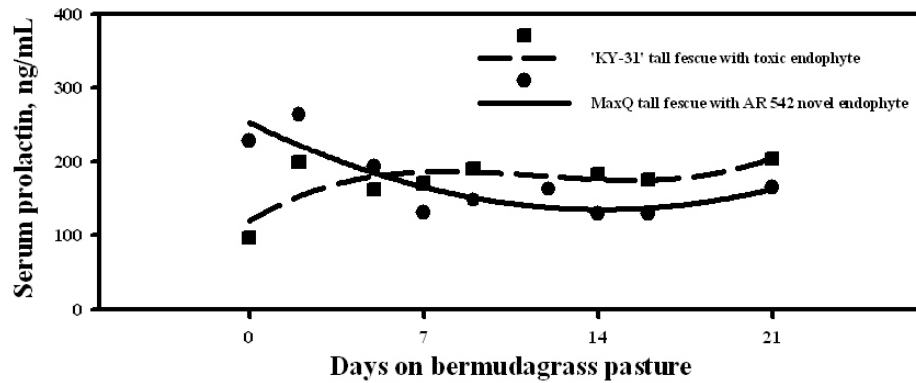


Figure 5. Serum prolactin concentrations monitored in steers following grazing of Kentucky-31 tall fescue with the toxic endophyte or MaxQ tall fescue with the novel endophyte and placement on bermudagrass pastures (Aiken and Loper, unpublished).

