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Case Study: Recovery from ergot alkaloid-induced vasoconstriction for steers conditioned to grazing seedhead-suppressed and unsuppressed pastures of toxic endophyte-infected tall fescue[1]

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ABSTRACT

Chemical seedhead suppression of toxic endophyte–infected (E+) tall fescue (*Lolium arundinaceum*) can enhance steer performance and mitigate the adverse effects of ergot alkaloids on cattle physiology; however, it is not known if seedhead suppression can mitigate alkaloid-induced vasoconstriction and improve postgraze performance. A 2-yr experiment was conducted with Angus crossbred steers using a pasture phase to precondition steers to grazing seedhead-suppressed E+ tall fescue; unsuppressed E+ fescue; or a bermudagrass (*Cynodon dactylon*), white clover (*Trifolium repens*), and Kentucky bluegrass (*Poa pratensis*) control. A pen phase followed to monitor luminal areas of the caudal artery for assessing alkaloid-induced vasoconstriction and BW to compare the E+ treatments with the nontoxic treatment. During the pen phase, luminal areas of caudal arteries in steers preconditioned on suppressed E+ were comparable ($P > 0.10$) with those for nontoxic preconditioning on and after 28 and 13 d on the nontoxic diets (DNTD) in the first and second years, respectively. Caudal arteries in steers preconditioned on unsuppressed E+ were constricted compared ($P > 0.10$) with the nontoxic preconditioned steers over all DNTD and from 0 to 34 DNTD in the first and second years, respectively. Body weights of steers preconditioned on suppressed pastures were similar ($P > 0.10$) to the nontoxic steers, except for 0 and 8 DNTD in the first year and 6 DNTD in the second year. Body weights for steers on unsuppressed pastures were less ($P < 0.10$) than those of nontoxic steers over all DNTD in each year. Results indicated that chemical seedhead suppression of E+ fescue can relieve alkaloid-induced vasoconstriction and improve postgraze performance.

Key words: beef cattle, endophyte, fescue toxicosis, tall fescue

INTRODUCTION

Kentucky 31 tall fescue is the predominant grass used for grazing in the transition zone between the temperate northeast and subtropical southeast of the United States. Unfortunately, a fungal endophyte (*Epichloe coenophiala*) that infects most Kentucky 31 fescue plants produces ergot alkaloids that can induce toxicosis in cattle. Fescue toxicosis causes cattle to be severely heat stressed in moderate air temperatures (Aldrich et al., 1993; Al-Haidary et al., 2001). Ergot alkaloids bind biogenic amide receptors in the vasculature to induce persistent vasoconstriction, which reduces blood flow to peripheral tissues and incapacitates the animal's ability to thermo-regulate core body temperature (Rhodes et al., 1991; Oliver, 2005). Cattle exhibiting signs of fescue toxicosis also have a rough coat during the summer and have reduced prolactin concentrations (Schmidt and Osborn, 1993; Strickland et al., 1993, 2011).

Chaparral herbicide (Dow AgroSciences Inc., Indianapolis, IN) contains metsulfuron methyl, which has been demonstrated to suppress seedhead emergence of tall fescue (Aiken et al., 2012). Seed heads contain the highest concentrations of ergot alkaloids and, coincidentally, are selectively grazed by cattle (Aiken et al., 1993; Goff et al., 2012). Aiken et al. (2012) reported greater ADG and a 2-fold increase in serum prolactin concentrations for steers grazing seedhead-suppressed toxic endophyte–infected (**E+**) tall fescue compared with those grazing unsuppressed E+ tall fescue. Maintaining tall fescue in a vegetative stage of growth also was found to increase CP of leaf blade tissues, and there was an overall increase in CP and IVDMD of suppressed E+ tillers (Aiken et al., 2012; Goff et al., 2015). Aiken et al. (2012) reported that leaf blades and sheaths of suppressed and unsuppressed E+ plants had similar concentrations of the ergovaline, which indicated that the benefit of seedhead suppression is through

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alleviation of toxic seedheads and improving the nutritive value of suppressed tall fescue.

It is uncertain whether vascular saturation of ergot alkaloids in cattle that graze seedhead-suppressed E+ fescue is less than those grazing unsuppressed E+ fescue. It also is not known whether the improved BW gain performance with consumption of suppressed E+ fescue can benefit postgraze performance with a nontoxic diet. A pen study was conducted with the objective to compare vasoconstriction of the medial caudal artery and BW gain between steers previously grazed on seedhead-suppressed and unsuppressed E+ fescue pastures, and a bermudagrass, white clover, and Kentucky bluegrass mixed nontoxic pasture.

MATERIALS AND METHODS

The research was conducted for 2 consecutive years at the University of Kentucky's C. Orin Little Research Farm in Versailles, Kentucky. The experiment consisted of 2 phases; (1) a pasture preconditioning phase to expose the cattle to ergot alkaloids and (2) a pen experiment to monitor changes in luminal areas of the median caudal artery and unshrunk BW. Angus crossbred steers were used in both years. All animal care and use procedures were reviewed and approved by the University's Institute Animal Care and Use Committee.

Pasture Preconditioning Phase

In the first year (2012), 36 steers with mean BW of 323 ± 29 (SD) kg were randomly assigned to 1 bermudagrass–white clover control and 2 toxic E+ tall fescue pastures (n = 12 steers per pasture treatment) with 1 tall fescue pasture being sprayed with Chaparral herbicide to suppress seedhead emergence of tall fescue and the other not being spraying with the herbicide. Steers on each treatment were rotationally stocked using two 3.0-ha paddocks (stocking rate = 2 steers/ha) to provide 2 wk of grazing and 2 wk of rest for each pasture. The nontoxic control pasture contained 'Wrangler' bermudagrass in mixture with 'Will' ladino white clover, and Kentucky bluegrass. Grazing was initiated on March 29 and terminated on July 11 (103 d of grazing). The pastures were stocked lightly to allow accumulation of seedheads.

In the second year (2013), 11 steers were assigned to unsuppressed toxic endophyte–infected pasture and 12 were assigned to the 3.0-ha nontoxic control pasture used in the first year. Six tester steers from seedhead-suppressed pastures were randomly chosen from tester steers used by Williamson et al. (2016). The initial mean BW was 244 ± 28 kg, and all steers were selected from the same contemporary group of steers. Grazing was initiated on April 16 and terminated on July 8 (83 d of grazing). All pastures were continuously stocked at rates of 3.7 steers/ha for the unsuppressed treatment and 4.0 steers/ha for the nontoxic pastures. Although the unsuppressed and control pastures had fixed stocking rates, the suppressed pasture used variable stocking to control forage mass to within a range that minimized the effect of forage mass on animal performance (Mott and Lucas, 1953). The average stocking rate for this treatment was 3.6 steers/ha. Six steers from each preconditioning treatment were randomly chosen for monitoring during the pen phase.

The pastures assigned the Chaparral treatment were sprayed on March 19, 2012, and April 8, 2013, when the tall fescue was in a vegetative stage of growth. The herbicide was sprayed in quantities each year to provide 13.2 g of metsulfuron-methyl/ha and 87.1 g of aminopyralid/ha. Unsuppressed pastures were sprayed with Milestone (Dow AgroSciences Inc.) for weed control, which was applied at a rate that delivered the same amount of aminopyralid per hectare as the Chaparral treatment. Pastures were fertilized on March 15, 2012, and March 28, 2013, with polycoated urea (ESN, Agrium Inc., Calgary, Alberta, Canada) to apply 62 kg of N/ha.

All animals were treated with moxidectin (Cydectin, Fort Dodge Animal Health, Fort Dodge, IA) on the initial weigh date in both years. Steers were implanted with Synovex S (200 mg of progesterone, 20 mg of estradiol; Fort Dodge Animal Health). Steers were offered free-choice minerals [2013: Burkmann Mills, Danville, KY (zinc, 3.5 g/kg of DM minimum; manganese, 2 g/kg of DM minimum; iron, 2 g/kg of DM minimum; copper, 0.3 g/kg of DM minimum; selenium, 0.09 g/kg of DM maximum; iodine, 0.07 g/kg of DM minimum; cobalt, 0.05 g/kg of DM minimum)].

Forage mass was not measured in preconditioning pastures because stocking rates were considered too light to generate grazing pressures that could limit animal performance (Mott and Lucas, 1953; Mott, 1960; Sollenberger and Vanzant, 2011). At 2-wk intervals for each year, single whole tillers of tall fescue were clipped, at the plant crown from 25 randomly selected plants from each tall fescue pasture. To remove any negate bias toward selecting vegetative or reproductive tillers, a single tiller was grabbed for clipping at the base of the plant without observing whether it was vegetative or reproductive. The samples were freeze-dried in a Botanique Model 18DX485A freeze drier (Botanique Preservation Co., Peoria, AZ) and ground to pass a 1-mm mesh screen (Cyclotec 1093 sample mill, FOSS North America, Eden Prairie, MN). Samples were analyzed for ergovaline and its stereoisomer, ergovalinine, using a modification described by Carter et al. (2010) of the HPLC fluorescence procedure of Yates and Powell (1988).

Pen Phase

At the termination of the preconditioning phase, the steers were randomly placed in 2 adjacent pens partially covered by a 3-sided barn. In the first year, the pen phase was conducted from July 11 to August 22 (42-d duration), and in the second year it was conducted from July 10 to August 20 (41-d duration). Steers were group fed free-choice corn silage and 2.3 kg of soybean hulls per steer