Steer Responses to Feeding Soybean Hulls on Toxic Tall Fescue Pasture

G. E. Aiken,*2 PAS, L. K. McClanahan,† and F. N. Schrick‡

*USDA-ARS, Forage-Animal Production Research Unit, Lexington, KY 40546; †Kentucky Cooperative Extension Service, Harrodsburg 40330; and ‡Department of Animal Science, University of Tennessee, Knoxville 37996-4574

ABSTRACT

A grazing experiment was conducted in 2004 and 2005 to evaluate effects of feeding pelleted soybean hulls (SBH) on weight gain, hair coat rating, rectal temperature, and serum prolactin of steers grazed on toxic tall fescue [Schedonorus arundinaceus (Schreb.)]. Forty steers [initial BW in 2004 = 257 ± 22 (SD) kg; initial BW in 2005 = 348 ± 27 kg] were assigned to five 3-ha pastures of toxic tall fescue that were randomly assigned either with (n = 2) or without (n = 3) pelleted SBH (2.3 kg/d per steer, as fed) feeding. Grazing was initiated in early June and was terminated at 112 d of grazing in 2004 and at 102 d of grazing in 2005. Feeding pelleted SBH increased (P < 0.05) ADG. Although the response to SBH was not different (P > 0.10) between the 2 yr, ADG was less in 2005 when there was drier weather. Cost of additional ADG from feeding pelleted SBH was below a breakeven of $120/ton pelleted SBH for a cattle price of $1.76/kg BW. Percentages of steers with rough hair coat rating averaged 93% and were not different (P > 0.10) between treatments at the conclusion of grazing in both years. Rectal temperatures were not different (P > 0.10) between years and treatments. Prolactin concentrations were not different (P > 0.10) between treatments in 2005, but tended to be lower in SBH steers in 2005. Results indicated that feeding pelleted SBH can cost-effectively increase steer weight gain, but will not alleviate or reduce severity of toxicosis.

Key words: beef cattle, tall fescue, fescue toxicosis, soybean hulls

INTRODUCTION

Tall fescue is a cool-season perennial grass that is grown on approximately 15 million ha east of the Great Plains between the temperate Northeast and subtropical Southeast (Thompson et al., 2001), a region commonly referred to as the “fescue belt.” An endophyte (Neotyphodium coenophialum) infects tall fescue plants and produces ergot alkaloid toxins that induce fescue toxicosis. Symptoms of the malady include retention of rough hair coat, elevated body temperature, labored respiration, decreased serum prolactin, and poor BW gain (Schmidt and Osborn, 1993). Consequently, cattle exhibiting toxicosis can undergo severe heat stress in the presence of high ambient temperature and humidity (Hemken et al., 1981; Spiers et al., 2005).

Poor BW gain and market value of cattle exhibiting symptoms of toxicosis have limited the widespread use of tall fescue for commercial stocker production (Hoveland, 1993). Average daily gain on endophyte-infected tall fescue is typically low, ranging from 0.20 to 0.60 kg/d (Paterson et al., 1995). Interseeding clovers or feeding concentrates has been recommended as a method to dilute ergot alkaloids in the diet and reduce their adverse effects on animal performance and physiology (Ball, 1984; Ball et al., 2002). Stokes et al. (1988) reported 2-fold greater ADG for steers grazed on toxic tall fescue and supplemented with ground corn at 0.65% of BW (0.49 kg/d) than for those not supplemented (0.24 kg/d), but serum prolactin was lower in steers that were supplemented on toxic fescue than in those grazed on endophyte-free fescue. Aiken et al. (1998) reported that feeding a broiler litter-ground corn mixture to steers
on toxic fescue increased ADG and reduced the severity of toxicosis, but low serum prolactin concentrations and rough hair coats indicated that toxicosis was not completely eliminated. Increasing BW gain on toxic tall fescue may be related to increases in digestible OM intake and not to complete alleviation or reduction of fescue toxicosis. A grazing experiment was conducted with toxic fescue to evaluate the effects of feeding soybean hulls (SBH) on steer ADG and to determine if there was effective dilution of ergot alkaloids to alleviate or reduce the severity of fescue toxicosis.

MATERIALS AND METHODS

A grazing experiment was conducted with yearling steers in 2004 and 2005 at the University of Kentucky Animal Research Center in Woodford County. An initial pasture phase was conducted to evaluate effects of feeding SBH. The experimental protocol was reviewed and accepted by Institution’s Animal Care and Use Committee at the University of Kentucky.

Forty crossbred steers, primarily of Angus breeding, in each year were stratified by BW for assignment to five 3.0-ha pastures of 20+ yr-old stands of toxic tall fescue. Steers were supplemented with (n = 2) or without pelleted SBH (n = 3) treatments in a completely randomized design. Cattle were placed in pastures for a 6-d adjustment period before recording initial unshrunk BW on June 3, 2004 [initial BW = 257 ± 22 (SD) kg] and June 2, 2005 (initial BW = 348 ± 27 kg). Steers in 2004 were weighed at 28-d intervals until grazing was terminated at 112 d. In 2005, they were weighed at 28, 56, and 98 d of grazing. Cattle were treated initially and at 56 d with doramectin pour-on dewormer (Pfizer Animal Health, Exton, PA).

Steers in pastures assigned the pelleted SBH treatment were group-fed daily between 0900 and 1000 h to provide as-fed consumption of 2.3 kg/d per steer and maintain consumption of 0.5 to 1.0% of BW over the duration of grazing. The SBH was pelleted to control dust. Steers in each pasture were provided free-choice trace mineralized salt (salt, 92.0% minimum; Zn, 0.35% minimum; Mn, 0.2% minimum; Fe, 0.2% minimum; Cu, 0.03% minimum; Se, 0.009% maximum; I, 0.007% minimum; Co, 0.005% minimum; Cargill Salt, Minneapolis, MN).

On the final day of grazing, hair coats were rated, rectal temperatures were recorded, and blood samples were collected. Hair coats were rated as sleek, rough, or transitional (i.e., some roughness of hair over the rump and shoulder regions). Rectal temperatures were taken with a Cooper digital thermometer (Cooper-Atkins Corp., Middlefield, CT). Blood was centrifuged for 15 min at 10,000 × g to obtain serum, which was stored frozen (0°C) and subsequently assayed for prolactin following procedures of Bernard et al. (1993).

Pastures were fertilized before grazing in both years with N at a rate of 67 kg/ha. Forage mass was monitored with a disk meter that was similar in design to one described by Bransby et al. (1977), with the exception that the falling plate was 32 cm in diameter. Disk meter height was recorded for 50 random locations within each pasture at 14-d intervals. On August 17, 2004, and October 22, 2005, forage was clipped to ground level beneath the disk meter plate for 5 locations within each pasture. Locations were chosen to provide a wide range in disk meter heights. These samples were dried at 60°C in a forced-air oven for 72 h and then weighed. Dry matter per unit of land area was subsequently regressed on disk meter height.

Rainfall data was collected from a weather station that was within 1 km of the experimental site. Single tillers from 50 random plants within each pasture were collected on June 3 and September 22 in 2004 and on July 26 and September 9 in 2005. Tillers were placed on ice and subsequently freeze-dried in a Botanique Model 18DX485A freeze-drier (Botanique Preservation Co., Peoria, AZ), ground through a 1-mm screen, and assayed for ergovaline by HPLC fluorescence using a modification of a procedure developed by Yates and Powell (1988). Separation was conducted with an Altima C18 150 mm × 4.6 mm column with 3 μ particle size (Alltech Inc., Nicholasville, KY). Elution solutions were 75 mM ammonium acetate (A) in water:acetonitrile (3:1, vol/vol) and acetonitrile (B). Elution gradient was as follows: 95:5 (A:B) for 1 min; linear change to 60:40 (A:B) during the next 15 min and maintained for 5 min; changed to 0:100 (A:B) in 1.5 min and maintained for 5 min; changed to 100:0 (A:B) in 1 min, and maintained for 6 min before returning to 95:5.

Statistical Analyses

Responses were analyzed using PROC MIXED of SAS (Littell et al., 1996). Pasture was used in all analyses as the experimental unit. Pasture and pen treatments were re-randomized each year to evaluate year as the main plot component of the statistical models (Steel and Torrie, 1980). Year was analyzed as a fixed effect to evaluate year × treatment interactions. Responses to feeding pelleted SBH were analyzed as the split-plot feature of the model. Distributions of hair coat ratings taken at the conclusion of the pen phase were analyzed using the chi-square test in SAS to determine associations with feeding pelleted SBH.

Cost of additional BW gain was analyzed following procedures described by Aiken (2002). Costs of pelleted SBH per incremental kilogram increase in ADG (cost of additional gain over the control) were calculated over a range of pelleted SBH costs of $70 to $200/ton pelleted SBH at $10 intervals. Cost of additional gain was analyzed using PROC TTEST in SAS to determine cost combination to determine the maximum pelleted SBH cost to obtain a cost of additional ADG that was lower (P < 0.05) than breakeven costs that were set to rep-
resent cattle prices of $1.76/kg BW ($0.80/lb BW), $1.98/kg BW ($0.90/lb BW), $2.20/kg BW ($1.00/lb BW), and $2.43/kg BW ($1.10/lb BW).

RESULTS AND DISCUSSION

Ergovaline Concentrations

Concentrations of ergovaline averaged 0.24 ± 0.24 (SD) and 0.44 ± 0.17 µg/g DM on June 3 and September 22, respectively, in 2004, and 0.62 ± 0.21 and 0.84 ± 0.11 µg/g DM, respectively, on July 26 and September 9, respectively, in 2005. Generally greater ergovaline concentrations in 2005 could have been related to drier weather patterns. During the experimental periods there was 247 mm of rainfall in 2004 and 189 mm of rainfall in 2005, but 91 mm of the rainfall in 2005 was over a 6-d period (Figure 1).

Although a threshold concentration of ergovaline has not been established for eliciting toxicosis symptoms, a bioassay conducted by Klotz et al. (2007) with the bovine lateral saphenous vein indicated that ergovaline is a potent vasoconstrictor. A vasoconstriction response was elicited with a 1 × 10⁻⁸ M ergovaline concentration. It was suggested that abundance of ergovaline in the plant, high potency, and the binding strength of the alkaloid to biogenic amide receptors could result in slow accumulation in tissue.

Forage Availability

Forage availability averaged 4,496 ± 47 (SEM) kg DM/ha and was not affected (P > 0.10) by feeding pelleted SBH. The stocking rate was set low (2.7 steers/ha) to encourage forage accumulation, a condition that promotes higher ergot alkaloid concentrations in tall fescue (Belesky and Hill, 1997). There was no year effect even though rainfall was greater in 2004. Accumulated forage growth in the spring of 2005 was minimally grazed. Consumption of SBH likely resulted in substitution for toxic tall fescue (Goetsch et al., 1987); however, that was not expressed in the forage availabilities. Methodologies used to estimate forage availability generally lack the accuracy and precision necessary to detect differences in forage availability attributable to differential DMI (Aiken and Bransby, 1992).

Weight Gain

Average daily gain with feeding pelleted SBH (0.53 ± 0.03 kg/d) was greater (P < 0.001) than without pelleted SBH feeding (0.31 ± 0.02 kg/d), and the ADG response was similar between the 2 years (Table 1). Weight gains in 2004 (0.55 ± 0.56 kg/d), when there was greater rainfall, were greater (P < 0.001) than those in 2005 (0.29 ± 0.02 kg/d). Aiken et al. (1998) reported similar ADG between steers grazed on endophyte-infected tall fescue and fed 2.3 kg/d (as fed) of a deep-stacked broiler litter-ground corn mixture compared with nonsupplemented steers grazed on noninfected tall fescue. Furthermore, supplementation with the litter-corn mixture for steers on endophyte-infected tall fescue resulted in an 81% increase in ADG. Supplementation with cracked corn or corn gluten meal also has increased ADG of steers grazing endophyte-infected tall fescue, but with no effect on ruminal fermentation or OM digestion (Elizalde et al., 1998).

Cost of Weight Gain

Cost of additional ADG with feeding 2.3 kg pelleted SBH/steer was below the breakeven cost with highest cattle price ($2.43/kg BW) for a wide range of pelleted SBH prices (<$170/ton; Figure 2). However, breakeven pelleted SBH costs with the intermediate cattle prices (<$150/ton and <$140/ton for the $2.20 and $1.98/kg BW prices, respectively) suggest that higher volume, bulk purchases of pelleted SBH are likely needed to reduce SBH costs to provide a net return from the additional weight gain. Breakeven costs with the $1.76/kg BW cattle price were <$120/ton, which indicated that a low cost of pelleted SBH will be needed to provide a net return from additional BW gain in the presence of low cattle prices.

Figure 1. Rainfall data for months in 2004 and 2005 that the grazing experiment was conducted, and the 12-yr average.
There were no differences ($P > 0.10$) in hair coat ratings between years and treatments at the conclusion of grazing. Combined over years and treatments, 93.0% of the hair coats were rough, 2.8% were transitional, and 4.2% were sleek. The low frequency of transitional and sleek hair coats indicated consumption rate of SBH was not sufficient to dilute the ergot alkaloids and alleviate the rough hair coat symptom. Therefore, the rough hair coat symptom of cattle grazing toxic tall fescue is not a good indicator of poor weight gain if the cattle are fed supplements. Transitional and sleek hair coat ratings for fescue-fed cattle in the late summer can be attributed to either genetics or the actual shedding of rough hair coats (Olson et al., 2003).

**Rectal Temperature**

Rectal temperatures were not different ($P > 0.10$) between steers with and without feeding pelleted SBH, and the responses were not different between years ($P > 0.10$). Although there was not a nontoxic fescue control in the experiment to determine if the rectal temperatures reflected those of steers exhibiting toxicosis, the rectal temperatures were elevated compared with those indicative of a healthy and stable animal (Smith, 1986). Furthermore, mean ambient temperature on days the grazing trial was concluded in 2004 (21.8°C) and 2005 (22.6°C) were likely too low to dramatically elevate rectal temperatures. Body temperature in steers with and without SBH appeared to be elevated to the same extent, which suggests that dilution of ergot alkaloids with feeding pelleted SBH was not sufficient to improve dissipation of excessive body heat.

**Serum Prolactin**

Serum prolactin concentrations were not different ($P > 0.10$) between treatments in both years, but were greater ($P < 0.05$) in 2005, even though ergovaline concentrations in fescue were numerically higher in 2005 than in 2004. Prolactin concentrations were much lower than those reported by Aiken et al. (1998) and Aiken et al. (2006), but measurements in those experiments were done in the late spring and early summer when the longer day length increases prolactin concentrations; measurements in the present experiment were done in the late summer when the shorter day length decreases prolactin concentrations (Karg and Schams, 1974). Similar to rectal temperatures, lack of a nontoxic control negated a determination of whether the prolactin concentrations reflected those of steers exhibiting toxicosis.

### Table 1. Average daily gain, rectal temperature, and serum prolactin for steers grazed on toxic tall fescue pastures in 2004 and 2005, with or without feeding pelleted soybean hulls (SBH) at a daily consumption of 2.3 kg/d per (as fed)

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<tbody>
<tr>
<td>ADG, kg/d</td>
<td>0.66a</td>
<td>0.45b</td>
<td>0.41a</td>
<td>0.16b</td>
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<tr>
<td>Rectal temperature, °C</td>
<td>40.5</td>
<td>40.6</td>
<td>40.9</td>
<td>40.5</td>
</tr>
<tr>
<td>Serum prolactin, ng/mL</td>
<td>2.1</td>
<td>1.5</td>
<td>3.7</td>
<td>6.1</td>
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*Least square means of treatments within years with different letters are different ($P < 0.05$).

*Effects: year, $P < 0.0001$; treatment, $P < 0.0001$; year × treatment, $P > 0.10$.

*Effects: year, $P < 0.10$; treatment, $P > 0.10$; year × treatment, $P > 0.10$.

*Effects: year, $P < 0.05$; treatment, $P > 0.10$; year × treatment, $P > 0.10$.

**Figure 2.** Trends in costs of additional ADG from pelleted soybean hulls (SBH) fed to steers on toxic tall fescue with a consumption of 2.3 kg/d (as fed) over a range of pelleted SBH costs. Points in trend lines are those whereby equal or lower pelleted SBH costs were statistically lower ($P < 0.05$) than breakeven costs for cattle selling prices of $1.76, $1.98, $2.20, and $2.43/kg BW.
fescue toxicosis. However, prolactin concentrations increased once the steers were placed on a nontoxic diet (Aiken et al., 2008). Aiken et al. (1998) reported greater serum prolactin in cattle grazing endophyte-free tall fescue than those grazing toxic tall fescue, and feeding a broiler litter-ground corn supplement to steers on toxic tall fescue did not increase prolactin concentrations. Similarly, feeding pelleted SBH at the consumption rate offered in the present experiment did not increase prolactin concentrations.

**IMPLICATIONS**

Feeding pelleted SBH to steers grazing toxic fescue pasture can cost effectively increase ADG. This management has the greatest promise with higher cattle prices; with lower cattle markets, pelleted SBH will need to be purchased at lower costs to improve chances of obtaining profitable additional weight gain. Studies are needed, however, to determine if lower amounts of SBH can be fed to lower breakeven costs without overly compromising weight gain. Steers with and without pelleted SBH had a high percentage of rough hair coats and similar rectal temperatures and serum prolactin concentrations, which indicate that feeding pelleted SBH did not effectively dilute the ergot alkaloids. Results of the experiment indicated that feeding pelleted SBH will cost effectively increase weight gain without alleviating fescue toxicosis or reducing its severity.

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**LITERATURE CITED**


