ABSTRACT: Crossbred steers were grazed in the spring and early summer on endophyte-infected (*Neotyphodium coenophialum*), Kentucky-31 tall fescue (*Lolium arundinaceum*) pastures to evaluate effects and interactions of feeding pelleted soybean hulls (PSBH) and steroid hormone implants (SHI) on steer performance, serum prolactin, and hair coat ratings (HCR). Steers were stratified by BW for assignment to six 3.0-ha toxic tall fescue pastures. With or without daily PSBH feeding, treatments were assigned randomly to pastures as the main plot treatment in a split-plot design. Pelleted soybean hulls were group-fed to provide 2.3 kg(steer·d−1) (as fed). With or without SHI (200 mg of progesterone and 20 mg of estradiol) treatments were randomly assigned as the subplot treatment to 2 steer subgroups within each pasture. Sixty-four steers were grazed for 77 d in 2007, and 60 steers were grazed for 86 d in 2008. Pasture forage mass declined linearly over time, but the rate of decline was greater (*P* = 0.001) in 2007 than in 2008. Pasture forage mass was never below 2,300 kg of DM/ha in either year. Average daily gain for steers on the combined PSBH and SHI treatments was greater (*P* < 0.01) than for those on the PSBH-only, SHI-only, and control (no SHI, no PSBH) treatments. Average daily gain for the PSBH-only steers was greater (*P* < 0.01) than for SHI-only and control steers and tended (*P* = 0.063) to be greater for SHI-only than for control steers. Steroid implants did not affect (*P* = 0.826) serum prolactin concentrations; however, prolactin concentrations in PSBH steers, with or without SHI, were increased (*P* = 0.01) 2-fold over SHI-only and control steers. Feeding PSBH and SHI treatments both reduced (*P* < 0.05) the percentage of steers with rough HCR, and a greater percentage of steers fed PSBH tended (*P* = 0.076) to have sleek hair coats. An economic analysis was conducted, which determined that costs of additional ADG with PSBH feeding were below breakeven costs over a wide range of PSBH costs and cattle prices. Breakeven costs for PSBH-only treatment for a range of cattle prices of $1.80 to $2.40/kg of BW were less than $120/t, whereas with PSBH feeding combined with SHI the breakeven cost was less than $240/t. Results indicate that steers grazing endophyte-infected tall fescue can be fed PSBH and implanted with steroid hormones to cost effectively increase ADG and that feeding PSBH can increase serum prolactin concentrations and induce some shedding of rough hair coats.

Key words: beef cattle, fescue toxicosis, hair coat, prolactin, soybean hull, steroid hormone implant

INTRODUCTION

Tall fescue (*Lolium arundinaceum* L.) is a cool-season perennial grass and is the predominant pasture grass in the fescue belt, which extends from the lower temperate northeast United States to the upper subtropical south-
phytate-infected tall fescue may be implanted with ster-roid hormones to improve BW gain (Coffey et al., 1992; Bransby et al., 1994; Aiken et al., 2006). In addition, feeding grains or oilseed coproducts to cattle grazing endophyte-infected tall fescue increased BW gain and body condition (Aiken et al., 2008). Feeding grains or coproduct feeds in combination with steroid hormone implants (SHI) may have additive effects on BW gain of cattle grazing endophyte-infected fescue and possibly mitigate the adverse effects of fescue toxicosis. Therefore, the objective was to determine if feeding pelleted soybean hulls (PSBH) in combination with SHI would mitigate fescue toxicosis in steers grazing endophyte-infected fescue pastures.

**MATERIALS AND METHODS**

The experimental protocol was reviewed and approved by the Institutional Animal Care and Use Committee at the University of Kentucky (UK). Grazing experiments were conducted for 77 and 86 d in 2007 and 2008, respectively, at the UK Animal Research Center (UK-ARC) in Woodford County, Kentucky.

Six 3.0-ha pastures of Kentucky-31 tall fescue (Lolioarundinaceaeum), infected with the toxic, wild-type endophyte (Neotyphodium coenophialum), were used in the experiment. Two adjacent pastures were treated as blocks, with 2 blocks of pastures being on a Maury (fine, mixed, semiactive, mesic Typic Paleudalfs) silt loam soil and the third block being on a McAfee (fine, mixed, active, mesic Mollic Hapludalfs) silt loam soil. Treatments were assigned to pastures using a split-plot design with 3 replications. With or without feeding PSBH treatments were assigned to pastures within blocks as the main plot treatments, and with or without SHI treatments were assigned to 2 steer subgroups within each pasture as the subplot treatments.

Steers (8 to 12 mo old; primarily Angus crossbred) were received approximately 2 wk before initiation of data collection and placed on dormant bermudagrass [Cynodon dactylon (L.) Pers.,] with free-choice access to endophyte-infected tall fescue hay. Steers were purchased locally and previously weaned for a minimum of 45 d before sale.

Before assignment of SHI treatments, steers were assigned to subgroups within pastures so that mean BW and variance in BW was similar across the 12 subgroups. Sixty-four steers (initial BW (±SD) = 292 ± 26 kg) were used in 2007. To balance steer numbers among treatments, 6 steers were assigned to implant subgroups in the 2 pastures of 1 block and 6 steers were assigned to nonimplant subgroups in the 2 pastures of another block. In all remaining subgroups, n = 5. Sixty steers were used in 2008 (initial BW = 300 ± 27) to provide equal numbers of steers in each pasture subgroup. Stocking rates were set low to encourage forage accumulation, a condition that promotes greater ergot alkaloid concentrations in tall fescue (Belesky and Hill, 1997). Steers in pastures assigned to the feeding treat-ment were group-fed daily to provide 2.3 kg of PSBH steer/d (as fed).

The grazing study was conducted from April 19 to July 5 in 2007, and from April 29 to 24 July in 2008. Cattle were provided free-choice access to trace minerals (Zn, 0.35% minimum; Mg, 0.2% minimum; Fe, 0.2% minimum; Cu, 0.03% minimum; Se, 0.009% maximum; I, 0.007% minimum; Co, 0.005% minimum; DM basis).

Pastures were fertilized in early April 2007 at a rate of 67.2 kg of N/ha using aqueous N. In 2008, pastures were fertilized in late March with 28 kg of N/ha, and an additional 56 kg of N/ha was applied in early April, generating a total of 84 kg of N/ha. Pastures were mowed to a 20- to 30-cm stubble height the first week of June of each year to remove seedheads and minimize risk of pinkeye infections (infectious bovine keratoconjunctivitis). Pastures were also mowed to a 15- to 20-cm stubble height approximately 2 wk before grazing in 2008 to remove excessive residual herbage from fall growth. This mowing occurred during peak growth to provide substantial regrowth before grazing. Early mowing was not done in 2007 because accumulation of summer and fall growth in 2006 was low due to low rainfall.

Steers were placed in pastures on April 13 in 2007 and April 23 in 2008 for a 6-d adjustment period to pastures and to allow activation of implants before taking initial BW. Steers were treated with moxidectin dewormer (Cydectin, Fort Dodge Animal Health, Fort Dodge, IA), and subgroups assigned to receive the SHI treatment were ear-implanted with Synovex-S (200 mg of progesterone, 20 mg of estradiol; Fort Dodge Animal Health, Fort Dodge, IA) before the start of grazing.

Cattle were weighed unshrunk on April 19, May 17, June 14, and July 5 (termination of grazing) in 2007, and on April 29, May 27, June 24, and July 24 in 2008. Duration of grazing was enough days to minimize any confounding effects of gut fill on BW gain that can occur when measuring unshrunk BW over durations less than 67 d (Aiken and Tabler, 2004). Ten milliliters of blood was collected from the jugular vein on the last 2 dates in each year. Blood was centrifuged for 15 min at 10,000 × g (20°C), and serum was stored frozen (−25°C) for assaying prolactin following procedures of Bernard et al. (1993). The intra- and interassay CV of samples collected in 2008 were 10.0 and 8.4%, respectively, and for samples collected in 2007 they were 10.0 and 12.0%, respectively. On the date when final BW were recorded, hair coats were rated as being sleek (less than 25% coverage by rough hair), transitional (25 to 75% coverage by rough hair), or rough (greater than 75% coverage of rough hair; Aiken et al., 1998, 2008).

Ultrasoundography was used to measure growth in cross-sectional area of the LM and external fat thickness as an indicator of body condition. Ultrasound scans were taken the day before taking initial BW and the day after final weighing with an Aloka SSD-500V (Tokyo, Japan) instrument with a 3.5-MHz linear array transducer (UST 6049; 170-mm window). A certified ultrasound technician scanned between the 12th and
13th ribs to acquire cross-sectional area of the LM and rib fat thickness (1213RFT). Initial LM area (LMA) in 2007 and 2008 were 42.2 ± 4.5 and 47.3 ± 1.1 cm², respectively, and initial 1213RFT in 2007 and 2008 were 3.2 ± 0.4 and 3.3 ± 0.4 mm, respectively. A second scan was taken horizontally between the pin and hook bones over the rump to measure rump fat thickness (RFT). Initial RFT in 2007 and 2008 were 3.1 ± 0.1 and 3.0 ± 0.1 mm, respectively.

Pasture forage mass was measured to verify that light stocking rates resulted in greater forage masses using a disk meter with a diameter of 45 cm and a weight of 1.9 kg, as described by Bransby et al. (1977). Disk meter height (DMH) was recorded for 50 randomly chosen locations within each pasture at 14-d intervals. Calibration samples were collected on June 22 in 2007 and June 17 in 2008 by clipping forage below the disk meter plate to the soil surface at 5 random locations per pasture. All samples were dried at 60°C in a forced-air oven for 48 h and weighed. Calibration equations were calculated by regressing sample dry weight over DMH to estimate forage mass (kg of DM/ha) from mean DMH for each pasture [2007: forage mass = 709 + 563 DMH (cm), r² = 0.82; 2008: forage mass = 197 + 136 DMH (cm), r² = 0.72].

Single tillers were clipped at the plant crown from 50 randomly chosen plants within each pasture to determine the ergovaline concentrations of herbage. Tiller samples were collected on April 25, May 8, May 22, June 5, June 22, and July 7 in 2007, and April 30, May 19, June 5, June 17, June 30, and July 16 in 2008. Tillers were placed on ice and subsequently freeze-dried (Botanique model 18DX485A freeze drier, Botanique Preservation Co., Peoria, AZ), ground through a 1-mm screen, and assayed for ergovaline by HPLC florescence using a modification of a procedure developed by Yates and Powell (1988). Separation was conducted with an Alltima C18 150-mm × 4.6-mm column with a 3-μm particle size (Grace Davison Discovery Science, Deerfield, IL). Elution solutions were 75 mM ammonium acetate (A) in water:acetonitrile (3:1, vol/vol) and acetonitrile (B). Elution gradient was 95:5 (A:B) for 1 min; linear change to 60:40 (A:B) during 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.

Single tillers of 50 plants were also clipped at the crown in each pasture on June 5 in 2007 to estimate endophyte infection levels. Tiller samples were frozen (−20°C) until analyzed using immunoblot test kits obtained from Agrinoistics Ltd. Co. (Watkinsville, GA).

Breakeven cost of PSBH for additional BW gain achieved, with and without SHI, was analyzed following procedures described by Aiken (2002). Costs of PSBH per incremental kilogram increase in ADG (over the control) were calculated over a range of PSBH costs of $70 to 350/t at $10 intervals. Cost of additional BW gain was analyzed using PROC TEST (SAS Inst. Inc., Cary, NC) to determine at which costs of additional ADG for each treatment and PSBH cost combination were significantly less (P < 0.05) than breakeven costs to generate potential profit from the additional ADG. Breakeven costs were analyzed for 4 cattle prices: $1.80, $2.00, $2.20, and $2.40/kg of BW.

Data were analyzed as randomized block design with a split-plot treatment arrangement using a mixed model (PROC MIXED, SAS Inst. Inc.). Data were examined as a split-plot design using subgroup within pasture as the experimental unit for animal responses (n = 12) and pasture as the experimental unit for pasture responses (n = 6). Animal responses were analyzed for the following effects: year (error a = block × year), PSBH, year × PSBH [error b = block × PSBH (year)], SHI, year × SHI, PSBH × SHI, and year × PSBH × SHI (error c = residual error). Pasture responses were analyzed for effects of year (error a = block × year), PSBH, and year × PSBH (error b = residual error). Means separations were performed with the appropriate error terms on least squares means using pairwise contrasts (PDIFF option of SAS). Hair coat ratings (HCR) were not independent within steer subgroups, so each rating was analyzed separately for the same effects as the other animal responses, but these data were transformed with an arcsine function to stabilize the variances (Steel and Torrie, 1980). Because sampling dates were different in each year, days of year that samples were collected were evaluated as a continuous variable. Year and PSBH feeding were evaluated as discrete variables and day of year (DOY) was analyzed so as to determine linear, quadratic, and cubic trends over time. Effects were determined at the α = 0.05 level of significance, and tendencies of effect were determined at the α = 0.10 level of significance.

**RESULTS AND DISCUSSION**

**Forage Mass**

Least squares means for forage mass were greater (P = 0.001) in 2007 (3,947 ± 98 kg of DM/ha) than in 2008 (2,653 ± 96 kg of DM/ha). Rainfall was likely a contributing factor for differences in forage growth; rainfall during 2008 was consistently less than the 14-yr average (University of Kentucky, 2010), whereas in 2007 it was greater than the average in April and July (Figure 1). Furthermore, there was 12 cm of rainfall over the 30 d before the start of grazing in 2007 and only 5 cm of rainfall during the same period in 2008.

Fixed, continuous grazing resulted in linear declines in forage mass over time, but there was a year × DOY interaction (P < 0.001) on forage mass, with the rate of decline being faster in 2007 than in 2008 (Figure 2). Although forage declined over time, it was greater than 2,300 kg of DM/ha at the termination of grazing in both years, which indicated that forage mass did not limit animal performance (Martz et al., 1999).
Feeding PSBH reduced forage mass in 2007 ($P < 0.01$), but not in 2008 ($P = 0.263$; Figure 2). Linear slopes were similar ($P = 0.313$) between with and without PSBH treatments even though a PSBH effect would not be expected until later DOY. Greater DMI with feeding PSBH in 2007 apparently began reducing forage mass before taking the first forage mass measurements on d 19 after the PSBH treatment was initiated. Greater pasture growth and forage mass in 2007, as compared with 2008, may have improved selective grazing to facilitate greater DMI by steers fed PSBH.

Endophyte Infection Levels and Ergovaline Concentrations

Pastures averaged endophyte infection levels of 80.0 ± 4.2%. Bond et al. (1984) estimated that ADG of calves grazing toxic, endophyte-infected tall fescue will decrease approximately 0.05 kg for each 10% increase in infection level. In another experiment, Crawford et al. (1989) reported an approximate 0.07 kg/d depression in ADG for each 10% unit increase in endophyte-infection during spring and summer grazing of tall fescue. Ergovaline is the ergot alkaloid in greatest concentration in tall fescue (Lodge-Ivey et al., 2006) and has shown to be the most potent in causing constriction of the vasculature (Klotz et al., 2007). Ergovaline concentration in 2007 varied from 0.3 mg/kg of DM to 0.9 mg/kg of DM. In 2008, ergovaline concentration ranged from 0.4 to 0.6 mg/kg of DM. Aiken et al. (2009) used ultrasonography to evaluate the vasoconstrictive response in heifers consuming diets with lesser and greater concentrations of ergovaline. Heifers fed a diet with 0.79 μg of ergovaline/g of DM exhibited a constrictive response within 27 h, and those fed a diet with 0.39 μg of ergovaline/g of DM responded within 51 h.

Ergovaline concentrations in the fescue showed curvilinear changes over the growing season in both years, with cubic ($P = 0.002$) and quadratic ($P < 0.001$) relationships being detected in 2007 and 2008, respectively (Figure 3). There were year × DOY interactions on linear ($P < 0.001$) and quadratic ($P < 0.001$) coefficients. In 2007, ergovaline concentration increased between 115 and 128 DOY. Ergovaline may have increased with advancing plant maturity and seed set (Rottinghaus et al., 1991). In 2007, ergovaline concentrations in herbage declined after clipping of seed heads in early June. Subsequently, pastures were dominated by vegetative tillers and showed a gradual accumulation of ergovaline until d 183 DOY when they peaked at 0.85 mg/kg of DM. A different pattern of ergovaline concentration was observed in 2008, which could be partially attributed to low rainfall after the early-June mowing in 2008.

ADG

Average daily gain was greater ($P = 0.02$) in 2007 (mean ADG = 0.98 ± 0.03 kg/d) than in 2008 (mean ADG = 0.87 ± 0.02 kg/d), and there was no year × treatment interaction ($P > 0.10$). There was a positive PSBH × implant interaction ($P = 0.013$) on ADG (Table 1). Combination of the 2 treatments provided a 71% increase ($P < 0.001$) in ADG over the control treatment ($P < 0.001$) and 29% greater ($P < 0.001$) ADG than the PSBH-only treatment, and 52% greater ($P < 0.001$) ADG than with SHI-only treatment.

Aiken et al. (2008) showed that ingestion of PSBH, fed in the same amounts as the present experiment, by yearling steers grazing endophyte-infected fescue increased ADG by 74%. Grazing and PSBH feeding was
for the full duration of summer, coinciding with the summer slump in fescue quality and quantity. Richards et al. (2006) reported that PSBH fed to steers at 0.6% of BW per day in combination with free-choice, green-chopped endophyte-infected tall fescue constituted approximately 32% of the OM intake. In spite of a −0.39 substitution ratio, total OM intake was greater with PSBH supplementation. This response suggests that PSBH improves ADG by increasing OM intake.

Average daily gain tended (\( P = 0.063 \)) to increase with SHI. Aiken et al. (2006) concluded that ADG of calves grazing endophyte-infected fescue will respond strongly to SHI if forage mass is not limited. Although forage mass in the present experiment was never less than 2,300 kg of DM/ha, additive effects of combining PSBH and SHI indicated that additional nutrients and increased OM intake from feeding PSBH facilitated a stronger response to SHI than to SHI-only.

### Ultrasound Measures

There tended to be a year effect (\( P = 0.077 \)), but no year \( \times \) treatment interaction (\( P > 0.20 \)) on cross-sectional LMA. Longissimus muscle area at the 12th and 13th rib averaged 50.7 cm\(^2\) in 2007 and 54.6 cm\(^2\) in 2008. Ultrasonography indicated that SHI and PSBH treatments alone had no effect (\( P > 0.80 \)) on LMA, but there was a PSBH \( \times \) SHI interaction. Combining PSBH with SHI resulted in a 15.6% increase in LMA over that of the control treatment, a 14.0% increase over SHI-only, and a 13.1% increase over feeding PSBH-only (Table 1). There was no year effect (\( P = 0.241 \)) or a year \( \times \) SHI interaction (\( P = 0.201 \)) on LMA/100 kg of BW, but there was a tendency for a year \( \times \) PSBH (\( P = 0.097 \)) interaction on the measure. Feeding PSBH increased LMA/100 kg of BW in 2007 (\( P < 0.001 \)) but not in 2008 (\( P = 0.169 \)). There also was a PSBH \( \times \) SHI interaction (\( P = 0.037 \)) on LMA/100 kg of BW. Steers on the SHI-only treatment had the smallest LMA/100 kg of BW, and there were no differences between control and PSBH with or without SHI treatments. Although the greatest LMA was achieved by feeding PSBH with SHI, this response was apparently related to the additional BW gain rather than a direct effect on growth rate of the LM. Decreased LMA/100 kg of BW for SHI without PSBH than for the control treatment suggests that the treatment could reduce growth rate of the LM relative to other tissues.

Rump fat thickness was not different (\( P = 0.22 \)) between years, but there was a tendency of a year \( \times \) treatment interaction (\( P > 0.08 \)), which was related to the combined treatments in 2007 (5.6 mm) having greater (\( P < 0.05 \)) RFT than in 2008 (3.8 mm). There also was a PSBH \( \times \) SHI interaction (\( P = 0.014 \)) on RFT. Steers on the SHI-only treatment had the least (\( P < 0.05 \)) RFT. Rump fat thickness was not different (\( P = 0.321 \)) between the PSBH-only and the combined PSBH and SHI treatments. Combining the treatments provided a 27% increase in RFT over SHI-only and a 17.5% increase in RFT over the control treatment. This response suggests that feeding PSBH or the combined

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**Table 1.** Average daily gain and final ultrasound measures of LM area (LMA), LMA/100 kg of BW, 12- to 13th-rib fat thickness (1213RFT), and rump fat thickness (RFT) for steers grazing toxic tall fescue with different combinations of feeding pelleted soybean hulls (PSBH) and steroid hormone implants (SHI)\(^1\)

<table>
<thead>
<tr>
<th>Item</th>
<th>PSBH/SHI</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADG, kg/d</td>
<td>No/No</td>
<td>0.72(^c)</td>
</tr>
<tr>
<td>LMA, cm(^2)</td>
<td>No/Yes</td>
<td>50.1(^b)</td>
</tr>
<tr>
<td>LMA/100 kg of BW, cm(^2)</td>
<td>Yes/No</td>
<td>0.28(^b)</td>
</tr>
<tr>
<td>1213RFT, mm</td>
<td>Yes/Yes</td>
<td>4.3(^c)</td>
</tr>
<tr>
<td>RFT, mm</td>
<td>No/No</td>
<td>4.0(^c)</td>
</tr>
<tr>
<td></td>
<td>No/Yes</td>
<td>4.3(^c)</td>
</tr>
<tr>
<td></td>
<td>Yes/No</td>
<td>4.3(^c)</td>
</tr>
<tr>
<td></td>
<td>Yes/Yes</td>
<td>4.3(^c)</td>
</tr>
</tbody>
</table>

\(^{a–c}\)Means within rows with different letters are significantly different (\( P < 0.05 \)).

\(^{1}\)Means are averages over 2 yr (n = 6 for each treatment).

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**Figure 3.** Curvilinear relationships between ergovaline concentrations and day of year (DOY) in toxic endophyte-infected tall fescue grazed in 2007 and 2008.
effect of feeding PSBH with implantation encourages fat deposition.

Similar to RFT, 1213RFT did not differ \( (P = 0.29) \) between years. There was no year × PSBH interaction \( (P = 0.467) \) on 1213RFT, but a tendency \( (P = 0.064) \) for a year × SHI interaction on the measure. Rib fat thickness in 2008 tended \( (P = 0.054) \) to be greater with \( (4.4 \pm 0.4 \text{ mm}) \) SHI than without \( (3.8 \pm 0.4 \text{ mm}) \). There was no overall effect of implantation \( (P = 0.38) \) on 1213RFT thickness, but there was a positive response \( (P = 0.002) \) to feeding PSBH. Additional 1213RFT of the PSBH steers suggests that PSBH promoted fat deposition through increased energy intake. Although Richards et al. (2006) showed a reduction in herbage intake of endophyte-infected tall fescue with feeding PSBH, there was greater energy intake. Steroidal implants increase the quantity and percentage of lean tissue and reduce the deposition of fat (Lemieux et al., 1990). Feeding PSBH apparently had a stronger influence than SHI on external fat and cross-sectional LMA.

Breakeven Cost of PSBH for Additional BW Gain

Feeding PSBH without SHI provided greater ADG than the control treatment, but economic analysis indicated that cost of PSBH would need to be low to provide a cost of additional ADG below the breakeven cost (Figure 4). Without implants, cost of PSBH would need to be less than $120/t for cost of additional ADG to fall below the breakeven and generate a positive return with the highest cattle price ($2.40 kg of additional ADG). With SHI, cost of additional ADG was below the breakeven cost for greater PSBH costs. Cost of additional ADG could be achieved with PSBH costs below $240/t for the lowest cattle price ($1.80/kg of additional ADG). Therefore, cost effectiveness of feeding PSBH was much greater when feeding was combined with SHI. It should be emphasized that the analysis is based on selling prices and is not an evaluation of profitability because it does not account for negative profit margins that reduce the value of BW gains.

Serum Prolactin

Prolactin is consistently decreased in cattle stressed by fescue toxicosis, and therefore, it has primarily served as a marker for toxicosis even though it has not been implicated as a causal factor (Strickland et al., 1993). There were no differences in prolactin concentrations between years \( (P = 0.943) \) or year × treatment interactions \( (P > 0.39) \), which indicated alkaloid concentrations in the herbage was sufficient to elicit a prolactin response. Steroid hormone implant did not affect \( (P = 0.972) \) serum prolactin concentrations. Likewise, Coffey et al. (1992) reported that implanted stocker cattle grazing endophyte-infected tall fescue did not exhibit increased prolactin concentrations. Steers fed PSBH had greater \( (P < 0.001) \) prolactin concentrations than those not fed PSBH. Prolactin concentrations in steers fed PSBH averaged 103.5 \pm 12.0 \text{ ng/mL}, whereas those not fed PSBH averaged 42.5 \pm 12.2 \text{ ng/mL}. Therefore, feeding PSBH resulted in a greater than 2-fold increase in serum prolactin concentrations.

Greater prolactin concentrations in steers fed PSBH could be attributed to a dilution effect of PSBH on ergot alkaloids in the diet. However, previously discussed greater consumption of herbage with feeding PSBH in 2007 contradicts this explanation because greater consumption of tall fescue also reflects greater consumption of ergot alkaloids. Prolactin concentrations in steers fed PSBH could have responded to the steers being at a greater plane of nutrition. Serum prolactin concentration in dairy heifers fed a diet to achieve an ADG greater than 1.0 kg/d ADG had greater prolactin concentrations than those on a diet that achieved growth rates of approximately 0.7 kg/d (Petitclerc et al., 1983). Conversely, Aiken et al. (2008) reported that feeding PSBH had no effect on prolactin concentrations in steers grazing endophyte-infected tall fescue from June to September. Grazing in the present experiment was mostly of rapid growth of immature herbage, whereas for Aiken et al. (2008) the grazing was primarily during a period of low pasture growth and accumulation of mature herbage from spring growth. Furthermore, ergot alkaloids are stored in external fat (Realini et al., 2005), and greater external fat thickness with feeding PSBH in the present experiment could have reduced alkaloid concentrations in vasculature circulation.
HCR

Cattle suffering from tall fescue toxicosis may retain rough hair coats through the summer months, and the retained hair coat may increase their susceptibility to heat stress (McClanahan et al., 2008). An explanation for the rough hair coats on fescue cattle during the summer has not been delineated, but Oliver (2005) speculated that it is caused by nutrient deficiencies from vasoconstriction or altered hormone concentrations in hair follicles. Percentages for each HCR were not different \((P > 0.30)\) between years, and there were no year × PSBH or year × SHI interactions \((P > 0.10)\). There were reductions in rough HCR with PSBH \((P = 0.035)\) or SHI \((P = 0.027)\) treatments (Figure 5), and there were no interactions with year \((P > 0.10)\) or between the 2 treatments \((P = 0.856)\). No effects were detected on transitional HCR. There was a tendency \((P < 0.076)\) of greater percentage of sleek HCR with feeding PSBH, but not with SHI. Therefore, SHI treatment did not increase percentages of transitional and sleek HCR even though the treatment reduced percentage of rough HCR. Feeding PSBH apparently resulted in a trend of a greater percentage of sleek HCR and reduced rough HCR. Feeding PSBH at the consumption rate used in the experiment could have overcome a nutrient deficiency to trigger shedding, but reduction in rough HCR hair with SHI could be associated with a hormonal triggering of shedding.

**Conclusions**

Results indicated that feeding PSBH to steers grazing toxic endophyte-infected tall fescue can provide a 31% increase in ADG, but BW gain can be increased 64% if steers fed PSBH are also implanted with steroid hormones. Analysis of breakeven costs showed that PSBH would need to be purchased at a low cost (<$120/t), with high cattle prices, to achieve a positive return from the additional ADG from feeding PSBH without SHI. The synergistic effect of SHI and PSBH on ADG increased the cost effectiveness of feeding PSBH at relatively high PSBH costs and low cattle prices. Steroid implantation did not affect responses associated with fescue toxicosis, but feeding PSBH provided a 2-fold increase in serum prolactin and a reduced percentage of steers exhibiting rough hair coats at the conclusion of grazing. Combining feeding PSBH with SHI can cost effectively increase BW gain and reduce the severe effect that fescue toxicosis has on BW gain and physiology.

**LITERATURE CITED**


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