Interaction of breed type and endophyte-infected tall fescue on milk production and quality in beef cattle

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ABSTRACT: Decreased milk production of beef cattle grazing endophyte-infected (EI) tall fescue (TF), an important cool season grass in the southeastern United States, can affect calf growth. The objective was to determine whether a thermal or heat-tolerant Bos taurus breed of cattle, Romosinuano (RO), would tolerate EI TF toxins relative to Angus (AN) cattle. Milk production and quality were examined on AN and RO cows grazing endophyte-free (EF; variety K-31; n = 36) or EI TF (variety K-31; n = 37) along with growth of their Charolais-sired calves in 2007 and 2008 in west central Arkansas. Cows calved between early February and late March (spring). Milk yield and quality, BW, rectal temperature, and serum prolactin were determined at 57.1 ± 2.6 d postpartum and every 28 d thereafter between April and August. Milk yield was greater in AN compared with RO cows (P < 0.001), but not influenced by forage type (P > 0.88). Percent milk fat was greater in cows grazing EF TF in April, but greater for cows grazing EI TF in July (forage × month, P < 0.001). Percent milk fat was greater for RO than AN cows (P < 0.001). Percent milk protein (P < 0.001) was greater and somatic cell counts (log-transformed; P < 0.001) were less in RO than AN cows. Milk lactose was greater for RO compared with AN cows in June through August (breed × month, P = 0.004). Adjusted weaning BW of calves was similar between EF and EI TF in 2007, but greater for calves from EF than EI TF in 2008 (forage × year, P = 0.03). Rectal temperature was similar between RO cows grazing EF and EI TF, but greater in AN cows grazing EI compared with EF TF in most months (forage × breed × month × year, P < 0.001). Serum prolactin was reduced in both breeds of cows grazing EI TF between April and July of both years and greatest in RO cows grazing EF TF (breed, P < 0.001; forage × month, P < 0.001). These data suggest that RO cows were more thermal-tolerant, but still susceptible to toxins in EI TF as shown by a reduction in serum concentrations of prolactin. However, milk production was not influenced by EI TF as previously observed, but milk fat percent was decreased in early lactation in this group of cows. Milk yield and quality were different between AN and RO cows during the period of lactation observed.

Key words: beef cattle, milk production, milk quality, tall fescue

INTRODUCTION

Grazing endophyte-infected (EI) tall fescue (TF; Festuca arundinacea Schreb., also called Lolium arundinaceum) can lead to decreased animal performance due to ergot alkaloids produced by the endophyte (Neotyphodium coenophialum) within the plant (Porter and Thompson, 1992). Eradication of this cool season perennial grown on more than 20 million ha in the United States is not practical because of its importance for livestock grazing (Bouton, 2000). The endophyte aids in protecting the plant from heat stress, drought, and insects, thus leading to greater plant persistence compared with endophyte-free (EF) TF (Hill et al., 1991; Bouton et al., 1993; West et al., 1993). Signs of fescue

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toxicosis in ruminants grazing TF include decreased systemic prolactin, increased core body temperature, decreased feed intake, and decreased milk production (Hoveland et al., 1983; Porter and Thompson, 1992; Paterson et al., 1995). Circulating prolactin is often decreased because the ergot alkaloids act as dopaminergic agonists (Muller-Schweinitzer et al., 1978).

During summer months when core body temperature is increased (Wolfenson et al., 1993; Trout et al., 1998; Wilson et al., 1998), fescue toxicosis elicits its greatest impact on the animal. Tropically adapted cattle are more thermal-tolerant than breeds of cattle from temperate climates (Finch, 1986; Hammond et al., 1996). The Romosinuano (RO) is a tropically adapted Bos taurus breed of Spanish origin developed in the Sinú valley of northern Colombia (Rouse, 1971). The breed has been described previously (Riley et al., 2007) and determined to be more heat tolerant than Angus (AN) cattle (Hammond et al., 1996). The objective was to determine whether RO, a thermal-tolerant Bos taurus breed of cattle, would tolerate EI TF toxins relative to AN cattle by examining milk production and quality and calf growth between the 2 breeds and forages.

**MATERIALS AND METHODS**

All experimental procedures were reviewed and accepted by the Institutional Animal Care and Use Committee at USDA-ARS in Booneville.

**Experimental Design**

Milk production and quality were examined in 4- and 5-yr-old (third and fourth parity) AN and RO cows in good body condition (BCS = 6.0 ± 0.12; 1 = emaciated, 9 = fat) grazing EF or EI TF in the summers of 2007 and 2008 at the USDA, ARS, Dale Bumpers Small Farms Research Center, Booneville, AR. Angus cows were raised locally (2007: n = 12; 2008: n = 11) or transported from the USDA, ARS, SubTropical Agricultural Research Station, Brooksville, FL (2007: n = 7; 2008: n = 6) 2 yr before the study began. All RO cows were transported from the ARS, Brooksville Station 2 yr before study began (2007: n = 18; 2008: n = 19).

Cows were bred to 1 of 4 Charolais bulls during a 60-d period in May and June 2006 and 2007 in Booneville, AR, to produce Charolais × AN (CA) or Charolais × RO (CR) calves. Pregnant cows were blocked by breed (and origin of AN breed), previous grazing exposure (EF or EI TF), and randomly assigned to continuously graze replicated Kentucky 31 EF and EI TF pastures (n = 2/or 4age type/yr) each starting in early November 2006 and 2007 (Table 1). A stocking rate of 1.25 cows/ha was used for all forage treatments. Cows calved on pasture, and BW was determined on day of new forage treatment. Body weight of calves was determined within 24 h after birth. Male calves were castrated at that time. Subsequent BW of calves was determined the morning before cows were milked as described below.

Table 1. Number of beef cows within each breed and forage treatment, endophyte-free (EF) or endophyte-infected (EI) tall fescue, in 2007 and 2008

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Calves were weaned on October 9, 2007, and October 14, 2008, and BW determined at that time. Adjusted weaning weight was [(weaning weight – birth weight)/d of age at weaning] × 205 + birth weight. Because bulls used for production of calves used in this study were rotated among pastures during breeding to minimize fescue toxicosis of males, sire of calf was not determined; thus, sire effects were not examined.

All pastures were fertilized based on soil tests with N, P, and K in split applications in spring (February and March) and again in early October. Forage availability was never limiting based on visual examination and hay supplementation was unnecessary. Percent infection with endophyte was determined using a tissue print-immunoblot detection method (Gwinn et al., 1991) on 100 random tiller samples collected from each fescue variety in November 2007. Ambient temperature and relative humidity were recorded on site at the Booneville location and a temperature-humidity index (THI) estimated by daily maximum temperature (T) and relative humidity (RH; measured within 4 km of the research pastures): [(1.8 × T + 32) – (0.55 – 0.0055 × RH) × (1.8 × T – 26)] (Figure 1). The first year of the study occurred after a year of drought, and rainfall was normal for both years.

**Milk Production**

Milk production was estimated by collecting milk from cows that had been separated from calves for approximately 14 h (Brown et al., 1996) every 28 d starting at 57.1 ± 2.6 d postpartum in mid-April to August of 2007 and 2008. Cows and calves from 1 EF and 1 EI pasture were brought to a small pasture (approximately 2 ha) of bermudagrass the morning before milking, and 2 d later the procedure was repeated with cows from the second EF and EI TF pasture. Cattle would have been overly heat-stressed to accomplish milking all cows in 1 d. At this time, BW of cows and calves were determined, and blood was collected from cows. Subsequently, cows were allowed to comingle and graze bermudagrass. Cows and calves were separated at 1630 h the evening before milking. Milk collection started at 0630 h the next morning. Rectal temperature was determined using a rectal thermometer (GLA M700 Agricultural Electronics, San Luis Obispo, CA) and oxytocin (20 USP units/mL) was administered intramuscularly (i.m.) immediately before milking to
induce milk ejection. Acepromazine maleate (10 mg/mL) was administered i.m. as needed to alleviate stress of handling (2 cows in 2008). Milk was collected using a single-cow portable machine (Brown et al., 1996). After a cow was completely milked, milk was weighed, manually homogenized, and 50-mL duplicate samples were collected for estimates of milk fat, milk protein, milk lactose, and somatic cell count (SCC; Heart of America DHIA, Manhattan, KS). Daily milk yield was estimated as the net weight of milk adjusted to a 24-h basis [(milk weight/14) × 24; Brown et al., 1996]. Cattle were sprayed with water to cool if they exhibited signs of heat stress (excessive drooling or panting) after the milking procedure.

**Prolactin Analysis**

Blood (approximately 7 mL) was collected from a coccygeal vessel on day before cows were milked. Samples were placed on ice and then centrifuged (3,000 × g for 20 min at 4°C). Serum was collected and stored at −20°C until analyzed. Concentrations of prolactin were determined by a double-antibody RIA (Spoon and Hallford, 1989). The detection limit of the assay is 0.2 ng at 95% of maximum binding. Samples were run in a single assay with an intra-assay CV of 4.8%.

**Statistical Analyses**

Milk production, milk quality traits, serum concentrations of prolactin, rectal body temperature, and calf and cow BW were analyzed as repeated measures (Littell et al., 1996) using mixed models with first-order autoregressive covariance structure (SAS Inst. Inc., Cary, NC). Pasture was the experimental unit. Pasture replicate was initially included in the model. If it was not different, replicates were pooled within forage type. The experiment was a factorial design with forage and breed as the main effects; and calf sex (calf BW analyses only), month, year, and significant interactions were included in the model. Somatic cell counts were log-transformed: ln(SCC + 1). Statistical inferences were made on transformed data, and untransformed least squares means were presented. Means separation was determined using preplanned pairwise comparisons using the t-test when treatment effect was P < 0.05. Trends were reported at P < 0.10. For the variables milk production, SCC, milk lactose percent, and rectal temperature, order of milking was included as a covariate. Day of age was used as a covariate for calf BW analysis. Age of cow was examined as a covariate for milk production and quality traits, but was not significant and excluded from the final model.

Heterogeneity of regression was used to determine relationships between milk production and days postpartum, calf BW and day of age, and ADG and cumulative milk fat production (area under curve/112 d; Wilcox et al., 1990). Values of individuals within forage type or breed were used. Variables included in the mixed model were also tested in this model. Relationships were determined to be linear (P = 0.01).

**RESULTS**

Endophyte infection rates were 11 and 15% in both EF TF pastures. The rates were 80, 98, and 72% in the EI TF pastures that were used in 2007 only, 2008 only, and both years, respectively.

**Milk Production**

Milk production was similar between cows grazing EF and EI forage. Angus produced more milk than RO cows between April and June (breed × month, \( P < 0.001 \)) and tended to produce more milk in July (\( P = 0.05 \); Figure 2A). Milk production over days postpartum was similar between AN grazing EF and EI forage between 60 and 180 d postpartum, but declined more slowly in RO cows grazing EI than EF forage (\( P < 0.001 \); Figure 2B). Based on the slopes of the regression, milk production decreased by 13 g/d in RO cows grazing EF TF compared with 2.8 g/d in RO cows grazing EI TF forage.

**Milk Quality Traits**

Milk fat percentage tended to increase in AN cows grazing EI compared with EF forage, but was similar between RO cows grazing either forage (forage × breed, \( P = 0.07 \)) and greater for RO compared with AN cows (breed, \( P < 0.001 \); EF AN, 4.28 ± 0.16%; EF RO, 5.16 ± 0.15%; EI AN, 4.62 ± 0.15%; EI RO, 4.94 ± 0.15%). Milk fat percentage (\( P < 0.001 \)) and production (\( P < 0.001 \)) was greater in cows grazing EF forage
in April, but less in July compared with cows grazing EI forage (forage × month; Figure 3A and B). Milk fat production was greater in AN compared with RO cows in April and May, but similar between the 2 breeds in June through August (breed × month, \( P < 0.001 \); Figure 3C). Milk protein percentage was greater in RO compared with AN cows (3.97 > 2.93 ± 0.04%; \( P < 0.001 \)). Milk protein production was less in RO than AN cows in April (\( P = 0.04 \)), but greater by July and August (\( P = 0.02 \); breed × month, \( P < 0.001 \); Figure 4). There was no breed × forage interaction for milk fat or protein production, or milk protein percentage.

Milk lactose percent was similar in April and May between AN and RO cows, but greater in RO cows between June and August (breed × month, \( P = 0.004 \); Figure 5A). However, milk lactose production was greater in AN than RO cows between April and June and similar in July and August (breed × month, \( P < 0.001 \); Figure 5B). Milk lactose percent was greater in 2008 than in 2007 in AN cows; greater in RO than AN cows in 2007, but similar between breeds in 2008 (2007: AN, 4.67; RO, 4.90; 2008: AN, 4.94; RO, 4.92 ± 0.04%; breed × year, \( P = 0.005 \)). There tended to be reduced milk lactose percent in AN cows grazing EI compared with EF forage and RO cows grazing either forage (forage × breed, \( P = 0.05 \)), but there was no interaction for milk lactose production. Percent solids-not-fat was greater in RO than AN cows (9.82 > 8.61 ± 0.05%; \( P < 0.001 \)), and greater in 2008 than 2007 (9.29 > 9.14 ± 0.05%; \( P = 0.04 \)). Somatic cell counts were greater in AN than RO cows (584 > 57 ± 114 × 1,000 cells/mL; \( P < 0.001 \)) and similar between EF and EI forage (EF, 348; EI, 293 ± 114 × 1,000 cells/mL), but there was no forage × breed interaction.

**Calf BW**

Birth weight of calves was similar between EF and EI TF forage (36.0, 35.8 ± 0.71 kg, respectively), greater for CA than CR calves (37.4 > 34.3 ± 0.71 kg; \( P = 0.003 \)), and greater in 2008 than 2007 (37.0 > 34.8 ± 0.71 kg; \( P = 0.03 \)). In 2007, calf BW was similar among forage types and breeds between April and June, but was greater in CR calves on EI than EF forage in July (forage × breed × month × year, \( P = 0.002 \); Figure 6A). In 2008, BW of CR calves on EI forage was less than CA calves on the same forage in May (\( P = 0.01 \)) and June (\( P = 0.02 \)), but otherwise BW was similar among forages and breed types (Figure 6B).

In 2007, adjusted weaning weight of calves, determined in early October, was similar between forage treatments. In 2008, adjusted weaning weight was greater (\( P = 0.01 \)) for calves from EF compared with EI TF (2007: EF, 215.1 ± 6.1; EI, 219.3 ± 6.1; 2008: EF, 244.0 ± 6.1; EI, 222.3 ± 5.8 kg; forage × year, \( P = 0.03 \)). Adjusted weaning weight was similar between breed types (CA, 220.4; CR, 230.0 ± 4.3 kg; \( P = 0.13 \)). Average daily gain (birth to weaning) was greater for CR than CA calves (954 > 893 ± 19 g/d; \( P = 0.02 \)). In 2007, ADG was similar between forage groups, but in 2008, calves from EF gained more BW than calves from EI TF forage (2007: EF, 877 ± 27; EI, 901 ± 28; 2008: EF, 1,010 ± 27; EI, 904 ± 26 g/d; forage × year, \( P = 0.01 \)).
Preweaning BW Gain vs. Milk Production

The relationship between preweaning ADG of calves to milk fat production (area under curve/112 d) is illustrated in Figure 7. Calf sex \((P = 0.03)\) and year \((P = 0.009)\) were significant, and forage \(\times\) year \((P = 0.06)\) tended to be significant, suggesting that the intercept or ADG was different for those effects. The regression of daily milk fat production on ADG was different between forages \((P = 0.03)\). The general case was that conversion efficiency (BW gain/fat) increased with increasing fat production. The interaction showed that efficiency increased more rapidly for calves on EI TF. Intercept for breed type CA was less than that for CR \((P = 0.001)\). Regression of milk fat production on calf ADG explained 25.8\% of the remaining variation after the significant fixed effects of breed, forage, calf sex, year, and forage \(\times\) year were removed.

Rectal Temperature, Prolactin, BW of Cows

In 2007, rectal temperature of cows was consistently greatest in AN cows grazing EI forage compared with EF forage or RO cows (forage \(\times\) breed \(\times\) month \(\times\) year, \(P < 0.001\); Figure 8A). Rectal temperature was similar between RO cows grazing EF and EI pastures. A similar pattern was observed in April and May 2008, but rectal temperature was similar among groups of cows in July (Figure 8B). Serum concentrations of prolactin were greater in RO than AN cows \((P < 0.001)\) and greater in cows grazing EF compared with EI forage between April and June (forage \(\times\) month, \(P < 0.001\); Figure 9).

Body weight of AN cows was greater than RO cows in April and May and similar between June and August (breed \(\times\) month, \(P < 0.001\); Figure 10A). Body weight of cows was similar between EF and EI TF when forage treatment was initiated (EF, 517 ± 10; EI, 514 ± 9 kg), greater in AN than RO cows (530 ± 10 > 501 ± 9 kg; \(P < 0.04\)), and greater in the first compared with the second year (534 ± 9 > 497 ± 10 kg; \(P < 0.009\)). Body weight of cows grazing EF forage was greater than cows grazing EI forage between April and June and similar between breeds in July and August (forage \(\times\) month, \(P < 0.001\); Figure 10B).

DISCUSSION

Milk Production and Calf Growth

In this study, grazing EI TF did not lead to reduced milk production between April and August of the years examined. Similarly, BW of calves was not different between forage types during this time with the exception of CR calves in May and June 2008. However, adjusted weaning weights and ADG were reduced in calves from EI compared with EF TF in 2008, but not 2007. Previous studies at this location indicated a reduction in calf growth throughout the summer and at weaning when...
calf and dam grazed EI compared with EF TF (Burke et al., 2001; Burke and Rorie, 2002). As calves relied more on forage and less on milk toward late summer in the current experiment, especially in 2008, BW gains may have accelerated in EF TF calves without restriction of TF toxins, perhaps because of increased rainfall and greater forage growth and quality in early fall.

Milk production of AN compared with RO cows was markedly greater between April and June, but milk production of RO cows declined little over time. This difference in milk production did not lead to lighter calves between breeds of cows even though RO calves were 6% lighter at birth. Calf BW gains from RO dams may have benefited due to greater percent milk fat and protein along with greater thermal-tolerance from RO genetics. In a study conducted in Florida, birth weights and preweaning ADG were similar between purebred AN and RO calves (Riley et al., 2007). In that study, weaning weights of female calves were similar, but male RO weighed more than male AN. In another study, ADG of AN compared with RO calves was greater in winter months, but not summer months, suggesting an advantage of heat tolerance in RO calves (Chase et al., 1997).

Calves on EF TF were more efficient converting milk fat (representing energy) to BW gain than those on EI TF at reduced milk fat production, but efficiency was similar with greater production. This would suggest that calves on EI TF were more dependent on milk due to the effects of the endophyte toxin on ADG per se. Brown and Brown (2002) reported an interaction of the regression of preweaning ADG on milk fat yield with breed of dam (Brahman vs. AN) and forage type (EI TF vs. bermudagrass). The slope was greater for calves from Brahman cows than for calves from AN cows on bermudagrass, but slopes were similar between breeds of cows grazing EI TF. These data suggest that the use of calf weaning weight to calculate milk production according to NRC (1996) would be difficult, and at the very least, should be adjusted for forage type and quality. It is unfortunate that most reports on the relationship of milk production and calf ADG do not characterize the forage for availability or nutritive value. Although breed of cow did not interact with the regression of calf ADG on milk production, other

Figure 4. Effect of breed [Angus (AN; closed circles) or Romosinuano (RO; open squares)] on least squares means and SEM of milk protein production. Milk was collected every 28 d starting at 57.1 ± 2.6 d postpartum in April and continued through August in 2007 and 2008 after separation from calves for 14 h. There was a breed × month interaction (P < 0.001; * indicates P < 0.10, and ** indicates P < 0.05 for differences between breeds within a particular month).

Figure 5. Effect of breed [Angus (AN; closed circles) or Romosinuano (RO; open squares)] on least squares means and SEM of milk lactose percent (A) and production (B). Milk was collected every 28 d starting at 57.1 ± 2.6 d postpartum in April and continued through August in 2007 and 2008 after separation from calves for 14 h. There was a breed × year (P < 0.006) and a breed × month interaction (P < 0.005; * indicates P < 0.01 for differences between breeds within a particular month) for milk lactose percent and a breed × month interaction (P < 0.001; * indicates P < 0.05, and ** indicates P < 0.01 for differences between breeds within a particular month) for milk lactose production.
reports have suggested that calves from cows with diminished milk production or those from reduced milk production systems gained more BW per unit of milk than calves from increased milk producers or increased production systems (Fiss and Wilton, 1993; Mallinckrodt et al., 1993). By accounting for milk intake and feed intake, Freking and Marshall (1992) determined that cow-calf production efficiency was improved with increasing milk production.

**Milk Quality Traits**

Milk fat percent was reduced in milk from EI cows in April, which led to reduced milk fat production, but both of these measurements increased in July so that these measurements were similar to those of cows that grazed EF TF. Brown et al. (1993, 1996) reported a reduction in milk fat percent between April and September in cows grazing EI TF compared with those grazing bermudagrass. Percentages of milk fat in those studies were much less than the current study. Bermudagrass is a warm season grass or is vegetative during summer months, which could have accounted for differences between forage groups in that study. Percent milk protein, lactose, SNF, and SCC were not influenced by forage, in agreement with data reported by Brown et al. (1993, 1996). Somatic cell counts were just over 10-fold greater in AN than RO cows. Reasons for this breed difference are not clear, but may be related to adaptation of the RO through natural selection in Columbia.

**Rectal Temperature, Prolactin, and BW of Cows**

Signs of fescue toxicosis existed in cows grazing EI TF consistent with previous studies (Hoveland et al., 1983; Porter and Thompson, 1992; Paterson et al., 1995). Rectal temperature was greater in AN cows grazing EI TF in April and May of both years. The THI was more consistent from month to month on day of milking in 2007, whereas, coincidentally, ambient temperature declined on day of milking in June through August 2008, which could have led to similar rectal temperatures between AN cows grazing EF or EI TF. This could have also occurred as demands from lactation decreased, reducing metabolic rate of cow. In agreement with previ-
ous studies (Hammond et al., 1996; Chase et al., 1997), mean body temperature of RO cows in the current experiment was less than that of AN cows for most of the days examined.

Body weight of pregnant cows in the fall at the beginning of forage treatment was similar between EF and EI TF. By the following April, BW of cows grazing EI TF was reduced compared with those grazing EF TF. Body weight of EF TF cows declined by July and August, likely due to decreasing forage quality. Crude protein was determined over an 8-yr period on EI TF pastures on this research station; average CP increased from 10 to 16% between January and March and decreased from 16% in April to 9% in June and remained at 9% until after August (M. A. Brown, unpublished data). Romosinuano cows were lighter in the fall and in early lactation compared with AN cows but did not lose BW by mid and late lactation as AN cows did. Because of greater thermal-tolerance, DMI was likely maintained in RO compared with AN cows.

Serum concentrations of prolactin, an accepted marker of fescue toxicosis, were reduced in both breeds of cows grazing EI compared with EF TF in April through June. Heat stress may lead to increased prolactin production (Hooley et al., 1979; Walker et al., 1990), which could have been masked in cows consuming fescue toxins, but could have occurred in AN cows grazing EF TF between April and July, coinciding with their increased rectal temperatures. Prolactin declined in August in AN cows. Alternatively, early pregnancy has been associated with decreased prolactin (Kann and Denamur, 1974), and an advancing stage of pregnancy could have led to decreased prolactin in AN cows grazing EF TF in August. Serum concentrations of prolactin increased in ewes fed an EI TF seed diet after the end of the study, which coincided with early pregnancy, whereas concentrations of prolactin in ewes fed TF seed without toxins declined (Burke et al., 2006). This same phenomenon could have occurred in cows grazing EI TF in the current study, in that serum concentrations of prolactin increased in June, or after cows were bred, compared with April and May. It is not clear why serum concent-

Figure 8. Least squares means and SEM of rectal temperatures determined in Angus (AN; closed circles) or Romosinuano (RO; open squares) cows grazing endophyte-free (EF; solid lines) or endophyte-infected (EI; dashed lines) tall fescue pastures. Rectal temperature was determined before collection of milk every 28 d starting at 57.1 ± 2.6 d postpartum in April and continued through August in 2007 (A) and 2008 (B). There was a 4-way interaction (forage × breed × month × year, \( P < 0.001 \)).

Figure 9. Least squares means and SEM of serum concentrations of prolactin in Angus (AN; closed circles) or Romosinuano (RO; open squares) cows grazing endophyte-free (EF; solid lines) or endophyte-infected (EI; dashed lines) tall fescue pastures. Blood samples were collected every 28 d starting at 57.1 ± 2.6 d postpartum in April and continued through August in 2007 and 2008. There was a breed effect (\( P < 0.001 \)) and a forage × month interaction (\( P < 0.001 \)).
trations of prolactin were greater in RO compared with AN cows grazing EF TF.

In 2007, pastures were recovering from drought that occurred in 2006. Decreased BW of cows in fall 2007 compared with 2006 could be attributed to reduced BW of AN cows in response to grazing EI TF during summer 2007, whereas few of the cows in this study grazed EI TF during summer 2006. Cows were re-randomized in fall 2007 and resulted in similar BW at start of treatment.

In conclusion, an addition of RO genetics or thermal-tolerance to a southern pasture of EI TF provided greater tolerance to TF toxins as shown by stable body temperature, but serum concentrations of prolactin were still reduced. Although calves from RO cows gained more BW by weaning than those from AN cows, a potential bias against the redder calves at the sale barn could influence overall economics and must be examined. Milk production was not greatly influenced in mature cows grazing EI TF. Cows used in this study were maintained in good body condition, which may allow for tolerance to fescue toxins and acceptable production in a cow-calf herd. Further examination of economics and performance of RO type calves is necessary before any recommendation can be made on use of RO genetics on southern farms.

**LITERATURE CITED**


