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Evaluation of Tall Fescues for Stocker Cattle in the Gulf Coastal Plain[1]

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ABSTRACT

New cultivars of nontoxic endophyte-infected (NE) tall fescue must be evaluated under grazing conditions before their commercial release. This research was conducted to compare 2 NE tall fescue cultivars with toxic endophyte-infected Kentucky-31 (KY-31) and an endophyte-free (EF) tall fescue in the Coastal Plain region of southwestern Arkansas. Eleven 0.81-ha pastures were planted to KY-31 (n = 3), EF (cv. Barcel, Barenbrug USA, Tangent, OR; n = 3), or the NE tall fescue cultivars BarOptima, infected with the E-34 endophyte (BarOptima PLUS E-34, Barenbrug USA; n = 3), and Jesup, infected with the AR542 endophyte (MaxQ, Pennington Seed Inc., Madison, GA; n = 2). Pastures were grazed by growing beef calves (n = 33/yr, initial BW = 244 ± 9.5 kg) for 2 yr beginning in January of each year. After 2 grazing seasons, pastures that contained endophyte (KY-31, Jesup AR542, BarOptima PLUS E-34) had greater stand counts than EF ($P < 0.01$), averaging 83, 78, 70, and 9% stands, respectively. Prolactin concentrations, off-pasture BW, ADG, and BW gain were greater ($P \leq 0.05$) for calves grazing NE tall fescue compared with KY-31 in both years. The results of this study indicate that BW gain of calves grazing NE tall fescue in the Coastal Plain of Arkansas was greater than that of calves grazing KY-31, and that persistence of NE was greater than that of EF.

Key words: growing cattle, grazing, *Festuca arundinacea* Shreb., *Neotyphodium ceonophialum*, performance

INTRODUCTION

There are approximately 4.8 million ha of Bermudagrass [*Cynodon dactylon* (L.) Pers.] in the southern United States. Stocker producers in the Gulf Coastal Plain need cool-season forages to complement the predominantly warm-season grass forage base. Cool-season annuals must be reestablished each year, which increases costs of production. This has stimulated interest in persistent high-quality perennials. Most cool-season perennial grasses are short lived in the South, but tall fescue (*Festuca arundinacea* Shreb.) infected with the naturally occurring endophyte *Neotyphodium ceonophialum* has the benefit of improved persistence. Chemical composition of these endophyte-infected tall fescues indicates they are of high nutritive value during the fall and early spring (Beck et al., 2006), although performance of grazing livestock is limited by fescue toxicosis (McMurphy et al., 1990; Thompson et al., 1993; Gunter and Beck, 2004). Endophyte-free (**EF**) tall fescue cultivars were introduced in the 1980s, with large increases in animal performance, but stand failure often occurred within 2 to 4 yr (Coombs et al., 1999; Gunter and Beck, 2004). Beneficial endophytes have been identified that have the dual advantages of stand persistence and improved animal performance when used to replace toxic endophytes. Research has been conducted to evaluate cultivars of these nontoxic endophyte-infected (**NE**) tall fescues in Georgia (Parish et al., 2003), northwest Arkansas and southwestern Missouri (Nihsen et al., 2004), southern Oklahoma and northeast Louisiana (Hopkins and Alison, 2006), and north-central Arkansas (Beck et al., 2008). The tall fescue cultivar Jesup, infected with the AR542 endophyte, has been commercially released as MaxQ (Pennington Seed Inc., Madison, GA), and research indicates that this cultivar is persistent, with improved animal performance in a wide range of environments (Parish et al.,

[1] Mention of trade names or commercial products in this article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the USDA.

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2003; Hopkins and Alison, 2006; Beck et al., 2008). New cultivars of NE tall fescue must be evaluated under grazing conditions before their release; thus, this research was conducted to evaluate a new NE tall fescue cultivar and compare it with Jesup AR542, toxic endophyte-infected, and EF tall fescues in the Coastal Plain region of Arkansas.

MATERIALS AND METHODS

All animal procedures in the following experiment were conducted in accordance with the recommendations of the Consortium (1999) and were approved by the University of Arkansas Institutional Animal Care and Use Committee.

Establishment and Forage Management

Eleven 0.81-ha pastures were planted to toxic endophyte-infected Kentucky-31 tall fescue (**KY-31**; n = 3), EF tall fescue (cv. Barcel, Barenbrug USA, Tangent, OR; n = 3), or NE tall fescue cultivars BarOptima, infected with the E-34 endophyte (BarOptima PLUS E-34, Barenbrug USA; n = 3), and Jesup, infected with the AR542 endophyte (MaxQ, Pennington Seed Inc.; n = 2). The EF cultivar Barcel, which was selected for use in this experiment because it is a commonly available EF variety and was the genetic material from which the NE variety BarOptima PLUS E-34 was selected (D. Singh, Barenbrug USA; personal communication). Pastures were prepared by spraying twice (6-wk interval) with 1.4 kg active ingredient/ha of glyphosate [*N*-(phosphonomethyl) glycine; Roundup Original Max, Monsanto Co., St. Louis, MO] on September 1 and October 13, 2004. Pastures were sown with 22 kg tall fescue seed/ha to a depth of 0.6 cm in mid-October 2004 using a no-till drill (25-cm row, Tye Pasture Pleaser, AGCO Co., Duluth, GA). Pastures were situated in a floodplain at the University of Arkansas Division of Agriculture, Southwest Research and Extension Center (33°42′ N, 93°31′ W) near Hope, Arkansas. The soil type was Una silty clay loam, which is deep, poorly drained, and nearly level, with slopes of 0 to 1% (Hoelscher and Laurent, 1979). Pastures were fertilized with 57 kg/ha of N as ammonium nitrate in October and March of each year as well as P and K to meet soil-test recommendations (Chapman, 1998) as determined by annual soil testing.

Forage availability was estimated monthly using a calibrated rising-plate meter (Michell and Large, 1983). Beginning in December each year, 20 rising-plate height measurements were taken monthly from each pasture. Plate readings were calibrated by clipping the forage within a 30.5-cm^2 quadrat to a height of 2.5 cm in each pasture. Additional forage samples were collected monthly by hand-plucking forage in 20 locations in each pasture to mimic forage consumed by cattle for characterization of forage chemical composition. Rising-plate calibration and forage chemical composition samples were dried to a constant weight at 50°C in a forced-air oven. Dry weights of rising-plate calibration clippings were used to relate forage mass (kg/ha) to plate height within each forage type by linear regression for forage mass prediction ($R^2 \geq 0.87$), using the regression procedure (SAS Institute Inc., Cary, NC). Calves were removed from pastures when forage allowance became limited (<850 kg forage DM/ha).

Forage chemical composition samples were ground to pass a 2-mm screen in a Wiley Laboratory Mill (model 4, Thomas Scientific, Swedesboro, NJ) and were analyzed for DM and ash (AOAC, 1990). Neutral detergent fiber and ADF were assayed by the batch procedures outlined by Ankom Technology Corp. (Fairport, NY) modified from Van Soest et al. (1991). Concentration of N was determined by rapid combustion (FP-528, Leco Corp, St. Joseph, MI) and CP was calculated as the percentage of N × 6.25.

Ten randomly selected tall fescue tillers were harvested from each pasture on May 3, 2006, January 12, 2007, February 28, 2007, and May 23, 2007. These tillers were screened for the presence of ergot alkaloid by competitive ELISA assay (Phytoscreen Tiller Ergot Alkaloid ELISA Assay, Agrinostics Ltd. Co., Watkinsville, GA). Stand counts of tall fescue pastures were based on grid-frame quadrat readings. The quadrat consisted of a 76-cm^2 steel-wire frame divided into 25 cells (15 cm^2). The percentage of cells containing at least one live tall fescue crown (or partial crown, not overhanging leaves) was averaged across 50 random throws per pasture during each fall and spring. All pastures were sprayed on October 13, 2006, in the fall before the second year of grazing, with 1.68 kg active ingredient/ha of diuron (Karmex, Dupont, Wilmington, DE) to control annual grasses [*Hordeum pusillum*, *Lolium perenne* L. ssp. *multiflorum* (Lam.) Husnot, and *Bromus japonicus*] present in pastures. Annual grasses contaminating pastures ranged in percentage from 15 to 75%; this contamination was greater for EF pastures because stand densities were less than for NE or KY-31 pastures.

Animal Management

The pasture replicates were stocked (3.7 calves/ha) with 11-mo-old calves (2 steers and 1 heifer/pasture, initial BW = 244 ± 9.5 kg, 75 to 87% Angus) on January 4, 2006, and January 9, 2007, when >1,250 kg forage DM/ha was accumulated. These calves were from the Southwest Research and Extension Center cow herd and before the study were fed warm-season grass hay [predominantly *Cynodon dactylon* (L.) Pers., but also including *Digitaria ciliaris* and *Paspalum dilatatum*], which contained 10% CP and 55% TDN (DM basis), along with 0.91 kg/d of corn gluten feed supplement. Grazing during the performance study was managed using the put-and-take method, as described by Sollenberger and Burns (2001). The 3 original calves in each pasture were used as tester animals (n = 33 each year) to measure performance,

and additional calves were added as needed to equalize forage availability among pastures. Grazers were added or removed based on visual evaluation of forage availability conducted weekly. Grazing days per hectare were calculated using the total number of days that both tester and grazer animals were present on pastures divided by the area of the pastures (0.81 ha).

During March of 2006, all pastures were destocked for 5 d, when they were flooded for a brief period of time. At the end of the study in 2006, grazing of EF pastures was terminated on May 24 because all additional grazers were removed from pasture and the regrowth rate of pastures were still unable to provide adequate forage mass for the tester calves alone. Grazing of KY-31 and NE was terminated on June 21.

During 2007, grazing was terminated in an EF pasture on March 6 and in the other EF pastures on April 3; as in 2006, all additional grazers were removed from pasture and the regrowth rate of pastures were still unable to provide adequate forage mass for the tester calves alone. Calves grazing KY-31 were removed from pasture on May 1, when the calves were observed to be in considerable heat stress (i.e., panting, drooling, and standing in mud by the water source; Stuedemann and Hoveland, 1988). Grazing was terminated on all NE pastures on May 29, when increasing maturity of the forage caused the nutritive quality to become limiting for growth.

During the performance study, calves were offered 0.46 kg/d per calf (as-fed basis) of a corn-based supplement, primarily to serve as a carrier for a mineral premix. The supplement was formulated to supply 1.1 Mcal ME/d and 114 g mineral premix/d; feeding rate was prorated for feeding 3 times weekly (on Monday, Wednesday, and Friday of each week). The mineral premix (Sunbelt Custom Minerals Inc., Sulfur Springs, TX) contained (as-fed basis) 14% Ca and 7% P from $CaCO_3$ and Ca_2PO_4, 5% Mg from MgO, and 14% NaCl, as well as vitamins (661,500 IU/kg vitamin A, 221 IU/kg vitamin E, and 66,150 IU/kg vitamin D), and trace minerals (1,000 ppm Mn from $MnSO_4$, 2,355 ppm Fe from $FeSO_4$, 1,250 ppm Cu from $CuSO_4$, 3,000 ppm Zn from $ZnSO_4$, 20 ppm Co from $CoCO_3$, 26 ppm Se from sodium selenite, and 25 ppm I from ethylenediamine dihydroiodide).

Body weight and BW gain of calves were based on a single weight (unshrunk) at the initiation and termination of grazing and at 28-d intervals. Weights were taken in this way to reduce the stress on calves grazing toxic endophyte pastures. The use of full BW to estimate ADG has been shown to be as effective as shrunk weights if the duration between initial and final BW is sufficient to reduce variation in gut fill (>67 d; Aiken and Tabler, 2004). Blood was collected via jugular venipuncture at the initiation of grazing and at 28-d intervals. Blood was collected into 7-mL vacuum tubes without preservative (Vacutainer 366431, Becton Dickinson, Franklin Lakes, NJ). Immediately after collection, blood was placed in a refrigerator at the study site at 4°C for 6 h after collection. Samples were then transported 6.5 km to the Southwest Research and Extension Center Forages and Ruminant Nutrition Laboratory. Serum was separated by centrifugation at 1,000 × *g* for 30 min at 20°C. Serum was then decanted and stored at −20°C for subsequent analysis. Serum prolactin was analyzed by RIA using a primary and purified standard and iodination preparations supplied by the National Hormone and Peptide Program, as described by Spoon and Hallford (1989).

Statistical Analysis

Animal performance for the winter period (January through March) and spring (April until calves were removed from pasture) was analyzed by year as a completely randomized design, using the mixed models procedure (SAS Institute Inc.); pasture was the experimental unit (Steel and Torrie, 1980), calf was the sampling unit, and pasture within treatment was included in the random statement. Serum prolactin concentrations were analyzed using the mixed procedure of SAS by year for each date, using pasture within treatment in the random statement. Serum prolactin concentration at the initiation of the study was used as a covariate for analysis of subsequent sample dates. Least squares means of animal performance and serum prolactin concentration were separated using preplanned contrasts: 1) toxic endophyte tall fescue (KY-31) versus EF (Barcel) and NE tall fescues (BarOptima PLUS E-34 and Jesup AR542); 2) EF versus NE tall fescues; and 3) BarOptima PLUS E-34 versus Jesup AR542. Forage DM yield for each year was analyzed by ANOVA with the general linear models procedure of SAS to test for the effects of treatment, sampling date, and their interaction, using residual error as the error term. Mean forage chemical composition was calculated by collection date and forage treatment, using the means procedure of SAS. Stand counts of tall fescue were analyzed by ANOVA with the general linear models procedure of SAS to test for the effects of treatment, sampling date, and their interaction, using residual error as the error term. Least squares means of stand counts were separated using preplanned contrasts: 1) EF versus endophyte infected (KY-31 and NE), 2) KY-31 versus NE, and 3) BarOptima PLUS E-34 versus Jesup AR542.

RESULTS AND DISCUSSION

Forage Dry Matter Availability

The actual and normal (30-yr mean) temperature and precipitation from June to the following May for the establishment year (2004 to 2005) and the 2 yr of grazing (2005 to 2006 and 2006 to 2007) at the University of Arkansas Southwest Research and Extension Center are presented in Figures 1 and 2, respectively. Temperatures were normal during the year of establishment, but were below normal during both grazing years. During establishment, precipitation was near

normal levels except for being wetter than normal conditions in October, November, and January. Drought conditions were prevalent during the grazing study, with less than normal precipitation in all months except January 2007, when nearly twice the normal precipitation was recorded.

In 2006, there was no effect of forage treatment ($P = 0.43$) or forage treatment × sampling date ($P = 0.46$), but forage DM availability was affected ($P < 0.01$) by sampling date (Figure 3). Because forage growth was accumulated from the fall and winter, the available forage DM peaked in early January and declined through the late winter and spring until calves were removed from EF pastures in May. Forage DM availability then began to increase in the remaining pastures until calves were removed in June.

There was no effect of forage treatment × sampling date on forage DM availability ($P = 0.62$) in 2007, but forage availability was affected ($P < 0.01$) by the main effects of forage treatment and sampling date (Figure 4). Contaminating annual grasses were treated in all pastures before the second grazing season; thus, forage DM availability was less ($P < 0.01$) in EF pastures than in KY-31 or NE tall fescue pastures because stand densities were low and little annual grass was present because of the application of herbicide, which was designed to remove competition by annual grasses the previous fall. Forage DM availability remained constant from January through March and began to increase ($P < 0.05$) in April and May, which was associated with a normal flush of spring regrowth. Tester calves remained on EF pastures as long as possible before grazing termination to determine the performance of calves grazing these pastures, even though forage availability was less than ideal.

When stands were evaluated (Figure 5) in April 2005, EF (15% stand counts) did not differ ($P = 0.16$) from endophyte-infected pastures (35%). In December 2005, stand counts indicated that percentage of coverage of tall fescue by EF improved to 45%; this was less ($P = 0.04$) than either NE or KY-31 (82%), which did not differ ($P \geq 0.48$). Tall fescues with endophyte infection, whether toxic or nontoxic, remained constant at approximately 75% and were greater ($P < 0.01$) than EF through the rest of the study. Endophyte-free pastures declined in stand density during the grazing study, resulting in nearly complete stand loss (<10% stand) by the end of grazing in 2007 (Figure 5). This was the reason for low forage production in 2007, which made early removal of calves from EF pastures in March and April 2007 necessary. Research at the same site in the late 1980s (J. M. Phillips, Morehead State University, Morehead, KY; personal communication) indicated that stands of EF tall fescue were completely gone within 4 yr. In the Gulf Coastal Plain in Louisiana, endophyte-free tall fescue was reported to offer only 2 to 3 yr of productive grazing (Coombs et al., 1999). The loss of EF tall fescue stands within 2 yr of grazing in the current study probably resulted from drought conditions prevalent during the study (Figure 2). Endophyte infection of tall fescue improves seedling vigor, drought tolerance, and plant persistence (Hill et al., 1991; West, 1994; Belesky and Fedders, 1995), and NE infection of tall fescue has resulted in similar effects on plant persistence (Bouton et al., 2002). The percentages of tall fescue tillers that were determined by competitive ELISA assay to contain ergot alkaloids were 87, 7, 16, and 10% (±5.7) for KY-31, EF, BarOptima PLUS E-34, and Jesup AR542, respectively, indicating there was approximately 11% contamination of EF and NE pastures with toxic endophyte-infected tall fescue.

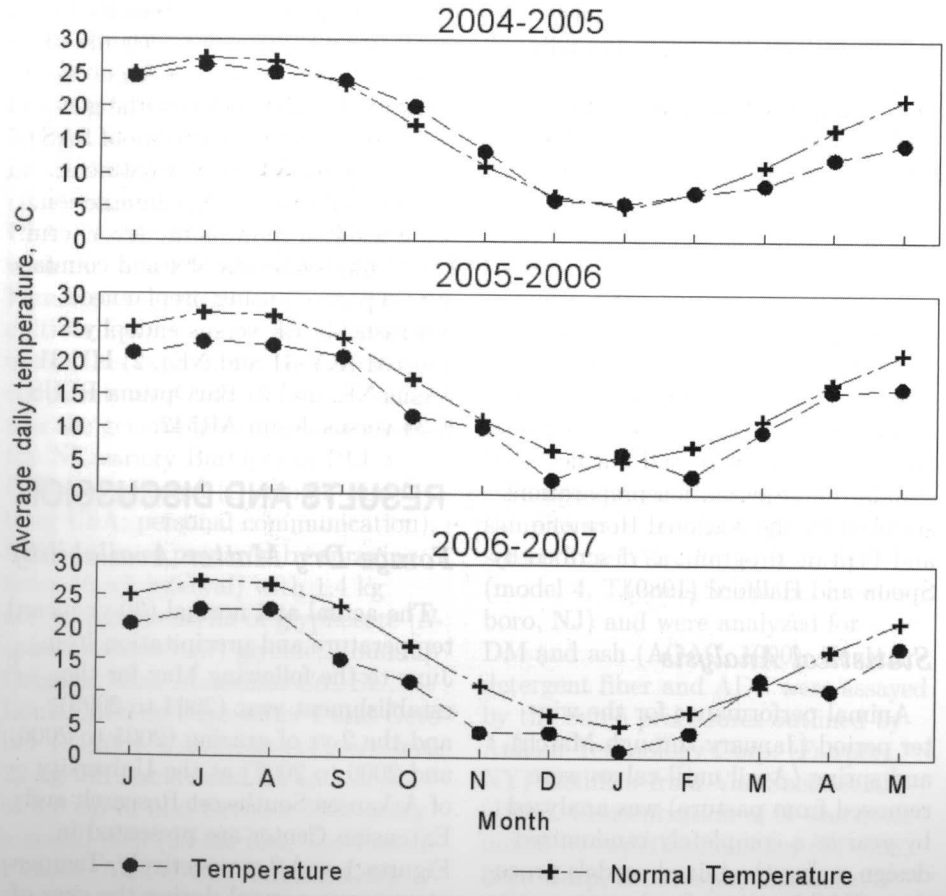

Figure 1. Actual and normal (30-yr mean) temperature from June through May for the establishment year (2004 to 2005) and the 2 yr of grazing (2005 to 2006 and 2006 to 2007) near Hope, Arkansas (National Oceanic and Atmospheric Administration National Weather Service, 2008).

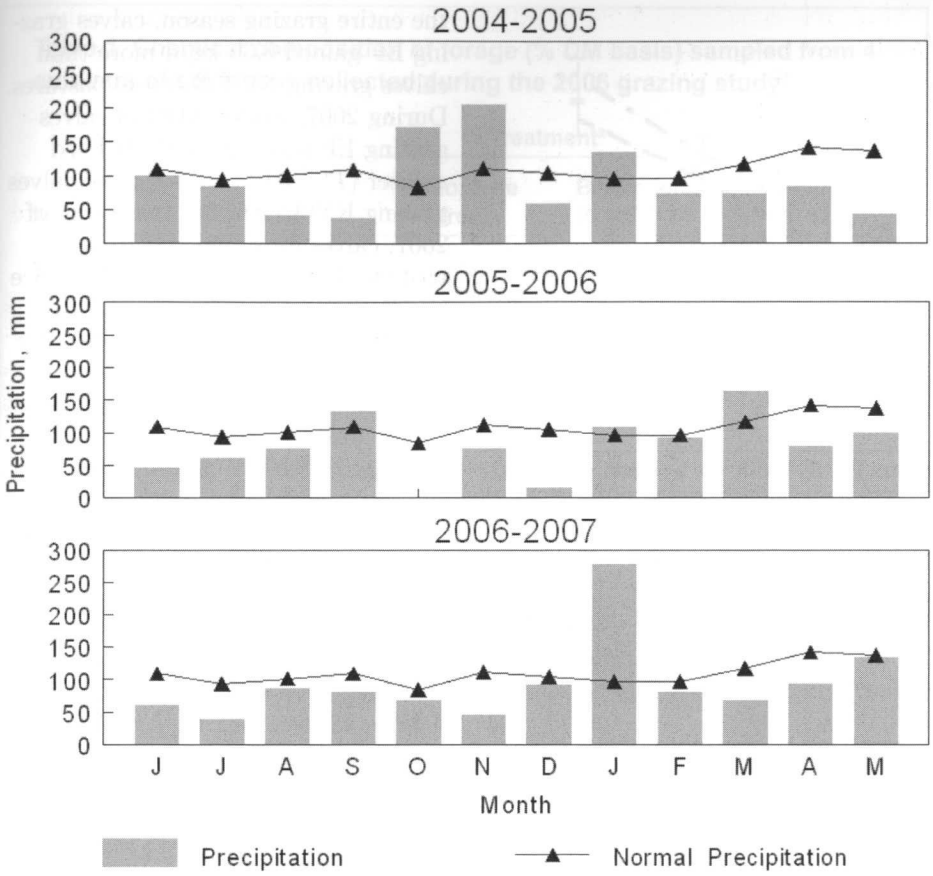

Figure 2. Actual and normal (30-yr mean) precipitation from June through May for the establishment year (2004 to 2005) and the 2 yr of grazing (2005 to 2006 and 2006 to 2007) near Hope, Arkansas (National Oceanic and Atmospheric Administration National Weather Service, 2008).

Forage Nutritive Value

Chemical composition (mean ± SD) of forage samples collected during 2006 and 2007 are presented in Tables 1 and 2, respectively. There was a decline in CP concentration of KY-31 and NE tall fescue from January to February in both years, followed by increased CP with the initiation of spring regrowth in March and April. Crude protein concentration of KY-31 and NE then declined through May and June, corresponding with seasonal increases in maturity. In 2006, CP concentration in EF was >20% of DM until May and June. Forage samples were not collected after the removal of calves from EF and KY-31 in 2007 because without grazing pressure, changes in maturity would be expected to occur at a different rate than in pastures in which calves continued to graze. An increase in NDF concentration was noted throughout the grazing season in both years, whereas ADF concentration remained relatively constant until increases were observed in April and May of both years. Using the Arkansas TDN equation developed for tall fescue—TDN = 58.4 + 1.034 × CP − 0.42 × ADF—as described by Davis et al. (2002), calculated TDN of the forages in this study ranged between 63 to 70%, which was adequate for a 250-kg growing steer to gain between 0.6 and 0.9 kg/d (NRC, 1996), and CP content was adequate for growth in excess of 1.2 kg/d (≥12.4% CP; NRC, 1996) until the end of grazing in late April or early May of each year.

Animal Performance

Animal performance is presented by year and season in Table 3. During 2006, BW of EF and NE calves were 33 and 48 kg greater ($P \leq 0.02$) at the end of the winter grazing period and on removal from pasture, respectively, than those of KY-31 calves. During 2007, BW at the end of the winter period did not differ ($P = 0.18$) between KY-31 and nontoxic (EF and NE) pastures. This lack of difference may have been because BW of EF was 24 kg less ($P = 0.05$)

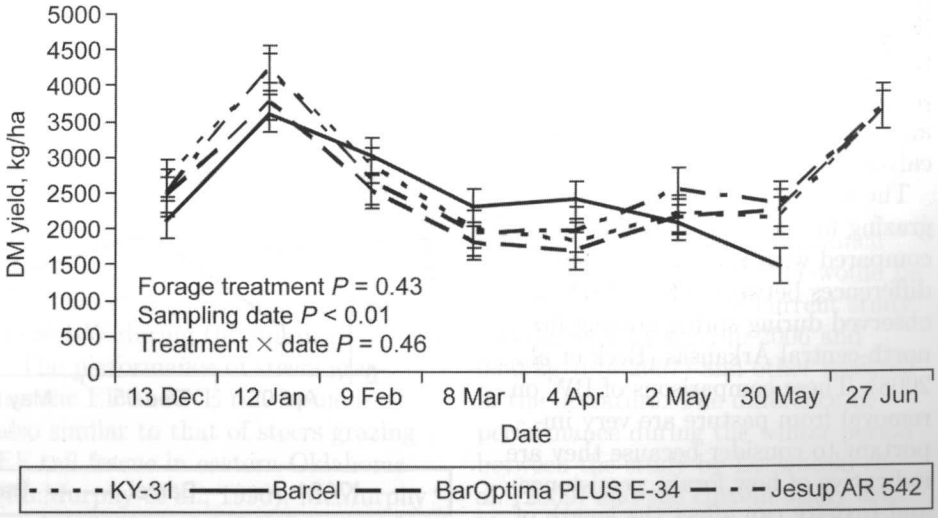

Figure 3. Effect of endophyte infection and cultivar of tall fescue on forage DM availability from 2005 to 2006. KY-31 = toxic endophyte-infected Kentucky-31 tall fescue; Barcel = endophyte-free tall fescue (Barenbrug USA Inc., Tangent, OR); BarOptima PLUS E-34 = nontoxic endophyte-infected (NE) tall fescue (Barenbrug USA); and Jesup AR542 = NE tall fescue (MaxQ, Pennington Seed Co., Madison, GA).

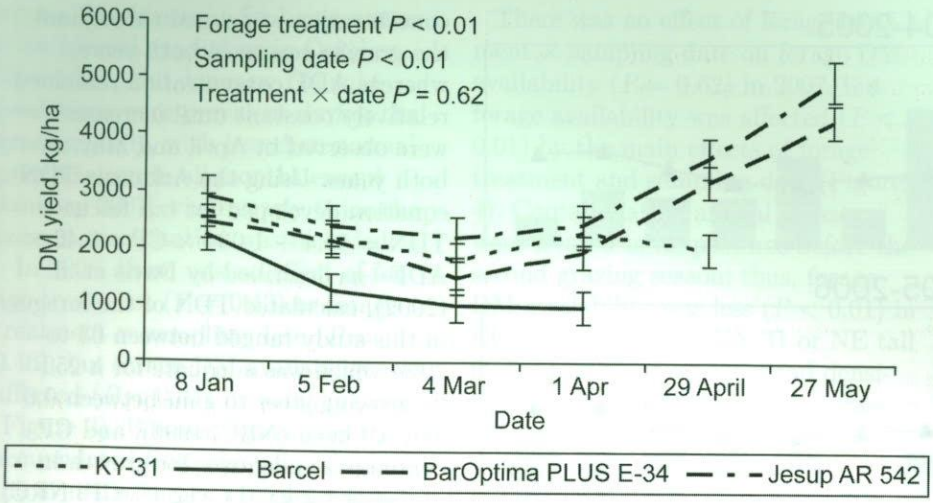

Figure 4. Effect of endophyte infection and cultivar of tall fescue on forage DM availability from 2006 to 2007. KY-31 = toxic endophyte-infected Kentucky-31 tall fescue; Barcel = endophyte-free tall fescue (Barenbrug USA Inc., Tangent, OR); BarOptima PLUS E-34 = nontoxic endophyte-infected (NE) tall fescue (Barenbrug USA); and Jesup AR542 = NE tall fescue (MaxQ, Pennington Seed Co., Madison, GA).

than NE at that time. In 2007, off-pasture BW of calves from EF and NE pastures were 25 kg greater ($P = 0.05$) than those of KY-31 calves. Because calves were removed from EF pastures at the end of the winter grazing period, off-pasture BW of EF was 67 kg less ($P < 0.01$) than that of NE, which is due to the longer grazing season for NE compared with EF pastures. Cattle were removed from EF pastures at an earlier date than from KY-31 and NE pastures because all additional grazers were removed from pasture and regrowth rates of pastures were still not able to provide adequate forage mass for the tester calves alone.

The increase in BW at the end of grazing for calves grazing EF and NE compared with KY-31 is similar to differences between NE and KY-31 observed during spring grazing in north-central Arkansas (Beck et al., 2008). These comparisons of BW on removal from pasture are very important to consider because they are indicative of how forage persistence and toxicity can affect the length of the grazing season and animal performance. Stocker operation sales are based on either calf BW or BW gains; thus, factors that affect the length of the grazing period can have large impacts on profitability of the stocker cattle operation.

Average daily gain during 2006 (Table 3) was 0.40 kg greater ($P = 0.02$) during the winter and 0.65 kg greater during the spring ($P = 0.04$) for calves grazing EF and NE pastures than for calves grazing KY-31 pastures. Over the entire grazing season, calves grazing EF and NE pastures gained 0.55 kg/d more ($P < 0.01$) than calves grazing KY-31. Over the entire grazing season, calves grazing EF gained 0.35 kg/d more than calves grazing NE tall fescue pastures. During 2007, winter ADG of calves grazing EF and NE was 0.24 kg/d greater ($P = 0.01$) than that of calves grazing KY-31. During the spring of 2007, calves were removed from EF pastures because the forage allowance was limiting, but calves grazing NE pastures gained 0.21 kg/d more ($P = 0.04$) than calves grazing KY-31.

The increased performance of calves grazing EF and NE tall fescue compared with KY-31 tall fescue is similar to performance differences reported previously. Beck et al. (2008) observed in a 3-yr study that steers grazing NE tall fescue in north-central Arkansas gained 0.85 kg/d during both the fall and spring grazing seasons compared with 0.63 kg/d during the fall and 0.31 kg/d during the spring for KY-31. Parish et al. (2003) reported that steers grazing Jesup AR542 in Georgia gained 0.26 kg/d more in the fall and 0.43 kg/d more in the spring than steers grazing Jesup infected with toxic endophyte. Nihsen et al. (2004) reported that cattle grazing EF tall fescue and NE tall fescue in Arkansas and Missouri gained an average of 0.24 kg more daily than cattle grazing toxic endophyte KY-31 fescue. Hopkins and Alison (2006)

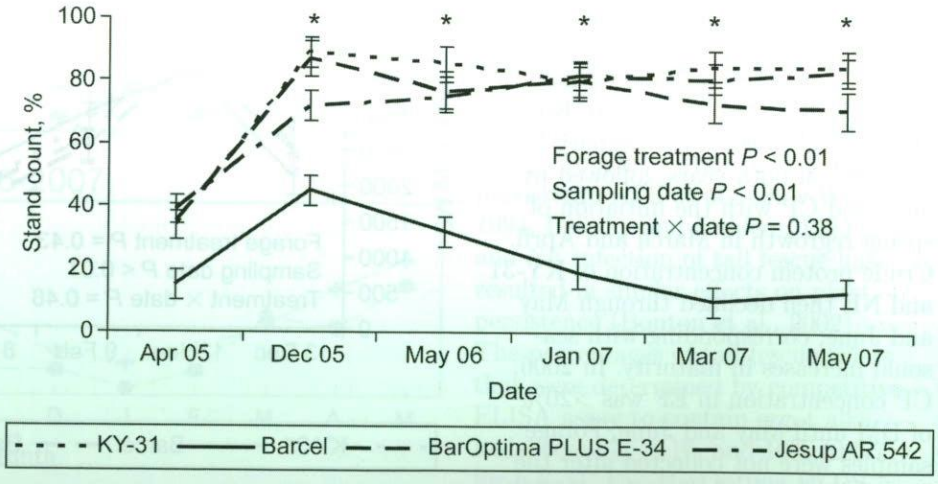

Figure 5. Effect of endophyte infection and cultivar of tall fescue on percentage of stand from April 2005 to May 2007. KY-31 = toxic endophyte-infected Kentucky-31 tall fescue; Barcel = endophyte-free tall fescue (Barenbrug USA Inc., Tangent, OR); BarOptima PLUS E-34 = nontoxic endophyte-infected (NE) tall fescue (Barenbrug USA); and Jesup AR542 = NE tall fescue (MaxQ, Pennington Seed Co., Madison, GA). *Endophyte-free versus endophyte-infected (KY-31 and NE) contrast ($P < 0.05$).

Table 1. Chemical composition of forage (% DM basis) sampled from 4 cultivars of tall fescue collected during the 2006 grazing study[1]

	Treatment[2]			
Item	KY-31	Endophyte free	BarOptima PLUS E-34	Jesup AR542
CP				
December 15	14.7 ± 1.1	24.1 ± 5.9	22.1 ± 1.0	16.6 ± 0.1
January 5	14.3 ± 0.3	22.3 ± 4.3	16.3 ± 0.5	15.6 ± 0.9
February 1	12.5 ± 0.9	21.9 ± 5.5	15.0 ± 1.1	14.7 ± 1.6
March 6	18.2 ± 2.7	27.1 ± 4.7	21.1 ± 1.7	21.8 ± 0.9
April 3	23.5 ± 3.8	25.6 ± 3.0	25.9 ± 1.5	25.0 ± 2.7
May 1	13.2 ± 2.8	14.4 ± 2.1	15.8 ± 1.6	13.9 ± 2.3
May 29	13.1 ± 3.4	15.5 ± 3.4	17.9 ± 3.1	12.8 ± 2.1
June 26	15.1 ± 1.7	—	15.5 ± 0.7	16.8 ± 0.6
NDF				
December 15	45.5 ± 1.1	30.8 ± 3.8	42.1 ± 2.6	48.3 ± 1.9
January 5	49.2 ± 0.9	44.4 ± 4.5	49.1 ± 0.6	40.2 ± 2.1
February 1	53.4 ± 2.1	44.1 ± 8.8	52.4 ± 3.2	51.4 ± 1.6
March 6	57.1 ± 1.0	47.4 ± 3.4	53.4 ± 1.3	53.0 ± 1.9
April 3	53.2 ± 2.2	50.3 ± 3.5	52.7 ± 1.5	52.5 ± 0.1
May 1	57.4 ± 1.5	59.1 ± 0.7	58.3 ± 0.9	60.2 ± 0.8
May 29	62.1 ± 2.1	60.5 ± 1.8	59.3 ± 2.4	63.5 ± 4.7
June 26	59.5 ± 1.9	—	58.6 ± 3.2	59.1 ± 0.4
ADF				
December 15	23.2 ± 4.5	18.0 ± 2.6	21.8 ± 1.0	23.6 ± 1.1
January 5	25.0 ± 0.5	21.5 ± 3.3	24.9 ± 0.5	25.6 ± 1.2
February 1	26.9 ± 1.7	19.6 ± 5.0	25.4 ± 1.7	25.0 ± 1.0
March 6	26.0 ± 4.1	19.4 ± 1.7	24.5 ± 1.2	23.9 ± 1.0
April 3	23.5 ± 3.8	24.9 ± 1.0	25.6 ± 0.7	25.5 ± 0.8
May 1	29.6 ± 3.4	29.8 ± 0.8	29.1 ± 0.5	29.6 ± 0.4
May 29	42.3 ± 6.6	38.4 ± 1.0	37.3 ± 3.5	41.8 ± 5.3
June 26	31.7 ± 1.0	—	30.9 ± 1.5	31.1 ± 0.3

[1]Values are means ± SD and are on a percentage DM basis.

[2]Treatments included KY-31 = toxic endophyte-infected Kentucky-31 tall fescue; endophyte-free tall fescue (cv. Barcel, Barenbrug USA Inc., Tangent, OR); BarOptima PLUS E-34 = nontoxic endophyte-infected (NE) tall fescue (Barenbrug USA); and Jesup AR542 = NE tall fescue (MaxQ, Pennington Seed Co., Madison, GA).

reported that in south-central Oklahoma, there was no difference in ADG of steers grazing EF, toxic endophyte, or NE tall fescue during the fall. During the spring, Hopkins and Alison (2006) reported the ADG of steers grazing tall fescue infected with NE in Oklahoma was 0.20 kg greater than for toxic endophyte Georgia-5 and was 0.38 kg greater than toxic endophyte-infected KY-31 tall fescue. In northeastern Louisiana, Hopkins and Alison (2006) reported that ADG during the spring was 0.36 kg greater for EF and NE tall fescue than for toxic endophyte tall fescue. Franzluebbers and Stuedemann (2006) reported that calves grazing NE tall fescue gained 0.26, 0.34, and 0.22 kg/d more than calves grazing toxic endophyte tall fescue during the winter, spring, and fall, respectively, but did not gain more BW during the summer.

The performance of steers grazing the EF and NE tall fescue is also similar to that of steers grazing EF tall fescue in eastern Oklahoma (McMurphy et al., 1990). McMurphy et al. (1990) reported that gains of steers grazing tall fescue with a low endophyte infection rate (0.7% infection) were 0.21 kg greater than ADG of steers grazing highly infected tall fescue (>76% infection). In a combined analysis of 12 tall fescue grazing studies, the relationship between the percentage of toxic endophyte infection and animal performance was reported as ADG (g/d) = 928 − 4.86 × (% infection) for spring grazing (Thompson et al., 1993), indicating that for every percentage unit increase in endophyte infection, ADG was reduced by nearly 5 g.

Calves grazing EF and NE pastures gained in excess of what the analysis of forage chemical composition would suggest, indicating that the sampling technique may have underrepresented the quality of the diet actually consumed by the calves. The performance of calves grazing KY-31 during the winter period (0.74 kg/d in 2006 and 0.56 kg/d in 2007) was less than the analysis of forage chemical composition would suggest, indicating that DMI was less than would be expected from nontoxic pastures of the same quality. Dry matter intake of forage-based diets has a large impact on animal performance, and the reductions in performance observed in this and other studies during the fall and winter, when toxin levels are normally considered low and the effect of heat stress would be negligible, indicates that DMI of toxic tall fescue diets may be to blame. In North Carolina, growing cattle strip-grazed stockpiled EF, NE, or toxic endophyte-infected Jesup tall fescue from December to late February over 5 seasons (Drewnoski et al., 2009). The performance of these growing calves did not differ with endophyte status, and the performance of calves strip-grazing the EF and NE pastures was much lower (0.58 kg/d) than what would be expected in view of the current study (averaging 1.14 kg/d in 2006 and 0.80 kg/d in 2007) and other research in the literature. The difference in performance during the winter period between the study by Drewnoski et al. (2009) and the current study are likely due to grazing management, where strip-grazing could limit the diet selectivity or DMI of grazing calves.

Total BW gain (Table 3) during the winter and spring grazing periods was

Table 2. Chemical composition of forage sampled from 4 cultivars of tall fescue collected during the 2007 grazing study[1]

	Treatment[2]			
Item	KY-31	Endophyte free	BarOptima PLUS E-34	Jesup AR542
CP				
January 5	22.1 ± 0.7	29.9 ± 2.1	24.4 ± 2.1	23.1 ± 2.9
February 2	15.4 ± 1.0	20.4 ± 6.4	16.2 ± 1.7	17.5 ± 0.3
March 2	21.2 ± 3.7	30.8 ± 4.7	24.6 ± 1.2	19.5 ± 1.8
March 30	28.3 ± 1.0	27.1 ± 2.5	26.9 ± 0.3	28.3 ± 1.6
April 27	21.2 ± 1.7	—	17.9 ± 2.9	18.4 ± 6.7
May 25	—	—	14.8 ± 2.4	15.3 ± 1.9
NDF				
January 5	51.3 ± 0.9	44.3 ± 4.1	49.4 ± 1.9	51.4 ± 1.1
February 2	61.2 ± 0.3	56.9 ± 11.3	60.9 ± 2.1	58.9 ± 1.2
March 2	61.0 ± 1.1	51.0 ± 3.4	56.1 ± 0.9	62.0 ± 2.3
March 30	53.0 ± 2.6	51.5 ± 1.5	53.2 ± 3.2	51.7 ± 0.3
April 27	60.2 ± 0.6	—	60.6 ± 0.8	54.6 ± 9.9
May 25	—	—	63.5 ± 3.7	62.5 ± 2.3
ADF				
January 5	24.6 ± 5.9	19.8 ± 2.4	23.0 ± 1.4	24.2 ± 0.4
February 2	25.0 ± 0.5	32.8 ± 9.4	33.9 ± 1.5	31.5 ± 1.7
March 2	29.3 ± 1.3	27.0 ± 5.0	26.1 ± 0.3	30.9 ± 2.3
March 30	23.6 ± 1.0	25.4 ± 3.6	24.0 ± 0.6	24.3 ± 0.2
April 27	29.1 ± 1.0	—	29.8 ± 1.1	27.5 ± 3.6
May 25	—	—	33.8 ± 2.8	33.9 ± 0.8

[1]Values are means ± SD and are on a % DM basis.

[2]Treatments included KY-31 = toxic endophyte-infected Kentucky-31 tall fescue; endophyte-free tall fescue (cv. Barcel, Barenbrug USA Inc., Tangent, OR); BarOptima PLUS E-34 = nontoxic endophyte-infected (NE) tall fescue (Barenbrug USA); and Jesup AR542 = NE tall fescue (MaxQ, Pennington Seed Co., Madison, GA).

greater ($P = 0.02$) for EF and NE tall fescue pastures than for KY-31 in 2006. Total BW gain did not differ ($P \geq 0.24$) between cattle grazing EF tall fescue and NE tall fescue in 2006. In 2007, BW gain of calves grazing EF and NE tall fescue did not differ ($P = 0.18$) because BW gain of EF calves was less ($P = 0.05$) than BW gain of calves grazing NE. Over the entire 2007 grazing season, calves grazing NE gained 50 kg more ($P = 0.03$) than those grazing KY-31 and gained 69 kg more ($P < 0.01$) than those grazing EF. Beck et al. (2008) reported that total BW gain of steers grazing NE tall fescue in the spring was increased in a pattern similar to the present study, compared with steers grazing KY-31 pastures.

Grazing days per hectare (Table 3) during 2006 were greater ($P = 0.05$) for KY-31 than for EF and NE, yet total BW gain per hectare was 284 kg/ha greater for EF and NE than for KY-31. In 2007, grazing days per hectare did not differ ($P = 0.65$) for KY-31 compared with EF and NE, but did differ ($P < 0.01$) between EF and NE pastures because the reduced forage availability of EF pastures forced early removal of calves from the EF pastures. Body weight gain per hectare (Table 3) during 2007 tended ($P = 0.09$) to be greater (by 103 kg) for EF and NE pastures than for KY-31 pastures, but EF pastures produced 237 kg/ha less ($P = 0.01$) than NE pastures. The BW gain per hectare observed in the present study is similar to that reported by Parish et al. (2003) during the spring grazing season over 3 yr at 2 locations in Georgia. Differences in BW gain per hectare between NE tall fescue and KY-31 reported by Beck et al. (2008) were considerably greater than in the current study, possibly because Beck et al. (2008) reported BW gain per hectare over both the fall and spring grazing seasons. Based on performance, stocking rate, and length of the grazing season reported by McMurphy et al. (1990), BW gain per hectare in Oklahoma was 66 kg greater for tall fescue pastures containing a low endophyte infection rate (7% infection) compared with highly infected tall fescue (76% infection).

In January of both 2006 and 2007, serum prolactin concentrations (Table 4) did not differ ($P \geq 0.47$) for KY-31 compared with EF and NE tall fescue or between EF and NE tall fescues. On all subsequent sampling dates during 2006, serum prolactin concentrations of calves grazing KY-31 were less than ($P \leq 0.03$) those of calves grazing EF and NE tall fescue. In 2007, serum prolactin concentrations tended ($P = 0.06$) to be greater in February, and were greater ($P = 0.04$) in April and May for EF and NE than for KY-31, supporting the conclusion that fescue endophyte toxins were the cause for heat stress observed in calves grazing KY-31 in the late spring grazing period. Reduced serum prolactin concentration is commonly associated with fescue toxicosis (Hurley et al., 1980; Hoveland et al., 1983), and these results are consistent with previous studies involving comparisons of toxic endophyte, NE, and EF tall fescue (Parish et al., 2003; Nihsen et al., 2004) and of endophyte-infected and EF tall fescue seed fed to sheep (Gadberry et al., 2003).

IMPLICATIONS

These results indicate that NE tall fescue is more persistent than EF tall fescue in the Gulf Coastal Plain of southwestern Arkansas, and animal performance of calves grazing NE tall fescue is greater than that of calves grazing KY-31. Decreases in serum prolactin concentrations of calves grazing KY-31 compared with NE and EF tall fescue indicate that fescue

Table 3. Least squares means of performance of steers grazing toxic endophyte-infected (KY-31), endophyte-free, or nontoxic endophyte-infected tall fescues

	Treatment[1]					Contrast[3]		
Item	KY-31	Endophyte free	BarOptima PLUS E-34	Jesup AR542	SEM[2]	1	2	3
2006								
BW, kg								
January	228	228	227	226	5.7	0.88	0.84	0.97
April	290	332	316	321	9.4	0.02	0.27	0.75
Off pasture[4]	324	375	374	368	9.9	<0.01	0.80	0.69
ADG, kg								
Winter[5]	0.74	1.25	1.05	1.11	0.11	0.02	0.27	0.75
Spring[6]	0.49	1.51	1.06	0.85	0.21	0.04	0.08	0.56
Overall	0.58	1.37	1.05	0.97	0.10	<0.01	0.03	0.67
BW gain, kg								
Winter	62.5	104.7	87.9	92.8	9.4	0.02	0.27	0.75
Spring	27.4	42.3	59.1	47.5	7.2	0.02	0.24	0.30
Overall	96.6	147.3	146.7	140.0	9.6	<0.01	0.76	0.67
Grazing days/ha	679	561	622	704	18.3	0.05	<0.01	0.03
Total BW gain/ha, kg	420	777	652	685	68.2	0.01	0.25	0.77
2007								
BW, kg								
January	264	263	259	255	11.5	0.71	0.71	0.83
April	308	306	330	329	7.8	0.18	0.05	0.98
Off pasture[7]	326	306	375	372	8.8	0.05	<0.01	0.77
ADG, kg								
Winter	0.56	0.78	0.82	0.81	0.07	0.01	0.71	0.97
Spring	0.58	—	0.82	0.76	0.07	0.04	—	0.65
Overall	0.57	0.78	0.82	0.79	0.06	0.01	0.80	0.77
BW gain, kg								
Winter	46.7	44.4	68.7	68.4	7.8	0.18	0.05	0.98
Spring	16.3	—	46.3	43.5	5.3	0.05	—	0.72
Overall	63.0	44.4	115.2	111.6	8.6	0.03	<0.01	0.81
Grazing days/ha	380	207	484	519	41.2	0.65	<0.01	0.61
Total BW gain/ha, kg	221	166	398	408	44.7	0.09	0.01	0.88

[1]Treatments included KY-31 = toxic endophyte-infected (EF) Kentucky-31 tall fescue; endophyte-free tall fescue (cv. Barcel, Barenbrug USA Inc., Tangent, OR); BarOptima PLUS E-34 = nontoxic endophyte-infected (NE) tall fescue (Barenbrug USA); and Jesup AR542 = NE tall fescue (MaxQ, Pennington Seed Co., Madison, GA).

[2]For Jesup AR542, n = 2; for KY-31, EF, and BarOptima PLUS E-34, n = 3.

[3]Preplanned contrasts included 1) KY-31 versus EF and NE; 2) EF versus NE; and 3) BarOptima PLUS E-34 versus Jesup AR542.

[4]In yr 1, cattle were removed from EF pastures on May 24, KY-31 on June 21, and NE pastures on June 21.

[5]Winter period was from January through March.

[6]Spring period was from April until calves were removed from pasture.

[7]In yr 2, cattle were removed from 1 EF pasture on March 6 and from the remaining EF pastures on April 3; cattle were removed from KY-31 on May 1 and from all NE pastures on May 29.

toxicosis was the primary limiting factor for growth performance of calves grazing those pastures but is not a factor affecting NE pastures. The 0.25 kg/d increase in BW gain from NE tall fescue compared with KY-31 translates to a 49-kg increase in total BW gain and a 183-kg increase in gain per hectare. The cost of establishment and persistence of NE tall fescue should be considered before establishing, but for cattle producers retaining ownership past weaning, the observed boost in performance provides a great deal of economic incentive to renovate pastures with these nontoxic endophyte-infected tall fescue varieties.

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Table 4. Effect of tall fescue endophyte infection and cultivar on serum prolactin concentrations of growing beef calves during the grazing study

	Treatment[1]					Contrast[3]		
Prolactin concentration, ng/mL	KY-31	Endophyte free	BarOptima PLUS E-34	Jesup AR542	SE[2]	1	2	3
2006								
January	33.8	37.4	23.8	36.2	7.3	0.88	0.45	0.32
February	0.8	88.9	55.9	118.3	17.2	<0.01	0.97	0.06
March	3.4	91.3	43.3	132.9	25.9	0.03	0.93	0.07
April	3.2	153.5	108.2	153.7	17.4	<0.01	0.34	0.14
May	2.5	266.8	150.3	99.9	50.3	0.02	0.06	0.53
2007								
January	19.7	21.8	21.1	50.6	6.2	0.16	0.13	0.03
February	2.9	35.9	19.7	38.9	10.5	0.06	0.65	0.34
March	30.9	73.6	75.3	86.0	30.3	0.18	0.85	0.82
April	0.9	—	26.9	47.3	7.1	0.04	—	0.21
May	1.2	—	62.2	135.7	20.7	0.04	—	0.15

[1]Treatments included KY-31 = toxic endophyte-infected (EF) Kentucky-31 tall fescue; endophyte-free tall fescue (cv Barcel, Barenbrug USA Inc., Tangent, OR); BarOptima PLUS E-34 = nontoxic endophyte-infected (NE) tall fescue (Barenbrug USA); and Jesup AR542 = NE tall fescue (MaxQ, Pennington Seed Co., Madison, GA).

[2]For Jesup AR542, n = 2; for KY-31, EF, and BarOptima PLUS E-34, n = 3.

[3]Preplanned contrasts included 1) KY-31 versus EF and NE; 2) EF versus NE; and 3) BarOptima PLUS E-34 versus Jesup AR542.

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