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Performance of beef heifers grazing stockpiled fescue as influenced by supplemental whole cottonseed¹

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ABSTRACT: The objectives of this study were to determine the composition of stockpiled fescue from December through February over 2 yr and to determine the performance of heifers grazing stockpiled fescue with or without supplemental whole cottonseed. In early December, 36 heifers (initial BW 277 ± 0.70 kg, yr 1; 266 ± 2.2 kg, yr 2; and initial BCS of 5.0 ± 0.04) were assigned randomly to 6 groups. Each group was assigned randomly to a 2.4-ha tall fescue pasture (98% endophyte infected), which had received 76 kg of N/ha on September 1. Group was the experimental unit for all measures. Forage DM available during grazing (to ground level) averaged 3,913 and 5,370 kg/ha in yr 1 and 2, respectively. The pasture was strip-grazed for 83 d, with daily forage allocation. Three groups were fed whole cottonseed (0.90 kg of DM/heifer; 24.4% CP, DM basis) daily at 0.33% of BW, and a small amount of a corn-based concentrate (0.19 kg of DM/heifer) to assure complete cottonseed consumption. Nutritive value of forage (dry basis) was determined each week by sampling each pasture to the 5-cm target grazing height. Forage disappearance was estimated every 2 wk from pre- and postgraze forage mass. Forage CP was 16.8% in yr 1 and 12.6% in yr 2. In vitro true

organic matter digestibility (IVTOMD) was 82.0 and 71.9%, and ADF was 25.9 and 30.7% in yr 1 and 2, respectively. Most indicators of forage quality declined slightly through the winter, although they recovered in late winter in yr 1. The proportion of fescue that was green declined ($P < 0.05$) from December (79% in yr 1 and 64% in yr 2) to February (62% in yr 1 and 52% in yr 2). Green tissue averaged 20.4 and 15.2% CP, 91 and 87% IVTOMD, and 22.1 and 23.3% ADF in yr 1 and 2, respectively. Brown tissue averaged 10.3 and 8.5% CP, 64 and 62% IVTOMD, and 35.7 and 37.4% ADF in yr 1 and 2, respectively. Shrunk ADG (0.46 vs. 0.56 kg/d in yr 1 and 0.23 vs. 0.46 kg/d in yr 2) and change in BCS (-0.03 vs. 0.33 in yr 1 and 0.13 vs. 0.5 in yr 2) was greater ($P < 0.05$) for supplemented heifers. Supplemented heifers had greater serum urea nitrogen in yr 1 (9.5 vs. 10.5 mg/dL; $P < 0.07$) and yr 2 (7.2 vs. 8.6 mg/dL; $P < 0.01$). Forage disappearance was similar between supplemented and unsupplemented heifers (3.19 vs. 3.39 kg·heifer⁻¹·d⁻¹ in yr 1 and 4.14 vs. 4.17 kg·heifer⁻¹·d⁻¹ in yr 2, respectively). Heifers responded to supplementation, but performance was lower than expected based on forage nutrient content.

Key words: *Festuca arundinacea* Schreb., heifer, stockpiled fescue, supplement, whole cottonseed

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INTRODUCTION

Stockpiled tall fescue (*Festuca arundinacea* Schreb.) is the accumulation of autumn growth that can be grazed during winter (Mays and Washko, 1960). Winter grazing would appear to be an economical alternative to hay, but gains of growing cattle may be unacceptable when animals graze fescue despite apparently good nutritive value (Poore et al., 2000).

Low BW gain of growing cattle grazing during winter usually indicates a need for some level of energy or protein supplementation, or both. Cattle producers in the southeastern United States have utilized by-products including soybean hulls, wheat midds, corn gluten feed, and whole cottonseed for supplementing cattle (Poore et al., 2002; Rogers et al., 2002) to improve winter performance. However, few data are available in the Southeast that couple winter grazing of stockpiled fescue with supplementation programs (Allen et al., 1992; Poore et al., 2000). The objectives of this experiment were to determine the composition of stockpiled fescue from December through February and to determine performance and intake of developing heifers grazing stockpiled tall fescue with or without supplemental whole cottonseed.

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MATERIALS AND METHODS

Heifers

Thirty-six Angus cross heifers (initial BW of 277 ± 0.70 kg in yr 1, and 266 ± 2.2 kg in yr 2; initial BCS 5.0 ± 0.04) were used each year in a completely randomized design. Heifers were purchased as USDA M-1 calves from a state-graded, feeder calf sale. Age of the heifers was unknown, but they were presumed to be approximately 12 mo of age at the beginning of the experiment. As these were medium-frame heifers, they would have an anticipated mature BW of 450 to 550 kg.

Heifers were stratified by BW and randomly allotted to 6 groups. The 6 groups were then randomly assigned to 1 of 2 treatments, and each group was then randomly assigned to 1 of 6 pastures. Heifers were vaccinated against clostridial and respiratory diseases (UltraBac-7 and Bovashield-4, Pfizer Animal Health, New York, NY) and were treated with an internal and external parasiticide (IVOMEC Pour-On, Merial, Deluth, GA) at 0.1 mL/kg of BW at the initiation of the study and again on d 28. The protocol was approved by the Institutional Animal Care and Use Committee at North Carolina State University.

Full BW was determined on 2 consecutive days followed by a shrunk BW (12 h without feed or water) at the beginning and end of the study. Full BW were recorded every 28 d. In yr 2, full BW were also taken on d 7. All BW were obtained at 0800 before allocating fresh forage. Body condition scores on a 1 to 9 scale (1 = extremely thin to 9 = extremely fat; NRC, 1996) were assigned at the beginning and end of the study and every 28 d, by the same experienced evaluator.

Each morning, heifers were given a daily forage allocation using a portable electric fence. Drinking water was available in each paddock and was no more than 183 m from the grazing front. No back-fence was used except in yr 2 when a back-fence was used only during days when forage disappearance was determined. To minimize the effect of potential differences in pasture composition, the groups were rotated among the pastures each week.

Samples for determination of serum urea N (SUN) were taken via jugular venipuncture on d 27, 55, and 83 using vacuum tubes without additive (Becton Dickinson, Franklin Lakes, NJ). Blood samples were held on ice for no more than 4 h before transport to the laboratory, where they were centrifuged at $10,000 \times g$ for 10 min. Serum was aspirated and stored at -20°C until analysis. Serum urea N was determined by an automated diacetyl-monoxime method (Marsh et al., 1965).

Pasture Characterization

The six 2.4-ha pastures, established more than 30 yr before the study, were grazed from December 3, 1997, to February 23, 1998 (yr 1), and again from November

25, 1998, to February 15, 1999 (yr 2). Pastures were predominantly Kentucky-31 tall fescue but contained significant proportions of common bermudagrass (*Cynodon dactylon* (L.) Pers.), with small proportions of other species. The soil was a Cecil clay loam (fine, kaolinitic, thermic, typic Hapludult).

Before nitrogen application, pastures were grazed by beef cows and then clipped to a 7 to 8 cm stubble height. On September 1, the pastures were fertilized with 76 kg of N/ha from ammonium nitrate. Soil tests indicated no need for other fertilizer or lime applications. Endophyte infection (*Neotyphodium coenophialum*) level was determined each year by the North Carolina Department of Agriculture and Consumer Services from 100 tillers taken from the 6 paddocks at the beginning of the study (Association of Official Seed Analysts, 1993). Ninety-eight percent of tillers sampled tested positive for endophyte.

Forage mass, before the initiation of the grazing and sampling (late November) was quantified by use of a plate meter (Vartha and Matches, 1977; Mueller et al., 1990). To estimate initial forage mass in the entire paddock before grazing began, 30 to 40 canopy-height readings were taken at random from each paddock 1 wk before stocking. The plate readings were used to predict mass based on a regression equation developed from sampling the forage dry weight from 15 (yr 1) or 9 (yr 2) 0.25-m² sample areas. Initial average forage mass (to ground level) of the entire pasture area was 4,499 and 5,910 kg/ha in yr 1 and 2, respectively.

Supplements

Heifers on both treatments were given free-choice access to a high-magnesium mineral supplement (Mag-O-Min, Southern States Cooperative Inc., Richmond, VA) containing 13.1% Ca; 4.7% P; 10.0% Mg; 7.25% Na; 2,812 ppm zinc; 847 ppm copper (from sulfate); and 2,484 ppm Mn. The supplement was labeled to contain 242,290, 33,040, and 275 IU/kg of vitamin A, D, and E, respectively, and 26 ppm Se. Mineral supplement consumption was recorded weekly.

Level of supplemental, whole fuzzy cottonseed (WCS) was based on 0.33% of BW, as recommended by Rogers et al. (2002). The total supplement consisted of 0.85 kg·heifer⁻¹·d⁻¹ of WCS DM (34.6% ADF, 24.4% CP, and 15.3% EE, on a DM basis) and 0.20 kg·heifer⁻¹·d⁻¹ (DM) of a mix of corn and soybean meal (3.4% ADF, 15.8% CP, and 1.27% EE, on a DM basis) in yr 1, and 0.96 kg·heifer⁻¹·d⁻¹ of WCS DM (32.0% ADF, 23.6% CP, and 18.6% EE, on a DM basis) and 0.23 kg·heifer⁻¹·d⁻¹ (DM) of cracked corn (2.5% ADF, 9.2% CP, and 3.3% EE, on a DM basis) in yr 2.

The supplement was given in the morning in a plastic feeder, with bunk space of 0.46 m per heifer and before providing access to a fresh strip of grass. The WCS was adjusted each 28 d to 0.33% of BW. The initial plan was for the supplement to be only WCS, but at the beginning of the study in yr 1 it was clear that the

heifers would not aggressively consume all of the offered WCS, so the small amount of concentrate was spread on top of the WCS to ensure complete and rapid consumption.

Forage Disappearance

Estimates of forage mass before grazing (pregrazing) and after grazing (postgrazing) were determined on 5 dates during the 83-d grazing period. Thirty to 40 plate readings were taken on a 1-d strip of forage before and after grazing. The amount of forage present before and after grazing was predicted by measuring forage OM in 9 (yr 1) or 14 (yr 2) 0.25-m² reference areas cut to soil level with hand-held, battery-operated, electric sheep shears (Sunbeam, Botany, New South Wales, Australia) before and after grazing.

Forage samples obtained from the cut areas were dried at 60°C for 48 h, air equilibrated, weighed, ground using a 2-mm screen in a Wiley Mill, and then analyzed for DM (at 105°C) and ash (AOAC, 1999). Percentage OM was calculated as 100 – percentage of ash. Separate equations were used to determine the pre- and postgrazing forage mass each time forage disappearance measurements were taken.

Pasture disappearance was then determined by subtracting the postgraze forage OM/ha from the pregraze forage OM/ha on daily strips of grass and multiplying by the total area offered (Mueller et al., 1990). In yr 1, heifers were given their daily forage allocation and access to all the previously grazed area. In yr 2, a back fence was installed to allow access only to the current day's allocation, and the area that had been grazed the previous 2 d. The back fence allowed an average of 0.003 ha/heifer of previously grazed area in addition to the fresh strip of forage. This area allowed enough room to prevent crowding on the grazing front but prevented the opportunity for extensive back grazing (grazing the previously grazed area of the pasture). Measurements were also made on this back-fenced area using the plate to monitor pre- and postgraze canopy mass as just described for the fresh strip of forage. Organic matter disappearing from the previously grazed area was added to that of the fresh strip to give total disappearance. The efficiency of forage use was calculated as the percentage of pregraze forage mass removed on the intake measurement day.

Forage Sampling

To determine the nutritive value of the forage, whole-canopy forage samples were taken weekly from each of the 6 pastures. Samples consisted of 10 areas of 15 × 15 cm that were clipped to a 5-cm height and that were randomly selected from the area to be grazed during the next 7 d. Every 2 wk, forage samples were subsampled for separation into green and brown tall fescue and other forage species (primarily bermudagrass). In yr 1, subsamples from 3 paddocks were pooled for sepa-

rations, whereas in yr 2, separations were performed for each paddock. All samples were weighed, dried in a forced air oven at 60°C for 48 h, allowed to air equilibrate for 24 h, and then weighed again before further processing. All samples were ground through a 5-mm screen, and then a 50-g subsample was reground through a 1-mm screen in a Wiley Mill (Arthur H. Thomas Co., Philadelphia, PA) before laboratory analysis.

Laboratory Analyses

Forage samples (whole canopy, and green and brown fescue fractions) were analyzed in duplicate for DM, OM, CP, *in vitro* true organic matter disappearance (IVTOMD), NDF, ADF, cellulose, and lignin. Dry matter (105°C), ash, and CP (Kjeldahl N × 6.25) were determined according to AOAC (1999), and OM was calculated as 100 – % ash. Neutral detergent fiber, ADF, 72% sulfuric acid lignin (ADL), and cellulose were determined sequentially according to Van Soest et al. (1991) using the Ankom Fiber Analyzer (Ankom Corp., Fairpark, NY). *In vitro* true dry matter digestibility was determined by a modification of the method of Tilley and Terry (1963) using NDF termination in an Ankom Daisy^{II} IV 100 apparatus (Ankom Corp., Fairpark, NY). Residues were subsequently ashed to determine IVTOMD values by subtracting OM remaining in the bags from OM in the original samples. Cottonseed and concentrate were sampled weekly, pooled by month, and analyzed for DM, OM, CP, NDF, and ADF as just described, except that heat stable α -amylase (Van Soest et al., 1991) was used for NDF determination on the grain samples. Ether extract was determined on WCS and concentrate as described by AOAC (1999).

The 6 whole-canopy fescue samples for each date were pooled on an equal weight basis and then sent to a commercial laboratory for mineral analysis (Dairy One Forage Testing Laboratory, Ithaca, NY). Cottonseed, grain, and mineral supplement were also tested for minerals by Dairy One, and the WCS and grain were shown to be free of mycotoxins (aflatoxin, zearalenone, and deoxynivalenol) by the North Carolina Department of Agriculture and Consumer Services forage testing laboratory.

Statistical Analysis

Statistical analysis was conducted using the GLM procedure of SAS (SAS Inst. Inc., Cary, NC). Total canopy composition was tested for the effects of year, treatment, date, and all associated interactions. Treatment was not significant for any measure ($P = 0.49$ to $P = 0.77$), so treatment was excluded from the model. Year, date, and date × year were significant ($P < 0.05$), so forage composition data are presented for each date by year. Green and brown tissue composition was tested for effects of tissue color, year, date, and associated interactions. Year, date, and date × year were signifi-

Table 1. Long-term monthly mean precipitation (precip) and temperature, and departures from the long-term mean in yr 1 and 2¹

Month	30-yr mean			Yr-1 departure			Yr-2 departure			Days <0°C	
	Precip, ² mm	Max, ² °C	Min, ² °C	Precip, mm	Max, °C	Min, °C	Precip, mm	Max, °C	Min, °C	Yr 1	Yr 2
August	103	30	20	-68	1	2	-5	1	0	0	0
September	82	27	16	-11	1	0	9	3	1	0	0
October	73	22	9	1	1	1	-14	2	2	0	0
November	77	17	4	13	-2	0	-24	1	2	7	2
December	82	12	0	6	-1	2	10	2	4	9	8
January	90	9	-2	133	3	5	74	6	5	7	9
February	95	11	0	64	2	3	-54	4	3	5	10

¹Precipitation and temperature during yr 1 and 2 measured on-site, and 30-yr mean precipitation and temperature are from the National Weather Service, RDU International Airport (21 km from the research site).

²Precip = monthly mean precipitation in mm; Max °C = monthly mean high temperature; and Min °C = monthly mean low temperature.

cant ($P < 0.05$), so composition of green and brown tissue was presented for each date by year. To evaluate the pattern of forage composition over time, forage composition (including mineral composition) was tested for linear and quadratic effects within year, using the GLM procedure of SAS.

Heifer data, including BCS, ADG, mineral intake, gain per hectare, and stocking rate, were tested for effects of treatment, year, and year \times treatment interactions with group being the experimental unit. Year, and year \times treatment were significant for many of the heifer measures, so means are presented by year. Weight gains from d 1 to 7 and d 7 to 83 were only determined in yr 2, so they were analyzed separately. Forage disappearance and estimated OM intake, and pre- and post-graze forage mass were tested for effects of treatment, year, sample date within year, and associated interactions. Treatment \times week was not significant ($P = 0.10$ to $P = 0.99$), so means are presented by year. Serum urea nitrogen data were tested for treatment, year, sample date, and associated interactions. Sample year was significant ($P = 0.01$), whereas date \times treatment within year was not ($P = 0.39$ to $P = 0.71$), so data are presented by year averaged across dates. Pre- and postgraze forage mass, forage use efficiency, forage disappearance, estimated OM intake, and SUN utilized repeated measures, so group within treatment was used to test for treatment differences.

RESULTS AND DISCUSSION

Climatological Data

Rainfall pattern and amounts varied during the 2 yr of the study (Table 1). In yr 1, the rainfall was below average the month before and during the accumulation period in September followed by above average rainfall in October and November when compared with the 30-yr means. During winter months pastures received above average rainfall. In yr 2, rainfall was near aver-

age in August and September but was below average in October and November. Precipitation was then above average in December and January and below average in February. In yr 1, the lack of moisture in August may have limited the growth of bermudagrass that was within the forage canopy. In yr 2, late summer rainfall was adequate, possibly allowing bermudagrass to grow through the end of the summer in all of the paddocks. Gerrish et al. (1994) reported a similar problem in a stockpiled fescue study with the invasion of foxtail (*Setaria* species). The presence of warm season species can alter whole canopy nutritive value because of its quality and stage of growth. The ample rainfall in August of yr 2 also produced greater ($P < 0.01$) pregraze forage mass (5,370 kg/ha) as compared with yr 1 (3,913 kg/ha). Average temperature for the 2-yr study was considerably greater than the 30-yr average for the area.

Forage Composition

Whole Canopy. In vitro true organic matter digestibility declined linearly ($P < 0.05$) in both years of the study, and in yr 1, a quadratic trend was also present ($P < 0.01$) as a result of an increase in quality in the late winter. The IVTOMD ranged from 86.6 to 77.8% for yr 1 and 76.0 to 67.3% for yr 2 (Table 2). Ross and Reynolds (1979) reported average in vitro dry matter digestibility (IVDMD) figures of 76.9 and 68.4% for stockpiled fescue in early and late samples, respectively. In other work from North Carolina, IVDMD concentrations of 71.7% were obtained in October, and they stayed above 60.0% through February (Burns and Chamblee, 2000). Lower IVDMD numbers in March were due to low amounts of green tissue in the canopy. Ocumpaugh and Matches (1977) documented fairly stable IVDMD values of 63 to 68% from September to early November harvests. When freezing temperatures stopped growth in November, they reported that IVDMD percentages decreased by 1%/wk.

At the initiation of the experiment, CP concentrations were 17.7% in yr 1 and 12.8% in yr 2, and were 18.5

Table 2. Nutritive composition (DM basis) of whole-canopy, stockpiled tall fescue¹

Item	Date																SEM	P-value ²	
	Yr 1 Yr 2	Dec. 3 Dec. 1	Dec. 9 Dec. 8	Dec. 16 Dec. 15	Dec. 22 Dec. 21	Dec. 30 Dec. 29	Jan. 6 Jan. 5	Jan. 13 Jan. 12	Jan. 18 Jan. 19	Jan. 27 Jan. 26	Feb. 3 Feb. 2	Feb. 10 Feb. 9	Feb. 17 Feb. 16	Feb. 24 Feb. 24	L	Q			
IVTOMD, ³ %																			
yr 1	83.8	85.5	86.6	83.1	82.5	79.8	78.3	80.1	78.2	77.8	85.0	83.1	82.6	0.98	0.01	0.01			
yr 2	72.3	74.7	76.0	73.3	70.3	74.7	72.5	72.9	69.3	68.0	67.3	71.3	ND ⁴	1.43	0.01	0.47			
CP, %																			
yr 1	17.7	18.4	17.7	16.7	16.4	15.2	15.6	15.6	15.2	13.8	19.9	18.5	18.2	0.48	0.86	0.01			
yr 2	12.8	12.8	13.6	12.3	12.4	11.9	12.5	12.6	12.9	12.8	12.9	12.1	ND	0.48	0.51	0.55			
NDF, %																			
yr 1	52.8	52.1	47.4	52.0	52.6	54.9	58.2	56.8	57.1	57.1	53.3	57.0	58.3	0.68	0.01	0.18			
yr 2	59.1	58.6	56.4	59.6	61.2	56.8	59.1	60.9	64.1	65.3	63.3	61.4	ND	1.08	0.01	0.49			
ADF, %																			
yr 1	23.5	23.3	23.0	25.3	25.6	26.7	28.5	27.9	28.5	28.0	24.1	25.8	26.6	0.45	0.01	0.01			
yr 2	28.8	27.5	28.7	30.3	31.9	28.9	30.3	30.5	33.3	34.2	32.7	31.5	ND	0.63	0.01	0.41			
Cellulose, %																			
yr 1	20.9	20.2	20.7	22.7	22.6	23.2	25.0	24.6	25.0	24.7	21.2	22.9	23.7	0.38	0.01	0.01			
yr 2	25.0	24.2	25.3	26.8	27.9	25.9	26.8	27.1	29.0	29.0	28.2	27.6	ND	0.57	0.01	0.08			
Lignin, %																			
yr 1	2.21	2.58	1.99	2.29	2.69	3.03	3.14	2.94	2.99	3.09	2.51	2.60	2.58	0.137	0.01	0.01			
yr 2	3.60	3.35	3.49	3.29	3.58	2.70	3.08	3.14	3.85	4.83	4.49	3.84	ND	0.223	0.01	0.01			

¹Stockpiled from September 1 and then sampled December through February.

²L = linear; and Q = quadratic.

³In vitro true organic matter disappearance.

⁴ND = not determined.

and 12.1%, respectively, by mid February (Table 2). Crude protein levels declined in the midwinter months in yr 1 but recovered in late winter (quadratic; $P < 0.05$). In yr 2, CP levels were stable throughout the winter. In neither year did CP levels fall below 11.9%. Such levels should meet the nutritive requirements of heifers assuming adequate DMI (NRC, 1996). Collins and Balasko (1981) found CP levels of 7.0, 7.4, and 7.2% for fescue stockpiled beginning in mid July and harvested in December, January, and February. More consecutive days of freezing temperatures at their location and an earlier beginning date may have contributed to the low values. After an August beginning for accumulation in North Carolina, Burns and Chamblee (2000) found CP concentrations were greatest in October (15.4%), lowest in December (11.0%) and that they recovered in March (13.5%). The decline in nutritive value is explained by leaf senescence and deterioration due to freezing temperatures. Freezing temperatures may rupture cell membranes, allowing leaching of digestible fractions from the plant, leaving the insoluble fractions (Ocumpaugh and Matches, 1977). Increasing CP levels in late February of yr 1 indicates new spring growth as evidenced by a 5% increase in green tissue.

Neutral detergent fiber levels gradually increased linearly throughout the study in both years ($P < 0.01$). Initial NDF levels were 52.8% on December 3 in yr 1 and 59.3% on December 1 in yr 2 before increasing to 57.1% on January 27 in yr 1 and 65.2% on January 26 in yr 2 (Table 2). Burns and Chamblee (2000) reported NDF concentrations that exhibited a similar trend from a September 1 accumulation date at 49.7% in December, 57.7% in January, and 59.4% in February. Ross and Reynolds (1979) documented NDF values from an August accumulation date averaging 40% in November and approaching 60% by January.

Concentration of ADF increased through the winter in both years of the study ($P < 0.01$). In yr 1 there was also a quadratic effect in that ADF levels declined ($P < 0.01$) in late winter. Whole canopy ADF levels were 23.5% on December 3 in yr 1 and increased to 28.5% on January 27, before declining to 26.6% by February 24 (Table 2). In yr 2, ADF was 28.9% on December 1 and increased ($P < 0.01$) throughout the winter. Burns and Chamblee (2000) found ADF levels of 23.7% when December and February dates were averaged together. Fribourg and Bell (1984) reported greater initial ADF levels of 30.0 to 34.0%, which did not vary during the stockpile period (July to January) and were not affected by stockpile initiation date.

Cellulose ranged from 20.9 to 25.2% at the beginning of the experiment for yr 1 and 2, respectively (Table 2). These levels increased throughout the study reaching 24.7% on February 3 in yr 1 and 29.0% on February 2 in yr 2. Brown and Fontenot (1963) reported cellulose concentration of 27.2% in an August 14 accumulated stockpile sampled at various intervals up to 13 wk after initiation.

Lignin levels were 2.2 and 3.6% at the beginning of the study for the 2 respective years (Table 3). Lignin concentrations showed both linear and quadratic effects ($P < 0.01$) in both years. In yr 1 lignin levels increased in midwinter but then declined in late winter. In yr 2, lignin declined slightly through midwinter but then increased as winter progressed. Archer and Decker (1977) reported similar lignin levels of 3.5, 5.0, and 5.0% for stockpiled fescue sampled in October, November, and December, respectively. Brown and Fontenot (1963) found much greater lignin levels in stockpiled forage sampled at various times after an August 14 mowing (7.1 to 9.3%).

Phosphorus levels for the 2 yr were 0.28 and 0.24% on December 3 (yr 1) and December 1 (yr 2), respectively, and remained similar throughout the trial (Table 3). Ross and Reynolds (1979) reported average phosphorus levels of 0.16 and 0.19% for a 2-yr study. Phosphorus levels declined from 0.25% in October to below 0.18% in December in the study of Ross and Reynolds (1979), a level below the requirement of a dry pregnant beef cow (NRC, 1996).

Potassium concentrations declined through the winter in both years ($P < 0.08$ in yr 1; $P < 0.01$ in yr 2) but recovered late in yr 1, probably due to the infiltration of new growth. Potassium concentration was 3.08% on December 3 (yr 1) and 2.82% on December 1 (yr 2) and generally decreased to 2.61 and 2.14% at the completion of the study in yr 1 and 2, respectively (Table 3). Ross and Reynolds (1979) reported declining K concentrations throughout their study, dropping below the requirement for a dry pregnant beef cow by midwinter. Throughout the experiment reported here, the P and K requirements for the heifers were met (NRC, 1996). Tissue composition of other minerals remained unchanged or declined slightly through the winter months (Table 3) and were generally at or above requirements for the heifers (NRC, 1996).

Percentage of Fescue and Green and Brown Fescue Fractions. In yr 1, fescue made up approximately 97% of the canopy, and there was little contamination with warm season species (Table 4). In yr 2, warm season species contribution to sward DM was 28, 14, and 16% for the months of December, January, and February, respectively (Table 5). Bermudagrass was the primary invading warm season species present in the canopy in both years. Summer grazing management and weather may have influenced the high proportion of warm season species in yr 2.

In yr 1, 79% of the fescue tissue was green at the beginning of the study, and green tissue declined to 64% on February 24 (Table 4). In yr 2, green tissue made up 64% of the fescue on December 21, declining to 52% on February 16 (Table 5). Archer and Decker (1977) found that the proportion of green tissue declined in autumn-saved pastures from approximately 80% (October) to 54% (December). Burns and Chamblee (2000) reported the proportions of green tissue in the canopy from a September 1 accumulation date. Two

Table 3. Mineral composition (DM basis) of whole-canopy, stockpiled tall fescue¹

Item	Date																P-value ²	
	Yr 1 Yr 2	Dec. 3 Dec. 1	Dec. 9 Dec. 8	Dec. 16 Dec. 15	Dec. 22 Dec. 21	Dec. 30 Dec. 29	Jan. 6 Jan. 5	Jan. 13 Jan. 12	Jan. 18 Jan. 19	Jan. 27 Jan. 26	Feb. 3 Feb. 2	Feb. 10 Feb. 9	Feb. 17 Feb. 16	Feb. 24	R ²	L	Q	
Ca, %																		
yr 1	0.51	0.41	0.41	0.41	0.45	0.42	0.42	0.39	0.43	0.44	0.35	0.35	0.38	0.34	0.57	0.01	0.89	
yr 2	0.52	0.41	0.40	0.40	0.43	0.39	0.40	0.39	0.42	0.40	0.44	0.39	0.45		0.52	0.30	0.02	
P, %																		
yr 1	0.28	0.28	0.25	0.25	0.25	0.26	0.26	0.26	0.24	0.26	0.31	0.31	0.29	0.28	0.41	0.11	0.08	
yr 2	0.24	0.24	0.24	0.20	0.24	0.21	0.21	0.22	0.24	0.22	0.26	0.22	0.25		0.26	0.42	0.15	
Na, %																		
yr 1	0.013	0.012	0.012	0.006	0.010	0.007	0.007	0.006	0.005	0.008	0.006	0.006	0.004	0.004	0.65	0.01	0.46	
yr 2	0.020	0.014	0.014	0.012	0.017	0.011	0.011	0.013	0.012	0.016	0.014	0.009	0.009		0.34	0.06	0.63	
Mg, %																		
yr 1	0.28	0.26	0.26	0.25	0.26	0.26	0.26	0.23	0.22	0.22	0.22	0.21	0.21	0.20	0.92	0.01	0.30	
yr 2	0.29	0.27	0.27	0.28	0.28	0.27	0.27	0.26	0.24	0.23	0.24	0.23	0.23		0.78	0.01	0.46	
S, %																		
yr 1	0.23	0.21	0.21	0.21	0.21	0.19	0.19	0.20	0.20	0.18	0.24	0.23	0.23	0.23	0.53	0.21	0.01	
yr 2	0.24	0.25	0.25	0.20	0.21	0.19	0.19	0.19	0.20	0.20	0.20	0.20	0.18		0.68	0.03	0.10	
K, %																		
yr 1	3.14	3.01	3.01	2.73	2.46	2.60	2.60	2.51	2.16	2.30	2.82	2.70	2.66	2.61	0.65	0.08	0.01	
yr 2	2.54	3.10	3.10	2.49	2.92	2.34	2.34	2.34	2.23	1.80	2.27	2.15	2.12		0.57	0.01	0.61	
Cu, ppm																		
yr 1	— ³	11	11	6	7	5	5	5	6	4	5	4	6	5	0.66	0.01	0.03	
yr 2	8	5	5	6	8	7	7	7	8	14	10	7	7		0.24	0.21	0.34	
Zinc, ppm																		
yr 1	—	27	20	21	22	23	23	19	20	18	23	21	22	20	0.46	0.10	0.07	
yr 2	29	20	20	21	23	21	21	20	23	27	26	35	23		0.33	0.22	0.14	

¹Stockpiled from September 1 and then sampled December through February.

²L = linear; and Q = quadratic.

³Missing data.

Table 4. Nutritive composition (DM basis) of green and brown tissue of stockpiled fescue, yr 1¹

Item	Date of sampling							SEM	P-value ²	
	Dec. 3	Dec. 16	Dec. 30	Jan. 13	Jan. 27	Feb. 10	Feb. 24		L	Q
Canopy composition, %										
Fescue	97.1	97.5	98.1	99.8	97.8	95.9	96.9	1.33	0.23	0.17
Green fescue	78.5	76.9	66.6	58.3	57.6	61.2	61.5	2.66	0.01	0.01
Brown fescue	21.5	23.1	33.4	41.7	42.4	38.8	38.5	2.66	0.01	0.01
IVTOMD, ³ %										
Green	86.9	92.0	91.1	89.1	90.9	91.9	91.3	0.88	0.09	0.36
Brown	63.9	65.9	65.8	63.1	58.4	69.1	64.3	2.24	0.99	0.59
CP, %										
Green	20.2	18.8	17.9	18.3	19.0	24.4	24.0	0.47	0.01	0.01
Brown	10.7	10.9	9.9	10.1	9.6	11.3	9.3	0.47	0.41	0.85
NDF, %										
Green	50.1	43.8	46.3	54.5	52.9	51.9	54.2	0.75	0.02	0.78
Brown	70.0	68.5	71.2	72.3	73.6	70.4	73.4	0.72	0.04	0.56
ADF, %										
Green	22.1	20.4	21.2	23.7	22.8	20.7	23.5	0.22	0.20	0.88
Brown	34.6	34.5	36.0	36.5	37.1	34.7	36.6	0.33	0.09	0.19
Cellulose, %										
Green	19.9	18.8	19.6	21.7	20.8	18.8	21.7	0.30	0.17	0.99
Brown	29.2	29.4	30.6	31.1	31.4	29.4	31.9	0.55	0.10	0.59
Lignin, %										
Green	1.95	1.42	1.52	1.81	1.78	1.69	1.68	0.10	0.99	0.47
Brown	4.85	4.62	4.87	4.76	4.71	4.37	4.06	0.27	0.07	0.25

¹Stockpiled from September 1 and then sampled December through February.²L = Linear; and Q = Quadratic.³In vitro true organic matter disappearance.**Table 5.** Nutritive composition (DM basis) of green and brown tissue of stockpiled fescue, yr 2¹

Item	Date of sampling						SEM	P-value ²	
	Dec. 8	Dec. 21	Jan. 5	Jan. 19	Feb. 2	Feb. 16		L	Q
Canopy composition, %									
Fescue	— ³	72.2	85.7	—	84.0	96.5	3.11	0.75	0.86
Green fescue	—	63.5	61.6	—	50.1	52.0	1.58	0.04	0.20
Brown fescue	—	36.6	38.4	—	49.9	48.0	1.58	0.04	0.20
IVTOMD, ⁴ %									
Green	85.2	85.6	86.2	87.7	88.7	89.8	0.87	0.01	0.44
Brown	66.0	66.4	60.9	61.2	59.4	60.9	0.73	0.01	0.11
CP, %									
Green	15.6	14.3	13.3	15.8	16.4	16.2	0.51	0.11	0.17
Brown	8.7	7.9	6.9	9.0	9.3	8.2	0.39	0.54	0.62
NDF, %									
Green	51.8	50.1	49.3	50.0	55.6	49.8	0.29	0.65	0.77
Brown	68.3	67.1	73.9	74.0	75.4	76.2	0.78	0.01	0.43
ADF, %									
Green	23.9	23.2	22.6	22.5	25.0	22.3	0.18	0.73	0.75
Brown	35.2	34.3	38.1	37.6	39.6	39.4	0.51	0.01	0.68
Cellulose, %									
Green	22.0	21.5	21.0	21.0	23.3	20.7	0.15	0.87	0.91
Brown	30.7	30.6	33.9	25.4	34.2	35.1	0.63	0.26	0.25
Lignin, %									
Green	1.84	1.67	1.55	1.59	1.80	1.47	0.07	0.15	0.58
Brown	4.34	3.62	4.03	4.30	5.12	4.07	0.16	0.31	0.99

¹Stockpiled from September 1 and then sampled December through February.²L = linear; and Q = quadratic.³Missing values.⁴In vitro true organic matter disappearance.

year green tissue averages were 58% for December, 42% for January, and 30% for February, showing greater sward deterioration than in the study reported here.

Green tissue IVTOMD from the accumulated forage harvested in December was 86.9 and 85.2% in yr 1 and 2, respectively (Tables 4 and 5), and the IVTOMD for green tissue was 91.3 and 89.8% (in yr 1 and yr 2, respectively) by late February. In yr 1, there was no difference over the winter, whereas in yr 2 there was a linear increase ($P < 0.01$) over time. Brown tissue was lower in nutritive value at 63.9 and 66.0% IVTOMD in December for the 2 yr, respectively. In yr 1, the IVTOMD of brown fescue did not change over winter, but in yr 2 there was a linear decline ($P < 0.01$). Archer and Decker (1977) reported IVDMD of 90% for green tissue and 67% for brown tissue in mid November. The IVDMD had a slight decrease to 87.0% for the green fraction and little change for the brown fraction at 68.2% at the last harvest date in December. Burns and Chamblee (2000) found levels of IVDMD for green tissue that averaged 77.6% in December from a September initiation. Their IVDMD percentages did not change into February at 77.2%. For comparison with other studies it is important to note IVDMD values are approximately 12.9 percentage units lower than IVTOMD values (Goering and Van Soest, 1970).

Crude protein of green tissue differed considerably between years. In yr 1, CP values were 20.2, 18.3, and 24.0% for December 3, January 13, and February 24 harvest dates, respectively (Table 4). In yr 2, CP levels were 15.6, 15.8, and 16.2% for December 8, January 19, and February 16 harvest dates (Table 5). Burns and Chamblee (2000) found 2-yr average CP levels from July and August accumulations of 11.0, 11.5, and 12.4% for green tissue sampled in December, January, and February. In yr 1 of the current study, CP of the whole canopy increased from 15.2 to 19.9% from January 22 to February 10, most likely due to an increase in the CP concentration in young green leaves (Table 4).

Crude protein of brown tissue in yr 1 was 10.7, 10.1, and 9.3% for December 3, January 13, and February 24 harvest dates, respectively. Crude protein values in yr 2 were 8.7, 9.0, and 8.2% for December 8, January 19, and February 16 harvest dates, respectively (Table 5). Burns and Chamblee (2000) noted similar levels of CP in brown tissue for July and August accumulations (9.1, 9.7, and 9.2% for December, January, and February samplings, respectively).

The NDF of green fescue averaged 50.5% in yr 1 and 51.1% in yr 2 and did not change from December to February in either year. The NDF of brown tissue did not change over the winter in yr 1, whereas it increased ($P < 0.01$) in yr 2 (Tables 4 and 5). Burns and Chamblee (2000) reported no differences between December and March NDF for green tissue that averaged 47.5%.

The ADF levels for green tissue harvested in early December were 22.1 and 23.9% for yr 1 and 2, respectively. There was no significant change over the winter in either year. The ADF of brown tissue sampled in

Table 6. Performance of heifers grazing stockpiled fescue from early December through February and with or without cottonseed supplement

Item	Control	WCS ¹	SEM	P-value ²
Initial wt, kg				
yr 1	264	267	2.75	0.24
yr 2	257	256		0.69
ADG, kg/d (shrunk)				
yr 1	0.46	0.56	0.058	0.03
yr 2	0.23	0.46		0.01
ADG, kg/d (full d 1 to 83)				
yr 1	0.35	0.46	0.058	0.02
yr 2	0.18	0.41		0.01
ADG, kg/d (full d 1 to 27)				
yr 1	0.03	0.15	0.074	0.29
yr 2	-0.11	0.09		0.09
ADG, kg/d (full d 27 to 83)				
yr 1	0.56	0.68	0.026	0.01
yr 2	0.41	0.63		0.01
ADG, kg/d (full d 7 to 83)				
yr 2	0.42	0.63	0.022	0.01
Initial BCS ³				
yr1	5.0	5.0	0.05	0.97
yr2	5.0	5.1		0.39
Change in BCS ⁴				
yr 1	-0.03	0.33	0.092	0.02
yr 2	0.13	0.50		0.02
SUN, ⁵ mg/dL				
yr 1	9.44	10.48	0.308	0.07
yr 2	7.82	9.79		0.01

¹Whole cottonseed.

²P-value for treatment effect.

³Body condition score.

⁴Change from the beginning to the end of the trial.

⁵Serum urea nitrogen.

early December was 34.6 and 35.2% (yr 1 and 2, respectively). The ADF levels in brown tissue did not change over the winter in yr 1 but increased linearly ($P < 0.01$) as winter progressed in yr 2.

Cellulose levels in green tissue did not change over the winter in either year, averaging 20.1 and 21.5% for yr 1 and 2, respectively (Tables 4 and 5). Cellulose in brown tissue averaged 30.4 and 33.0% in yr 1 and 2, respectively, and cellulose content did not change over the winter.

Lignin levels in green tissue did not vary through the winter in either year and averaged 1.7%. Lignin levels in brown tissue also remained stable at 4.6 and 4.2% for the 2 respective years (Tables 4 and 5).

Heifer Performance

Weight Gain. Heifers supplemented with whole cottonseed had a greater ADG ($P < 0.03$, yr 1; $P < 0.01$, yr 2) and a greater improvement in BCS ($P < 0.02$) than the control group for each year of the study. A year \times treatment interaction was noted for both shrunk ($P < 0.04$) and full ($P < 0.06$) ADG (Table 6). In yr 2, supplemented cattle showed a greater gain response (based on shrunk BW) to supplement (+0.23 kg/d) as compared with yr 1 (+0.10 kg/d). Full pasture BW were also taken

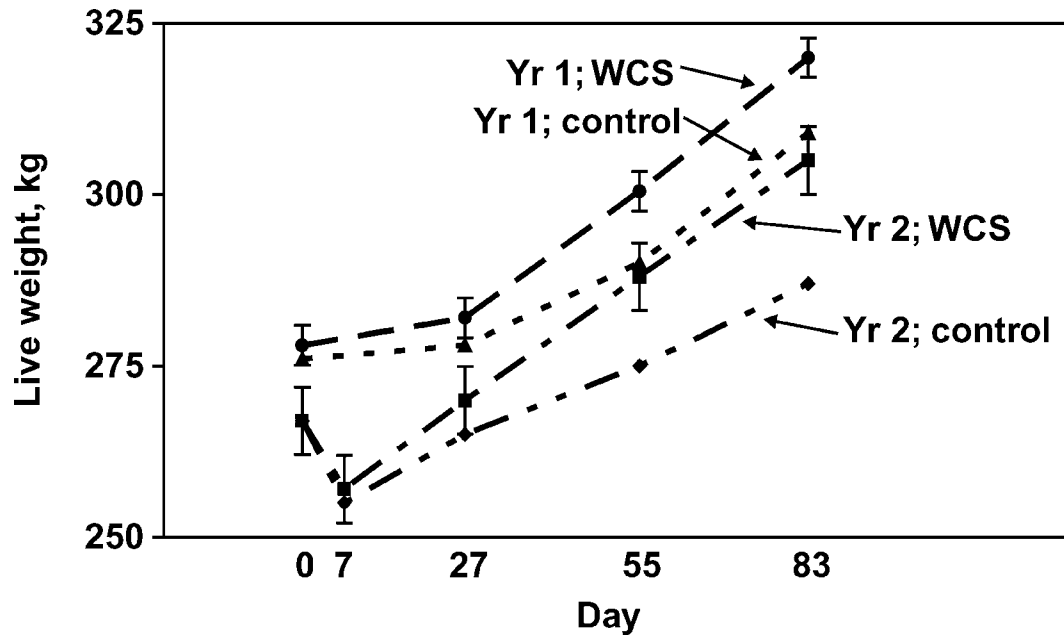


Figure 1. Full live BW of heifers grazing stockpiled fescue from December through February during 2 yr and with or without whole cottonseed supplement (WCS). Bars are SEM within year.

to monitor the BW gains of the heifers throughout the study. Full pasture BW at d 27 was similar to BW observed on d 0 of the study (Figure 1). One additional BW comparison was made in yr 2 to document suspected BW losses during the first week (Figure 1). The first 7 d on trial showed a rapid decline in full weight. This was possibly related to changes in gut fill as heifers were fed on medium quality orchardgrass hay before they were placed on pasture. Seven-day full weights were very similar to the initial shrunk weights of the heifers. It is important to note that the heifers never exhibited signs of hunger (bawling, restlessness, pacing) throughout the study, but they never appeared to be “full” based on a visual appraisal of ruminal distension. The BW loss during the first 7 d in yr 2 had a negative impact on the ADG for the entire study. Weight gains calculated from d 27 to 83 showed year and treatment effects ($P < 0.01$) and the interaction between year and treatment tended to be significant ($P = 0.11$), again because response to supplement was greater in yr 2. Daily gain of unsupplemented cattle during the last 56 d on trial were 0.56 kg/d in yr 1 and 0.41 kg/d in yr 2, whereas supplemented heifers gained 0.68 and 0.63 kg/d for the 2 respective years. These gains are closer to the heifer performance expected when grazing forage with high nutritive value. A summary of supplementation research with stockpiled fescue showed that cattle usually respond to supplementation with energy supplements; responses tend to be greater when energy is from sources other than grain-based concentrates (Poore et al., 2000).

Nutrient analysis of stockpiled fescue often overpredicts the BW gain observed for grazing heifers (Poore et al., 2000). The fungal endophyte *Neotyphodium coe-*

nophialum, which lives within the fescue plant, has been related to detrimental effects on performance of cattle grazing stockpiled fescue. Beconi et al. (1995) showed that cattle grazing endophyte-free KY-31 stockpiled fescue gained 0.92 kg/d, whereas those on infected KY-31 only gained 0.68 kg/d.

In Oklahoma, Smith et al. (1989) obtained ADG without supplementation of 0.54 kg/d for Angus steers that grazed infected fescue November through March (76% endophyte infection level). The greater ADG compared with the current study may have resulted from their low initial stocking rate (2.1 heifer/ha) allowing more selective grazing or perhaps from differences in weighing conditions.

An additional fact that influences heifer gain in winter grazing systems is the length of the grazing season. Smith et al. (1989) documented weight gains of 0.89, 0.43, and 0.3 kg/d for November to December, November to January, and November to March grazing intervals, respectively.

The method of allocating pasture feed to animals can influence performance in grazing systems. Strip-grazing minimizes selectivity, which improves use but may reduce performance (Marsh, 1979). Heifers in this experiment received a daily forage allocation in contrast to earlier studies that utilized continuous grazing. Whereas the method of forage allocation we used may have reduced heifer performance somewhat, the improved use of pasture with a strip-grazing system would be economical assuming heifers reach target weights for breeding. Based on projected mature weights for the heifers, they would need to weigh an average of 325 kg at the time of breeding (14 mo of age) for optimal reproductive performance. Supplemented heifers in

Table 7. Heifer performance, forage mass, and intake on stockpiled fescue pastures grazed by heifers from early December through February and with or without cottonseed supplement

Item	Control	WCS ¹	SEM	P-value ²
Gain, kg/ha				
yr 1	222.8	293.5	18.0	0.02
yr 2	146.9	318.5		0.01
Stocking rate for the grazing period, heifer/ha				
yr 1	5.87	6.35	0.228	0.18
yr 2	7.84	8.40		0.12
Pregraze forage mass, kg/ha				
yr 1	3,802	4,024	125.3	0.01
yr 2	5,332	5,409		0.76
Postgraze forage mass, kg/ha				
yr 1	2,066	2,267	70.6	0.21
yr 2	2,694	2,932		0.09
Forage use, ³ %				
yr 1	44.5	42.5	1.47	0.58
yr 2	49.4	46.0		0.20
Mineral intake, kg-heifer ⁻¹ ·d ⁻¹				
yr 1	0.138	0.089	0.009	0.01
yr 2	0.077	0.068		0.49
Forage organic matter disappearance, kg-heifer ⁻¹ ·d ⁻¹				
yr 1	3.19	3.39	0.234	0.68
yr 2	4.14	4.17		0.46
Estimated organic matter intake, kg-heifer ⁻¹ ·d ⁻¹				
yr 1	3.19	4.38	0.234	0.01
yr 2	4.14	5.29		0.01

¹Whole cottonseed.²P-value for treatment effect.³Forage use to the ground level, calculated as: (pregraze forage mass – postgraze forage mass) × 100.

this study would approach that weight, assuming their rate of gain (0.65 kg/d) was sustained for the 30 d after removal from the fescue pastures.

Body Condition Score. Initial BCS of heifers were similar both years (5.0). Supplemented heifers had a greater increase in BCS ($P < 0.02$) than control heifers, which only maintained body condition (Table 7). Maintaining or improving BCS just before the breeding season is important for successful conception (Ensminger et al., 1990). Supplementation with WCS produced a significant change in BCS over the control (Table 7), supporting recommended supplementation of heifers grazing infected stockpiled fescue through the winter.

Serum Urea Nitrogen. The SUN levels showed an increase ($P < 0.01$) from supplementation in both years (Table 6). Hammond et al. (1994) showed that blood urea nitrogen measurements may be useful in making protein supplementation adjustments for grazing beef cattle. In yr 2, SUN levels for the control groups remained below 8 mg/dL until d 83, indicating that heifers may have been somewhat deficient in protein intake (Hammond et al., 1994). In yr 1, CP levels were greater in the forage, and SUN levels were above 8 mg/dL for both treatments. This helps explain the greater response to supplement observed in yr 2.

Gain per Hectare. Gain per hectare showed effects of treatment and a year × treatment interaction ($P < 0.01$ and $P < 0.03$, respectively). The supplemented heifers had the greater gain per hectare each year compared

with the unsupplemented heifers ($P < 0.02$; Table 7), with a greater response in yr 2.

Stocking Rate. The stocking rate (heifer/ha) varied by year ($P < 0.01$) due to the greater forage mass in yr 2 (Table 7). There was no difference between treatments on the stocking rate between the supplemented and unsupplemented cattle.

Pregraze Forage Mass. Cattle performance is normally closely related to the quality and quantity of forage available during grazing (Marsh, 1979). Forage mass varied by year ($P < 0.01$), and week within year ($P < 0.01$). When heifers were given fresh forage in yr 1, there was an average (across treatments) of 3,913 kg/ha available for grazing compared with 5,370 kg/ha in yr 2. Pregraze forage mass was slightly greater ($P < 0.01$) for supplemented heifers in yr 1 but was similar for treatments in yr 2.

Postgraze Forage Mass. Postgraze forage mass varied by year, and sampling date within year ($P < 0.01$ and $P < 0.01$, respectively). The postgraze residual forage (averaged across treatments) was greater in yr 2 than 1 (2,813 and 2,166 kg/ha, respectively). In yr 2, there was more pregraze forage mass, and grazing allocations were intentionally increased to leave more postgraze residue. Supplemented heifers tended ($P < 0.09$) to leave more residual forage when compared with the control in yr 2. There were no indications that pasture mass limited heifer intake in either year based on the postgraze canopy heights and the behavior of the heifers.

Forage Use Efficiency. Forage use efficiency varied by year and week within year ($P < 0.01$ and $P < 0.01$ respectively). Efficiency of use was the similar for both treatments (Table 7).

Estimated Intake. Supplemented heifers were fed 0.85 kg of WCS/d and 0.17 kg of mixed grain/d in yr 1 and 0.96 kg of WCS/d and 0.20 kg of cracked corn/d (DM basis) in yr 2. Mineral consumption showed effects of year ($P < 0.01$), treatment ($P < 0.01$), and year \times treatment interaction ($P < 0.05$). Mineral intake was greater ($P < 0.01$) for unsupplemented cattle in yr 1 but was similar between treatments in yr 2 (Table 7). The addition of 1.1 kg of supplement (WCS and grain-based concentrate) did not reduce the forage disappearance for the supplemented heifers in either year (Table 7).

Forage OM disappearance varied by year and sampling date within year but was not influenced by treatment. The greater forage disappearance in yr 2 partially resulted from a better accounting of total grazed forage. Based on postgraze forage estimates to soil level, heifers obtained 0.44 kg of OM heifer⁻¹·d⁻¹ in yr 2 from the 0.003 ha of additional grazing area added to the intake strip, even though a large part of the extra grazed area was less than 5 cm in height. In yr 1, the heifers were able to utilize all of the previously grazed areas when disappearance calculations were made leading to some unaccounted forage disappearance.

Supplementation increased total estimated OM intake (**OMI**) compared with the unsupplemented groups in both years ($P < 0.05$, Table 7). Effects of year and sampling date within year were also seen for total intake ($P < 0.01$ and $P < 0.01$, respectively). Total OMI averaged across treatments was greater in yr 2 compared with yr 1 at (4.72 vs. 3.79 kg·heifer⁻¹·d⁻¹; $P < 0.01$).

Based on the NRC requirements, unsupplemented heifers would have needed about 3.5 kg of TDN per heifer (based on an average weight of 273 kg) to obtain the observed ADG of 0.35 kg/d (NRC, 1996). Limiting heifers to only a small amount of previously grazed area, and accounting for forage disappearance in the previously grazed area, increased forage disappearance estimates in yr 2, but values still appear to be low. Assuming that IVTOMD is nearly equal to TDN, estimated OMI was still 15% below the intake required for the observed gain in the unsupplemented heifers. Whereas CP level in forage was above concentrations normally considered adequate for heifers of this weight, calculations of CP intake from forage disappearance suggests that CP was adequate in yr 1 but was marginally deficient in yr 2, which is consistent with the SUN levels reported (Table 6).

To achieve proper development, these heifers need to gain approximately 0.65 kg/d, which was achieved by the supplemented heifers. To gain at that rate, the heifers would have needed to consume 4.2 kg of TDN daily, and based on similar assumptions about forage TDN, and book values for cottonseed TDN, the total

estimated OMI of 5.29 kg/d would have provided 4.1 kg of TDN.

Ulyatt et al. (1974) reported that pasture sampling estimates of intake were 30 to 40% lower than heifer methods. In contrast Macoon et al. (2003) compared the pasture sampling method with the pulse-dose marker technique that is commonly used to determine intake in grazing experiments. They concluded that the pasture sampling method was more comparable to that predicted from cow performance than the pulse-dose marker method, which resulted in greater, and sometimes unrealistic, estimates of forage intake.

Underestimation of intake by the disappearance method could be due to several factors, such as a failure to sample below grazing height, ample regrowth before postgrazing clipping, and losses during cutting and collection of grazing samples (Mueller et al., 1990; Unruh and Fick, 2002). Despite these limitations the pasture sampling method used in the current study gave useful forage intake estimates. This observation is consistent with Macoon et al. (2003), who concluded that this method would be useful in situations with well-managed rotationally stocked pastures with short grazing periods.

IMPLICATIONS

Nutritive value of stockpiled fescue has the potential to meet the requirements of replacement beef heifers, but heifer performance may be lower than expected due to low levels of forage intake. Feeding whole cottonseed at 0.33% of body weight plus a small amount of concentrate to stimulate consumption will allow producers to graze heifers through the winter on stockpiled fescue and approach minimum gains needed to reach acceptable body weight and condition.

LITERATURE CITED

- Allen, V. G., J. P. Fontenot, and D. R. Notter. 1992. Forage systems for beef production from conception to slaughter: II. Stocker systems. *J. Anim. Sci.* 70:588–596.
- AOAC. 1999. International Official Methods of Analysis. 16th ed. Assoc. Off. Anal. Chem., Arlington, VA.
- Archer, K. A., and A. M. Decker. 1977. Autumn-accumulated tall fescue and orchardgrass. II. Effect of leaf death on fiber components and quality parameters. *Agron. J.* 69:605–609.
- Association of Official Seed Analysts. 1993. Rules for testing seed. *J. Seed Technol.* 16:1–113.
- Beconi, M. G., M. D. Howard, T. D. A. Forbes, R. B. Muntifer, N. W. Bradley, and M. J. Ford. 1995. Growth and subsequent feedlot performance of estradiol-implanted vs. nonimplanted steers grazing fall-accumulated endophyte-infested or low-endophyte tall fescue. *J. Anim. Sci.* 73:1576–1584.
- Brown, R. H., and J. P. Fontenot. 1963. Digestibility of fall grown Kentucky 31 fescue. *Agron. J.* 55:321–324.
- Burns, J. C., and D. S. Chamblee. 2000. Summer accumulation of tall fescue at low elevations in the humid piedmont. II. Fall and winter changes in nutritive value. *Agron. J.* 92:217–224.
- Collins, M., and J. A. Balasko. 1981. Effects of N fertilization and cutting schedules on stockpiled tall fescue. II. Forage quality. *Agron. J.* 73:821–826.

- Ensminger, M. E., J. E. Oldfield, and W. W. Heinemann. 1990. Page 94 in *Feeds and Nutrition*. Ensminger Publ. Co. Clovis, CA.
- Fribourg, H. A., and K. W. Bell. 1984. Yield and composition of tall fescue stockpiled for different periods. *Agron. J.* 76:929–934.
- Gerrish, J. R., P. R. Peterson, C. A. Roberts, and J. R. Brown. 1994. Nitrogen fertilization of stockpiled tall fescue in the Midwestern USA. *J. Prod. Agric.* 7:98–104.
- Goering, H. K., and P. J. Van Soest. 1970. Forage fiber analysis. USDA Agric. Handbook 379. US Gov. Print Office, Washington, DC.
- Hammond, A. C., E. J. Bowers, W. E. Kunkle, P. C. Genho, S. A. Moore, C. E. Crosby, and K. H. Ramsay. 1994. Use of blood urea nitrogen concentration to determine time and level of protein supplementation in wintering cows. *Prof. Anim. Sci.* 10:24–31.
- Macon, B., L. E. Sollenberger, J. E. Moore, C. R. Staples, J. H. Fike, and K. M. Portier. 2003. Comparison of three techniques for estimating the forage intake of lactating dairy cows on pasture. *J. Anim. Sci.* 81:2357–2366.
- Marsh, R. 1979. Effect of herbage DM allowance on the immediate and longer term performance of young Friesian steers at pasture. *N. Z. J. Agric. Res.* 22:209–219.
- Marsh, W. H., B. Fingerhut, and H. Miller. 1965. Automated and manual direct method for the determination of blood urea. *Clin. Chem.* 11:624–627.
- Mays, D. A., and J. B. Washko. 1960. The feasibility of stockpiling legume-grass pasturage. *Agon. J.* 52:190–192.
- Mueller, J. P., J. T. Green, and J. N. Rahmes. 1990. Capacitance meter and falling plate disc meter methodology and use in grazing management. Page 67–72 in the 46th Proc. Southern Pasture Forage Crop Improv. Conf., ARS USDA, Beltsville, MD.
- NRC. 1996. *Nutrient Requirements of Beef Cattle*. 7th rev. ed. Natl. Acad. Press, Washington, DC.
- Ocuppaugh, W. R., and A. G. Matches. 1977. Autumn-winter yield and quality of tall fescue. *Agron. J.* 69:639–643.
- Poore, M. H., G. A. Benson, M. E. Scott, and J. T. Green. 2000. Production and utilization of stockpiled fescue to reduce beef cattle production costs. *Proc Am. Soc. Anim. Sci.* Available: <http://www.asas.org/symposia/0622.pdf> Accessed August 22, 2005.
- Poore, M. H., J. T. Johns, and W. R. Burris. 2002. Soybean hulls, wheat middlings and corn gluten feed as supplements for cattle on forage-based diets. *Vet. Clin. Food Anim.* 18:213–231.
- Rogers, G. M., M. H. Poore, and J. C. Paschal. 2002. Feeding cotton byproducts to cattle. *Vet. Clin. Food Anim.* 18:267–294.
- Ross, J. P., and J. H. Reynolds. 1979. Nutritive value of fall-stockpiled tall fescue. *Tenn. Farm Home Sci.* 112:44–48.
- Smith, S. C., J. D. Enis, K. S. Lusby, W. E. McMurphy, J. C. Hobbs, and C. A. Strasia. 1989. Improving the pasture and feedlot profitability of fescue cattle. *OK State Univ. Circ. E-884*, Stillwater, OK.
- Tilley, J. M., and R. A. Terry. 1963. A two-stage technique for in vitro digestion of forage crops. *J. Brit. Grass. Soc.* 18:104–111.
- Ulyatt, M. J., P. C. Barclay, J. A. Lancashire, and C. S. M. Armstrong. 1974. The feeding value to sheep of 'Grasslands Tama' West-erwolds ryegrass, 'Grasslands Paroa' Italina ryegrass and 'Grasslands Ruanui' perennial ryegrass under rotational grazing management. *N. Z. J. Exp. Agric.* 2:231–236.
- Unruh, L. J., and G. W. Fick. 2002. Correcting measurements of pasture forage mass by vacuuming the stubble. *Agron. J.* 94:860–863.
- Van Soest, P. J., J. B. Robertson, and B. A. Lewis. 1991. Methods for dietary fiber, neutral detergent fiber and nonstarch polysaccharides in relation to animal nutrition. *J. Dairy Sci.* 74:3583–3597.
- Vartha, E. W., and A. G. Matches. 1977. Use of a weighted-disk measure as an aid in sampling the herbage yield on tall fescue pastures grazed by cattle. *Agron. J.* 69:888–890.

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