Comparison of Tifton 85 and Coastal Bermudagrasses for Yield, Nutrient Traits, Intake, and Digestion by Growing Beef Steers[1]

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ABSTRACT: A study was undertaken to compare Tifton 85 (T85) and Coastal (CBG) bermudagrasses for effects of cultivar and age at harvest on yields of DM and digestible DM, in vitro digestion, nutrient content, cell wall composition, in situ digestion kinetics, and feed intake and digestion by growing beef steers. In Exp. 1, T85 and CBG forages staged for growth in May or July of 1993 were harvested at 3, 4, 5, 6, 7, and 8 wk from subplots. Tifton 85 bermudagrass had 7.1% greater DM yield, 18.2% higher ($P < .05$) digestible DM yield, and 7.1% greater IVDMD than CBG, and, after 5 wk of forage growth, IVDMD of both T85 and CBG decreased with increased age at harvest ($P < .05$). In Exp. 2, T85 and CBG forages staged for growth in July 1997 were harvested at 2, 3, 4, 5, 6, and 7 wk from subplots. Even though T85 had higher concentrations of NDF and ADF than CBG, T85 had 34.1% higher DM yield, 47.9% higher digestible DM, 55.0% higher digestible NDF, 91.7% higher digestible ADF, greater IVDMD, in vitro NDF and ADF disappearances, and higher in situ DM and NDF digestion ($P < .05$). Coastal bermudagrass had higher concentrations of lignin and lower concentrations of total neutral sugars, arabinose, glucose, and xylose than T85 ($P < .05$). In vitro digestibilities of DM, NDF, and ADF were lower and concentrations of ADF and lignin were greater for 7- vs 6-wk harvests of both T85 and CBG ($P < .05$). In Exp. 3, T85 and CBG forages staged for growth in July 1997 were harvested as hay at 3, 5, and 7 wk from .8-ha pastures and fed to 36 individually penned growing beef steers (initial BW = 244 kg) to quantify ad libitum intake without supplementation. Tifton 85 bermudagrass had lower concentrations of lignin and ether-linked ferulic acid and greater concentrations of NDF, ADF, hemicellulose, and cellulose than CBG ($P < .05$). Steers fed T85 had higher ($P < .05$) digestion of DM, OM, NDF, ADF, hemicellulose, and cellulose than steers fed CBG. Digestion of NDF, ADF, hemicellulose, and cellulose decreased ($P < .05$) with increased age at harvest for both cultivars. In conclusion, T85 produced more DM and had more digestible nutrients in vitro, in situ, and in vivo than CBG, and 3 and 5 wk of growth would be recommended ages to harvest either cultivar.

Key Words: Age, Cynodon dactylon Cultivars, Digestion, Intake, Maturity

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Introduction

When compared with other cultivars of bermudagrass (*Cynodon dactylon*), such as Coastal (**CBG**) or Tifton 78, Tifton 85 (**T85**) was higher yielding and more digestible (Hill et al., 1993, 1996). Tifton 85 has been widely grown in the southern U.S., Central and South America, and Southern Africa. Hill et al. (1993) reported greater productivity and performance by steers grazing T85 compared with Tifton 78 bermudagrass pastures. West et al. (1998) reported that even though there was a decline in DMI and milk yield, milk fat and apparent digestibilities of dietary NDF and ADF by lactating dairy cows were improved with increasing level of T85 in total mixed rations. These workers did not observe differences in lactation response when bermudagrass was used as either silage or hay in the total mixed ration. Mandebvu et al. (1998a) reported that even though a

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corn silage-based total mixed ration had higher readily and total potentially digestible DM fractions than a T85-based total mixed ration, a 3.5-wk-old T85-based total mixed ration had in situ digestion profiles similar to a corn silage-based total mixed ration. Mandebvu et al. (1998b) reported that even though an increase in maturity of T85 from 3.5 to 7 wk did not show an increase in NDF concentration, there were marked declines in in vitro DM and NDF disappearances that emphasized the importance of proper harvest practices for this forage. The objectives of this study were to compare T85 and CBG for effects of cultivar and age at harvest on 1) yields of DM, digestible DM, NDF, and ADF; 2) IVDMD, in vitro NDF and ADF disappearances, nutrient content, cell wall composition, and in situ digestion kinetics; and 3) feed intake and digestion by growing beef steers.

Materials and Methods

Experiment 1

In May 1993, established plots (1.37 × 3.96 m) of T85 and CBG arranged in five replications each were divided into six randomly designated subplots (1.37 × .61 m). Subplots were fertilized with 560 kg/ha of 10-10-10 (N-P_2O_5-K_2O) and forage growth staging began on May 25 to allow regrowth ranging from 3 to 8 wk to be harvested on July 20. Staging was done by mowing with a sickle bar mower at weekly intervals leaving a 2.5-cm stubble. Additional N fertilizer (336 kg/ha of 34-0-0) was applied during each staging. Following the first harvest all plots were mowed to a 2.5-cm stubble and fertilized with 168 kg/ha of 34-0-0; staging and harvest procedures were repeated beginning on July 21 so that a second harvest could be made on September 15. Harvested forage samples (.10 m^2) from each subplot were dried at 60°C and ground to pass a 1-mm screen in a Wiley mill (model 3; Arthur H. Thomas Co., Philadelphia, PA). In vitro DM disappearance after 48 h of incubation followed by subsequent acid and pepsin digestion for an additional 48 h was determined (Moore and Mott, 1974). Data were analyzed with the GLM procedures of SAS (1989) as a completely randomized design with a factorial arrangement of two harvest dates × two cultivars × seven ages at harvest (cultivar, age at harvest, and replication served as class variables). Least squares means are presented for main effects when interactions were not significant ($P > .10$), and in addition, treatment means for the individual factors are presented in tables in the Appendix.

Experiment 2

Forages. In July 1997, three replicated .81-ha pastures each of T85 and CBG were selected as experimental sites. Main plots 2.44 × 87.78 m in size of both T85 and CBG were divided into duplicate subplots, 1.22 × 9.14 m, that were then randomly assigned to one of six ages at harvest (2 to 7 wk). Subplots were separated by 1.22 × 2.74 m buffer zones. All forage plots were mowed on July 7, 1997, to stage growth leaving a 2.5-cm stubble and fertilized with 467 kg/ha of 24-6-12 (N-P_2O_5-K_2O). Forages were harvested after 2, 3, 4, 5, 6, or 7 wk of regrowth by cutting a strip (.56 × 9.14 m) in the middle of the subplots using a rotary mower with a bagging attachment. Harvested forages were weighed, dried at 60°C, and ground to pass a 6-mm screen in a Wiley mill. The samples, ground to pass through the 6-mm screen, were sub-sampled and ground to pass through a 1-mm screen in a Wiley mill for chemical analysis and in vitro digestion. Samples ground to pass through the 6-mm screen were used for in situ digestion.

In Situ Digestion. Forage samples for in situ digestion were incubated for 0, 6, 12, 24, 36, 48, 72, and 96 h using two ruminally cannulated, lactating Holstein cows fed a total mixed ration containing 17.0% T85 hay, 22.0% corn silage, 8.0% whole cottonseed, and 53.0% concentrate on a DM basis. About 5 g of sample DM were weighed into duplicate 10 × 20 cm dacron bags (Ankom Technology Corporation, New York, NY). Bags were made from N-free white polyester monofilament fabric with a 53 μm (±10) pore size and allowing a 12.5-mg/cm^2 sample surface area. Upon removal from the rumen, bags were immediately immersed in ice water for 15 min to inhibit further microbial action and processed according to Nocek (1985). At 0 h, bags were soaked in warm water (± 39°C) for 15 min and washed to estimate disappearance of DM due to solubility and physical expulsion of DM during the washing procedure. Bags were dried at 60°C for 48 h and weighed thereafter, the in situ digesta samples were ground to pass through a 1-mm screen in a Cyclone sample mill (UD Corporation, Boulder, CO) and analyzed for NDF concentration (Van Soest et al., 1991). Dry matter residue remaining in the bag after digestion was expressed as a fraction of the initial DM weighed into the bag to determine the undigested DM fraction. Dry matter disappearance from 6 to 96 h of incubation was calculated by subtracting the undigested percentage from 100. Neutral detergent fiber residue remaining in the bag after digestion was also expressed as a fraction of the initial NDF weighed into the bag to determine the undigested NDF fraction, and NDF disappearance from 6 to 96 h of incubation was calculated by subtracting the undigested percentage from 100. The initial NDF weighed into each bag for each forage treatment was determined by multiplying the initial sample DM weighed into each bag by the NDF concentration of each forage treatment determined as described by Van Soest et al. (1991).

Chemical Analysis. Samples ground to pass a 1-mm screen in a Wiley mill were analyzed for

IVDMD, DM (100°C), ash (500°C), CP (AOAC, 1995), ash-free NDF, ADF (Van Soest et al., 1991), ADL, cellulose (Van Soest and Wine, 1968), and hemicellulose as the difference between NDF and ADF. In vitro DM disappearance after 48 h of incubation followed by subsequent acid and pepsin digestion for an additional 48 h (Moore and Mott, 1974) and in vitro NDF and ADF disappearances at 48 h were also determined. In vitro NDF or ADF disappearance was calculated by expressing the NDF or ADF concentration in the digesta samples at the end of the 48 h-incubation period as a fraction of the initial NDF or ADF concentration in the sample. Cell walls were isolated from samples using the Uppsala method (Theander and Westerlund, 1986; Theander, 1991) as modified by Hatfield and Weimer (1995). Even though NDF has often been referred to as cell walls, cell walls determined using the Uppsala method contain pectins and more cell wall protein. The cell walls were analyzed for acid insoluble lignin (**AIL**), total neutral sugars, total uronosyls, and neutral sugar composition using a modified Saeman hydrolysis procedure (Saeman et al., 1963; Hatfield et al., 1994; Hatfield and Weimer, 1995). Ferulic and *p*-coumaric acids were analyzed using the method of Ralph et al. (1994).

Statistical Analysis. Yield and in vitro and in situ DM or NDF disappearance data were analyzed with the GLM procedures of SAS (1989) as a completely randomized design with a factorial arrangement of two cultivars × six ages at harvest (cultivar, age at harvest, and replication served as class variables). Least squares means are presented for main effects when interactions were not significant ($P > .10$), and, in addition, treatment means for the individual factors are presented in tables in the Appendix. In situ DM and NDF disappearance data were also analyzed with the NLIN procedures of SAS (1989) by fitting the data to the nonlinear model $p = a + b(1 - e^{-ct})$ of Ørskov et al. (1980) to calculate digestion constants, where a = the readily digested fraction, b = the slowly digested fraction, a + b = the total potentially digestible fraction, and c = the rate of digestion for the slowly digested fraction (or potentially digestible fraction for NDF). Because disappearance of NDF was minimal during the early hours of fermentation, data collected up to 6 h of incubation were not included in the statistical analysis.

Experiment 3

On July 7, 1997, six paddocks (.81 ha each) of T85 and CBG (three paddocks for each cultivar) were mowed to stage growth and fertilized with 467 kg/ha of 24-6-12 (N-P_2O_5-K_2O), and harvested as hay after 3, 5, or 7 wk of regrowth (vegetative stage of growth, nonflowering stems). Hay was stored as conventional 20-kg rectangular bales in a covered barn. Thirty-six beef steers (average age = 9 mo; average initial and final BW [without removal from feed and water] of 244 and 249 kg, respectively) were ranked by initial BW and sequentially assigned to one of six treatments to achieve the same mean BW across treatments. Steers equipped with neck collars were housed in individual 1.22 × 2.02 m pens fitted with rubber mats in an enclosed building. Animals were fed 7-wk-old T85 from a previous harvest for ad libitum intake during a 2-wk adaptation period. At the end of the adaptation period animals were fed treatment hays for ad libitum intake without protein or energy supplementation at 0800 and 1500 and had a free-choice mineral supplement and water. Apparent digestibility of nutrients was determined using Cr_2O_3 as an external marker (Prigge et al., 1981). Beginning at 1400 on d 2 of the test period, steers were administered a 10-g Cr_2O_3 bolus in a gelatin capsule daily for 10 d. During the test period, feed offered and refused by each steer was recorded daily and samples were collected for determination of DM and chemical analyses. Fecal grab samples were collected every 8 h starting at 1400 on d 8 of the test period; this made a total of 12 collections per steer. Hay samples and feces were dried at 60°C for 72 h, composited by steer, and ground to pass a 1-mm screen for chemical analysis.

Chemical Analyses. Chemical analyses for hay and fecal samples were similar to those described in Exp. 2. In addition fecal samples were analyzed for Cr_2O_3 using the method of Brisson (1956). Samples of feed refused by steers were analyzed for DM concentration only for the determination of DM intake.

Statistical Analyses. Data were analyzed with the GLM procedures of SAS (1989) as a completely randomized design with a factorial arrangement of two cultivars × three ages at harvest (cultivar, age at harvest, and animal served as class variables). Least squares means are presented for main effects when interactions were not significant ($P > .10$), and, in addition, treatment means for the individual factors are presented in tables in the Appendix. Regression analyses were also conducted to determine the relationship between nutrient digestion by growing beef steers and nutrient concentration.

Results and Discussion

Experiment 1

Tifton 85 bermudagrass had a 18.2% higher digestible DM yield and 7.1% higher IVDMD than CBG ($P < .05$; Table 1). Because T85 had consistently higher IVDMD and digestible DM than CBG at all ages at harvest, no interactions between cultivar and age at harvest were observed ($P > .10$). Dry matter and digestible DM yields of both bermudagrass forages increased while IVDMD decreased with increased age at harvest ($P < .05$). Because T85 had higher digestible DM yield than CBG, more nutrients would

Table 1. Dry matter yield (DMY), digestible DM yield (DDMY), and in vitro DM disappearance (IVDMD) at 48 h of incubation of Tifton 85 and Coastal bermudagrasses harvested at different ages in July and September (Exp. 1)

	Month			Cultivar			Age, wk						
Item	July	September	SE	Tifton 85	Coastal	SE	3	4	5	6	7	8	SE
DMY, t/ha	4.3	4.4	.2	4.5	4.2	.2	2.2[c]	2.8[c]	4.1[b]	4.7[b]	5.8[a]	6.5[a]	.3
DDMY, t/ha	2.6[a]	2.2[b]	.1	2.6[a]	2.2[b]	.1	1.4[d]	1.7[d]	2.4[c]	2.6[bc]	3.0[ab]	3.4[a]	.2
IVDMD, %	61.0[a]	52.5[b]	.4	58.7[a]	54.8[b]	.4	62.2[a]	59.7[b]	58.5[b]	56.3[c]	52.9[d]	51.0[e]	.7

[a,b,c,d,e]Within a row within month, cultivar, or age, means without a common superscript letter differ ($P < .05$). There were no month × age, month × age, cultivar × age, or month × cultivar × age interactions.

be available for digestion and utilization for animals fed T85. The findings in our study are consistent with those of Hill et al. (1993) who reported that T85 had greater DM yield and higher IVDMD than CBG. In the study by these workers, T85 and CBG were grown on Tifton loamy sand soils, exposed to similar environmental conditions, and harvested at same stages of growth. Mandebvu et al. (1998b) also found that when T85 and CBG were compared at similar stages of maturity, T85 had higher IVDMD. The IVDMD for T85 observed in our study was also similar to that reported by Mandebvu et al. (1998a).

Experiment 2

Nutrient and Cell Wall Composition. When compared with CBG, T85 had greater concentrations of OM, NDF, ADF, hemicellulose and cellulose and a lower concentration of ADL ($P < .05$; Table 2). This is in agreement with earlier work by Mandebvu et al. (1998a,b, 1999). Concentrations of ADF and ADL in bermudagrass forages were greater at 7- vs 6-wk harvest ($P < .05$). Coastal bermudagrass had a higher level of AIL than T85, and T85 had a higher concentration of cell walls, total neutral sugars, arabinose, rhamnose, glucose, and xylose than CBG ($P < .05$; Table 3). As bermudagrass aged from 2 to 7 wk, the concentration of cell walls also increased. The greater lignin concentration in CBG when compared with T85 (Tables 2 and 3) and the higher amount of cellulose in the cell walls of T85 when compared with CBG (Table 2) would be expected to make the cell wall fraction of T85 more digestible than that of CBG at similar ages at harvest (Tables 4 and 5). Cellulose is not covalently linked to lignin or any other cell wall polymer (Jung and Ralph, 1990). Increased lignin concentration in CBG could also cause stearic hindrance of fibrolytic enzymes by blocking their contact with cell wall polysaccharides.

Digestible Yields and In Vitro Digestion of DM, NDF, and ADF. Tifton 85 bermudagrass had 34.1% higher DM yield, 47.9% higher digestible DM yield (.71 vs .48 t/ha), 55.0% higher digestible NDF yield (.62 vs .40 t/ha), 91.7% higher digestible ADF yield (.46 vs .24 t/ha), and higher in vitro disappearances of DM, NDF, and ADF than CBG ($P < .05$; Table 4). Hill et al. (1993) reported that T85 produced 26% greater DM yield and had 11% higher IVDMD than CBG. Others reported that T85 had higher IVDMD than

Table 2. Nutrient composition of Tifton 85 and Coastal bermudagrasses harvested at different ages (Exp. 2)

	Cultivar (C)			Age (A), wk							Interaction	
Nutrient	Tifton 85	Coastal	SE	2	3	4	5	6	7	SE	C × A[a]	SE
	% of DM											
OM												
Tifton 85				93.3	92.8	93.1	93.1	92.2	91.8		*	.3
Coastal				93.7	93.1	93.6	93.0	91.5	90.2			
CP												
Tifton 85				20.8	16.8	18.9	16.2	13.8	11.1		*	.8
Coastal				21.1	14.5	18.4	18.4	16.3	13.6			
NDF	69.2[b]	66.4[c]	.4	68.7[b]	65.5[c]	68.2[b]	68.0[b]	67.7[b]	68.9[b]	.7	NS	1.0
ADF	30.7[b]	29.2[c]	.3	28.7[d]	29.4[cd]	29.4[cd]	28.9[d]	30.6[c]	32.7[b]	.5	NS	.6
Hemicellulose	38.5[b]	37.2[c]	.3	40.0[b]	36.1[c]	38.8[b]	39.1[b]	37.1[c]	32.6[c]	.5	NS	.8
Cellulose	27.6[b]	25.3[c]	.3	24.8[d]	25.1[d]	25.7[d]	25.9[d]	27.5[c]	29.7[b]	.5	NS	.7
ADL	4.8[c]	5.4[b]	.2	4.8[cd]	5.6[bc]	4.7[d]	4.3[d]	5.1[cd]	6.2[b]	.3	NS	.4

[a]Level of significance for cultivar × age interaction is denoted by * for ($P < .05$) and NS for not significant.
[b,c,d]Within a row within cultivar or age, means without a common superscript letter differ ($P < .05$).

Table 3. Chemical components of cell walls of Tifton 85 and Coastal bermudagrasses harvested at different ages (Exp. 2)

	Cultivar (C)			Age (A), wk							Interaction	
Item	Tifton 85	Coastal	SE	2	3	4	5	6	7	SE	C × A[a]	SE
Cell walls, g/kg DM	707.2[d]	680.2[e]	5.2	648.3[f]	685.5[e]	686.6[e]	680.3[e]	705.5[e]	755.5[d]	9.1	NS	12.8
	g/kg cell walls											
AIL[b]	198.2[e]	225.7[d]	2.2	219.2[de]	221.5[d]	208.7[efg]	202.5[g]	205.1[fg]	214.7[def]	3.8	NS	5.4
Uronosyls[c]	31.3	32.3	.5	33.2	31.4	30.8	32.3	32.1	30.9	.8	NS	1.1
Neutral sugars	808.0[d]	778.9[e]	2.7	800.8[d]	785.4[ef]	797.3[de]	807.4[d]	794.5[de]	775.6[f]	4.7	NS	6.6
Fucose	.70	.59	.05	.65	.70	.58	.70	.55	.68	.09	NS	.12
Arabinose												
Tifton 85				67.9	63.5	67.4	66.0	67.7	63.1		*	.89
Coastal				66.6	62.1	65.0	64.0	60.1	59.2			
Rhamnose	.71[d]	.27[e]	.14	.20[e]	.18[e]	.77[d]	.01[f]	1.15[d]	.65[d]	.26	NS	.36
Galactose	24.1	23.6	.3	24.3	23.6	23.9	23.9	23.9	23.4	.5	NS	.7
Glucose	431.2[d]	415.1[e]	2.3	425.0[de]	422.6[e]	421.1[ef]	434.9[d]	424.9[de]	410.4[f]	4.0	NS	5.6
Xylose	282.9[d]	273.6[e]	1.3	281.1[d]	272.1[e]	281.8[d]	281.5[d]	277.2[de]	275.8[de]	2.2	NS	3.2
Mannose	2.53	2.94	.20	2.35[e]	3.48[d]	2.88[d]	1.32[f]	2.85[d]	3.55[d]	.35	NS	.50

[a]Level of significance for cultivar × age interaction is denoted by * for ($P < .05$) and NS for not significant.
[b]Acid insoluble lignin.
[c]Total uronic acids.
[d,e,f,g,h]Within a row within cultivar or age, means without a common superscript letter differ ($P < .05$).

CBG harvested at 3 wk (61.7 vs 51.4%) or 6 wk (56.9 vs 50.8%) (Mandebvu et al., 1999). Mandebvu et al. (1998b) observed that the IVDMD of T85 harvested at 3.5 wk, a second cutting for T85 of 3.5 wk of regrowth, and CBG harvested at 4 wk of growth was 63.6, 59.9, and 52.0%, respectively.

The higher DM and fiber digestibilities of T85 when compared with CBG (Table 4) may be partially explained by the lower concentrations of lignin (Tables 2 and 3). This is consistent with that reported by Mandebvu et al. (1999). Even though yields of DM, digestible DM, NDF, and ADF increased ($P < .05$) with increased age at harvest, there was a general decline in in vitro disappearances of DM, NDF, and ADF (Table 4).

In Situ DM and NDF Digestion Kinetics. When compared with CBG, T85 had higher in situ DM disappearance at 72 and 96 h of incubation and a 1.3% higher slowly digestible fraction of DM ($P < .05$; Table

Table 4. Digestible DM, NDF, and ADF yields and in vitro DM, NDF, and ADF disappearances of Tifton 85 and Coastal bermudagrasses harvested at different ages (Exp. 2)

	Cultivar (C)			Age (A), wk							Interaction	
Item	Tifton 85	Coastal	SE	2	3	4	5	6	7	SE	C × A[a]	SE
DM yield, t/ha	1.22[b]	.91[c]	.07	.14[e]	.23[e]	.42[e]	.80[d]	1.32[c]	3.45[b]	.13	NS	.18
	Digestible yield, t/ha											
DM												
Tifton 85				.11	.19	.31	.61	.88	2.15		*	.08
Coastal				.06	.08	.19	.38	.69	1.50			
NDF												
Tifton 85				.11	.17	.28	.57	.77	1.84		**	.07
Coastal				.05	.06	.16	.33	.58	1.21			
ADF												
Tifton 85				.09	.10	.21	.47	.61	1.28		**	.05
Coastal				.04	.03	.10	.25	.43	.60			
	In vitro disappearance at 48 h, %											
DM	61.1[b]	57.3[c]	.6	62.9[b]	58.0[d]	59.3[cd]	62.1[bc]	59.8[bcd]	52.9[e]	1.1	NS	1.5
NDF	55.7[b]	48.0[c]	.8	58.1[b]	49.2[c]	52.3[c]	56.4[b]	51.2[c]	44.1[d]	1.4	NS	2.0
ADF	41.4[b]	32.5[c]	1.3	46.1[b]	27.0[d]	37.3[c]	44.8[b]	39.7[bc]	26.9[d]	2.2	NS	3.2

[a]Level of significance for cultivar × age interaction is denoted by * for ($P < .05$), ** for ($P < .01$), and NS for not significant.
[b,c,d]Within a row within cultivar or age, means without a common superscript letter differ ($P < .05$).

Table 5. In situ DM and NDF digestion of Tifton 85 and Coastal bermudagrasses harvested at different ages (Exp. 2)

	Cultivar (C)			Age (A), wk							Interaction	
Item	Tifton 85	Coastal	SE	2	3	4	5	6	7	SE	C × A[a]	SE
	In situ DM digestion											
Disappearance, %												
48 h	50.6	48.1	1.1	49.7	50.4	48.1	51.3	51.3	45.2	1.9	NS	2.7
72 h	62.2^{c}	55.7^{d}	1.3	66.1^{c}	58.3^{d}	56.8^{d}	59.0^{d}	59.3^{d}	54.1^{d}	2.2	NS	3.2
96 h	59.2^{c}	55.5^{d}	1.3	58.2	58.8	56.1	60.1	58.1	53.0	2.2	NS	3.2
Digestible fraction[b]												
Potentially, %	64.9	59.4	2.5	65.8	61.9	63.7	64.6	60.9	57.2	4.5	NS	10.9
Readily, %	14.4^{d}	19.2^{c}	1.8	18.8	13.5	20.7	17.0	15.2	14.7	2.9	NS	6.9
Slowly, %	50.5^{c}	40.2^{d}	1.8	47.0	48.4	43.0	47.6	45.7	42.5	3.4	NS	8.5
Rate, %/h	2.8	2.8	.4	2.7	3.2	2.1	2.7	3.5	2.9	.6	NS	1.6
Indigestible, %	35.1	40.6	2.5	34.2	38.1	36.3	35.4	39.1	42.8	4.5	NS	10.9
	In situ NDF digestion											
Disappearance, %												
48 h	39.3^{c}	34.1^{d}	1.5	38.7	36.4	34.3	39.2	39.3	32.2	2.5	NS	3.6
72 h	49.5^{c}	42.2^{d}	1.4	51.6^{c}	46.0^{cd}	44.7^{cd}	47.6^{cd}	44.5^{cd}	40.6^{d}	2.4	NS	3.5
96 h	50.7^{c}	44.9^{d}	1.4	52.9^{c}	47.7^{cd}	45.6^{cd}	49.7^{cd}	47.9^{cd}	42.8^{d}	2.3	NS	3.3
Digestible fraction[b]												
Potentially, %	54.7	49.7	3.1	54.7	52.5	50.5	53.8^{c}	48.3	45.2	5.2	NS	6.1
Rate, %/h	3.1	2.7	.3	1.6^{d}	3.0^{cd}	2.9^{cd}	3.0^{cd}	4.1^{c}	3.3^{c}	.4	NS	.5
Indigestible, %	45.3	50.3	3.1	45.3	47.5	49.5	46.2^{c}	51.7	54.8	5.2	NS	6.1

[a]There were no cultivar × age interactions.

[b]Digestible fractions were calculated by fitting disappearance data at 6, 12, 24, 36, 48, 72, and 96 h of incubation to the nonlinear equation: $p = a + b(1 - e^{-ct})$, where a = the readily digested fraction, b = the slowly digested fraction, a + b = the potentially digestible fraction, and c = the rate of digestion for the slowly digested fraction.

[c,d]Within a row within cultivar or age, means without a common superscript letter differ ($P < .05$).

5). Even though not statistically significant ($P > .05$), T85 had a 5.5% higher total potentially digestible fraction of DM than CBG. Tifton 85 bermudagrass had higher ($P < .05$) in situ NDF disappearance at 48, 72, and 96 h of incubation and a 9.1% greater potentially digestible fraction of NDF than CBG. Rates of DM or NDF digestion in situ were similar for T85 and CBG. Mandebvu et al. (1999) reported that when T85 and CBG were compared at 3- or 6-wk age at harvest, in situ DM and NDF disappearances decreased in the order of 3-wk T85, 6-wk T85, 3-wk CBG, and 6-wk CBG. These workers also reported that T85 had higher potentially digestible and slowly digestible fractions of DM and a higher potentially digestible fraction of NDF than CBG. As anticipated and observed by Mandebvu et al. (1998a, 1999), in situ disappearances and potentially digestible fractions of DM and NDF digestion decreased ($P < .05$) with increased age at harvest. Because both cultivars had similar rates of digestion of DM and NDF in situ, the most important difference in the digestion profile of these two cultivars of bermudagrass was in the total potential extent of digestion. The low extent of DM and NDF digestion in CBG when compared with T85 may be partially attributed to greater lignin content of CBG (Mandebvu et al., 1999).

Experiment 3

Nutrient and Cell Wall Composition. Tifton 85 had greater concentrations of NDF, ADF, hemicellulose, and cellulose, a lower concentration of ADL, and higher IVDMD than CBG ($P < .05$; Table 6). Concentrations of NDF and ADF did not increase with increased age at harvest after 5 wk for both cultivars. This atypical situation may be attributed to the accelerated fresh growth experienced in wk 4 to 7 from the rainfall received during wk 4 to 6 following periods of drought in wk 1 and 3 (Figure 1). The immature forage from the accelerated growth lowered the NDF and ADF contents of the forage harvested after 7 wk, thus disrupting the pattern of increase in the concentrations of NDF and ADF normally observed with increased age at harvest. Tifton 85 bermudagrass had higher ($P < .05$) concentrations of cell walls, total neutral sugars, arabinose, glucose, and xylose, and lower concentrations of AIL and ether-linked ferulic acid (monomers and dimers) than CBG (Table 7). Mandebvu et al. (1999) also reported that CBG had higher ether-linked ferulic acid than T85 harvested at 3 (6.2 vs 8.1 g/kg cell walls) or 6 wk (4.9 vs 7.6 g/kg cell walls). The unusual rainfall pattern for this growing season (Figure 1) might have resulted in the failure to observe changes in the chemical components of cell walls with increased age at harvest. This may

Table 6. In vitro dry matter disappearance (IVDMD) at 48 h of incubation and nutrient composition of Tifton 85 and Coastal bermudagrasses harvested as hay at different ages and fed to growing beef steers (Exp. 3)

	Cultivar (C)			Age (A), wk				Interaction	
Nutrient	Tifton 85	Coastal	SE	3	5	7	SE	C × A[a]	SE
IVDMD, %	63.2[b]	59.4[c]	.2	62.7[b]	60.5[c]	60.7[c]	.03	NS	.4
				% of DM					
OM	93.7	93.8	.1	93.5[d]	93.7[c]	94.0[b]	.1	NS	.1
CP									
Tifton 85				15.8	14.5	12.6		**	.2
Coastal				14.7	15.8	13.1			
NDF	75.1[b]	70.9[c]	.2	72.9[c]	75.2[b]	71.0[d]	.3	NS	.4
ADF	32.8[b]	30.6[c]	.2	31.7	31.9	31.5	.2	NS	.3
Hemicellulose	42.3[b]	40.3[c]	.3	41.2[c]	43.3[b]	39.5[d]	.3	NS	.5
Cellulose									
Tifton 85				29.6	29.4	26.9		*	.3
Coastal				26.4	26.1	25.8			
ADL									
Tifton 85				3.4	4.1	4.4		**	.04
Coastal				4.3	4.9	4.7			

[a]Level of significance for cultivar × age interaction is denoted by * for ($P < .05$), ** for ($P < .01$), and NS for not significant.
[b,c,d]Within a row within cultivar or age, means without a common superscript letter differ ($P < .05$).

also explain the decline in concentrations of cell walls, AIL, *p*-coumaric acid, and ferulic acid from wk 5 to 7 (Table 7). Even though lignin is the most commonly recognized limitation to cell wall digestion (Van Soest, 1965), recently it has been shown that ferulic acid linkages between lignin and cell wall polysaccharides may be a prerequisite for lignin to exert its effect (Jung and Allen, 1995). Arabinoxylan, a component of hemicellulose in grass cell walls, bonds directly with ferulic acid via an ester linkage, and in turn ferulic acid as monomers or dimers bonds with lignin via ester or ether linkages (Jung and Allen, 1995). While ruminal bacteria and fungi possess phenolic acid esterases that ultimately break down the ferulate ester linkages, anaerobic cleavage of ether linkages is not known to occur (Jung and Allen, 1995). The majority of *p*-coumaric acid is esterified to lignin and is, therefore, unlikely to directly affect polysaccharide digestion (Jung and Allen, 1995). The higher concentration of ether-linked ferulic acid in CBG may

Table 7. Chemical components of cell walls of Tifton 85 and Coastal bermudagrasses harvested as hay at different ages and fed to growing beef steers (Exp. 3)

	Cultivar			Age, wk			
Item	Tifton 85	Coastal	SE	3	5	7	SE
Cell walls, g/kg DM	737.4[a]	708.2[b]	2.4	711.9[b]	731.9[a]	724.7[a]	2.9
				g/kg cell walls			
Acid insoluble lignin	174.5[b]	202.8[a]	1.4	187.8	192.7	185.6	1.7
Total uronic acids	32.7	33.9	.5	34.6	33.8	31.6	.6
Ester *p*-coumaric acid	11.2	11.1	.08	11.1[a]	11.6[a]	10.8[b]	.10
Total ester ferulic acid	13.9[a]	12.6[b]	.24	13.8	12.8	13.2	.29
Ether *p*-coumaric acid	.15	.01	.10	.03	.20	.01	.12
Total ether ferulic acid	6.90[b]	8.12[a]	.35	6.58[a]	8.50[b]	7.45[ab]	.48
Neutral sugars	818.1[a]	791.9[b]	1.7	801.3	807.2	806.5	2.1
Fucose	.63	.50	.02	.60	.45	.65	.03
Arabinose	63.9[a]	59.4[b]	.3	60.4	62.5	62.1	.4
Rhamnose	.01[b]	.60[a]	.27	.25	.65	.01	.33
Galactose	20.8	20.5	.4	20.2	20.5	21.3	.5
Glucose	443.7[a]	436.2[b]	.9	443.5	437.8	438.7	1.2
Xylose	287.9[a]	273.3[b]	1.9	275.7	283.3	282.8	2.4
Mannose	1.20	1.33	.53	.70	2.00	1.10	.65

[a,b]Within a row within cultivar or age, means without a common superscript letter differ ($P < .05$). There were no cultivar × age interactions.

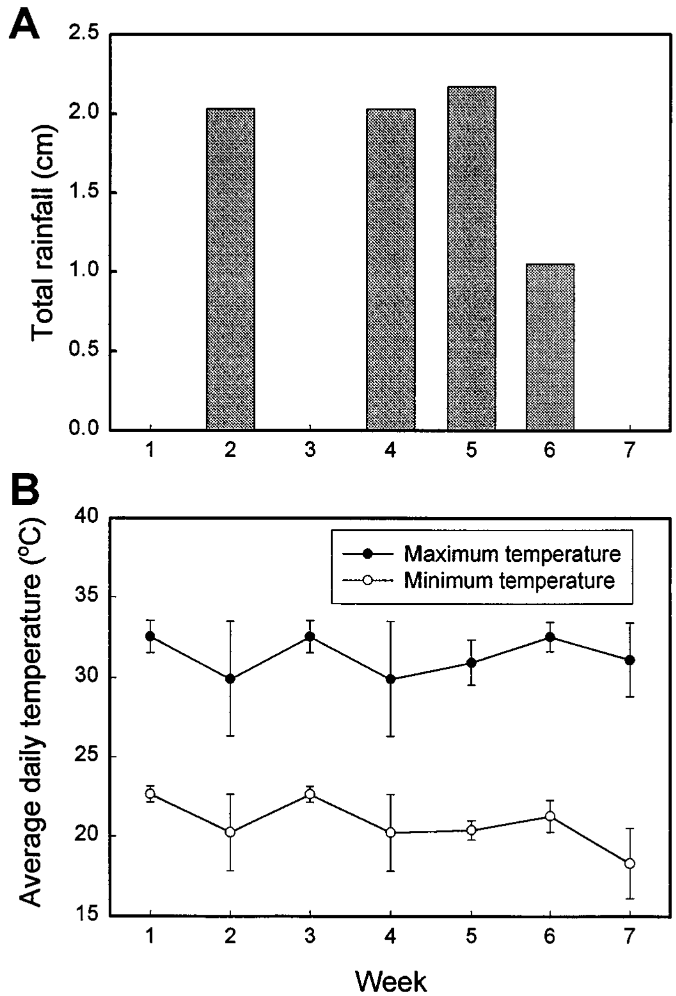

Figure 1. Total rainfall (A) received and average daily temperature (B) for the growing season during which Tifton 85 and Coastal bermudagrasses were harvested at different ages (Exp. 2 and 3).

therefore also partially explain the lower IVDMD of CBG when compared with T85.

Intake and Digestion of T85 and CBG by Growing Beef Steers. Even though intake of DM, OM, CP, and NDF by growing beef steers was similar for T85 and CBG (Table 8), steers fed T85 had greater intake of ADF, hemicellulose, and cellulose, and greater digestion of DM, OM, NDF, ADF, hemicellulose, and cellulose than steers fed CBG ($P < .05$). Intake of ADL was greater ($P < .05$) for steers fed CBG when compared with those that were fed T85. Hill et al. (1996) also failed to observe differences in DMI by growing beef steers fed T85 and CBG harvested at 4- or 6-wk stages of growth. They also reported greater DM digestibility by steers fed T85 than by those fed CBG (53.0 vs 46.4%). Hill et al. (1997) reported that when growing beef steers fed T85 were compared with those fed CBG, they had greater digestion of OM (54.3 vs 47.8%), ADF (59.5 vs 44.9%), and NDF (61.3 vs 51.3%). Nutrient digestibilities of T85 and CBG reported by Hill et al. (1996, 1997) by beef steers were lower than those observed in the present study. However, the digestibilities of OM, NDF, and CP reported in our study for CBG are in agreement with those observed by other workers with growing Holstein steer calves or beef cows (Galloway et al., 1992, 1993a,b; Forster et al., 1993).

Greater intakes of DM and OM of 7-wk-old bermudagrass forages by the steers when compared with the 3- or 5-wk-old forages (Table 8) may be attributed to the unusually lower NDF concentration for the 7-wk-old forage (Table 6). Age at harvest had no effect on digestibilities of DM, OM, and CP for either cultivar (Table 8). The decline ($P < .05$) in digestibilities of NDF, ADF, hemicellulose, and cellulose with increased age at harvest for both cultivars (Table 8) may be partially attributed to greater cell lignification associated with increased maturity. Intake of ADL by steers increased ($P < .05$) with increased age at harvest for both cultivars.

Linear regression analyses of nutrient digestion by growing beef steers against nutrient concentration in T85 and CBG showed that ADL caused the digestibilities of DM, OM, and NDF to decline at the same rate in both cultivars (Table 9). The relationship between total tract OM digestibility and ADL concentration (percentage) in T85 and CBG is expressed by the following equations.

$$\text{T85 total tract OM digestibility, \%} = 77.7 - 4.70 \times \text{ADL}$$

$$\text{CBG total tract OM digestibility, \%} = 74.7 - 4.43 \times \text{ADL}$$

The greater concentrations of lignin and ferulic acid ether linkages in CBG, while limiting the total potential extent of digestion of this cultivar when compared with T85, did not have any effect on the rate of digestion. Van Soest (1985) reported that while lignin was the primary factor setting the potential extent of digestion, it was less well correlated with rate of digestion. Regression analyses also showed that NDF digestibility in CBG declined with increase in hemicellulose concentration (Table 9). Even though the correlation was low (r = –.4), this observation may be related to the greater indigestible ether ferulic acid linkages ($P < .05$) between lignin and arabinoxylans (the major constituent of hemicellulose) in CBG than in T85 (Table 7). As anticipated, digestibilities of DM, OM, and NDF declined with the increase in NDF concentration in CBG. Intake and digestibility of forages containing a high cell-wall content normally declines with increased fiber concentration (Van Soest, 1965). Even though NDF concentration of T85 was higher than that of CBG ($P < .05$), there was a positive correlation between NDF concentration and digestibilities of DM, OM, and NDF in T85. This may be partially explained by the high

Table 8. Intake and total tract digestion of Tifton 85 and Coastal bermudagrasses harvested at different ages by growing beef steers (Exp. 3)

	Cultivar (C)			Age (A), wk				Interaction	
Item	Tifton 85	Coastal	SE	3	5	7	SE	C × A[a]	SE
Dry matter									
Intake									
kg/d	4.7	4.8	.1	4.6[c]	4.6[c]	5.0[b]	.1	NS	.1
% BW	1.90	1.93	.03	1.88[c]	1.86[c]	2.01[b]	.04	NS	.05
Digestion									
%	58.1[b]	53.3[c]	1.3	57.1	54.7	55.2	1.6	NS	2.3
kg/d	2.7	2.6	.1	2.6	2.5	2.7	.1	NS	.1
Organic matter									
Intake, kg/d	4.4	4.5	.1	4.3[c]	4.3[c]	4.7[b]	.1	NS	.1
Digestion									
%	59.1[b]	54.2[c]	1.3	58.2	55.6	56.1	1.6	NS	2.2
kg/d	2.6	2.4	.1	2.5	2.4	2.6	.1	NS	.1
Crude protein									
Intake, kg/d	.67	.69	.01	.70[b]	.71[b]	.64[c]	.02	NS	.03
Digestion									
%	59.8	58.4	1.2	58.2	59.5	59.5	1.5	NS	2.1
kg/d	.40	.40	.01	.41	.42	.38	.02	NS	.02
Neutral detergent fiber									
Intake, kg/d	3.5	3.4	.1	3.3	3.4	3.6	.1	NS	.1
Digestion									
%	65.5[b]	57.8[c]	1.2	64.1[b]	62.4[bc]	58.6[c]	1.5	NS	2.1
kg/d	2.3[b]	2.0[c]	.1	2.1	2.1	2.1	.1	NS	.1
Acid detergent fiber									
Intake, kg/d	1.53[b]	1.48[c]	.03	1.46[c]	1.49[bc]	1.56[b]	.03	NS	.05
Digestion									
%	61.3	51.4	1.3	58.7[b]	57.3[bc]	53.1[c]	1.7	NS	2.3
kg/d	.94[b]	.76[c]	.03	.85	.86	.83	.03	NS	.05
Hemicellulose									
Intake, kg/d	1.98[b]	1.89[c]	.04	1.88	1.92	2.00	.05	NS	.07
Digestion									
%	68.7[b]	62.8[c]	1.2	68.2[b]	66.3[bc]	62.9[c]	1.4	NS	2.0
kg/d	1.36[b]	1.19[c]	.04	1.28	1.28	1.26	.05	NS	.06
Cellulose									
Intake, kg/d	1.35[b]	1.28[c]	.02	1.29	1.30	1.35	.03	NS	.04
Digestion									
%	69.9[b]	61.0[c]	1.2	68.6[b]	65.7[bc]	62.0[c]	1.5	NS	2.1
kg/d	.94[b]	.78[c]	.02	.89	.86	.84	.03	NS	.04
Acid detergent lignin									
Intake, kg/d	.20[c]	.24[b]	.01	.20[c]	.22[bc]	.24[b]	.01	NS	.01
Digestion									
%	−13.1	−15.3	4.3	−21.5	−8.6	−12.5	5.2	NS	7.4
kg/d	−.02	−.03	.01	−.04	−.01	−.03	.01	NS	.02

[a]There were no cultivar × age interactions.
[b,c]Within a row within cultivar or age, means without a common superscript letter differ ($P < .05$).

digestibility of the fiber fraction of T85 and the low NDF content of forage harvested at 7 wk.

West et al. (1997) reported that, although DMI, average milk yield, and 3.5% fat-corrected milk yield were higher for lactating dairy cows fed alfalfa hay- or corn silage-based total mixed rations, NDF and ADF digestibilities were higher for the T85-based total mixed ration. West et al. (1998) reported that apparent digestibilities of NDF and ADF by lactating Holstein and Jersey cows increased as the level of T85 bermudagrass hay or silage was increased in the diet. These workers also reported that, although increasing dietary NDF from added bermudagrass reduced DMI and milk yield, storage form of bermudagrass (hay or silage) had little effect on milk yield and milk composition. They also concluded that the improved apparent digestibility of dietary NDF and ADF by lactating dairy cows suggested greater fiber digestion for bermudagrass sources and that T85 may be a suitable, partial substitute for alfalfa hay in lactating Holstein cow diets.

In summary, even though T85 had greater concentrations of NDF and ADF than CBG, T85 had higher yields of DM and digestible DM, NDF, and ADF,

Table 9. Linear regression analysis of total tract DM, OM, and NDF digestion (%) against the concentration (%) of NDF, ADF, ADL, cellulose, or hemicellulose in Tifton 85 and Coastal bermudagrasses harvested as hay at 3, 5, and 7 wk of growth and fed to growing beef steers[a] (Exp. 3)

Nutrient	Cultivar	Intercept ± SE	Slope ± SE	Significance level for slope[a]	R^2
		DM digestibility			
NDF	Tifton 85	–.086 ± 58.307	.77 ± .78	NS	.5
	Coastal	135.1 ± 3.2	–1.15 ± .04	*	.999
ADF	Tifton 85	–199.9 ± 479.3	7.86 ± 14.60	NS	.22
	Coastal	328.1 ± 158.7	–9.00 ± 5.20	NS	.8
ADL	Tifton 85	76.2 ± 7.4	–4.57 ± 1.86	NS	.9
	Coastal	71.2 ± 27.6	–3.86 ± 5.94	NS	.3
		OM digestibility			
NDF	Tifton 85	2.25 ± 61.3	.76 ± .82	NS	.5
	Coastal	136.3 ± 4.7	–1.16 ± .07	*	.997
ADF	Tifton 85	–184.9 ± 495.6	7.43 ± 15.10	NS	.2
	Coastal	313.7 ± 185.1	–8.50 ± 6.06	NS	.7
ADL	Tifton 85	77.7 ± 6.7	–4.70 ± 1.72	NS	.9
	Coastal	74.7 ± 25.8	–4.43 ± 5.57	NS	.4
		NDF digestibility			
Cellulose	Tifton 85	–27.5 ± 7.2	3.247 ± .250	*	.99
	Coastal	–29.2 ± 55.3	3.33 ± 2.12	NS	.7
Hemicellulose	Tifton 85	–16.3 ± 49.8	1.93 ± 1.18	NS	.7
	Coastal	67.6 ± 25.7	–.24 ± .64	NS	.13
ADL	Tifton 85	96.6 ± 21.7	–7.84 ± 5.45	NS	.7
	Coastal	75.1 ± 5.2	–3.71 ± 1.11	NS	.9

[a]Level of significance for regression slope is denoted by * for ($P < .05$) and NS for not significant.

higher in vitro disappearances of DM, NDF, and ADF, and higher in situ DM and NDF digestion. Coastal bermudagrass had higher concentrations of lignin and ether-linked ferulic acid than T85, and this may partially explain the lower DM and fiber digestibilities of CBG. Digestibilities of DM, NDF, and ADF in vitro were lower and concentrations of ADF and ADL were greater after 7 vs 6 wk of forage growth. Even though there were no differences in DMI or OM intake between cultivars by growing beef steers, steers fed T85 had improved digestion of DM, OM, NDF, ADF, hemicellulose, and cellulose compared with steers fed CBG. Digestion of NDF, ADF, hemicellulose, and cellulose decreased with increased age at harvest for both cultivars.

Implications

Tifton 85 bermudagrass is one of the most productive cultivars of bermudagrass released to date, and it has the potential of becoming widely grown in the southern United States and in tropical and subtropical countries. Because it is higher yielding and more digestible than Coastal bermudagrass, it has the potential of being used more extensively in feeding situations in which Coastal bermudagrass could only be used in limited amounts. Tifton 85 bermudagrass harvested at 3 to 5 wk of growth may be used as a fiber source in total mixed rations for high producing dairy cows and as the sole forage for cow-calf production and grazing beef cattle.

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Appendix Table 1. Treatment means for DM yield (DMY), digestible DM yield (DDMY), and in vitro DM disappearance (IVDMD) at 48 h of incubation of Tifton 85 and Coastal bermudagrasses harvested at different ages in July and September (Exp. 1)

			Age, wk						
Item	Month	Cultivar	3	4	5	6	7	8	SE
DMY, t/ha	July	Tifton 85	2.8	4.2	4.6	3.8	5.0	7.1	.6
		Coastal	2.4	2.8	4.2	4.1	5.1	6.0	
	September	Tifton 85	1.5	2.1	4.1	5.8	6.6	6.9	
		Coastal	2.1	2.2	3.6	5.0	6.5	6.4	
DDMY, t/ha	July	Tifton 85	1.9	2.8	3.0	2.4	2.9	4.0	.3
		Coastal	1.6	1.8	2.6	2.5	2.8	3.1	
	September	Tifton 85	.9	1.2	2.3	3.1	3.4	3.4	
		Coastal	1.2	1.2	1.9	2.5	3.1	2.9	
IVDMD, %	July	Tifton 85	66.9	65.3	64.6	63 0	59.2	56.6	1.3
		Coastal	66.1	62.8	62.1	60.0	53.7	51.4	
	September	Tifton 85	61.5	58.1	54.4	53.5	51.4	50.2	
		Coastal	54.4	52.5	52.7	48.7	47.2	45.7	

Appendix Table 2. Treatment means for nutrient composition of Tifton 85 and Coastal bermudagrasses harvested at different ages (Exp. 2)

Nutrient	Cultivar	Age, wk 2	3	4	5	6	7	SE
		% of DM						
OM	Tifton 85	93.3	92.8	93.1	93.1	92.2	91.8	.3
	Coastal	93.7	93.1	93.6	93.0	91.5	90.2	
CP	Tifton 85	20.8	16.8	18.9	16.2	13.8	11.1	.8
	Coastal	21.1	14.5	18.4	18.4	16.3	13.6	
NDF	Tifton 85	68.8	67.1	69.0	69.9	69.6	71.1	1.0
	Coastal	68.7	63.9	67.5	66.0	65.8	66.6	
ADF	Tifton 85	29.5	30.0	29.8	30.3	31.1	33.7	.6
	Coastal	28.0	28.8	29.1	27.4	30.1	31.6	
Hemicellulose	Tifton 85	39.3	37.1	39.3	39.6	38.5	37.4	.8
	Coastal	40.7	35.1	38.4	38.6	35.6	35.1	
Cellulose	Tifton 85	25.8	26.6	26.5	28.0	28.2	30.7	.7
	Coastal	23.7	23.6	24.9	23.9	26.7	28.8	
ADL	Tifton 85	4.8	4.7	4.4	4.1	4.8	6.0	.4
	Coastal	4.8	6.6	5.1	4.5	5.3	6.4	

Appendix Table 3. Treatment means for chemical components of cell walls of Tifton 85 and Coastal bermudagrasses harvested at different ages (Exp. 2)

Nutrient	Cultivar	Age, wk 2	3	4	5	6	7	SE
Cell walls, g/kg DM	Tifton 85	658.8	686.5	692.3	707.3	722.1	776.0	12.8
	Coastal	637.8	684.5	680.8	653.3	688.8	734.9	
		g/kg cell walls						
Acid insoluble lignin	Tifton 85	209.0	211.4	195.2	186.0	193.8	194.1	5.4
	Coastal	229.3	231.7	222.2	218.9	216.3	235.4	
Total uronic acids	Tifton 85	32.4	31.3	30.0	31.4	31.9	31.0	1.1
	Coastal	34.1	31.5	31.5	33.3	32.4	30.8	
Neutral sugars	Tifton 85	815.1	793.8	810.2	822.6	812.1	794.5	6.6
	Coastal	786.5	777.1	784.3	792.1	776.8	756.6	
Fucose	Tifton 85	.67	.80	.47	.77	.77	.73	.12
	Coastal	.63	.60	.70	.63	.33	.63	
Arabinose	Tifton 85	67.9	63.5	67.4	66.0	67.7	63.1	.9
	Coastal	66.6	62.1	65.0	64.0	60.1	59.2	
Rhamnose	Tifton 85	.4	.37	.83	.01	1.37	1.30	.36
	Coastal	.01	.01	.70	.01	.93	.01	
Galactose	Tifton 85	24.3	23.8	23.5	23.9	25.7	23.4	.7
	Coastal	24.3	23.4	24.2	23.8	22.1	23.5	
Glucose	Tifton 85	436.6	425.2	430.2	445.9	428.0	421.1	5.6
	Coastal	413.3	419.9	412.0	423.9	421.7	399.7	
Xylose	Tifton 85	282.8	276.7	285.1	286.0	285.6	281.2	3.2
	Coastal	279.4	267.6	278.5	277.0	268.9	270.3	
Mannose	Tifton 85	2.37	3.47	2.67	.01	2.93	3.77	.5
	Coastal	2.33	3.50	3.10	2.63	2.77	3.33	

Appendix Table 4. Treatment means for digestible DM, NDF, and ADF yields (t/ha) and in vitro DM, NDF, and ADF disappearances of Tifton 85 and Coastal bermudagrasses harvested at different ages (Exp. 2)

Item	Cultivar	Age, wk 2	3	4	5	6	7	SE
DM yield, t/ha	Tifton 85	.18	.31	.50	.96	1.45	3.89	.18
	Coastal	.10	.15	.34	.63	1.18	3.00	
		Digestible yield, t/ha						
DM	Tifton 85	.11	.19	.31	.61	.88	2.15	.08
	Coastal	.06	.08	.19	.38	.69	1.50	
NDF	Tifton 85	.11	.17	.28	.57	.77	1.84	.07
	Coastal	.05	.06	.16	.33	.58	1.21	
ADF	Tifton 85	.09	.10	.21	.47	.61	1.28	.05
	Coastal	.04	.03	.10	.25	.43	.60	
		In vitro disappearance at 48 h, %						
DM	Tifton 85	64.0	61.2	61.3	63.8	60.5	55.6	1.5
	Coastal	61.8	54.8	57.3	60.4	59.0	50.3	
NDF	Tifton 85	61.9	55.6	56.4	60.0	53.0	47.6	2.0
	Coastal	54.3	42.9	48.2	52.9	49.4	40.6	
ADF	Tifton 85	49.0	32.6	42.2	49.4	42.1	33.1	3.2
	Coastal	43.1	21.5	32.3	40.3	37.3	20.7	

Appendix Table 5. Treatment means for in situ DM and NDF disappearances of Tifton 85 and Coastal bermudagrasses harvested at different ages (Exp. 2)

Incubation time, h	Cultivar	Age, wk 2	3	4	5	6	7	SE
		In situ DM disappearances, %						
6	Tifton 85	24.1	22.8	25.8	22.3	22.8	21.2	2.9
	Coastal	26.8	22.9	30.3	27.4	25.3	22.0	
12	Tifton 85	29.1	27.1	28.7	28.8	29.0	24.7	2.8
	Coastal	36.6	28.3	26.9	29.5	31.4	28.5	
24	Tifton 85	41.4	41.2	37.4	38.7	42.5	35.3	2.4
	Coastal	39.1	36.5	35.9	40.1	42.1	36.8	
36	Tifton 85	47.3	48.2	46.7	47.3	47.7	42.1	3.3
	Coastal	47.2	47.9	41.3	46.3	46.6	41.3	
48	Tifton 85	52.9	51.8	50.3	50.4	52.1	46.2	2.7
	Coastal	46.5	49.1	45.9	52.3	50.6	44.3	
72	Tifton 85	72.8	62.9	60.2	60.5	62.1	54.6	3.2
	Coastal	59.4	53.7	53.4	57.5	56.5	53.6	
96	Tifton 85	63.8	60.3	57.2	60.3	58.7	55.1	3.2
	Coastal	52.6	57.2	55.0	59.9	57.6	51.0	
		In situ NDF disappearances, %						
12	Tifton 85	18.7	6.3	7.1	8.7	16.2	5.6	5.0
	Coastal	18.1	6.5	5.2	12.4	5.8	8.1	
24	Tifton 85	26.6	24.8	20.9	23.5	30.2	20.9	4.0
	Coastal	22.1	14.1	16.3	24.3	23.8	20.3	
36	Tifton 85	34.0	34.3	32.7	33.7	39.0	29.5	4.9
	Coastal	32.8	25.0	24.4	30.2	29.6	26.8	
48	Tifton 85	41.5	39.3	38.1	40.0	42.9	33.9	3.6
	Coastal	35.9	33.4	30.4	38.4	35.7	30.5	
72	Tifton 85	55.7	53.5	48.3	50.8	47.0	41.7	3.5
	Coastal	47.5	38.6	41.1	44.5	42.1	39.5	
96	Tifton 85	56.4	50.7	47.5	52.0	51.2	46.1	3.3
	Coastal	49.5	44.8	43.7	47.3	44.7	39.4	

Appendix Table 6. Treatment means for IVDMD at 48 h of incubation and nutrient composition of Tifton 85 and Coastal bermudagrasses harvested as hay at different ages and fed to growing beef steers (Exp. 3)

		Age, wk			
Nutrient	Cultivar	3	5	7	SE
IVDMD, %	Tifton 85	65.0	62.3	62.4	.4
	Coastal	60.4	58.8	59.0	
		% of DM			
OM	Tifton 85	93.5	93.7	93.8	.1
	Coastal	93.5	93.8	94.1	
CP	Tifton 85	15.8	14.5	12.6	.2
	Coastal	14.7	15.8	13.1	
NDF	Tifton 85	75.4	77.3	72.7	.4
	Coastal	70.3	73.0	69.4	
ADF	Tifton 85	32.8	33.0	32.7	.3
	Coastal	30.6	30.7	30.3	
Hemicellulose	Tifton 85	42.6	44.3	40.0	.5
	Coastal	39.7	42.3	39.0	
Cellulose	Tifton 85	29.6	29.4	26.9	.3
	Coastal	26.4	26.1	25.8	
ADL	Tifton 85	3.4	4.1	4.4	.04
	Coastal	4.3	4.9	4.7	

Appendix Table 7. Treatment means for chemical components of cell walls of Tifton 85 and Coastal bermudagrasses harvested as hay at different ages and fed to growing beef steers (Exp. 3)

		Age, wk			
Nutrient	Cultivar	3	5	7	SE
Cell walls, g/kg DM	Tifton 85	723.1	748.0	741.0	2.9
	Coastal	700.6	715.7	708.2	
		g/kg cell walls			
Acid insoluble lignin	Tifton 85	175.5	177.0	171.0	1.7
	Coastal	200.1	208.3	200.1	
Total uronic acids	Tifton 85	33.2	33.7	31.2	.6
	Coastal	35.9	33.9	31.9	
Ester *p*-coumaric acid	Tifton 85	11.4	11.5	10.6	.1
	Coastal	10.8	11.6	11.0	
Total ester ferulic acid	Tifton 85	14.9	13.2	13.7	.3
	Coastal	12.8	12.4	12.6	
Ether *p*-coumaric acid	Tifton 85	.05	.4	.01	.12
	Coastal	.01	.01	.01	
Total ether ferulic acid	Tifton 85	6.6	8.6	5.6	.48
	Coastal	6.6	8.45	9.3	
Neutral sugars	Tifton 85	816.6	820.1	817.6	2.1
	Coastal	786.0	794.2	795.4	
Fucose	Tifton 85	.7	.5	.7	.03
	Coastal	.5	.4	.6	
Arabinose	Tifton 85	63.1	64.7	63.9	.4
	Coastal	57.7	60.3	60.2	
Rhamnose	Tifton 85	.1	.1	.1	.33
	Coastal	.5	1.3	.1	
Galactose	Tifton 85	20.6	20.1	21.7	.5
	Coastal	19.8	20.9	20.9	
Glucose	Tifton 85	446.5	442.9	441.8	1.2
	Coastal	440.4	432.7	435.5	
Xylose	Tifton 85	285.7	289.3	288.6	2.4
	Coastal	265.6	277.2	277.0	
Mannose	Tifton 85	.01	2.6	1.0	.65
	Coastal	1.4	1.4	1.2	

Appendix Table 8. Treatment means for intake and total tract digestion of Tifton 85 and Coastal bermudagrasses harvested as hay at different ages and fed to growing beef steers (Exp. 3)

		Age, wk			
Nutrient	Cultivar	3	5	7	SE
Dry matter					
Intake					
kg/d	Tifton 85	4.5	4.7	4.9	.1
	Coastal	4.8	4.5	5.1	
% BW	Tifton 85	1.80	1.91	1.99	.05
	Coastal	1.96	1.82	2.03	
Digestion					
%	Tifton 85	60.3	58.5	55.3	2.3
	Coastal	53.9	50.9	55.1	
kg/d	Tifton 85	2.7	2.7	2.7	.1
	Coastal	2.6	2.3	2.8	
Organic matter					
Intake, kg/d	Tifton 85	4.1	4.4	4.6	.1
	Coastal	4.4	4.2	4.7	
Digestion					
%	Tifton 85	61.4	59.4	56.3	2.2
	Coastal	55.0	51.7	55.8	
kg/d	Tifton 85	2.5	2.6	2.6	.1
	Coastal	2.4	2.2	2.7	
Crude protein					
Intake, kg/d	Tifton 85	.70	.72	.60	.30
	Coastal	.70	.70	.67	
Digestion					
%	Tifton 85	60.4	60.9	58.0	2.1
	Coastal	56.1	58.1	61.0	
kg/d	Tifton 85	.42	.44	.35	.02
	Coastal	.39	.41	.41	
Neutral detergent fiber					
Intake, kg/d	Tifton 85	3.3	3.6	3.6	.1
	Coastal	3.3	3.2	3.6	
Digestion					
%	Tifton 85	69.0	67.6	59.9	2.1
	Coastal	59.2	57.1	57.2	
kg/d	Tifton 85	2.3	2.4	2.1	.1
	Coastal	2.0	1.8	2.0	
Acid detergent fiber					
Intake, kg/d	Tifton 85	1.45	1.56	1.58	.05
	Coastal	1.47	1.41	1.55	
Digestion					
%	Tifton 85	65.1	63.7	55.0	2.3
	Coastal	52.3	50.9	51.2	
kg/d	Tifton 85	.94	1.00	.87	.05
	Coastal	.77	.72	.80	
Hemicellulose					
Intake, kg/d	Tifton 85	1.90	2.05	2.00	.07
	Coastal	1.86	1.80	2.00	
Digestion					
%	Tifton 85	71.9	70.6	63.8	2.0
	Coastal	64.6	61.9	61.9	
kg/d	Tifton 85	1.36	1.45	1.28	.06
	Coastal	1.20	1.12	1.24	
Cellulose					
Intake, kg/d	Tifton 85	1.29	1.39	1.38	.04
	Coastal	1.30	1.21	1.33	
Digestion					
%	Tifton 85	73.5	71.9	64.2	2.1
	Coastal	63.6	59.4	59.9	
kg/d	Tifton 85	.95	1.00	.89	.04
	Coastal	.82	.72	.80	
ADL					
Intake, kg/d	Tifton 85	.19	.20	.22	.01
	Coastal	.21	.25	.25	
Digestion					
%	Tifton 85	−12.0	−11.7	−15.5	7.4
	Coastal	−30.9	−5.5	−9.5	
kg/d	Tifton 85	−.02	−.02	−.03	.02
	Coastal	−.07	−.01	−.02	