Harvest frequency affects herbage accumulation and nutritive value of brachiaria grass hybrids in Florida

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Abstract

Brachiaria 'Mulato II' is a hybrid brachiaria grass with superior nutritive value when compared with other warm-season grasses. The performance of 2 new brachiaria grass hybrids was compared with that of Mulato II in terms of herbage accumulation, nutritive value and ground cover in a series of experiments. In Experiment 1, Mulato II and lines BR02/1752 (now cv. Cayman) and BR02/1794 were harvested at 3- and 6-wk regrowth intervals in South Florida. Mulato II had greater herbage accumulation and ground cover than Cayman and BR02/1794, while Mulato II and Cayman had greater in vitro digestible organic matter (IVDOM) concentration than BR02/1794. Regrowth interval did not affect herbage accumulation and ground cover but herbage harvested at 3-wk intervals had greater nutritive value than 6-wk regrowth. In Experiment 2, Mulato II had similar IVDOM and CP concentrations to but greater herbage accumulation, ground cover and plant density than Cayman in North-Central Florida. In Experiment 3, Mulato II and Cayman plots were grazed at 2-, 4- or 6-wk intervals, and herbage accumulation and nutritive value were similar for both cultivars. Herbage nutritive value decreased and ground cover increased linearly as regrowth interval increased from 2 to 6 wk, and Mulato II had greater ground cover than Cayman. The new hybrids displayed no production or nutritive value advantages over Mulato II; regrowth intervals of less than 3 wk should be avoided to maintain *Brachiaria* hybrid stands in this subtropical environment.

Resumen

El híbrido de braquiaria Mulato II es un cultivar (cv.) con valor nutritivo superior al de otras gramíneas de clima cálido. En la Florida se compararon, en 3 experimentos, 2 nuevos híbridos de braquiaria: las líneas BR02/1752 (ahora: cv. Cayman) y BR02/1794, con cv. Mulato II, en términos de producción de forraje, valor nutritivo y cobertura del suelo. En el primer ensayo, conducido en el sur de la Florida y con intervalos de corte de 3 y 6 semanas, el cv. Mulato II presentó mayor producción de forraje y cobertura que el cv. Cayman y la línea BR02/1794, mientras que los cvs. Mulato II y Cayman presentaron mayor digestibilidad in vitro de la materia orgánica (DIVMO) que la línea BR02/1794. El intervalo de corte no afectó la producción de forraje y la cobertura pero en los cortes cada 3 semanas el valor nutritivo fue mayor que en los cortes cada 6 semanas. En el segundo ensayo, conducido en el centro-norte de la Florida, Mulato II presentó valores de IVDMO y concentración de proteína cruda similares a cv. Cayman, pero mayor producción de forraje, cobertura y densidad de plantas. En un tercer ensayo, también en el centro-norte de la Florida, los cvs. Mulato II y Cayman fueron sometidos a pastoreo cada 2, 4 y 6 semanas. Aquí, la producción de forraje y el valor nutritivo de ambos cultivares fueron similares. El valor nutritivo disminuyó mientras que la cobertura aumentó en forma lineal a medida que el intervalo de pastoreo aumentó de 2 a 6 semanas; el cv. Mulato II tuvo mayor cobertura que el cv. Cayman. Los nuevos híbridos no presentaron niveles de producción y calidad nutritiva más altos que cv. Mulato II; para garantizar la persistencia de los híbridos es necesario evitar intervalos de pastoreo inferiores a 3 semanas.

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Introduction

'Mulato' was the first hybrid to be released in the *Brachiaria* genus; it stems from an original cross of ruzi grass (*Brachiaria ruziziensis* clone 44-6) and palisade grass (*Brachiaria brizantha* cv. Marandu) (Argel et al. 2006). Subsequently, Mulato II was released because it had greater seed production than and similar forage production and nutritive value to Mulato. Mulato II is the result of 3 generations of crosses and screening conducted by the International Center for Tropical Agriculture (CIAT) in Colombia, including original crosses between ruzi grass and signal grass (*Brachiaria decumbens* cv. Basilisk; apomictic tetraploid) (Argel et al. 2007).

Mulato II has been a productive warm-season perennial grass in South Florida, with superior nutritive value to other warm-season grasses, and can be used for grazing (Inyang et al. 2010a) or harvested and conserved for feeding when needed (Vendramini et al. 2010). Following comparisons of herbage accumulation and nutritive value of 10 different species and cultivars of warm-season grasses in South Florida, Vendramini et al. (2010) concluded that Mulato II was among the species with greatest in vitro true digestibility (67%). Vendramini et al. (2012) compared animal performance, herbage accumulation and nutritive value of Mulato II, 'Tifton 85' bermuda grass (*Cynodon* spp.), pearl millet (*Pennisetum glaucum*) and sorghum-sudan grass (*Sorghum bicolor*) in North and North-Central Florida. Beef heifers grazing Mulato II, pearl millet and sorghum sudan grass had similar animal performance. Mulato II and Tifton 85 had similar herbage accumulation and crude protein (CP) concentrations, but Mulato II had greater in vitro digestible organic matter (IVDOM) concentration than the other species.

New *Brachiaria* hybrids were recently released by CIAT (Anon. 2011a, 2011b; Pizarro et al. 2013). Lines BR02/1794 and BR02/1752 (now released as cv. Cayman) were the result of a synthetic sexual breeding of palisade grass (*B. brizantha* CIAT 16320), ruzi grass and signal grass. Hare et al. (2013) compared Mulato II, Cayman and BR02/1794 in Thailand and concluded that cutting at 30-day intervals would produce CP levels 3−4 percentage units greater than cutting at 45- and 60-day intervals, but herbage accumulation would be 20% lower than cutting at the longer intervals. However, there is little information on herbage accumulation and nutritive value of these new hybrids in subtropical regions.

Regrowth interval is an important management practice that affects herbage accumulation, nutritive value and persistence of warm-season grasses. Inyang et al. (2010b) studied the effects of regrowth interval and stubble height on herbage accumulation, nutritive value and persistence of Mulato II. While herbage harvested at 2-wk regrowth intervals had greater nutritive value, herbage accumulation was less than observed for longer regrowth intervals, supporting results reported with other warm-season grasses. Vendramini et al. (2013) observed that bahia grass (*Paspalum notatum*) grazed at a 4-wk regrowth interval had greater herbage accumulation and persistence than pasture grazed at a 2-wk interval. These authors noted that the impact of regrowth interval on persistence was dependent on the bahia grass cultivar, with 'Argentine' more persistent than 'UF Riata', when grazed at a 2-wk regrowth interval.

Although it is crucial to understand the effects of regrowth interval on performance of warm-season grass species and cultivars, there are no reports in the literature about those effects on the new *Brachiaria* hybrids in Florida. The objective of this study was to compare herbage accumulation and nutritive value of Mulato II, Cayman and BR02/1794 under different regrowth intervals in Florida.

Materials and Methods

Experiment 1

This experiment was conducted at the University of Florida Range Cattle Research and Education Center, Ona, FL (27°26' N, 82°55' W) from July to November in both 2011 and 2012. The soil at the research site was classified as sandy siliceous, hyperthermic Alfic Alaquod (EauGallie sand). These sandy soils are poorly drained with slow permeability. Prior to initiation of the clipping study, mean soil pH (in water) was 5.9. Mehlich-I (0.05M HCl + 0.0125M H_2SO_4) extractable P, K, Mg and Ca concentrations in the Ap1 horizon (0 to 15-cm depth) were 33, 47, 246 and 1,323 ppm, respectively.

Treatments were the factorial combinations of 3 *Brachiaria* hybrids (Mulato II, Cayman and BR02/1794) x 2 regrowth intervals (3- and 6-wk) in a randomized complete block design with 4 replicates. The plots were established in April 2011 using a seeding rate of 13 kg/ha. The plots were irrigated 3 times weekly from April to June 2011 (total of 25 mm/wk), to ensure adequate establishment. In July 2011 and 2012, the plots received 35 kg N, 17 kg P and 64 kg K/ha to stimulate growth and provide maintenance P and K. An additional 80 kg N/ha was applied thereafter on 2 occasions at 6-wk intervals to provide a seasonal total of 195 kg N/ha.

Plot size was 3 m x 2 m with 1 m alleys between plots. In July 2011 and 2012, the plots were clipped at 7.5-cm stubble height and subsequently harvested at 3- or 6-wk regrowth intervals at the same height. Plots were harvested for 2 periods of 6 weeks in 2011 and 2012 (referred to as Periods 1 and 2 in the text). At harvest dates, herbage was harvested to a 7.5-cm stubble height from a 1.35 m^2 area at the center of the plot with a rotary blade mower (Sensation Mow-Blo Model 11F4-0) to determine herbage accumulation and nutritive value. Remaining herbage was clipped to the same stubble height and removed from the plots. Herbage accumulation, CP and IVDOM concentration data are presented by 6-wk periods and data from a given 6 wk reflect the total of one 6-wk or two 3-wk harvests within that period. The plots were not harvested from October 2011 to June 2012 and the forage accumulated during the period was clipped at 7.5-cm stubble height and removed from the plots to start the 2012 experimental period.

At harvest, total fresh weight was determined and 2 subsamples taken for determination of DM concentration and nutritive value. Subsamples were dried at 60 ºC for 48 h and ground to pass a 1-mm screen in a Wiley mill (Udy Corporation, Fort Collins, CO). Samples were analyzed for IVDOM using the 2-stage technique described by Tilley and Terry (1963) and modified by Moore and Mott (1974). Nitrogen concentration was determined using a micro-Kjeldahl method, a modification of the aluminum block digestion technique described by Gallaher et al. (1975). Crude protein was determined by multiplying N concentration by 6.25.

Ground cover was determined visually at the end of the 2012 experimental period using a 1-m^2 quadrat divided into 100, 10-cm x 10-cm squares. One quadrat was assessed per experimental unit. The proportion of squares with the sown species was reported.

Response variables were herbage accumulation, ground cover, CP and IVDOM concentration. The data were analyzed using PROC MIXED of SAS (SAS Institute Inc. 1996) with cultivar, regrowth interval, year and their interactions as fixed effects. Period was analyzed as a repeated measure using the unstructured covariance structure (UN). Block and its interactions were random effects. Treatments were considered different when $P<0.05$. Interactions not mentioned in the text were not significant ($P>0.05$). The means reported are least squares means, and means for month and year effects were separated by Fisher's protected least significant difference (LSD) at $P<0.05$.

Experiment 2

The study was located at the University of Florida Beef Research Unit, Gainesville, FL (29°44' N, 82°16' W; 48 m asl). The experiment was conducted from July to October 2010 and May to November 2011. Soils at the research site are Adamsville fine sand (uncoated, hyperthermic, Aquic Quartzipsamments). Prior to initiation of the study, mean soil pH (in water) was 6.1. Mehlich-I extractable P, K, Mg and Ca concentrations in the Ap1 horizon (0 to 15-cm depth) were 82, 49, 72 and 473 ppm, respectively.

Treatments were 2 *Brachiaria* hybrid cultivars Mulato II and line BR02/1752 (now cv. Cayman) distributed in a randomized complete block design with 4 replicates. Plots were 5 m x 5 m. Seed of Mulato II and Cayman was broadcast on a prepared seedbed at 20 kg/ha and rolled to ensure good seed-soil contact on 25 May 2010. In 2010, the plots were fertilized with 80 kg N/ha, as applications of 40 kg N/ha in July and August. In 2011, 160 kg N/ha was applied as 40 kg N/ha in April, June, July and September. In addition, the plots were fertilized with 42 kg K/ha in April 2011. The herbicide 2, 4-D [(2, 4-dichlorophenoxy) acetic acid] was applied to all plots at 1.0 kg a.i./ha on 20 July 2010 and 11 April 2011 for control of broadleaf weeds.

Plots were harvested on 27 August and 22 October 2010, and 21 June, 25 July, 7 September and 7 November 2011. An area of 3 m^2 at the center of the plot was harvested with a sickle bar mower at 10-cm stubble height. The harvested material was separated into species by hand and the proportion of the sown grass in the harvested material reported as a proportion of the total forage harvested. The herbage accumulation reported is the herbage accumulation of the sown species. The remaining herbage in the plot was cut to the same stubble height and the harvested material removed from the plot. Forage samples were processed and analyzed for CP and IVDOM concentrations according to the procedures described in Experiment 1.

Two observers estimated ground cover visually as the proportion of the experimental unit covered by the sown species on 17 April 2012. Plant density was determined by counting the numbers of plants/m^2.

Response variables were total herbage accumulation, sown grass herbage accumulation, CP, IVDOM, ground cover and plant density. The data were analyzed using PROC MIXED of SAS (SAS Institute Inc. 1996). Cultivar and year were considered fixed effects. Block and its interactions were random effects. Harvests were analyzed as repeated measures using the unstructured covariance structure (UN). Treatments were considered different when P<0.05. Interactions not discussed were not significant (P>0.05). Data are reported as least squares means and were compared using PDIFF (SAS Institute Inc. 1996).

Experiment 3

The study was located at the University of Florida Beef Research Unit, Gainesville, FL (29°44' N, 82°16' W; 48 m asl) on Adamsville fine sand (uncoated, hyperthermic, Aquic Quartzipsamments). Prior to initiation of the study, mean soil pH (in water) was 6.0. Mehlich-I extractable P, K, Mg and Ca concentrations in the Ap1 horizon (0 to 15-cm depth) were 70, 53, 101 and 583 ppm, respectively. The experiment was conducted from July to October 2010.

Treatments were the factorial combinations of 2 *Brachiaria* hybrid cultivars (Mulato II and Cayman) x 3 grazing frequency treatments (2-, 4- and 6-wk) arranged in a randomized complete block design with 3 replicates. Plots were 4 m x 4 m with a 1.5 m alley between plots. Seed of Mulato II and Cayman was broadcast on a prepared seedbed and rolled to ensure good seed-soil contact on 10 June 2010. The plots were irrigated to provide ~20 mm water/wk for 4 weeks after planting. The plots were fertilized with 112 kg K and 144 kg N/ha divided into 3 equal applications in May, June and July. Before sowing seed, the herbicide 2, 4-D [(2, 4-dichlorophenoxy) acetic acid] was applied to all plots at 1.0 kg a.i./ha on 28 May for control of broadleaf weeds. On 10 June, a 4% glyphosate [isopropylamine salt (10 g/kg) of N-phosphonomethyl glycine] solution was spot-sprayed on the remaining weeds in the experimental area.

Mean pre- and post-grazing herbage heights were estimated from 20 measurements per experimental unit. Before the grazing events, 2 samples of an area of 0.25 m^2 per plot were harvested with hand shears to a 15-cm stubble height to determine herbage mass and nutritive value. Forage samples were processed and analyzed for CP and IVDOM concentrations according to the procedures described in Experiment 1.

A subsample of the fresh herbage mass was separated into leaf, stem and dead material, dried at 60 ºC until constant weight, and the proportions of leaf and stem in the sward determined. Herbage accumulation was calculated as the sum of pre-grazing herbage mass across grazing events. Leaf and stem proportions, and CP and IVDOM concentrations are presented as the weighted averages of the grazing events. Ground cover was determined at the end of the grazing season by visual estimation by 2 observers as the proportion of the experimental unit covered by the sown species.

The plots were grazed by beef heifers (320 kg live weight) using the mob stocking technique (Mislevy et al. 1981). The plots were separated with an electric fence and grazed individually. The animals were removed when the forage reached the target stubble height (15 cm), which did not exceed 12 h occupation. Dates for the grazing events are reported in Table 1.

Response variables were herbage accumulation, canopy height, CP, IVDOM and ground cover. The data were analyzed using PROC MIXED of SAS (SAS Institute Inc. 1996). Cultivar and grazing frequency were considered fixed effects. Block and its interactions were random effects. Single degree of freedom orthogonal polynomial contrasts were used to test grazing interval effects. Treatments were considered different when P<0.05. Interactions not discussed were not significant (P>0.05). Data are reported as least squares means and were compared using PDIFF (SAS Institute Inc. 1996).

Results

Experiment 1

Mulato II accumulated more herbage than Cayman and BR02/1794 (P<0.05) (Table 2). There was a regrowth interval x period interaction on herbage accumulation (Table 3), with no difference in herbage accumulation between 3- and 6-wk regrowth intervals in the first period, but greater herbage accumulation for 3-wk than 6-wk regrowth interval in the second period. Total herbage accumulation was similar in 2011 and 2012 (mean = 2,750 kg DM/ha).

Mulato II, Cayman and BR02/1794 had similar CP concentrations (mean = 13.7%, s.e. = 0.7, P=0.45), while herbage harvested at 3-wk intervals had greater CP than that at 6-wk intervals (15.0 vs. 12.7%, s.e. = 0.5, P<0.01). In addition, there was a significant effect of period on CP concentration. Herbage harvested in Period 2 had greater CP concentration than that from Period 1 (16.0 vs. 11.6%, s.e. = 1, P<0.01). Crude protein concentration was greater (P<0.05, s.e. = 1) for herbage harvested in 2012 (14.6%) than in 2011 (13.0%).

Conversely, there was a cultivar effect on IVDOM concentration with Mulato II and Cayman having greater

IVDOM than BR02/1794 (P<0.05) (Table 2). There was a regrowth interval x period interaction on IVDOM concentration; while herbage harvested at 3-wk intervals had greater IVDOM than 6-wk material in both Periods 1 and 2, the magnitude of the difference was greater in Period 1 than Period 2 (Table 3). Corroborating the CP results, forage harvested in 2012 had greater (P<0.05, s.e. = 1) IVDOM concentration (63%) than that for 2011 (60%).

At the end of the experimental period in 2011, Mulato II had greater ground cover than Cayman (88 vs. 61%, s.e. = 6, P<0.02), with BR02/1794 intermediate (74%). There was no effect of regrowth interval on ground cover of the different cultivars.

Experiment 2

There was a year x cultivar x harvest interaction effect on herbage accumulation (Table 4). Herbage accumulation in 2010 was similar for Mulato II and Cayman, but herbage accumulation at July and November 2011 harvests and total herbage in 2011 were greater for Mulato II than for Cayman. There was no cultivar effect (P=0.45, s.e. = 3) on the proportion of the sown grass in the harvested forage; however, the proportion was greater (P<0.01, s.e. = 3) in 2011 (96%) than in 2010 (62%).

There was a harvest x year interaction on CP and IVDOM concentrations (Table 5). Crude protein concentrations in August and October 2010 were similar, but concentration in June 2011 exceeded those in July, September and November 2011. Conversely, IVDOM concentration in October was greater than in August 2010. In 2011, IVDOM concentration in June exceeded those in July and September (P<0.05) with concentration in November intermediate.

Mulato II had greater ground cover (43 vs. 8%) and plant density (8.3 vs. 1.0 plants/m^2) than Cayman in April 2012. These results may imply that Mulato II had greater cold tolerance than Cayman after experiencing 2 winters in Florida under the harvest management applied in this experiment.

Experiment 3

There was no effect of cultivar (P=0.81) or regrowth interval (P=0.69) on herbage accumulation, which averaged 9,200 kg DM/ha/annum across treatments.

Pre- and post-grazing sward canopy height increased linearly with increasing regrowth interval (Table 6), although the range in post-grazing height was only 4 cm. Cayman had greater pre-grazing canopy height than Mulato II (54 vs. 48 cm, s.e. = 1.5, P<0.01), greater proportion of stem (31 vs. 22%, s.e. = 3, P<0.01) and lesser proportion of leaf (63 vs. 74%, s.e. = 4, P<0.01). There was no difference between cultivars in percentage of dead material (6 vs. 4%, s.e. = 1, P=0.45).

Table 1. Dates of grazing events for Mulato II and Cayman grazed at different grazing frequencies (Experiment 3).

Grazing frequency (wk)	Date						
	14 Jul	28 Jul	11 Aug	25 Aug	8 Sep	22 Sep	6 Oct
2	X	X	X	X	X	X	X
4	X		X		X		X
6	X			X			X

Table 2. Herbage accumulation and in vitro digestible organic matter (IVDOM) concentration (average of Periods 1 and 2) in brachiaria grass hybrid cultivars (Mulato II, Cayman and BR02/1794) in Ona, FL (Experiment 1).

Response variable	Cultivar			s.e.
	Mulato II	Cayman	BR02/1794	
Herbage accumulation (kg DM/ha)	1,740a[1]	1,200b	1, 200b	70
IVDOM (%)	63a	62a	59b	1

[1]Means within rows followed by the same letter are not different (P>0.05).

Table 3. Regrowth interval x period interaction on herbage accumulation and in vitro digestible organic matter (IVDOM) concentration of brachiaria grass hybrid cultivars (Mulato II, Cayman and BR02/1794) in Ona, FL (Experiment 1).

Regrowth interval (wk)	Period 1[1]	Period 2
	Herbage accumulation (kg/ha)	
3	2,180a[2]	760a
6	2,200a	360b
s.e.	70	
	IVDOM (%)	
3	63a	67a
6	53b	63b
s.e.	1	

[1]Data are presented by 6-wk periods and reflect the total of one 6-wk or two 3-wk harvests within that period.
[2]Means within columns and parameters followed by the same letter are not different (P>0.05).

Herbage CP and IVDOM decreased linearly with increasing regrowth interval (Table 6), but there was no difference between Mulato II and Cayman in either parameter. The proportion of leaf in available forage decreased linearly with increasing regrowth interval, while the proportion of stem increased linearly. Average CP concentrations of leaves and stems were 17.2 and 9.7%, respectively, and corresponding IVDOM values were 70.9% and 57.3%.

Both regrowth interval and cultivar had significant effects on ground cover, with ground cover increasing linearly as regrowth interval increased from 2 to 6 wk (Table 6), and Mulato II having greater ground cover than Cayman (61 vs. 47%).

Discussion

This study has shown that Mulato II is better adapted for herbage production in the South Florida region than Cayman and BR02/1794. This contrasts with results obtained by Pizarro et al. (2013) in Thailand, where Cayman had greater herbage accumulation than Mulato II and BR02/1794 from 2005 to 2008.

The herbage accumulation observed in Experiment 1 was less than the 3,200 kg DM/ha recorded by Vendramini et al. (2010) for Mulato II with a 6-wk regrowth interval in summer in South Florida. Reduced herbage accumulation in the current experiment was possibly due to later planting and reduced soil fertility.

Table 4. Year x cultivar x harvest interaction effects on herbage accumulation (kg/ha) of brachiaria grass hybrid cultivars (Mulato and Cayman) in Gainesville, FL (Experiment 2).

Year	Cultivar	Month						Total	s.e.
		Jun	Jul	Aug	Sep	Oct	Nov		
2010	Mulato II			1,200a[1]		300b		1,500	200
	Cayman			1,500a		300b		1,800	
	P[2]			0.32		0.78		0.41	
	s.e.			200					
2011	Mulato II	1,000c	4,800a		3,400b		3,400b	12,600	200
	Cayman	1,300b	3,000a		3,200a		2,800a	10,300	
	P	0.37	<0.01		0.42		0.04	<0.01	
	s.e.			200					

[1]Means followed by the same letter within rows are not different (P>0.05).
[2]Significance of cultivar effect within harvests.

Table 5. Harvest x year interaction on crude protein (CP) and in vitro digestible organic matter (IVDOM) concentrations of brachiaria grass hybrid cultivars (Mulato II and Cayman) in Gainesville, FL (Experiment 2).

Response variable	Year	Month						s.e.
		Jun	Jul	Aug	Sep	Oct	Nov	
CP (%)	2010			9.9a[1]		10.4a		0.7
	2011	15.5a	10.6b		10.5b		11.2b	
IVDOM (%)	2010			64.3b		71.5a		
	2011	66.0a	63.2b		62.2b		64.1ab	1.5

[1]Means followed by the same letter within rows are not different (P>0.05). Values presented are averages across cultivars.

Table 6. Pre- and post-grazing canopy heights, crude protein (CP) and in vitro digestible organic matter (IVDOM) concentrations and ground cover of Mulato II and Cayman grazed at 2-, 4- and 6-wk grazing frequencies in Gainesville, FL (Experiment 3).

Response variable	Grazing frequency (wk)			P-value contrast	s.e.
	2	4	6		
Canopy height (cm)					
pre-grazing	38	52	63	<0.01 Linear	1.7
post-grazing	17	18	21	<0.01 Linear	0.5
CP (%)	17.2	14.2	11.8	<0.01 Linear	1.0
IVDOM (%)	71.4	67.2	64.4	<0.01 Linear	1.5
Ground cover (%)	42	51	69	0.02 Linear	2

For many grasses, longer regrowth intervals result in greater herbage accumulation (Interrante et al. 2009), but in this experiment and that conducted with Mulato II by Inyang et al. (2010b), there was no advantage in herbage accumulation for the 6- vs. 3-wk regrowth interval. It seems that 3-wk regrowth interval is sufficient for the brachiaria hybrids to optimize light interception and herbage accumulation without exacerbating reserve structures. On the other hand, the plants harvested at a 6-wk regrowth interval probably reached the maximum light interception before the growth period expired, with a resultant decrease in herbage accumulation due to self-shading and appearance of senescent leaves.

In Experiment 2, herbage accumulation by Mulato II and Cayman in 2010 (the establishment year) was lower than observed in a previous study conducted at the same location (Vendramini et al. 2012). The below average rainfall in September 2010 (38 mm vs. the 30-yr average of 135 mm) and October 2010 (0.2 mm vs. the 30-yr mean of 64 mm) may have negatively affected herbage accumulation of the brachiaria grass cultivars in late summer and early autumn. However, herbage accumulation in 2011 was similar to those for established Mulato II stands in the same location (Vendramini et al. 2012). In addition, the total Mulato II herbage accumulation in 2011 was similar to the annual herbage accumulation of Mulato II observed by Hare et al. (2009) in northeast Thailand of 10,200 kg DM/ha. Herbage accumulation in June was lower than at the other harvests in 2011 because there was an unexpected below 0 ^{o}C temperature event in April, followed by below average April rainfall (20 mm vs. the 30-yr average of 75 mm). The increase in proportion of the sown grass in the stand from 2010 to 2011 indicated that a period of 12 months after establishment may be necessary for the brachiaria grass hybrids to express their full herbage accumulation potential in South Florida.

In Experiment 3, total herbage accumulation during the entire season was similar to yields reported by Vendramini et al. (2012) in Central Florida, and in contrast with Experiments 1 and 2, Mulato II and Cayman had similar herbage accumulation. As harvest intervals were different, the herbage accumulation data in Experiment 3 were presented as the total for the growing season; in line with results for Experiment 1, no effects of harvest interval were observed. This finding contrasts with that of Inyang et al. (2010b), where cutting Mulato II at 2-wk intervals significantly reduced forage yields relative to longer regrowth intervals. In addition, Hare et al. (2013) observed that herbage accumulation in Mulato II, Cayman and BR02/1794 increased from approximately 11,000 kg/ha to 20,000 kg/ha in Thailand as regrowth interval was increased from 30 to 90 days. It is worth mentioning that these authors compared individual harvests at the target regrowth interval, whereas this research compared a single harvest of 6 wk with 2 harvests of 3-wk regrowth interval. The greater herbage accumulation presented by Hare et al. (2013) than in these projects in Florida was probably due to better soil characteristics, improved climatic conditions and N fertilization.

Pre-grazing canopy height increased linearly with increased regrowth interval and the pre-grazing heights observed in all treatments were above the 30 cm pre-grazing height suggested by da Silva and Nascimento (2007) as the target height for initiation of grazing on palisade grass. However, these authors suggested that the post-grazing height should be 15 cm and the heights found in our study were slightly above 15 cm. Although herbage accumulation was similar for both cultivars, Cayman had greater pre-grazing canopy height than Mulato II. This greater height possibly reflected the greater proportion of stem biomass in Cayman than in Mulato II, resulting in more upright plants.

Overall, the data suggest little difference in CP concentrations between cultivars but greater IVDOM in Mulato II and Cayman than in BR02/1794. The decrease in CP and IVDOM of all cultivars in Experiments 1 and 3 with increasing regrowth interval was not unexpected. The effects of regrowth interval on nutritive value of warm-season grasses are well documented in the literature and show that forage with greater maturity has greater proportions of cell wall and lignified tissue with lesser nutritive value (Johnson et al. 2001; Vendramini et al. 2008; Inyang et al. 2010b). Hare et al. (2013) observed that increasing cutting interval significantly reduced CP concentrations and increased ADF and NDF concentrations in stems and leaves of Mulato II, Cayman and BR02/1794 in Thailand. It is of interest that Cayman and BR02/1794 had higher stem CP levels than Mulato II at 30- and 45-day cutting intervals, while both had lower levels than Mulato II at the 60-day cutting interval. BR02/1794 had lower leaf CP levels than both Cayman and Mulato II at most cutting intervals.

The higher herbage CP and IVDOM concentrations later in the season reported in Experiment 1 reflect lesser herbage accumulation in the autumn resulting in less dilution of CP. Reduced growth temperatures like those observed in autumn have also been associated with greater herbage digestibility (Pitman and Holt 1982; Newman et al. 2005). Inyang et al. (2010b) reported that Mulato II in November had lesser herbage accumulation and greater nutritive value than in October.

The greater ground cover in Mulato II than in Cayman and BR02/1794 in Experiment 1 suggests that Mulato II is more persistent under defoliation than the other lines in subtropical areas. According to Beaty et al. (1970), frequent harvests reduce root, stolon and rhizome mass and the non-structural carbohydrates available for plant regrowth. There was no effect of regrowth interval on ground cover in Experiment 1 because the shortest regrowth interval was 3 wk, which allowed the plants to restore leaf area and possibly carbohydrate reserves before the subsequent harvest. Conversely, there was a linear decrease in ground cover as regrowth interval decreased in Experiment 3. Mislevy et al. (1991) observed that bahia grass harvested at 3-, 5-, and 7-wk regrowth intervals had greater concentration of total non-structural carbohydrates than at 2-wk intervals, and greater carbohydrate levels were associated with greater persistence. Inyang et al. (2010b) observed that shorter regrowth intervals (2 wk) may decrease ground cover of Mulato II, with harvesting every 4 wk resulting in greater cover than harvesting every 2 wk (87 vs. 83%, respectively).

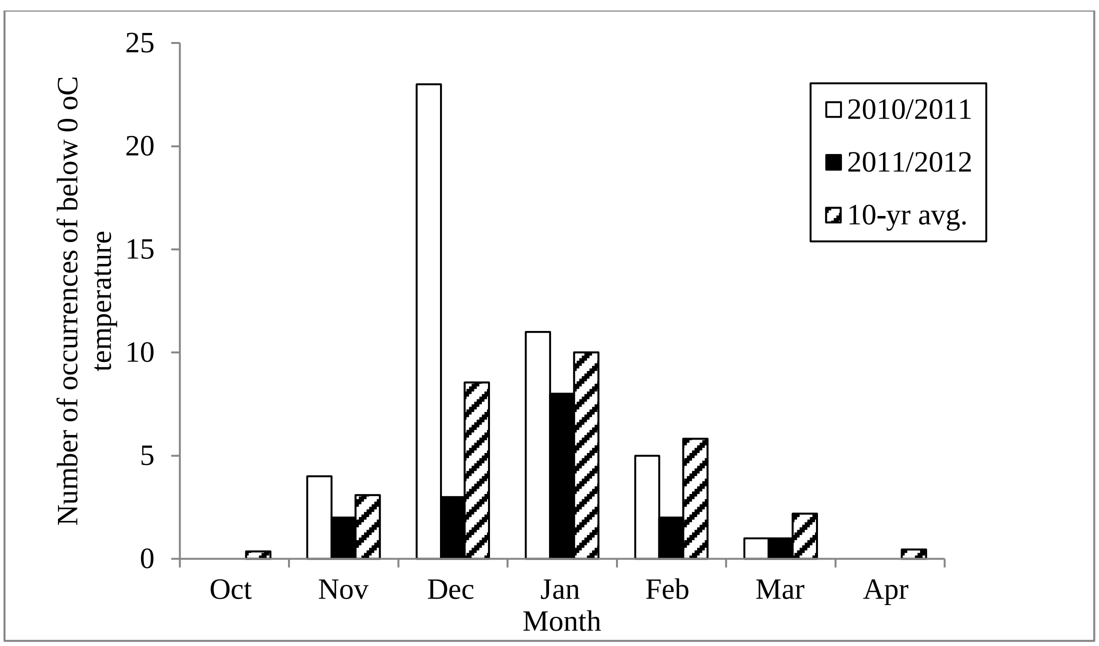

Figure 1. Number of days with one or more occurrences of below 0 °C temperature in Gainesville, FL during the winters of 2010/2011 and 2011/2012 plus the 10-yr average figures.

However, weather conditions might also have played a part. Vendramini et al. (2012) observed that ground cover of Mulato II in Gainesville, FL decreased after a severe cold period with several consecutive days with minimum temperatures reaching below 0 °C. The reduced ground cover and plant density of Cayman after 2 years indicates that this cultivar may not be a perennial forage in North-Central Florida. Conversely, ground cover and plant density of Mulato II exceeded those reported by Vendramini et al. (2012). Despite an above average number of below 0 °C events in December 2010 (Figure 1), Mulato II persisted well through the remainder of 2010/2011 and then the winter of 2011/2012 with more normal numbers of freezing mornings, indicating that this cultivar may be a warm-season perennial grass suited to locations with greater latitudes (30° N), provided the number of below 0 °C temperature events is approximately 10 events/yr.

Since the new brachiaria hybrids displayed no advantages over Mulato II in Florida and in many instances were inferior, we conclude that Mulato II appears a better adapted brachiaria grass hybrid for the subtropical conditions in this region. The 3-wk regrowth interval may be recommended to produce forage with greater nutritive value with no detrimental effects on herbage accumulation and ground cover. While shorter regrowth intervals promoted greater nutritive value in all hybrids, regrowth intervals of shorter than 3 wk should be avoided because of decreased plant persistence and ground cover.

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