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Research Paper

Performance of young Nellore bulls on guineagrass pastures under rotational stocking in the Brazilian Cerrado

Ganancia de peso de toretes Nellore en pasturas de guinea bajo pastoreo rotacional en el Cerrado brasileño

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Abstract

New highly productive guineagrass (*Megathyrsus maximus* syn. *Panicum maximum*) cultivars have been released in Brazil and grazing trials are necessary to evaluate their carrying capacity and forage quality. The objective of this study was to evaluate the liveweight gains of young Nellore bulls grazing 3 guineagrass cultivars under rotational stocking. The experiment was carried out in Planaltina (Federal District, Brazil) during a single rainy (November–April) and dry (May–August) season. Treatments were Massai (control), BRS Tamani and BRS Zuri cultivars. Zuri and Tamani pastures provided greater average daily liveweight gains (ADG) (0.38 and 0.42 kg/head, respectively) over the experimental period than Massai (0.28 kg/head). For all cultivars liveweight gains decreased markedly from May onwards at the beginning of the dry season. Nevertheless, bulls grazing Tamani and Zuri pastures still gained 0.20 kg/hd/d until late August, while those on Massai pastures gained only 0.08 kg/hd/d. The differences in ADGs can be explained to some extent by differences in quality of available forage. In vitro dry matter digestibility of plucked samples of Massai was 555 g/kg, compared with 621 g/kg for Tamani and 590 g/kg for Zuri. Crude protein concentration in plucked samples was also greater for Tamani and Zuri (71.9 and 74.2 g/kg, respectively) than for Massai (62.2 g/kg). As feed wastage was particularly high in Massai, further studies are needed to verify if higher stocking rates during the wet season could result in greater production of live weight per ha on this cultivar, assuming that ADG does not decrease further with the increased stocking rate.

Keywords: Crude protein, digestibility, grazing, stocking rate, tropical grass.

Resumen

En Brasil se han liberado nuevos cultivares del pasto guinea (*Megathyrsus maximus* sin. *Panicum maximum*) altamente productivos y es necesario evaluar su capacidad de carga y la calidad del forraje en condiciones de pastoreo. El objetivo de este estudio fue evaluar las ganancias de peso vivo de toretes Nellore en tres pasturas de guinea bajo pastoreo rotacional. El experimento se llevó a cabo en Planaltina (Distrito Federal), Brasil, durante una temporada lluviosa (noviembre–abril) y una temporada seca (mayo–agosto). Los tratamientos fueron los cultivares Massai (testigo), BRS Tamani y BRS Zuri. Zuri y Tamani proporcionaron mayores ganancias de peso vivo diarias (0.38 y 0.42 kg/animal, respectivamente) durante el período experimental que Massai (0.28 kg/animal). Para los tres cultivares, las ganancias de peso vivo animal disminuyeron notablemente a partir de mayo (comienzo de la estación seca). No obstante, los toretes pastoreando Tamani y Zuri ganaron 0.20 kg/animal/día hasta fines de agosto, mientras que los animales en Massai ganaron solo 0.08 kg/animal/día. Estos resultados se pueden explicar por las diferencias en la calidad del forraje disponible, determinada con base en un muestreo de simulación de pastoreo ('hand-plucking'). La digestibilidad in vitro

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de la materia seca de Massai fue de 555 g/kg, en comparación con 621 g/kg para Tamani y 590 g/kg para Zuri. La concentración de proteína cruda también fue mayor para Tamani y Zuri (71.9 y 74.2 g/kg, respectivamente) que para Massai (62.2 g/kg). Como el desperdicio de forraje fue particularmente alto en Massai, se necesitan más estudios para determinar si en este cultivar eventuales cargas animal más altas durante la temporada lluviosa podrían resultar en una mayor producción de peso vivo por hectárea sin afectar la ganancia de peso diaria por animal.

Palabras clave: Carga animal, digestibilidad, gramínea tropical, proteína cruda.

Introduction

There is an increasing demand for highly productive forage species for the Brazilian savannas ('Cerrados'), owing to the growing intensification of livestock and agricultural systems. Guineagrass (*Megathyrsus maximus* syn. *Panicum maximum*) is recommended for regions with annual rainfall of 800–1,800 mm on well-drained soils with medium-high fertility (Muir and Jank 2004). This species produces around 21 t DM/ha of forage per year in the Cerrados (Fernandes et al. 2014), almost all during the rainy season. As a result, these pastures usually require rotational stocking management to provide more efficient grazing by minimizing forage losses, especially for the high-tufted cultivars.

Massai and Tamani are small leafy guineagrass cultivars released by Embrapa (Brazilian Agricultural Research Corporation). Since its release in 2001, Massai has been increasingly cultivated in Brazil because it will produce well on less-fertile soils in comparison with other guineagrass cultivars (Volpe et al. 2008), but it has below-average nutritive value (Brâncio et al. 2003). The hybrid Tamani (intraspecific cross between sexual S12 and apomictic T60), released in 2015, has thin leaves and stems and higher digestibility than Massai (Fernandes et al. 2014). The cultivar Zuri was released by Embrapa in 2014, and in contrast with Massai and Tamani, is a tall tufted guineagrass, and is resistant to leaf spot disease (*Bipolaris maydis*). Zuri and Massai were developed from accessions collected by ORSTOM (Office de la recherche scientifique et technique outre-mer, France) in East African savannas during the 1960s, and designated at the time as T65 and T21, respectively.

In general, guineagrass grows vegetatively until autumn (April–May), when reproductive tillers emerge and nutritive value declines (Euclides et al. 2014). This growth pattern limits its use during the dry season as stand-over forage grown during the rainy season (i.e. stockpiling). The small-sized and early-flowering cultivar Tamani could be an option to prolong the use of guineagrass in the rainy-dry season transition.

The objective of this work was to compare the liveweight gains of young Nellore (*Bos indicus*) bulls in pastures of 3 guineagrass cultivars (Massai, Tamani and Zuri) in the Brazilian Cerrados under a rotational grazing system.

Materials and Methods

Experimental site

The study was carried out at the Embrapa Cerrados Research Center in Planaltina, Federal District, Brazil (15°35' S, 47°42' W; 993 masl) during a single production cycle from December 2013 to August 2014. The climate at the site is Aw (tropical savanna) according to the Köppen-Geiger classification (Peel et al. 2007). Daily rainfall and maximum and minimum daily air temperatures were recorded 1,400 m away from the experimental site (Table 1). The study was conducted on a clay soil (Rhodic Haplustox) with $pH_{(H2O)}$ 5.5, organic matter concentration 29 g/kg and P concentration of 4.2 mg/kg (Mehlich-I) in the 0–20 cm soil horizon.

In August 2010, 3 t/ha of dolomitic lime was broadcast onto a 5-yr-old *Brachiaria* spp. pasture (16 ha). On 3 February 2011, the area was plowed and disked, was divided into 6 blocks of 2.6 ha and seed of the 3 guineagrass cultivars was sown (2 blocks per cultivar) with a Semeato® machine into a prepared seedbed at a rate of 3 kg/ha. Row spacing was 0.25 m. A commercial granular fertilizer was applied at seeding to supply 14, 39 and 67 kg/ha of N, P and K, respectively. During the establishment phase annual applications of 100 kg N/ha (as urea) were made to paddocks and 35 kg P/ha (as simple superphosphate) was applied in October 2012. From planting until 2014, pastures were rotationally grazed for 28 days followed by 28 days rest during the rainy season (19 December–7 May) and 56 days grazing and 56 days rest during the dry season (8 May–28 August) (Maciel et al. 2018).

Experimental design and grazing management

Treatments were 3 guineagrass cultivars (Massai, Zuri and Tamani) distributed in a completely randomized design with 2 replications. From commencement of the grazing study, pastures were rotationally grazed at a variable stocking rate. Each experimental unit (2.6 ha)

Table 1. Monthly rainfall and mean monthly temperatures during the experimental period (2013–2014), and medium-term (1973–2003) mean values for Planaltina, Federal District, Brazil.

Month	2013	2014	Av.[1]	2013	2014	Av.	2013	2014	Av.
	Rainfall (mm)			Maximum temperature (ºC)			Minimum temperature (ºC)		
Jan	319	123	254	27	29	27	18	17	18
Feb	96	91	184	30	28	28	17	17	18
Mar	143	300	214	29	28	28	18	18	18
Apr	97	116	93	28	28	28	17	17	17
May	19	7	27	28	28	27	16	15	15
Jun	51	21	5	27	27	27	15	13	14
Jul	0	2	5	28	27	27	13	13	13
Aug	2	0	16	29	30	28	14	13	15
Sep	56	9	41	30	32	30	17	17	17
Oct	126	87	137	29	32	29	17	17	18
Nov	188	257	191	28	29	28	17	17	18
Dec	221	338	230	27	27	27	18	17	18
Total	1318	1351	1397	-	-	-	-	-	-

[1]Average data for 1973–2003.

was divided into 4 paddocks (0.65 ha each). The rest and grazing periods were 21 and 7 d, respectively, in the rainy season (19 December–7 May; 5 grazing cycles in 140 d) and 42 and 14 d, respectively, in the dry season (8 May–28 August; 2 grazing cycles in 112 d). N fertilizer of 100 kg N/ha was applied as urea, as equal dressings following grazing in the first 2 grazing cycles.

Animal measurements and herbage allowance

Five young (12-month-old) Nellore bulls per experimental unit were assigned as testers for animal performance evaluation. Mean initial weight was 216 ± 19.1 kg. A mineral mix (Minerthal®) was supplied ad libitum to animals throughout the experimental period. Other Nellore bulls, similar in weight to the testers, were added to or removed from the experimental units during each grazing cycle to ensure a mean daily herbage allowance (HA) of around 12 kg DM/100 kg LW (Hodgson 1990; Herling et al. 2011). These adjustments occurred at the beginning of the grazing cycle based on pre-grazing herbage mass and calculated as LW = [(HM × 0.65)/DG]/HA × 100, where LW is the live weight (kg/ha), HM is the pre-grazing herbage mass including dead material (kg DM/ha), DG is the days of grazing and HA is the daily herbage allowance (kg DM/100 kg LW). Bulls were weighed 'unshrunk' at the end of each grazing cycle in order to evaluate the average daily weight gain (ADG) and assess how many bulls to introduce for the next cycle. Herbage allowance was recalculated based on average live weight observed during each grazing cycle. Bulls were weighed 'shrunk' (i.e. after 16 h without feed or water) at the beginning and end of the experimental period.

In addition to calculating ADG, the stocking rate (SR – calculated as an animal unit of 450 kg/ha) and liveweight gain per unit area (GA) were also estimated.

Pasture parameters

Pre-grazing herbage mass (HM) was evaluated at the beginning of each grazing cycle in the control paddock (1 of 4 rotated paddocks) by destructive samplings (at soil level) along 3 transects (12 quadrats of 2.0 × 0.5 m). Three subsamples (each containing 4 original pre-graze HM samples) were obtained and separated into green leaf blades and green stems (true stem plus leaf sheaths) and dead material. Dead material was visually defined as senescent leaves and stems with ≥50% of the area as yellow or dry tissue. All samples were dried in an air-forced oven at 55 ºC for 72 h.

Nutritive value

Crude protein (CP) (AOAC 1990), neutral detergent fiber (NDF), acid detergent fiber (ADF) (as described in Van Soest et al. 1991) and in vitro dry matter digestibility (IVDMD) (as described by Tilley and Terry 1963 and modified by Moore and Mott 1974) were evaluated on dried 1 mm milled forage samples (Wiley mill). They were collected in the control paddock by the hand-plucking method (Sollenberger and Cherney 1995) on day 4 of the grazing period (7 days) for the second to the fifth grazing cycle and on day 7 for the sixth grazing cycle (14 days). No quality sampling was conducted in the first and seventh grazing cycles.

Data analysis

Data were analyzed using Proc Mixed (SAS 2002). For herbage mass components, nutritive value and SR, the effects of cultivar, grazing cycle and their interactions were assigned as fixed. Grazing cycle was analyzed as repeated measures and the covariance structure was chosen based on the parameters of Akaike information criterion. Mean ADG and GA of the entire experimental period were analyzed considering the effects of cultivar. For ADG, each tester was considered a subsample assigned as a random effect. The interactions not presented in the Results section were not significant (P>0.05) and treatments were considered different when P<0.05 by t test. Means reported were Least Square Means and were compared using PDIFF option. The accumulated weight gain of bulls over time (unshrunk weight) was analyzed as covariance analysis testing for polynomial effect of days using Proc Mixed.

Results

While adjustments in SR were pre-established based on a HA of 12 kg DM/100 kg LW, greater allowances were provided, mainly in the first and fifth grazing cycles, when extra bulls were not available to increase stocking pressure (Figure 1). The variation in HA was relatively uniform among treatments, except for Massai pastures in the dry season (last grazing cycle) when weight losses in bulls appeared imminent so only the 5 testers were retained on each experimental unit for all treatments, increasing Massai HA to ~21 kg DM/100 kg LW (Figure 1).

Average daily gains of bulls (ADG) were affected by cultivar (P = 0.0005), with Tamani and Zuri supporting higher values than Massai over the experimental period (0.42 and 0.38 vs. 0.28 kg/hd/d, respectively). Stocking rates for the different cultivars were not significantly different (P = 0.0816), although stocking rates on Tamani were consistently lower than on Massai and Zuri, regardless of grazing cycle, because of lower forage yields (Table 2). Stocking rate was affected by grazing cycle (P<0.0001) and after an initial increase from December to January, it declined steadily until the end of the experimental period, regardless of cultivar (Figure 2). There was an effect of grazing cycle (P<0.0001) on leaf allowance, but no effect of cultivar (P = 0.3195). Leaf allowance closely followed herbage allowance by increasing in early April and decreasing again with the beginning of the dry season in May (Figure 2). GA for the 3 cultivars was 310 (Massai), 300 (Tamani) and 362 (Zuri) kg LW/ha but differences were not significantly different (P = 0.5315) (mean 324 ± standard error of mean 37.5 kg LW/ha).

The accumulated weight gains of the young bulls over time fitted the quadratic model, and the slope for Massai pastures was lower than that for Tamani and Zuri (P = 0.0134) (Figure 3). According to the quadratic effect, bulls stopped gaining weight at 250 days (August 26) for Tamani and Zuri and at 219 days (July 26) for Massai.

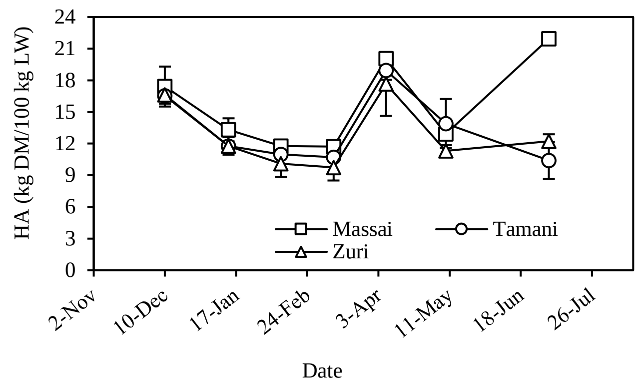

Figure 1. Herbage allowance (HA) in guineagrass pastures (cvv. Massai, Tamani and Zuri) during the experimental period in Planaltina, Federal District, Brazil. Each bar represents 2 standard deviations.

Cultivar had significant effects on herbage mass (HM) (P = 0.041), leaf mass (P = 0.045) and stem mass (P<0.0001) at the commencement of grazing. Massai presented greater HM than Tamani, while Zuri was intermediate (Table 2) and Tamani presented less leaf blade and stem than Massai and Zuri, regardless of grazing cycle. Amount of dead material was highest in Massai and lowest in Zuri, with significant (P<0.0001) differences between all cultivars. Forage quality was also affected by cultivar with crude protein concentration being highest in Zuri (74.2 g/kg) and lowest in Massai (62.2 g/kg; Table 2) (P = 0.039). IVDMD was highest in Tamani (621 g/kg) and lowest in Massai (555 g/kg) (P = 0.008).

Effects of grazing cycle on HM, leaf, stem and dead material are shown in Figure 4. In general HM and leaf yields peaked in April and declined steadily thereafter, while stem yields peaked in May. On the other hand dead material peaked in July.

Effects of grazing cycle on nutrient concentrations of forage on offer at the start of grazing are shown in Figure 5. Crude protein concentration and IVDMD were at their highest levels in March and April and declined subsequently and were lower in Massai than in Tamani and Zuri. On the other hand NDF concentration in available feed peaked in May, while ADF concentration continued to rise until July.

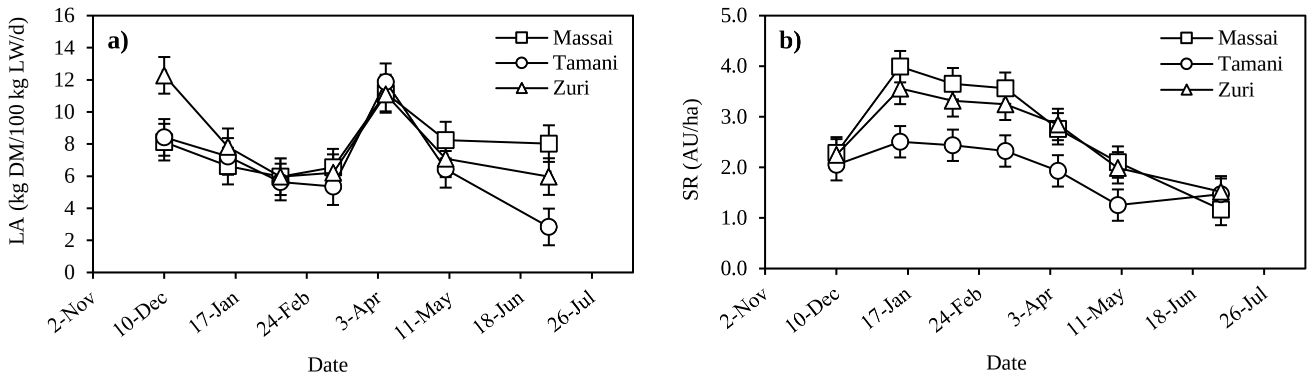

Figure 2. **a)** Mean leaf allowance (LA) and **b)** stocking rate (SR) in guineagrass pastures (cvv. Massai, Tamani and Zuri) during the experimental period in Planaltina, Federal District, Brazil. Each bar represents 2 mean square errors (MSE).

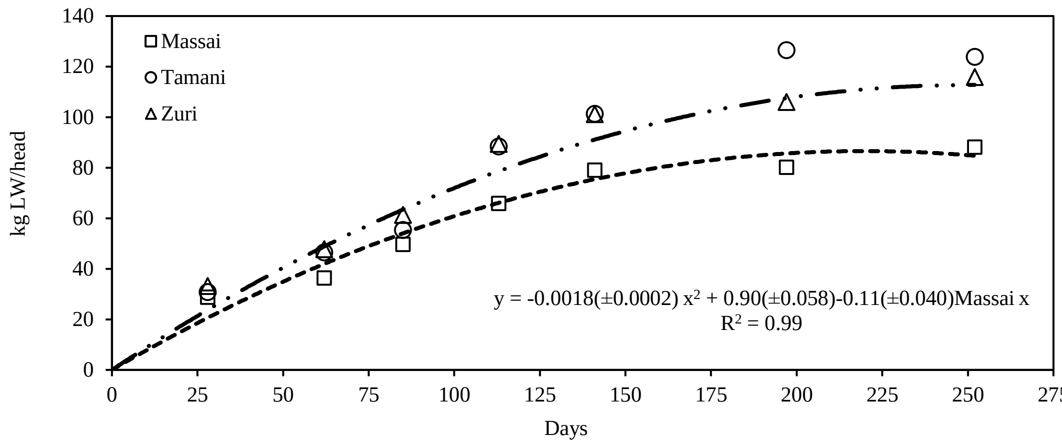

Figure 3. Accumulated liveweight (unshrunk) gain of young Nellore (*Bos indicus*) bulls on guineagrass pastures (cvv. Massai, Tamani and Zuri) in Planaltina, Federal District, Brazil. Each point represents 2 replications. The 2 quadratic curves present data for Tamani and Zuri (-..-) and Massai (---) cultivars, respectively.

Table 2. Mean stocking rate (SR), leaf allowance, pre-grazing herbage mass (HM), green leaf blade, green stem, dead material, in vitro dry matter digestibility (IVDMD) and crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF) concentrations of Massai, Tamani and Zuri cultivars in Planaltina, Federal District, Brazil.

Parameter	Cultivar			P	m.s.e.[3]
	Massai	Tamani	Zuri		
SR (AU/ha)	2.79	2.00	2.68	0.08	0.20
Leaf allowance (kg/100 kg LW/d)	7.82	6.82	8.06	0.32	0.54
HM (kg/ha)	6,093a[1]	3,900b	4,937ab	0.04	329
Green leaf (kg/ha)	2,840a	1,930b	2,826a	0.045	162
Green stem (kg/ha)	1,192a	595b	1,292a	<0.0001	86
Dead material (kg/ha)	2,060a	1,374b	819c	<0.0001	135
IVDMD (g/kg)[2]	555b	621a	590ab	0.008	12.6
CP (g/kg)	62.2b	71.9a	74.2a	0.039	3.2
NDF (g/kg)	716	686	696	0.106	6.5
ADF (g/kg)	415a	390c	401b	0.0005	3.5

[1]Means for cultivars followed by the same letter within rows do not differ (P>0.05) by t test.
[2]Quality parameters are for hand-plucked samples.
[3]Mean square error.

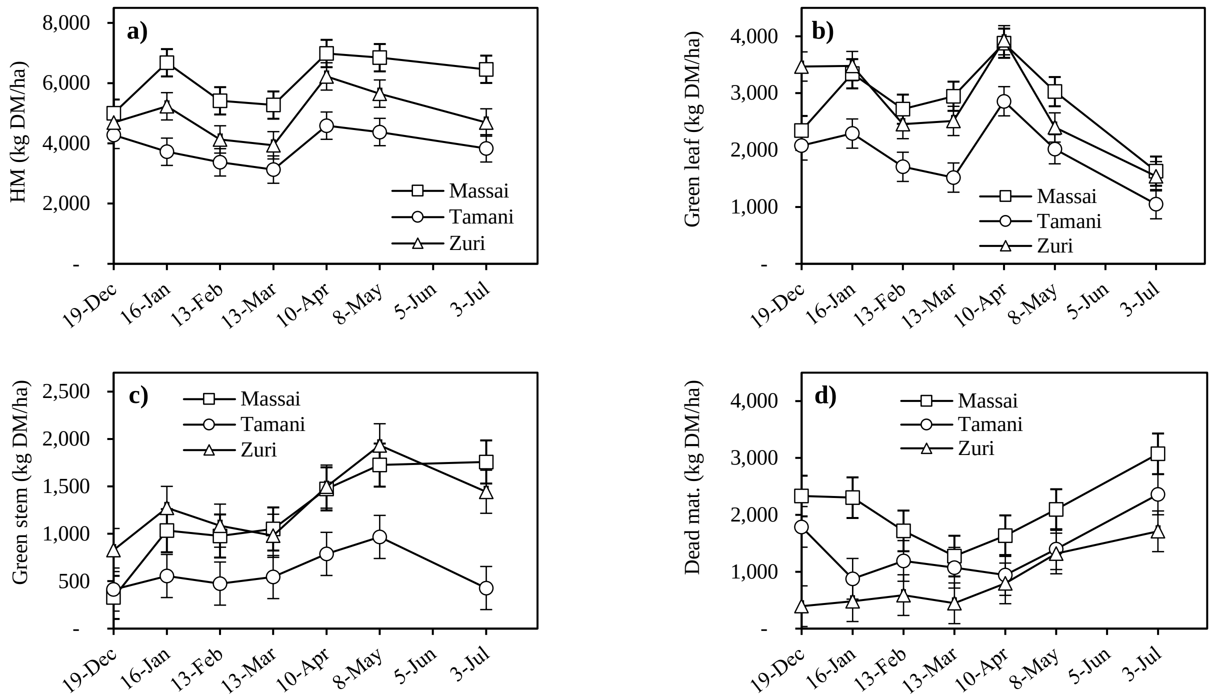

Figure 4. Pre-graze **a)** herbage mass (HM), **b)** green leaf blade, **c)** green stem and **d)** dead material in guineagrass pastures (cvv. Massai, Tamani and Zuri) in Planaltina, Federal District, Brazil. Each point represents 2 replications. Each bar represents 2 mean square errors (mse).

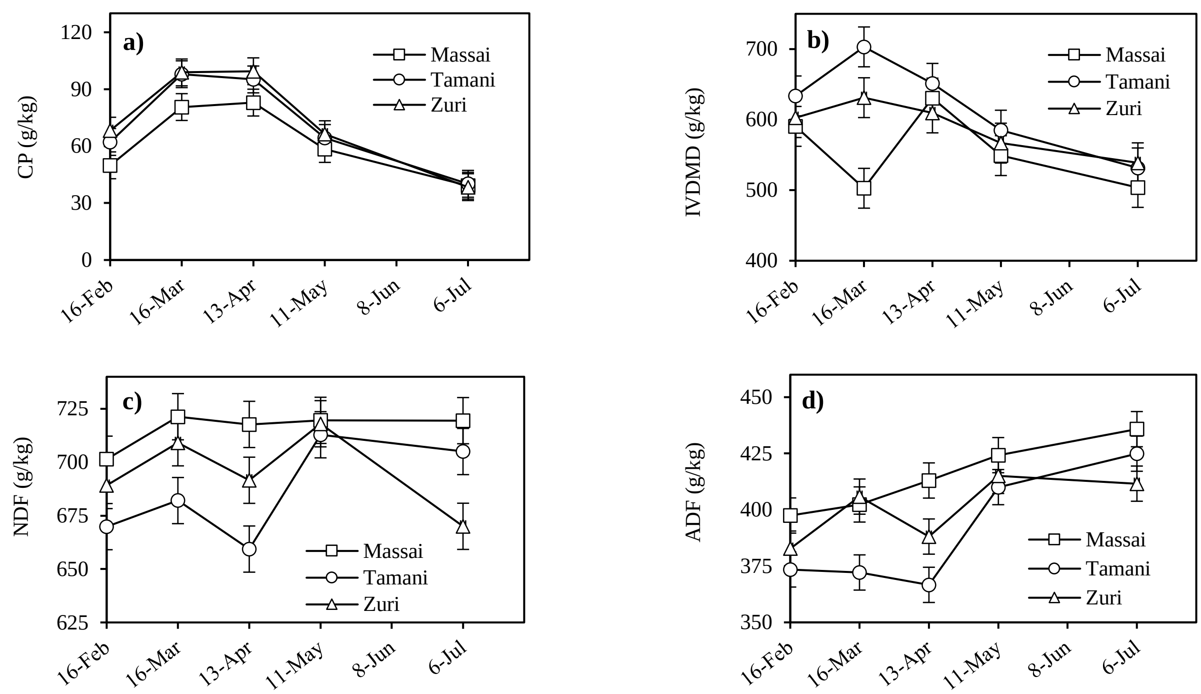

Figure 5. Variation in nutritive value of guineagrass cultivars in Planaltina, Federal District, Brazil with time: **a)** crude protein (CP); **b)** in vitro dry matter digestibility (IVDMD); **c)** neutral detergent fiber (NDF); and **d)** acid detergent fiber (ADF). Each point represents 2 replications. Each bar represents 2 mean square errors (mse).

Discussion

Although some variation occurred during the experimental period, overall we were successful in maintaining HA at similar levels among treatments throughout the study (Figure 1). The variations from the desired target levels which did occur were a result of simultaneous increases in forage accumulation and non-availability of extra bulls, as observed in early April, which in theory could be an opportunity to harvest the extra forage before flowering for haymaking. Towards the end of the experimental period, in order to avoid severe weight loss of the bulls, only the 5 testers were retained on the pastures, resulting in marked increases in HA in Massai pastures for the last grazing cycle. Despite this, leaf allowances remained similar between cultivars, and most importantly, at levels considered non-restrictive to forage intake and weight gain.

Using the alternate stocking method (2 rotated paddocks) in the same area as the current study, Maciel et al. (2018) also observed greater ADGs in the rainy season for bulls grazing Tamani and Zuri pastures than for those grazing Massai, but no differences were observed in the dry season. The overall mean ADG observed in the current study (0.36 kg/hd) was much lower than that observed by Maciel et al. (2018) in the rainy and dry seasons (0.54 kg/hd), at a mean stocking rate of 2.1 AU/ha. One can also speculate that the alternate stocking system provided a better opportunity for forage selection than the 4-paddock rotational system in the current study.

Average daily gain for steers grazing Massai in our study was similar to that observed in Campo Grande, MS, where Nellore steers gained 0.30 kg/hd/d over a full year on pastures managed under rotational stocking (Euclides et al. 2008). In the current study, the superiority in ADG of Tamani and Zuri over Massai was 49 and 36%, respectively. The quadratic response of accumulated liveweight gain/head confirmed the advantage of Tamani and Zuri over cultivar Massai (Figure 3), in both rainy and dry seasons. The estimated final individual unshrunk live weights of bulls (initial weight plus the liveweight gain for the period) were 310 kg/head for Massai and 340 kg/head for both Tamani and Zuri. This liveweight advantage on Tamani and Zuri pastures can result in more animals reaching the desired finishing weight, which can provide an economic benefit. According to the quadratic model, rate of liveweight gain from May onwards (beginning of dry season) decreased markedly, with the accumulated maximum gains occurring by July 26 (219 d) for Massai and August 26 (250 d) for Tamani and Zuri. In the dry season (May–August) bulls grazing Tamani and Zuri pastures still gained 0.20 kg/hd/d, while bulls on Massai pastures gained just 0.08 kg/hd/d. As rate of liveweight gain decreased steadily throughout the grazing period, even with HA maintained at a high level (~12 kg DM/100 kg LW), feeding a nitrogen supplement or giving access to a legume stand (e.g. protein bank of *Stylosanthes* spp. or *Cajanus cajan*) would become an option to maintain satisfactory levels of gain. Since the decline in rate of weight gain commenced earlier on Massai pastures than on Tamani and Zuri pastures, protein supplementation should start at least 30 days earlier on Massai pastures than on Tamani and Zuri pastures. On the other hand, the greater HM on Massai pastures would enable animals to be supported for a longer period or more animals to be supported for the same period in the dry season than on Tamani and Zuri, as long as nitrogen supplements are fed. Stocking Massai pastures more heavily early in the growing season could mean more of the DM produced was consumed rather than becoming senescent and possibly restricting access to new leaf. This hypothesis should be tested.

During the experimental period, the onset of flowering promoted a peak in stem percentage in the canopy and a concomitant decline in percentage of leaf, resulting in contrasting mean leaf blade:stem ratios of ~5.0 and 1.6 in December and May, respectively (Figure 4). Stockpiling of guineagrass forage for grazing from this time of the year onwards is considered counterproductive because flowering accentuates the decline in nutritive value and boosts the growth of thick stems that suppress intake (Benvenutti et al. 2008), although this effect could be less pronounced in small-sized Massai and Tamani due to thin stems and greater green leaf blade:green stem ratio (2.38 and 3.24, respectively) than Zuri (2.19). An earlier and prolonged flowering (starting in February) for Tamani could also contribute to lessening the negative effects of concentrated flowering at the end of the rainy season on plant morphology (i.e. stem increase) making it more useful during the rainy-dry season transition. Interestingly, the lower leaf blade:stem ratio for the late-flowering Zuri was not sufficient to affect ADG in comparison with leafy Massai and Tamani cultivars, even in the rainy-dry season transition. Measurements of non-compressed canopy height (considering the newest leaf insertion at pre-grazing) in the current study revealed mean values of 0.45, 0.39 and 0.56 m in the rainy season and 0.72, 0.61 and 0.89 m in the rainy-dry season transition for the cultivars Massai, Tamani and Zuri, respectively. This canopy height observed for Zuri was far from that observed when it was allowed to grow uninterruptedly (1.8 m), while Massai and Tamani heights were closer (0.60–0.70 m) (data not reported). Euclides et al. (2008) observed mean leaf blade:stem ratios of 4.2 and 2.1 for available forage of Massai and the high-tufted cultivar Mombaça of the same species, respectively, in rainy and dry seasons, a similar trend to that observed between Massai and Zuri in the current study. The mean dead material in Massai pastures was around 0.5 and 1.5-fold greater than in Tamani and Zuri pastures, respectively. The greater forage accumulation in Massai pastures associated with the largely unrestricted HA in March and during June-July would have contributed to the high levels of dead material in these pastures as a consequence of leaf senescence, probably leading to a large amount of forage that will be wasted, not consumed.

The IVDMD and CP of Tamani were 12 and 16% greater than those of Massai. Although Massai pastures produced a leafy canopy like Tamani, the nutritive value of Massai forage was usually lower, which ultimately was reflected in poorer animal performance as shown by Maciel et al. (2018). According to Maciel et al. (2018), digestibility of both Tamani and Zuri was 5 units higher than that of Massai, while CP was similar among cultivars. While our findings support these findings on digestibility, we found that CP was significantly lower in Massai than in Tamani and Zuri. The superior nutritive value of Tamani (formerly PM45) was also observed in a cutting trial, where leaf blade digestibility (in vitro digestibility of organic matter) and CP were 5 and 12% greater than for Massai, respectively (Fernandes et al. 2014). The CP concentration of Massai in our study (62 g/kg) was close to that observed by Brâncio et al. (2003) (~70 g/kg) and much lower than those observed by Gama et al. (2014) and Euclides et al. (2008) (81 and 89 g/kg, respectively), including both rainy and dry seasons.

In low latitudes of the Brazilian savanna region the dry season (April–October) receives about 15% of the annual rainfall, most of which falls in October. The water deficit is responsible for the marked decline in plant growth and reduction in nutritive value of forage, affecting grazing animal performance as a whole, as can be observed for the results obtained during the dry season in this study. According to Euclides et al. (2008), there was a decrease of 9% in IVDMD and 20% in CP from the rainy to the dry season in guineagrass pastures, with no changes in NDF. In the current study, IVDMD decreased 15% and CP decreased by 50% compared with rainy season mean values, probably affected by the absence of N fertilization in a prolonged period with low rainfall in Federal District (Table 1). In contrast with ADF, NDF remained relatively constant during the experimental period, including the transition between the rainy and dry seasons (April and May).

Individual cattle liveweight gains on Tamani and Zuri pastures were superior to those on Massai under rotational stocking management, due to their greater nutritive value (i.e. IVDMD and CP). However, Massai and Zuri pastures supported higher SRs than Tamani, which compensated for the lower ADG on Massai pastures and resulted in similar GA for Massai and Tamani with higher levels on Zuri. Feed wastage was particularly high in Massai, and further studies are needed to verify if higher stocking rates would increase GA on this cultivar by changing its canopy structure, without exacerbating the decrease in ADG. Zuri revealed greater productive potential and nutritive value than the other cultivars with positive effects on SR and ADG, simultaneously, even showing lesser leaf blade:stem ratio than Massai and Tamani. Rotational stocking is always a suitable option for managing highly productive guineagrass, avoiding forage losses and reduced grazing efficiency. However, for cultivars like Massai, and especially for Tamani, continuous stocking would be an option owing to favorable leaf blade:stem ratios and high nutritive value. Considering its great forage production potential but lesser nutritive value, Massai becomes an option for exclusive cow-calf farming systems, while Tamani and especially Zuri can be recommended for more demanding cattle categories (i.e. growing and fattening animals) in grass-fed systems by combining high carrying capacity and good forage quality. The high yields of Massai present possibilities for conservation as hay or silage for feeding back during periods of feed shortage.

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(Note of the editors: All hyperlinks were verified 4 April 2019.)

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