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The Tissue Flow in *Brachiaria brizantha* Pasture Under Intermittent Stocking

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Abstract

The present work aims to evaluate the morphological and structural characteristics of *Brachiaria brizantha* cultivars in the system of grazing in the intermittent stocking. The experiment was conducted at EMBRAPA - Beef Cattle. The experimental delineation used was a randomized block with three treatments and three repetitions. The treatments were constituted by grasses of the same species (*Brachiaria brizantha*) composed by cv. Xaraés, BRS Paiaguás, and the ecotype B4. On the heights of post-grazing, it was observed an interaction between seasons of the year and cultivars. It was observed that the leaf appearance rate (LAR) was higher in the cv. BRS Paiaguás, in relation to the other pastures. The leaf elongation rate (LER) was higher in perforations of the ecotype B4. In the winter, it was registered the lowest values of leaf area index (LAI), LAR, and LER, and, as a consequence, impact in a higher leaf life duration. Although there were some structural variations between tropical climate pastures, it was possible to verify that the phenotypic plasticity of these pastures presented the same behavior, once it suffered a higher influence of abiotic factors. Therefore, all the pastures of *B. brizantha* converged to the same LAI indicating high phenotypic plasticity.

Keywords: forage, morphogenesis, pasture, stocking

1. Introduction

The plasticity of the pasture structure plays an important role in the capacity of adapting to the handling of the pasture, once exists integration of plant physiological and environmental processes on the level of the tillers community, however, it is still wrongly understood (Gastal and Lemaire, 2015).

The structural components of the forage canopy suffer a strong influence of the morphogenic characteristics, that are genetically predetermined (Lemaire et al., 2009; Mazzanti and Lemaire 1994), however depending on the handling imposed plus the abiotic factors, the morphostructural characteristics of forage canopy can be modified (Barbosa et al., 2012).

In this way, the hypothesis tested was that tropical climate pastures of the same species, but with different growth habits, would present oscillations in phenotypic plasticity throughout the year. Therefore, the present work aims to evaluate the morphological and structural characteristics of *Brachiaria brizantha* cultivars in the system of grazing in the intermittent stocking.

2. Material and Methods

The experiment was conducted on EMBRAPA - Beef Cattle, located in Campo Grande-MS (Lat. 20º27’ S, Long. 54º37’ W and Alt. 530m). The climate of the region, according to the classification of Köppen, is the tropical rainy savannah type, Aw subtype, characterized by the well-defined occurrence of the dry period during the colder months of the year and rainy season during the summer months (Figure 1). The study was conducted from November 2015 to September 2016.

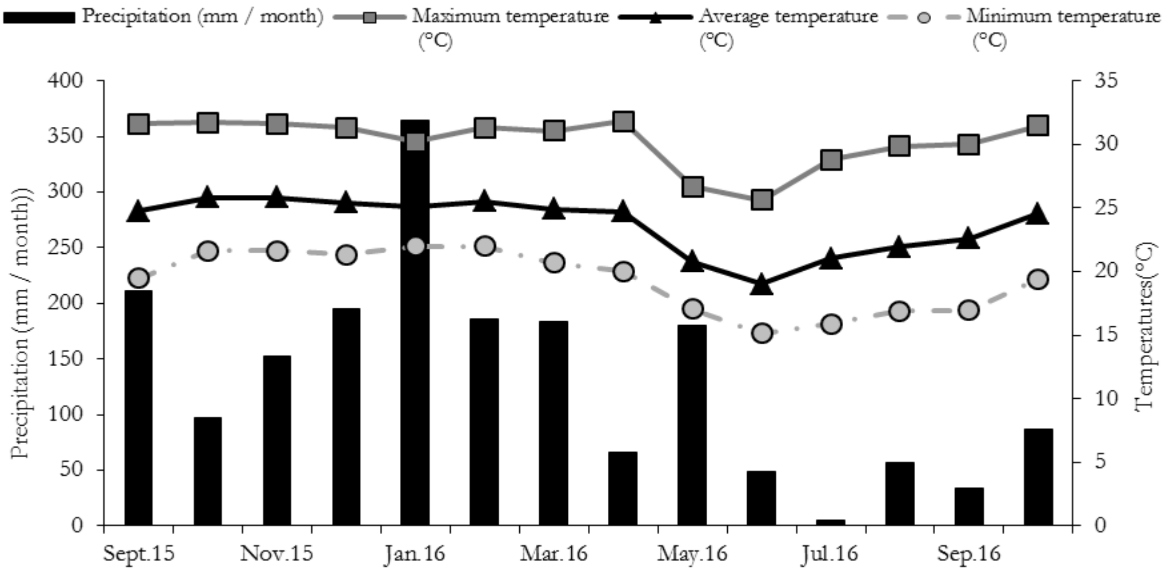

Figure 1. Average, minimum and maximum temperatures, monthly precipitation from September 2015 to October 2016

2.1 Treatments and Experimental Design

To conduct the test, soil samples were collected (0 – 10 cm) to fertility analysis. The soil of the experimental area is classified as Dystrophic Red Latosol, characterized by clay texture, pH acid, low base saturation and high concentration of aluminum. Therefore, from 2010 it was made the conventional soil preparation with correction with dolomitic limestone with the goal of elevating the saturation by bases at 50%. It was applied in coverage, 40 kg ha^{-1} of P_2O_5 and K_2O, elevate the phosphorus content to 4 - 8 mg dm^{-3} (P – Mehlich1) and the potassium content to 60 – 80 mg dm^{-3} and 50 kg ha^{-1} of FTE-BR12. It also was applied 150 kg ha^{-1} of N in the form of urea, divided into three portions in the months of November, December, and February.

The handling of the pasture used was under intermittent stocking with five days of grazing and 25 days of rest, in the water seasons (spring and summer), and seven days of pasture and 35 days of rest in the dry seasons (fall and winter). The experimental delineation used was of randomized blocks with three treatments and three replicates, a total of nine experimental units (pickets). Each picket was constituted by an area oh 1.5 ha equally subdivided into six sub-units (replicates) in a rotational grazing method. The treatments were constituted by grasses of the same species (*Brachiaria brizantha*) composed by *Brachiaria brizantha* cv. Xaraés, BRS Paiaguás, and the ecotype B4. 90 Angus steers were used for pasture defoliation during the occupation period, with an average initial weight of 180 kg.

2.2 Pasture Measures

For the height estimation in pre-grazing and every occupation day, 30 random points were registered in a sub picket of each module. This information corresponded to the average height, in centimeters, around the ruler. The population density of tillers (PDT m^{-2}) was estimated with the assistance of three frames of 1 m², randomly allocated within each sub picket, always on the occasion of pre-grazing of each cycle.

300 green foliage laminas were collected, being 100 of each graze to the integration of the leaf blade area for leaf area estimation (LA cm^2). Therefore, it was possible to get the estimates of leaf area index (LAI) given by the following formula: LAI= (LA x PDT) / soil area (adapted of Gastal and Lemaire, 2015).

In order to conduct the assessments related to the tissue flow, it was made the identification of the tiller through the colorful plastic rings to facilitate the location of them using the marked tiller technique. Therefore, 45 tillers per treatment were identified, 15 per repetition, distributed in three rules (5 tillers per rule). Each rule was randomly allocated in the sub picket, and the tiller allocated every 1m of distance. For each period of evaluation was remarked a new population of the tiller.

In the tiller, the length of the pseudostems (measured from soil to the last completely expanded ligule), of the leaf blade (measured from the expanded ligule to the blade end) and the leaf in elongation (ligule of the youngest leaf completely expanded to the end of the blade expanding) were measured, as well as the number of living leafs (NLL, tiller leaf^{-1}), the average of the number of leafs expanding and expanded by tiller during the evaluation period, excluding sheets having more than 50% of their length in senescence, when it was considered dead.

Therefore, it was possible to accomplish the following calculations: leaf appearance rate (LAR, tiller leaf^{-1} day^{-1}); the leaf elongation rate (LER, cm of leaf blade^{-1} day^{-1}); the stalk elongation rate (SER, cm tiller^{-1} day^{-1}); the phyllochron (Phylum. days leaf^{-1}). The life span of the sheets (LSL, days), is estimated by the equation: LSL = NLL x Phylum (Lemaire and Chapman, 1996).

2.3 Statistical Analysis

The data of height, morphogenesis and structure were submitted to the analysis of variance, in time split-plot scheme (year seasons: spring, summer, fall, and winter). Therefore, the model considered as the main factors: cultivars, time of year and interaction cultivars × time of year. After these processes, the test of Tukey multiple comparisons was made at 5% significance using statistical program R version 3.0.3.

3. Results and Discussion

3.1 Canopy Height

In the heights of post-grazing, it was observed the interaction between time of the year and cultivars ($P<0.05$), being verified that in ecotype B4 pastures in the spring, presented the highest heights in relation in the other times of the year. However, in pastures of cv. Xaraés the heights in spring and fall were proportionally similar ($P>0.05$). In pastures of cv. BRS Paiaguás the post-grazing heights did not present any ossification during the experimental period ($P>0.05$). Besides that, differences between the cultivars ($P<0.05$) were observed, once the pastures of B4 and cv. Xaraés presented the highest post-grazing heights in spring and fall in relation to the pasture of cv. BRS Paiaguás. In the pre-grazing, the effect of time of year was also verified on cultivars (P<0.05), in winter similar heights in the forage canopy for the three pastures of *B. brizntha* (Table 1) were observed.

Table 1. Height of forage canopy after post-grazing and pre-grazing of *Brachiaria brizantha* cultivars

Time	Ecotype B4	BRS Paiaguás	Xaraés	P-value
		Post-grazing (cm)		
Spring	51±4.77^{Aa}	26±3.33^{Ac}	41±1.18^{Ab}	0.001
Summer	34±6.52^{Ba}	21±1.60^{Aa}	28±1.98^{Ba}	0.074
Fall	36±1.65^{Ba}	22±1.58^{Ab}	35±1.39^{ABa}	0.001
Winter	23±2.05^{Ca}	24±1.37^{Aa}	28±1.47^{Ba}	0.413
		Pre-grazing (cm)		
Spring	86±5.73^{Aa}	48±4.33^{Ac}	73±1.66^{Ab}	0.001
Summer	59±10.82^{Ba}	36±2.75^{Bc}	46±3.03^{ABab}	0.011
Fall	60±3.64^{Ba}	40±1.91^{Bb}	63±2.61^{Aa}	0.001
Winter	37±3.73^{Ca}	32±1.37^{Ca}	40±2.05^{Ba}	0.338

Averages±standard error followed by the same letters, upper case in the columns, and lowercase in the lines do not differ by Tukey test, at 5% probability. P-value: probability of significant effect by the F-test.

Oscillations at pre-grazing heights between the *B. brizantha* were already expected because the studied pastures present different growth habits. Once pastures with a higher population density of tillers usually present a lower canopy height, on the other, hand the opposite can already be observed in cultivars with a lower population density of tillers, being verified a higher canopy height (Sbrissia and Da Silva, 2008). However, the post-grazing height suffers a higher defoliation strategy influence, which may impact on leaf area dynamics (Gastal and Lemaire, 2015).

3.2 Flow of Tissues, Structural Characteristics of the Grass

Information related to the morphogenesis and structure of the structural components (Table 2) did not present interaction between cultivars and time of the year (P>0.05). However, it was observed that the LAR was higher in the cv. BRS Paiaguás, in relation to the other pastures (P<0.05). The LER was higher in tillers of the ecotype B4 (P<0.05). The phyllochron to pastures of cv. Xaraés inferred in a higher interval between the appearance between two sheets (P<0.05). But to the other variables LAI, SER and LSL it was similar between the pastures (P>0.05). The tillers of the ecotype B4 presented a higher leaf blade length (P<0.05). The cv. BRS Paiaguás produced the higher PDT in relation to the other pastures of *B. brizantha*. The NLL was proportionally similar between the cultivars (P>0.05).

Table 2. Leaf area index and characteristics related to morphogenesis and structure of *Brachiaria brizantha* cultivars

Variable	Ecotype B4	BRS Paiaguás	Xaraés	P-value	SE
LAI	2.53^{a}	2.11^{a}	2.44^{a}	0.255	0.134
		Morphogenesis			
LAR	0.059^{ab}	0.070^{a}	0.049^{b}	0.014	0.003
LER	0.919^{a}	0.556^{b}	0.753^{ab}	0.022	0.066
SER	0.070^{a}	0.098^{a}	0.057^{a}	0.128	0.010
Phylum	20.28^{b}	20.28^{b}	23.89^{a}	0.006	1.13
LSL	81.88^{a}	68.18^{a}	89.71^{a}	0.051	3.87
		Structure			
NLL	4.13^{a}	4.14^{a}	3.88^{a}	0.207	0.077
LLB	19.69^{a}	16.49^{b}	14.71^{b}	0.003	0.599
PDT	198^{b}	374^{a}	232^{b}	0.001	12.94

Averages followed by equal letters, lowercase in the lines do not differ by Tukey test, at 5% probability. LAI: leaf area index: LAR: leaf appearance rate (tiller leaf^{-1} day^{-1}); LER: leaf elongation rate (cm of leaf blade^{-1} day^{-1}); SER: stems elongation rate (cm tiller^{-1} day^{-1}); Phylum: phyllochron (days leaf^{-1}); LSL: life span of the sheets (days); NLL: number of live leaves (tiller leaf^{-1}); LLB: length of leaf blade (cm); PDT: population density of tillers (m^{2}). P-value: probability of significant effect by the F-test; SE: Standard error.

Thus, pastures in which the handling leads to high leaf appearance rate, in general, present lower final length of leaf blade and also lower LSL (Barbosa et al., 2012; Lemaire et al., 2009; Montagner et al., 2011), but can be modified by the LAI. On this, Menezes et al (2019), suggest that the addition in the LAI could control the light quality that affects the leaf area of forage canopy, causing oscillations in the dynamics of growth.

In the winter, values of LAI, LAR and LER ($P<0.05$) were registered, resulting in a higher leaf life (Table 3). When these events occur naturally, there is a decrease in the population density of tiller, inducing the reduction in the forage production Difante et al. (2011). Barbosa et al. (2007) and Barbosa et al. (2012) and Montagner et al. (2011), studying tropical climate pasture show that in fall and winter, naturally occur deceleration of tissue flow and accumulation of biomass, once the reduction in plant growth is related to abiotic factors and the management strategy itself.

Table 3. Leaf area index and characteristics related to morphogenesis and structure of *Brachiaria brizantha* cultivars at the seasons

Variable	Spring	Summer	Fall	Winter	P-value
LAI	2.12^{bc}	3.30^{a}	2.78^{ab}	1.71^{c}	0.001
			Morphogenesis		
LAR	0.071^{ab}	0.087^{a}	0.062^{b}	0.033^{c}	<0.001
LER	1.00^{a}	0.887^{a}	0.817^{a}	0.329^{b}	0.001
SER	0.125^{a}	0.110^{ab}	0.049^{ab}	0.034^{b}	0.001
Phylum	16.98^{bc}	11.59^{c}	17.79^{b}	30.94^{a}	<0.001
LSL	74.47^{b}	43.38^{a}	74.73^{b}	108.84^{a}	<0.001
			Structure		
NLL	4.54^{a}	3.75^{b}	4.24^{a}	3.53^{b}	<0.001
LLB	18.41^{a}	17.07^{a}	17.02^{a}	15.39^{a}	0.227
PDT	233.74^{b}	294.18^{b}	325.22^{a}	232.96^{b}	<0.001

Averages followed by equal letters, lowercase in the lines do not differ by Tukey test, at 5% probability. LAI: leaf area index: LAR: leaf appearance rate (tiller leaf^{-1} day^{-1}); LER: leaf elongation rate (cm of leaf blade^{-1} day^{-1}); SER: stems elongation rate (cm tiller^{-1} day^{-1}); Phylum: phyllochron (days leaf^{-1}); LSL: life span of the sheets (days); NLL: number of live leaves (tiller leaf^{-1}); LLB: length of leaf blade (cm); PDT: population density of tillers (m ^{2}). P-value: probability of significant effect by the F-test.

On the other hand, it is worth emphasizing that the LSL above 60 days enabled to enhance the utilization of the fodder produced before die. According to Gastal and Lemaire, (2015), if the rest period remains shorter than the average life expectancy of grass species considered, than the efficiency of use will be optimized, besides controlling the accumulation of less desirable components, such as the pseudstems.

This fact can be verified in the SER, because it was proportional between the cultivars and the year seasons (Table 2 and 3), revealing that the defoliation in fixed days allows controlling the elongation of this component, in which, if uncontrolled increase occurs could degrade the process of defoliation by grazing, due to the reduction of the biomass ratio of leaf blades in dry periods (Euclides et al., 2014), besides being considered a physical barrier in the grazing process (Hodgson, 1990; Benvenutti et al., 2009).

Despite the three *B. brizantha* be susceptible to the seasonality of production, due to the deceleration in tissue flow, it is possible to infer that as a mechanism of adaptation the processes of organogenesis (LAR and LER, Table 4) it was not ceased during the trial period. Therefore, the forage materials have high phenotypic plasticity.

4. Conclusion

Even though there were some structural variations between the tropical climate pastures, it was possible to verify that the phenotypic plasticity of these pastures presented the same behavior, since it suffered a strong influence of abiotic factors. Therefore, all the pastures of *B. brizantha* converged to the same LAI indicating high phenotypic plasticity.

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