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Morphogenesis of marandu palisade grass closer to or farther from cattle feces varies by season

Morfogênese do capim-marandu próximo ou distante das fezes dos bovinos durante as estações do ano

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Abstract

The objective of this study was to evaluate the morphogenic and structural characteristics of the *Brachiaria brizantha* cv. Marandu Syn. *Urochloa brizantha* cv. Marandu during the different seasons of the year, in locations closer to or farther from feces deposited by cattle in pastures. The experimental design was in randomized blocks, with four replicates. The following response-variables were calculated: phyllochron (PHYL), leaf appearance rate (LAR), leaf elongation rate (LER), stem elongation rate (SER), leaf senescence rate (LSR), life span of the leaf (LSL), stem length (SL), leaf blade length (LBL), number of dead leaves per tiller (NDLT), and number of living leaves per tiller (NLLT). Farther from the feces, a larger phyllochron period was observed in all seasons. The LSL was greater in winter, especially farther from feces. Closer to feces, higher values were observed for LAR, LER and LBL compared with the sites farther from feces. The SL, SER, and NLLT were lower in the winter compared with the other seasons. In the summer, a greater NDLT value was observed than in the other seasons. The deposition of feces by cattle and the seasons of the year both affect the morphogenesis of *B. brizantha* cv. Marandu, generating the observed spatial and temporal variability in pasture grass.

Key words: *Brachiaria brizantha* syn. *Urochloa brizantha.* Growth. Tiller. Senescence.

Resumo

Objetivou-se avaliar as características morfogênicas e estruturais da *Brachiaria brizantha* cv. Marandu Syn. *Urochloa brizantha* cv. Marandu durante as estações do ano em locais próximos ou distantes das fezes depositadas pelos bovinos na pastagem. O delineamento experimental foi em blocos ao acaso, com quatro repetições. Foram calculadas as seguintes variáveis-respostas: filocrono (FIL), taxa de aparecimento foliar (TApF), taxa de alongamento foliar (TAlF), taxa de alongamento de colmo (TAlC), taxa de senescência foliar (TSeF), duração de vida da folha (DVF), comprimento do colmo (CC), comprimento da lâmina foliar (CLF), número de folhas mortas por perfilho (NFM) e número de folhas vivas por perfilho (NFV). Distante das fezes foi observado maior filocrono, independente da estação do ano. A DVF foi maior no inverno, sobretudo no local distante das fezes. Próximo das fezes, ocorreram maiores valores de TApF, TAlF e CLF, em relação ao local distante. O CC, TAlC e o NFV por perfilho foram inferiores no inverno,

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em relação às demais estações do ano. No verão, maior NFM por perfilho foi observado, em comparação às demais estações. A deposição de fezes pelos bovinos e as estações do ano modificam a morfogênese da *B. brizantha* cv. Marandu, o que gera variabilidade espacial e temporal do relvado da pastagem.
Palavras-chave: *Brachiaria brizantha* syn. *Urochloa brizantha.* Crescimento. Perfilho. Senescência.

Introduction

Ruminant excreta is an important means of returning nutrients to fodder plants in pastures, especially when fertilization practices are not performed. Indeed, the mineralization of cattle feces can increase the availability of nutrients in the soil (BRAZ et al., 2003), which has positive effects on pasture growth (SANTOS et al., 2011).

In pastures, the occurrence of sites with higher intensity and frequency of defoliation (overgrazing) is common; however, in the same pastures locations exist that are undergrazed, which are characterized by the presence of taller plants. Because ruminants also eliminate their excreta during grazing, this grazing selectivity of the animals generates irregular distribution of their excrement (feces and urine) in the pasture. Thus, the spatial distribution of feces in the pasture occurs heterogeneously (BRAZ et al., 2003), which compromises nutrient recycling in the pasture.

Additionally, the presence of animal feces also results in spatial variability in the vegetation in the pasture. Cattle have been observed to reject fodder plants in the presence of feces (WILLIANS; HAYNES, 1995), and the feces can also create areas of bare soil, which facilitates colonization by other plant species.

This modification of growth and rejection of fodder plants by the animals due to feces leads to the modification of the pasture structure, determining the availability of the pasture to grazing animals, which affects ingestive behavior, forage consumption, and animal performance. Thus, understanding the effects that the feces deposited by cattle in the pasture have on the development of the pasture is relevant due to their influence on the structural characteristics of the pasture and, consequently, on the responses of the grazing animals.

The study of morphogenesis is appropriate for evaluating the development of fodder plants in response to both biotic and abiotic factors in the pasture. Morphogenesis is the emergence and growth of the organs of the aerial portion of the plant in a community over time (PAULA et al., 2012). This knowledge enables the identification of the effects of cattle feces deposition in the pasture, thus leading to better understanding of the dynamics of the formation of the pasture structure.

Consequently, the objective of this study was to evaluate the seasonal variation in the morphogenetic and structural characteristics of *Brachiaria brizantha* cv. Marandu based on its location relative to feces deposited naturally by cattle in pastures managed under an intermittent grazing system.

Materials and Methods

This experiment was conducted from October 2011 to September 2012 in an approximately three hectare paddock planted with *Brachiaria brizantha* Stapf. cv. Marandu (marandu palisade grass), which was established in 2000 at the Capim-branco farm of the Federal University of Uberlândia (Universidade Federal de Uberlândia – UFU), in Uberlândia, MG, Brazil. The geographical coordinates of the location of this experiment were 18°53’19’’S and 48°20’57’’W, with an altitude of 835 m. The region has a tropical highland climate, with mild, dry winters and well-defined dry and rainy seasons. The average annual temperature and rainfall amount are 22.3°C and 1584 mm, respectively.

Climatic data during the experiment were monitored at the meteorological station located approximately 200 m from the study site (Table 1).

Before implementation of the experiment, soil samples were taken from the 0–20 cm layer for analysis of the fertility level, the results of which were as follows: pH in H_2O = 5.5, P = 1.3 $mg.dm^{-3}$ (Mehlich-1), K = 75 $mg.dm^{-3}$, Ca^{2+} = 1.7 $mg.dm^{-3}$, Mg^{2+} = 1.1 $mg.dm^{-3}$, and Al^{3+} = 0.0 $cmol_c.dm^{-3}$ (KCl 1 mol L^{-1}). Based on these results, liming of this pasture was not performed. Fertilization with phosphate (70 $kg.ha^{-1}$ of P_2O_5), nitrogen (90 $kg.ha^{-1}$ of N), and potassium (30 $kg.ha^{-1}$ of K_2O) was performed in October 2011 in accordance with the recommendations of Cantarutti et al. (1999) for a system with a medium level of technology, using the NPK formula 04:30:16 and urea. Urea was applied two more times, in January and March 2012, with each application corresponding to 50 $kg.ha^{-1}$ of N.

Table 1. Monthly averages of daily temperature, solar radiation, rainfall, and evapotranspiration from October 2011 to March 2012.

Month	Average temperature of the air (°C)			Solar radiation (Mj/day)	Rainfall (mm)	Evapotranspiration (mm)
	Average	Minimum	Maximum			
October	22.3	18.3	28.0	16.0	126.6	83.5
November	22.6	17.6	28.5	20.4	93.8	92.9
December	22.6	18.9	28.2	17.7	113.4	87.8
January	21.7	18.4	26.9	16.9	189.4	82.0
February	23.1	18.3	29.4	20.7	99.0	97.5
March	22.8	18.5	28.9	18.1	143.2	88.7
April	23.7	19.0	28.5	15.7	47.6	79.5
May	20.1	15.4	24.9	10.6	10.0	54.3
June	20.3	14.3	26.2	14.9	29.2	71.0
July	19.1	12.0	26.3	16.3	12.8	83.0
August	20.6	11.3	31.6	18.2	0.6	98.1
September	23.7	10.2	36.3	19.2	24.8	105.3

The marandu palisade grass pasture was managed with intermittent stocking and a variable stocking rate (4.4, 2.8, 3.6, and 1.8 AU/ha in the spring, summer, fall, and winter, respectively), using Nelore cattle (Table 2). The rest period varied for the different seasons of the year: 32 days in the summer, 31 days in the fall, and 31 days in the winter. The pasture contained four 3.0 ha paddocks, each with drinking troughs and feeding troughs to supply the concentrated supplement.

Throughout the duration of paddock occupation (in the four seasons of the year), the cattle had access to the concentrate, and their estimated consumption varied - 1.0 and 1.5 $kg.animal^{-1}.\ day^{-1}$ for the calves and the cows, respectively. The supply of the concentrate occurred within the paddock itself.

Table 2. Information regarding the periods of previous occupation of the pasture of marandu palisade grass during the year in which the evaluations were performed.

Month	Season	Average height (cm)		Period of occupation (PO) and characterization of the animals
		Pre-grazing	Post-grazing	
Nov	Spring	30	17	PO: six days 1st lot: 52 calves (270 kg) for five days 2nd lot: 20 dry cows (480 kg) for one day
Jan	Summer	28	16	PO: ten days One lot: 51 calves (300 kg)
Mar	Fall	26	14	PO: ten days One lot: 51 calves (380 kg)
Aug	Winter	25	15	PO: three days One lot: 20 dry cows (480 kg)

For the implementation of the experiment, four strips were marked, without fences, using the existing contour lines in the paddock as reference. These strips had relief gradient and were, therefore, used as blocks for the treatment distribution.

In each season (spring, summer, fall, and winter), in each strip, two locations were evaluated in the paddock (treatments) - one closer to (CF) and the other farther from (FF) feces deposited naturally by the cattle while the paddock was occupied. CF was any location immediately adjacent to feces, whereas FF was any location where no feces were present within a radius of approximately two meters. The experimental design was in randomized blocks with four replicates(strips).

The morphogenetic evaluation of the fodder plant was completed during the rest period in each of the four seasons. In each season, these evaluations were performed in a single grazing cycle. Thus, for spring, summer, fall, and winter, the evaluation periods occurred from 11/25/2011 to 12/20/2011, 1/30/2012 to 3/2/2012, 4/4/2012 to 5/5/2012, and 8/28/2012 to 9/28/2012, respectively.

Tillers were evaluated at locations in the pasture that had initially been of average condition. Three locations closer to feces and three locations farther from feces were chosen. At each location, four tillers were marked with a colored plastic ring. Thus, in each strip, 12 tillers closer to and 12 tillers farther from feces were chosen. The duration of the evaluation cycle varied with the length of the rest period, which was 25 days in the spring, 32 days in the summer, 31 days in the fall, and 31 days in the winter. In each evaluated grazing cycle, a new group of tillers was selected for evaluation.

With the aid of a scale ruler, measurements were taken of the leaf blade length and stem length of the marked tillers, once a week. The length of the expanded leaves was measured from the tip of the leaf blade to its ligule. For expanding leaves, the same procedure was adopted; however, the ligule of the last expanded leaf was used as the measurement reference. For senescent leaves, the length corresponded to the distance from the point where the senescence process had progressed up to the ligule of the leaf. The stem size was measured as the distance from the soil surface to the ligule of the newest expanded leaf. From this information, the following variables were calculated:

Leaf appearance rate (leaf/tiller.day): number of leaves that emerged per tiller, divided by the number of days in the evaluation period;

Phyllochron (days): inverse of the leaf appearance rate;

Leaf elongation rate (cm/tiller.day): sum of the total leaf blade elongation per tiller, divided by the number of days in the evaluation period;

Stem elongation rate (cm/tiller.day): sum of the total stem elongation and/or pseudostem per tiller, divided by the number of days in the evaluation period;

Life span of leaf (days): estimated by the following equation: Life span of leaf (LSL) = Number of living leaves per tiller (NLLT) x phyllochron (LEMAIRE; CHAPMAN, 1996);

Leaf senescence rate (cm/tiller.day): average negative variation in the average leaf blade length per tiller, resulting from the decrease in the green portion of the leaf blade, divided by the number of days in the evaluation period;

Number of living leaves per tiller: average number of leaves per fully expanded tiller, including the partially grazed leaves and those beginning the senescence process (less than 50% of the leaf blade senescent);

Number of dead leaves per tiller: average number of leaves per tiller with more than 50% of the leaf blade senescent during the evaluation period;

Leaf blade length (cm): average length of all living leaves on the tiller that were fully expanded and had not been grazed.

Stem length (cm): distance from the soil surface to the ligule of the newest fully expanded leaf, including stem and pseudostem.

The data obtained were submitted to analysis of variance in a randomized block design in a split-plot with time. The pasture locations corresponded to the plots, and the seasons of the year corresponded to the subplots. When the interaction between the factors (pasture location and season of the year) was not significant, the marginal averages of the levels of the primary factor (pasture location) or secondary factor (season of the year) were compared. When the interaction between the factors was significant, the comparison of the levels of one factor were performed separately for each level of the other factor. All analyses were performed using the Student-Newman-Keuls test at a significance level of up to 5% probability of type I error occurring.

Results and Discussion

The leaf appearance rate (LAR) of the marandu palisade grass was higher closer to feces than farther from feces. A contrary response pattern occurred with the phyllochron (Table 3). These results may have been influenced by the mineralization of the fecal organic material, which improves the fertility conditions of the soil and can thus increase the growth rate of the forage grass.

Table 3. Leaf appearance rate and phyllochron of the marandu palisade grass closer to and farther from cattle feces by season.

Location	Season				Average
	Spring	Summer	Fall	Winter	
	Leaf appearance rate (leaf/tiller.day)				
Closer to feces	0.114	0.105	0.065	0.022	0.077 A
Farther from feces	0.082	0.097	0.045	0.015	0.060 B
Average	0.098 a	0.101 a	0.055 b	0.018 c	
	Phyllochron (day)				
Closer to feces	8.8	9.5	15.4	45.5	19.8 B
Farther from feces	12.2	10.3	22.2	66.7	27.8 A
Average	10.5 c	9.9 c	18.8 b	56.1 a	

Averages followed by different lowercase letters in the rows and uppercase letters in the columns differ by the Student-Newman-Keuls test ($P<0.05$).

One of the nutrients that becomes available to fodder plants through the mineralization of organic matter is nitrogen (BRAZ et al., 2003), which has a positive effect on LAR. Paiva et al. (2011) found increasing values of LAR for *Brachiaria brizantha* cv. Marandu with pasture N application greater than 150 kg/ha year.

Unlike LAR, the period for the formation of two consecutive leaves on the same tiller, i.e., the phyllochron, was shorter in the spring and summer, intermediate in the fall, and longer in the winter (Table 3). The longer phyllochrons in the fall and winter can be explained by the unfavorable environmental conditions in the fall and especially in the winter, including lower rainfall than in the spring and summer (Table 1), which may have caused a water deficit in the soil. Moreover, in the winter, the minimum temperature was very low (10.2°C) in the month in which the morphogenesis evaluation occurred (Table 1). In a study with marandu palisade grass, Cruz et al. (2011) found a base temperature for the species to be less than 17.2ºC.

The base temperature is the temperature below which the accumulation of dry matter by the species is limited, so that this accumulation becomes zero or negligible (SENTELHAS et al., 1994).

In general, the leaf elongation rate (LER) was high in the spring and summer, intermediate in the fall, and low in the winter, regardless of the locations evaluated. In contrast, the stem elongation rate (SER) was lower in spring and winter compared with summer and fall (Table 4).

Table 4. Leaf and stem elongation rates of the marandu palisade grass closer to and farther from cattle feces by season.

Location	Season				Average
	Spring	Summer	Fall	Winter	
	Leaf elongation rate (cm/tiller.day)				
Closer to feces	2.31 aA	1.79 bA	1.05 cA	0.22 dA	1.34
Farther from feces	1.42 aB	1.61 aA	0.69 bA	0.20 cA	0.98
Average	1.87	1.70	0.87	0.21	
	Stem elongation rate (cm/tiller.day)				
Closer to feces	0.049	0.105	0.063	0.018	0.059 A
Farther from feces	0.040	0.080	0.084	0.022	0.057 A
Average	0.045 b	0.073 a	0.094 a	0.020 b	

Averages followed by distinct lowercase letters in the rows and uppercase letters in the columns, differ by the Student-Newman-Keuls test ($P<0.05$).

The adverse climate in the winter (Table 1) resulted in lower values for leaf and stem elongation than in the other seasons of the year (Table 4). The water deficit that is typical for this season adversely affects plant growth. The growth is characterized by increased cell volume, which is influenced by biochemical factors such as the loosening of the cell wall structure, increased respiration and protein synthesis and the physical action of the water entering into the cells and expanding the vegetable structures (PAIVA; OLIVEIRA, 2006).

The stem elongation rate (SER) was higher in the summer and fall than in the winter and spring (Table 4) because the environmental conditions favored plant development in the former two seasons. In the fall, the higher SER may also have been a consequence of the flowering of the marandu palisade grass. Upon analyzing the number of reproductive tillers of marandu palisade grass with continuous cattle grazing, Paula et al. (2012) observed a higher value in the fall than in the other seasons. When flowering, the forage grass lengthens its stem to provide higher exposure of the inflorescence through the canopy, which contributes to greater seed dispersal.

The greater elongation of the leaf blade in the spring and closer to the feces can be justified by the increased rainfall recorded during this period (Table 1), together with the effect of the increased availability of nutrients from the mineralization of the feces. This same response pattern was expected in the summer, but it did not occur (Table 4). In the fall and winter, the climate conditions were unfavorable for the mineralization of fecal organic matter and for the growth of the forage plant, likely explaining the absence of any effect of feces on leaf elongation in marandu palisade grass during these seasons (Table 4).

Throughout the year, the LER values were on average 20 times higher than the SER values (Table 4), likely because of the grazing management adopted in the experimental area, in which the pasture was approximately 25 cm in height in the pre-grazing condition (Table 2). Below this pre-grazing height, adequate incidence of light still occurs within the canopy because the pasture intercepts approximately 95% of the light, which increases neither stem elongation nor leaf senescence and results in a pasture with a predominance of living leaf blades, with positive effects on the morphological composition of the forage consumed by the grazing animals (TRINDADE et al., 2007).

The leaf senescence rate (LSR) was lower in the plants closer to feces (relative to those farther away) only during the spring and fall. Additionally, for the plants closer to feces, higher leaf senescence occurred in the winter compared with the other seasons (Table 5).

Table 5. Leaf senescence rate and leaf lifespan of the marandu palisade grass closer to and farther from cattle feces by season.

Location	Season				Average
	Spring	Summer	Fall	Winter	
	Leaf senescence rate (cm/tiller.day)				
Closer to feces	0.17 bB	0.16 bA	0.12 bB	0.25 aA	0.18
Farther from feces	0.24 aA	0.12 aA	0.31 aA	0.21 aA	0.22
Average	0.20	0.14	0.22	0.23	
	Lifespan of leaf (days)				
Closer to feces	31 bA	41 bA	55 abA	116 a B	61
Farther from feces	37 bA	42 bA	56 abA	145 a A	70
Average	34	41	56	131	

Averages followed by different lowercase letters in the rows and uppercase letters in the columns differ by the Student-Newman-Keuls test ($P<0.05$).

In the periods of transition between the rainy season and drought (spring and fall), the plants farther from feces may have exhibited worse nutritional status than those closer to feces due to the lower mineralization of the fecal organic matter. Thus, the plants farther from feces may have accentuated the senescence process of the older leaves to foster greater internal nutrient cycling (CAUDURO et al., 2006).

Internal nutrient cycling in this phase can increase the lifespan of the newest leaves, which have higher photosynthetic capacities and form in the upper layer of the canopy, where they receive more light. This cycling process is also beneficial during times of drought and nutritional deficiencies in the soil because the plant reuses previously acquired nutrients and also saves the energy required for the acquisition of these nutrients.

The restrictive climate of the winter, particularly due to the large water deficit in the soil (Table 1), accelerates leaf senescence (Table 5) as the plant reduces the leaf surface area in the pasture exposed to solar radiation and susceptible to loss of water through transpiration. This mechanism increases water economy when water is a limiting factor.

The absence of effects and the low LSR values in the plants farther from feces during all seasons (Table 5) were mainly due to the management of the pasture at 25–30 cm pre-grazing height - a range that corresponds to 95% interception of light by the canopy (TRINDADE et al., 2007).

The LSR is influenced by the grass height because the light incidence within the canopy is greater when the pre-grazing height of the cultivar is respected, which reduces competition for light and, consequently, decreases the LSR of the older leaf blades. Contrastingly, in grass taller than this height at which the canopy intercepts 95% of the light, lower strata of the pasture are very shady, which can cause a radiation level below the light compensation point of the basal leaves, the light intensity at which photosynthesis and respiration rates are equivalent (TAIZ; ZEIGER, 2013).

Generally, the leaves of the marandu palisade grass had a greater lifespan in the winter than in the spring or summer. The lifespan of the leaves of plants farther from feces was greater than that of plants closer to feces only in the winter (Table 5). According to Navas et al. (2003), the shorter lifespan of the leaves is associated with higher rates of growth and carbon fixation, whereas leaves with a longer lifespan contribute to the retention of nutrients in the plant. In the period in which factors needed for growth are more available (spring and summer), plants strategically absorb nutrients, and during times when these factors are limited, plants strategically conserve already assimilated nutrients.

In the winter and in the plants farther from feces, the LSR and LSL were both higher (Table 5). These results could appear paradoxical; however, within the same tiller, the survival of the newer leaves can increase, especially those that emerged during the winter, and senescence can also increase in the older leaves, which are more shaded and, therefore, have lower photosynthetic potential. The older leaves may already be in senescence; however, this process cannot exceed 50% of the leaf blade length or they would not be classified as being “alive”. Maintaining the highest number of living leaves per tiller (NLLT) can result in higher estimates of LSL, which is calculated by multiplying the NLLT by the phyllochron (LEMAIRE; CHAPMAN, 1996).

The numbers of living and dead leaves were similar in the plants closer to and farther from feces. In the winter, living leaves were less abundant than in other seasons. The largest number of dead leaves in the marandu palisade grass was observed in the summer (Table 6).

Table 6. Number of living and dead leaves per tiller of the marandu palisade grass closer to and farther from cattle feces by season.

Location	Season				Average
	Spring	Summer	Fall	Winter	
	Number of living leaves				
Closer to feces	5.1	5.0	4.5	2.4	4.3 A
Farther from feces	4.4	4.9	4.5	2.0	4.0 A
Average	4.8 a	5.0 a	4.5 a	2.2 b	
	Number of dead leaves				
Closer to feces	0.9	1.3	0.3	0.7	0.8 A
Farther from feces	0.8	1.3	0.6	0.7	0.8 A
Average	0.9 b	1.3 a	0.5 b	0.7 b	

Averages followed by different lowercase letters in the rows and uppercase letters in the columns differ by the Newman-Keuls test ($P<0.05$).

The high LSR in the winter (Table 5) justifies the lower NLLT in that season. In contrast, the higher number of dead leaves per tiller (NDLT) in marandu palisade grass during the summer can be attributed to the high tissue flow in the plant, in which leaf renewal is common.

The lack of effect of feces on living leaf abundance may be because NLLT is a genotypic characteristic that is stable in similar climatic conditions. However, the restrictive climate of the winter, with little or no rainfall and lower temperatures, reduces the number of living leaves and increases the number of dead leaves. Paiva et al. (2012) also observed a decrease in NLLT during the fall and winter due to the lower rate of leaf expansion and the higher LSR during these seasons compared with the summer. In summer, due to the greater climatic stability, the structural characteristics of the marandu palisade grass remain relatively stable. Likewise, upon evaluating the morphogenetic characteristics of marandu palisade grass managed at variable heights and variable stocking rates, Paula et al. (2012) found NLLT values similar to those in the present study for the different seasons of the year. The values found were 3.7, 5.0, 4.1, and 2.8 leaves per tiller for the spring, summer, fall, and winter, respectively.

Fecal deposition in the pasture increases the availability and concentration of nutrients in the soil (RODRIGUES et al., 2008), which leads to more accelerated plant growth. The more agreeable climate in the spring, summer, and fall also stimulates the growth of forage grass. Indeed, LER was higher in the spring and fall than in the winter. Moreover, in the spring, greater leaf elongation was observed in plants closer to feces (Table 4). These factors would justify the larger size of the leaf blade in the plants closer to feces and in the seasons with a favorable climate (Table 7).

Table 7. Average lengths of the leaf blades and stems of the marandu palisade grass closer to and farther from cattle feces by season.

Location	Season				Average
	Spring	Summer	Fall	Winter	
			Leaf blade length (cm)		
Closer to feces	16.0	13.9	14.9	12.0	14.2 A
Farther from feces	12.9	12.5	11.2	10.9	11.9 B
Average	14.5 a	13.2 ab	13.0 ab	11.4 b	
			Stem length (cm)		
Closer to feces	6.8	7.9	9.2	6.4	7.6 A
Farther from feces	6.9	7.1	7.9	6.7	7.2 A
Average	6.9 b	7.5 ab	8.6 a	6.6 b	

Averages followed by different lowercase letters in the rows and uppercase letters in the columns differ by the Newman-Keuls test ($P<0.05$).

The stem length of the marandu palisade grass was influenced only by season, with the highest value in the fall, an intermediate value in the summer, and the lowest value in the winter and spring (Table 7), possibly due to the concentration of the flowering of marandu palisade grass in the summer and fall, as previously discussed.

Because the spatial distribution of cattle feces in pastures is heterogeneous (BRAZ et al., 2003) and because the structural characteristics of the tillers are different at locations where fecal deposition by cattle occurs (Table 7), fecal deposition in pastures contributes to the spatial variability in the vegetation; i.e., it contributes to the formation of the horizontal structure of the pasture. This horizontal structure influences the ingestive behavior of the ruminants in the pasture, which has consequences for the consumption of the pasture and the performance of these animals (FONSECA et al., 2012).

Of all the evaluated morphogenetic characteristics, 60% varied with the presence of feces and 100% varied by season, which indicates the greater influence of the season (versus feces) on the development of marandu palisade grass. However, both factors have a significant effect on the development of this fodder plant.

Conclusions

The deposition of feces by cattle changes the morphogenesis of *Brachiaria Brizantha* cv. Marandu and, therefore, contributes to the spatial heterogeneity of the vegetation.

The morphogenetic and structural characteristics of *Brachiaria brizantha* cv. Marandu vary seasonally, which causes temporal variability of pasture vegetation.

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