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Effects of nitrogen fertilization and seasons on the morphogenetic and structural characteristics of Piatã (*Brachiaria brizantha*) grass

Efectos de la fertilización nitrogenada y las estaciones sobre las características morfogenéticas y estructurales del pasto Piatã (*Brachiaria brizantha*)

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Abstract

The objective of this study was to evaluate the morphogenetic and structural characteristics of Piatã grass under rotational stocking and nitrogen fertilization during the seasons. A randomized complete block design in a split-plot arrangement with three replications was used. The main plots were the applications of 0, 150, 300 and 450 kg per ha of N in the form of urea, and the subplots were seasons of the year: late summer/fall, winter, spring and summer. No interaction was detected between nitrogen fertilization and season for leaf appearance rate, leaf lifespan, number of live leaves and final length leaves. However, an interaction ($P<0.05$) of nitrogen fertilization and season influenced leaf elongation rate, phyllochron, leaf senescence rate and stem elongation rate. The leaf elongation rate and leaf appearance rate were linearly affected ($P<0.05$) by nitrogen fertilization. The seasons affected ($P<0.05$) the leaf lifespan and number of life leaves. The leaf lifespan decreased by 0.06 days for each kg of N applied. On the other hand, the number of live leaves increased by 0.0026 leaves/tiller for each kg of N. Fertilization with nitrogen positively affects morphogenetic and structural characteristics of Piatã grass under rotational stocking. This effect can be optimized during rainy periods in spring and late summer/autumn.

Keywords
Brachiaria brizantha • grazing management • leaf appearance rate • leaf elongation rate • leaf lifespan • leaf senescence rate

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Resumen

El objetivo de este estudio fue evaluar las características morfogenéticas y estructurales del pasto Piatã bajo pastoreo rotacional y fertilización nitrogenada durante las diferentes estaciones del año. Se utilizó un diseño de bloques completos al azar con un arreglo de parcelas divididas con tres repeticiones. Las parcelas principales fueron las aplicaciones de 0, 150, 300 y 450 kg/ha de N en forma de urea, y las subparcelas fueron las estaciones del año: finales de verano/otoño, invierno, primavera y verano. No se detectó interacción entre la fertilización nitrogenada y la estación para la tasa de aparición de hojas, la esperanza de vida de la hoja, el número de hojas vivas y longitud final de las hojas. Sin embargo, una interacción ($P<0,05$) de la fertilización nitrogenada y la temporada influyeron en la tasa de elongación de la hoja, filocrono, tasa de senescencia foliar y tasa de elongación del tallo. La tasa de elongación de la hoja y la tasa de aparición de la hoja se vieron afectadas linealmente ($P<0,05$) por la fertilización nitrogenada. Se observó un efecto ($P<0,05$) de las estaciones sobre la vida media foliar y el número de hojas vivas. La vida útil de la hoja disminuyó en 0,06 días por cada kg de N aplicado. Por otro lado, el número de hojas vivas aumentó en 0,0026 hoja/macollo por cada kg de N. La fertilización con nitrógeno influye positivamente en las características morfogenéticas y estructurales del pasto Piatã bajo pastoreo rotativo. Este efecto se puede optimizar durante los períodos de lluvia, en la primavera y al final del verano/otoño.

Palabras claves
Brachiaria brizantha • manejo del pastoreo • tasa de aparición de hojas • tasa de elongación de hojas • vida media foliar • tasa de senscencia de las hojas

Introduction

Brazil has an area of more than 160 Mha of pastures, and at least 100 Mha of these are sown pastures (7). *Brachiaria* spp. are the most commonly used grasses in Brazilian pastures. The *Brachiaria brizantha* cv. Piatã is one of the new recently cultivar introduced in Brazilian pasture. This cultivar has advantage of promoting slightly higher animal performance in the dry season (19).

The efficiency of forage use can be defined as the proportion of tissues that are removed by animals before forage entering the senescent state (8).

Therefore, to explore the maximum grass potential, it is necessary to know, understand and control its morphological characteristics, which is possible through morphogenetic studies associated with strict control of the height of the forage canopy (6, 19).

Tillers are considered the growth units of forage grasses, and the pasture is a population of tillers. For pasture to become perennial and persistent, there must be a balance between the appearance and death of tillers throughout the year, which allows grazing to adapt to different management conditions (15).

Leaf tissue production is regulated by environmental factors and influenced by the population density of tillers, and the interaction between these factors determines the morphogenetic rhythm of the plants (14). Thus, at the individual plant level, morphogenesis can be described by three basic characteristics: appearance, elongation and lifespan of the leaf (1).

The combination of these basic morphogenetic variables is responsible for the main structural characteristics of the pasture: leaf blade size, population density of tillers and number of live leaves per tiller (16). Thus, the morphogenetic rhythm determines the speed of recovery of leaf area after defoliation or its ability to maintain equilibrium in the case of pastures managed in rotational and continuous stocking, respectively (1).

Among the management practices that determine morphogenetic responses and structural characteristics, nitrogen fertilization is one of the most important. Therefore, due to the association of nitrogen fertilization and its role in several morphogenetic characteristics, involving the dynamics of leaves and tillers, it is necessary to evaluate the effects of this nutrient on grasses (5, 14) under environmental conditions of the southern region of the state of Mato Grosso.

Hypothesis

The hypothesis tested in this study was that nitrogen fertilization and seasons of the year affect morphogenetic and structural characteristics of Piatã grass.

Objetive

Evaluate the morphogenetic and structural characteristics of Piatã grass under rotational stocking and nitrogen fertilization during the seasons.

MATERIALS AND METHODS

Location of the experiment

The study was conducted at the Experimental Farm of the Universidade Federal de Mato Grosso from February 2014 to March 2015. This research station is located at 15°04'36" S, 56°04'36" W and is 141 m above sea level.

Climatic conditions

According to Koppen's classification, the climate is Aw, with a tropical megathermal climate, characterized by two well-defined dry (May to September) and rainy (October to April) seasons. The mean annual rainfall is 1,500 mm, with maximum intensity during January, February and March. The mean rainfall, insolation and temperature during the experimental period are shown in figures 1, 2 and 3 (page 45).

Treatments and experimental design

An established *Brachiaria brizantha* cv. piatã pasture was used. The experimental area was subdivided into 12 paddocks of 6 × 6 m, separated from each other by electrified fences and screens. A randomized complete block design in a split-plot arrangement with three replications was used. The main plots were the applications of 0, 150, 300 and 450 kg per ha of N in the form of urea, and the subplots were seasons of the year: late summer/fall, winter, spring and summer.

At the end of November of 2013, the pasture was cut at a height of 5 cm from the soil. Based on the soil analysis results, the soil was limed with dolomitic limestone, with 80% of lime's total relative neutralization (LTRN) carried out on the surface, aiming to raise the base saturation to 50%.

The fertilizer doses used were close to the recommendations of Souza and Lobato (2004), according to the requirement of the grass. After regrowth, the average height of 20 cm was maintained in all paddocks. At the end of December 2013, 120 kg ha^{-1} of P_2O_5 and 80 kg ha of K_2O using single superphosphate and potassium chloride, respectively, was applied. The source of phosphorus was applied in a single dose and the potassium in two doses. Nitrogen fertilization was divided into four doses according to the number of grazing cycles (table 1, page 46).

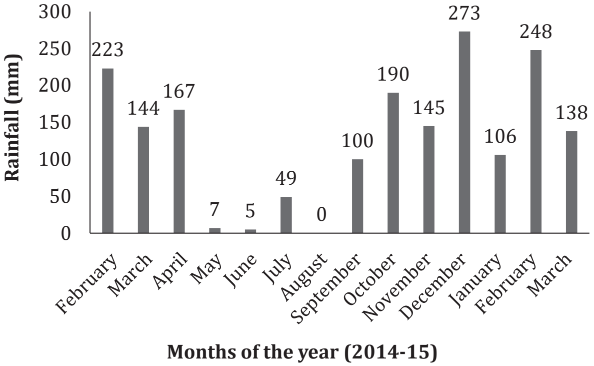

Figure 1. Monthly rainfall during the experiment.

Figura 1. Precipitación mensual durante el experimento.

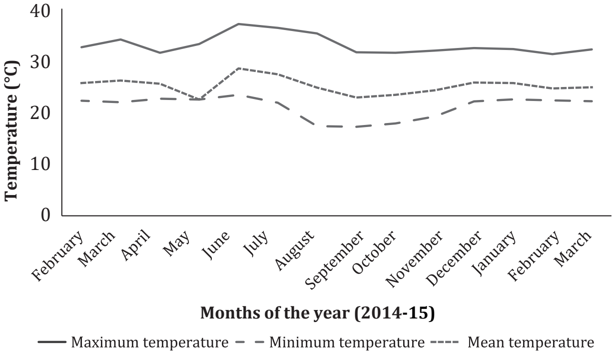

Figure 2. Mean, maximum and minimum temperatures during the experiment.

Figura 2. Temperaturas medias, máximas y mínimas durante el experimento.

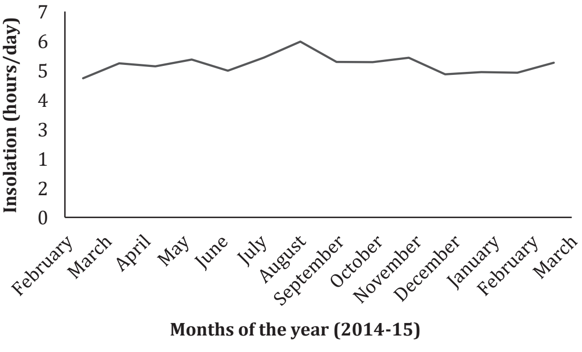

Figure 3. Insolation (hours/day) during the experiment.

Figura 3. Heliofanía (horas/día) durante el experimento.

Table 1. Nitrogen fertilization (kg/ha of N) applied to each paddock and its respective date of application during the experimental period.

Tabla 1. Fertilización con nitrógeno (kg/ha de N) aplicada a cada parcela y su respectiva fecha de aplicación durante el período experimental.

Level*	block	Date of application	1st application	Date of application	2nd application	Date of application	3rd application	Date of pplication	4th application	Total
0	I	-	-	-	-	-	-	-	-	0
0	II	-	-	-	-	-	-	-	-	0
0	III	-	-	-	-	-	-	-	-	0
150	I	2/8/14*	37.5	3/26/14**	37.5	5/8/14	37.5	11/2/14	37.5	150
150	II	2/8/14*	37.5	3/26/14**	37.5	5/8/14	37.5	11/2/14	37.5	150
150	III	2/8/14*	37.5	3/26/14**	37.5	5/8/14	37.5	11/2/14	37.5	150
300	I	2/8/14*	75	3/19/14**	75	10/6/14	75	11/9/14	75	300
300	II	2/8/14*	75	3/19/14**	75	10/6/14	75	11/9/14	75	300
300	III	2/8/14*	75	3/19/14**	75	10/6/14	75	11/9/14	75	300
450	I	2/8/14*	112.5	3/12/14**	112.5	10/19/14	112.5	11/17/14	112.5	450
450	II	2/8/14*	112.5	3/12/14**	112.5	10/19/14	112.5	11/17/14	112.5	450
450	III	2/8/14*	112.5	3/12/14**	112.5	10/19/14	112.5	11/17/14	112.5	450

*: First application of K_2O; **: Second application of K_2O.

*: Primera aplicación de K_2O; **: Segunda aplicación de K_2O.

The grazing management with rotational stocking strategy was characterized by the animal entry into and exit from the paddocks when the pasture showed 95% of light interception ($LI_{95\%}$) (pre-grazing) and 20 cm of height (post-grazing), respectively.

The pasture was grazed by sheep with average body weights of 50 kg using the mob-grazing technique (11), and the number of animals was dimensioned so that the lowering time of pastures would not exceed a daytime. Thus, a variable number of sheep was used per treatment, but maintained the same number of animals per repetition of treatment.

Grazing occurred on the same day for all replicates of the evaluated treatments, *i.e.* LI was considered as the average of the three replicates under the same treatment. After grazing, when the pasture showed 20 cm of height, the sheep were removed from the paddocks, placed in a one-hectare reserve pasture, and were returned when the pasture of Piatã grass reached the established pre-grazing target.

The monitoring of light interception was done using the sward analyzer AccuPAR Linear PAR/LAI ceptometer, Model PAR 80 (DECAGON Devices) in 10 places per paddock, in W-shaped trajectories (representative locations of the average conditions of the pasture during the sampling). Two readings were taken at each point: one above the sward and another at the soil surface (below the sward). These measurements were performed every six days until the approximation of the pre-established grazing target and every 2 days thereafter. The grazing intensity of Piatã grass was obtained from the results presented by Prado *et al.* (2014), who used LI as a parameter of grazing frequency.

Evaluation of the morphogenetic and structural characteristics

The evaluation of the morphogenetic and structural characteristics was performed in seven tillers per experimental unit. After each grazing cycle, tillers were randomly tagged on representative spots of the average sward condition (by visual evaluation of height and forage mass).

Every three tillers were assessed and measurements were taken of the leaf blade and stem (stem + leaf sheaths) lengths, leaf appearance, leaf expansion and senescence. These evaluations enabled the calculation of the leaf appearance rate (LAR, number of leaves appearing per tiller divided by the number of days of the evaluation period-leaf/tiller/day), the elongation rate (LER, sum of all the leaf blade elongations per tiller divided by the number of days under evaluation-mm/tiller/day) and the leaf senescence rate (LSR, sum of the senesced lengths of leaf blades present on the tiller divided by the number of days of the evaluation period -mm/tiller/day), the stem elongation rate (SER, sum of all the elongations of stems (stems + leaf sheaths) per tiller divided by the number of days of the evaluation period–mm/tiller/day), the number of live leaves per tiller (average number of expanding leaves and leaves expanded per tiller, not considering the leaves with more than 50% of this length senesced-leaves/tiller), phyllochron (which is the opposite of LAR-days/leaf), leaf lifespan (number of live leaves × phyllochron) and final leaf length (FLL, mean length of all expanded leaf blades–mm/tiller) (8).

Statistical analysis

To analyze the data, it was weighed the values of the variables that were grouped according to season. This is because some of the grazing cycles took place over two seasons. Thus, the value obtained for each variable was proportional to the number of days within each season of the year.

Therefore, data were grouped into four seasons: late summer/fall (from February 8 to June 20 of 2014); winter (from June 21 to September 21 of 2014); spring (from September 22 to December 20 of 2014); and summer (from December 21 of 2014 to March 19 of 2015).

The data were submitted to analysis of variance (ANOVA) and regression analysis using the MIXED procedure of SAS version 9.2 (21). When there was an interaction, data were unfolded to evaluate the effect of season in each nitrogen dose and the effect of dose in each season.

All statistical procedures were conducted by using 0.05 as the critical probability level for a type I error. Regression equations were chosen based on the determination coefficient and on the significance of the regression coefficients using the t test, adopting $\alpha = 0.05$.

RESULTS

No interaction was detected between nitrogen fertilization and season for LAR, leaf lifespan, number of live leaves and FLL. However, an interaction ($P<0.05$) of nitrogen fertilization and season influenced LER, phyllochron, LSR and SER. The LER was linearly affected ($P<0.05$) in all seasons. The highest values of LER were verified in spring, late summer/autumn, summer and winter, respectively (table 2).

The LAR was linearly affected ($P<0.05$) by nitrogen fertilization. An increase of 48.96% was observed for LAR when compared to the absence of nitrogen fertilization with the highest dose. The highest values of LAR were seen in spring and late summer/ autumn (table 3, page 49).

The phyllochron was linearly affected ($P<0.05$) by nitrogen fertilization in all seasons of the year (table 4, page 49). The highest phyllochron was found during winter of 44.06 days/leaf, which increased by 0.03 day/leaf for each kg of N applied. This value was higher than 50% of its value in spring (17.10 days/leaf), which only increased by 0.01 day/leaf for each kg of N.

The highest and lowest values of phyllochron were found during winter and spring, respectively, except in the dose of 450 kg of N/ha, which did not differ ($P>0.05$) among seasons.

Table 2. Leaf elongation rate (mm/tiller/day) of *Brachiaria brizantha* cv. Piatã subjected to rotational stocking and nitrogen fertilization during the seasons.

Tabla 2. Tasa de elongación foliar (mm/macollo/día) de *Brachiaria brizantha* cv. Piatã sometida a pastoreo rotativo y fertilización nitrogenada durante las estaciones del año.

Seasons	Nitrogen fertilization (kg/ha)				Regression equations	r^2
	0	150	300	450		
Late Summer/Fall	3.32b	8.81b	13.38b	22.13b	$\hat{Y} = 2.7636 + 0.0406\ N$	0.9792
Winter	1.77c	2.17d	3.07d	3.24d	$\hat{Y} = 1.7693 + .0035\ N$	0.9416
Spring	7.65a	15.59a	20.13a	30.60a	$\hat{Y} = 7.4866 + .0489\ N$	0.9784
Summer	4.09b	4.47c	7.51c	11.50c	$\hat{Y} = 3.1046 + .0168\ N$	0.9036
CV (%)	10.40					

Different letters within a column indicate significant differences ($P\leq0.05$); CV = coefficient of variation.

Letras diferentes dentro de una columna indican diferencias significativas ($P\leq0,05$); CV = coeficiente de variación.

Table 3. Leaf appearance rate (leaf/tiller/day) of *Brachiaria brizantha* cv. Piatã subjected to rotational stocking and nitrogen fertilization during the seasons.

Tabla 3. Tasa de aparición de hojas (hoja/macollos/día) de *Brachiaria brizantha* cv. Piatã sometida a pastoreo rotacional y fertilización nitrogenada durante las estaciones.

Nitrogen fertilization (kg/ha)					
0	**150**	**300**	**450**	**Regression equation**	**r^2**
0.0465	0.0511	0.0792	0.0838	$\hat{Y} = 0.0441 + 0.000094 N$	0.8994
Seasons					
Late summer/fall	Winter	Spring	Summer	CV (%)	
0.072ab	0.043c	0.091a	0.052bc	31.74	

Different letters within a column indicate significant differences ($P \leq 0.05$); CV = coefficient of variation.

Letras diferentes dentro de una columna indican diferencias significativas ($P \leq 0,05$); CV = coeficiente de variación.

Table 4. Phyllochron (days/leaf) of *Brachiaria brizantha* cv. Piatã subjected to rotational stocking and nitrogen fertilization during the seasons.

Tabla 4. Filocrono (días/hoja) de *Brachiaria brizantha* cv. Piatã sometida a pastoreo rotacional y fertilización nitrogenada durante las estaciones.

Seasons	**Nitrogen fertilization (kg/ha)**				**Regression equations**	**r^2**
	0	**150**	**300**	**450**		
Late Summer/Fall	20.43b	11.71b	9.83ab	6.61a	$\hat{Y}= 18.6496 - 0.0288 N$	0.8959
Winter	27.38a	20.57a	15.68a	10.00a	$\hat{Y}= 26.9656 - 0.0380 N$	0.9958
Spring	10.83c	10.24b	8.73b	5.11a	$\hat{Y}= 11.5293 - 0.0124 N$	0.8805
Summer	26.12ab	15.77ab	10.28ab	9.38a	$\hat{Y}= 23.7483 - 0.0371 N$	0.8741
CV (%)	23.00					

Different letters within a column indicate significant differences ($P \leq 0.05$); CV = coefficient of variation.

Letras diferentes dentro de una columna indican diferencias significativas ($P \leq 0,05$); CV = coeficiente de variación.

The LSR and SER were linearly affected ($P<0.05$) by nitrogen fertilization in all seasons (tables 5 and 6, page 50). The highest values of LSR and SER were verified in spring, late summer/autumn, summer and winter, respectively.

The seasons affected ($P<0.05$) the leaf lifespan and number of life leaves (table 7, page 50 and table 8, page 51). The leaf lifespan decreased by 0.06 days for each kg of N applied. On the other hand, the number of live leaves increased by 0.0026 leaves/tiller for each kg of N. The FLL was linearly affected ($P<0.05$) by nitrogen fertilization (table 9, page 51) and increased by 0.063 mm/tiller for each kg of N applied, but it was not affected ($P>0.05$) by season.

Discussion

The highest LER values in spring and late summer/autumn were caused by favorable climatic conditions, such as light, temperature, nutrient availability and mainly, water availability, as the greatest rainfall was recorded during this period (figures 1, 2 and 3, page 45).

Table 5. Life lifespan (days) of *Brachiaria brizantha* cv. Piatã subjected to rotational stocking and nitrogen fertilization during the seasons.

Tabla 5. Vida media foliar (días) de *Brachiaria brizantha* cv. Piatã sometida a pastoreo rotacional y fertilización nitrogenada durante las estaciones del año.

Nitrogen fertilization (kg/ha)					
0	**150**	**300**	**450**	**Regression equation**	**r^2**
65.75	54.50	45.75	39.00	$\hat{Y}= 64.6000 - 0.0593\ N$	0.9873
Seasons					
Late Summer/Fall	Winter	Spring	Summer	CV (%)	
52.33ab	58.83a	47.25b	46.58b	19.01	

Different letters within a column indicate significant differences ($P \leq 0.05$); CV = coefficient of variation.

Letras diferentes dentro de una columna indican diferencias significativas ($P \leq 0{,}05$); CV = coeficiente de variación.

Table 6. Number of live leaves (leaves/tiller) of *Brachiaria brizantha* cv. Piatã subjected to rotational stocking and nitrogen fertilization during the seasons.

Tabla 6. Número de hojas vivas (hojas/macollo) de *Brachiaria brizantha* cv. Piatã sometida a pastoreo rotacional y fertilización nitrogenada durante las estaciones.

Nitrogen fertilization (kg/ha)					
0	**150**	**300**	**450**	**Regression equation**	**r^2**
3.18	3.48	3.73	4.44	$\hat{Y}= 3.1056 + 0.0026\ N$	0.9355
Seasons					
Late Summer/Fall	Winter	Spring	Summer	CV (%)	
3.69b	3.40b	4.74a	3.00b	20.70	

Different letters within a column indicate significant differences ($P \leq 0.05$); CV = coefficient of variation.

Letras diferentes dentro de una columna indican diferencias significativas ($P \leq 0{,}05$); CV = coeficiente de variación.

Table 7. Leaf senescence rate (mm/tiller/day) of *Brachiaria brizantha* cv. Piatã subjected to rotational stocking and nitrogen fertilization during the seasons.

Tabla 7. Tasa de senescencia de la hoja (mm/macollo/día) de *Brachiaria brizantha* cv. Piatã sometida a pastoreo rotacional y fertilización nitrogenada durante las estaciones**.**

Seasons	**Nitrogen fertilization (kg/ha)**				**Regression equations**	**r^2**
	0	**150**	**300**	**450**		
Late Summer/Fall	1.82b	7.31b	11.88b	20.62b	$\hat{Y}= 1.2636 + 0.0406\ N$	0.9792
Winter	0.57c	0.67d	1.57d	1.74d	$\hat{Y}= 0.4793 + 0.0029\ N$	0.8911
Spring	6.15a	14.09a	18.63a	29.10a	$\hat{Y}= 5.9866 + 0.0489\ N$	0.9784
Summer	2.59b	2.97c	6.01c	10.00c	$\hat{Y}= 1.6046 + 0.0168\ N$	0.9036
CV (%)	6.20					

Different letters within a column indicate significant differences ($P \leq 0.05$); CV = coefficient of variation.

Letras diferentes dentro de una columna indican diferencias significativas ($P \leq 0{,}05$); CV = coeficiente de variación.

Table 8. Final leaf length (mm/tiller) of *Brachiaria brizantha* cv. Piatã subjected to rotational stocking and nitrogen fertilization during the seasons.

Tabla 8. Longitud final de la hoja (mm/macollo) de *Brachiaria brizantha* cv. Piatã sometida a pastoreo rotacional y fertilización nitrogenada durante las estaciones.

Nitrogen fertilization (kg/ha)					
0	**150**	**300**	**450**	**Regression equation**	**r²**
147.58	163.89	156.83	176.56	$\hat{Y}$= 147.11 + 0.0626 N	0.9867
Seasons					
Late Summer/Fall	Winter	Spring	Summer	CV (%)	
163.85a	157.16a	166.15a	157.69a	15.84	

Different letters within a column indicate significant differences (P≤0.05); CV = coefficient of variation.

Letras diferentes dentro de una columna indican diferencias significativas (P≤0,05); CV = coeficiente de variación.

Table 9. Stem elongation rate (mm/tiller/day) of *Brachiaria brizantha* cv. Piatã subjected to rotational stocking and nitrogen fertilization during the seasons.

Tabla 9. Tasa de elongación del tallo (mm/macollo/día) de *Brachiaria brizantha* cv. Piatã sometida a pastoreo rotacional y fertilización nitrogenada durante las estaciones.

Seasons	**Nitrogen fertilization (kg/ha)**				**Regression equations**	**r²**
	0	**150**	**300**	**450**		
Late Summer/Fall	0.83b	2.20b	3.34b	5.53b	$\hat{Y}$= 0.6923 + 0.0101 N	0.9794
Winter	0.44c	0.54d	0.76d	0.81d	$\hat{Y}$= 0.4440 = 0.0000 N	0.9437
Spring	1.91a	3.90a	5.03ª	7.65a	$\hat{Y}$= 1.8746 + 0.0122 N	0.9784
Summer	1.02b	1.12c	1.88c	2.88c	$\hat{Y}$= 0.7766 + 0.0042 N	0.9044
CV (%)	5.54					

Different letters within a column indicate significant differences (P≤0.05); CV = coefficient of variation.

Letras diferentes dentro de una columna indican diferencias significativas (P≤0,05); CV = coeficiente de variación.

Leaf expansion is one of the most sensitive physiological processes to drought, as it interrupts leaf and root elongation long before photosynthetic processes and cell division are affected (12, 24). The LER is directly related to the recovery speed of the leaf area index of the pasture after grazing (2). Thus, the increase of nitrogen fertilization promotes a faster recovery of the remaining leaf area index, reducing the grazing interval and consequently promoting an increase in the number of grazing cycles, ensuring a perennial pasture.

According to Duru and Ducrock (2000) the influence of nitrogen on LAR can be viewed as the result of a combination of several factors such as sheath height, leaf elongation and temperature. Thus, nitrogen stimulates the growth of the plant, with consequent elongation of the internodes. It can be inferred that the increase in nitrogen fertilization associated with grazing management based on light interception (LI 95%) and variable stocking rate allowed greater control of stem elongation. This management allows the new leaf to be pushed out of the leaf sheath, promoting the increase of LAR (13).

The highest LAR values in spring and late summer/fall can be explained by the occurrence of better climatic conditions observed in spring and late summer/autumn (figures 1 and 2, page 45) and the time of nitrogen fertilization (20). The results of phyllochron are in agreement with LAR because the larger the phyllochron the longer the time necessary for the expansion of a new leaf blade (25).

The development of stems increases the forage mass with a negative influence on pasture structure and light competition, compromising the grazing efficiency due to the decrease in the leaf:stem ratio (4, 18). The highest LSR during spring likely resulted from the higher rainfall (figure 1, page 45) associated with nitrogen fertilization, causing the plant begins senescence due to nutrient translocation for the expansion of new leaf blades (10). Thus, there was an acceleration of the biomass flow providing high LSR during this season.

The LSR is a very important morphogenetic characteristic in pasture management under rotational stocking especially when submitted to high nitrogen doses (22). The control of this characteristic by means of adjustment in the stocking rate, duration of grazing period and resting the pastures allows the loss of leaf tissue due to the senescence process being minimized (9). Thus, it can be inferred that grazing management using ecophysiological concepts (LI95%) allows the ideal grazing interval to occur when the greatest accumulation of leaves happens, but before the beginning of an accentuated accumulation of stem and dead material (2) promoting greater forage harvest efficiency.

A reduction of 59% in the leaf lifespan was found when comparing pastures without N fertilization and with 450 kg of N/ha. These results show that grasses without N fertilization use the maintenance of live leaves longer in detriment of the expansion of new leaves, as a survival strategy (table 2, page 48). On the other hand, the reverse occurs with high doses of N due to intense leaf renewal (9).

Nitrogen activity in FLL can be explained by the increase in the number of dividing cells, stimulating the production of new cells and providing an increase in LER (table 2, page 48), which contributed to changes in FLL (4) and the maintenance of a perennial pasture.

Conclusions

Fertilization with nitrogen positively affects morphogenetic and structural characteristics of Piatã grass under rotational stocking. This effect can be optimized during rainy periods in spring and late summer/autumn.

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