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Tillering and characterisation of tillers on marandu palisadegrass deferred and fertilised with nitrogen

Perfilhamento e caracterização de perfilhos do capim-marandu diferido e adubado com nitrogênio

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Highlights:
Deferred marandu palisadegrass tillers present high survival.
Nitrogen has no effect on tillering when canopies stay deferred for long periods.
Nitrogen improves the tiller structure in the shortest deferment period.
Nitrogen increases tiller number and weight in the deferred canopy.

Abstract

Evaluations of tillering dynamics and characteristics of the individual tillers allow the changes that occur in the growth and structure of the deferred and nitrogen (N) fertilised pasture to be understood. This work was carried out to evaluate the tillering and morphological characteristics of basal tillers in deferred canopies of *Brachiaria brizantha* syn. *Urochloa brizantha* cv. Marandu (marandu palisadegrass) submitted to two N doses (50 and 200 kg ha^{-1}). The evaluations were carried out at the beginning, middle and end of the deferment period. The experimental design was completely randomised in split-plot design with four replications. Tiller appearance rate (TAR) was higher at the beginning than in the middle and at the end of the deferment period, contrary to that observed for the number and weight of the tiller. Tiller mortality rate (TMR) was higher at the end than at the beginning and in the middle of the deferment period. The tiller population stability index (SI) was similar at the beginning and middle, but lower at the end of the deferment period. The leaf area of the tiller was higher in the middle compared to at the beginning and end of deferment. N dose did not influence TAR, TMR and SI. The canopy fertilised with 200 kg ha^{-1} of N presented a higher number and weight of tiller compared to the canopy fertilised with 50 kg ha^{-1} of N. The N increases the number and weight of tillers, but does not change tillering dynamics during the deferment period for marandu palisadegrass. The tillering decreases and the morphological composition of the tiller worsens with the increase in the deferment period in marandu palisadegrass.

Key words: *Brachiaria brizantha*. Morphological composition. Stability index. *Urochloa brizantha*.

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Resumo

As avaliações da dinâmica do perfilhamento e das características dos perfilhos individuais permitem compreender as modificações que ocorrem no crescimento e na estrutura do pasto diferido e adubado com nitrogênio (N). Este trabalho foi realizado para avaliar o perfilhamento e as características morfológicas dos perfilhos basais em dosséis diferidos de *Brachiaria brizantha* syn. *Urochloa brizantha* cv. Marandu (capim-marandu) submetidos a duas doses de N (50 e 200 kg ha^{-1}). As avaliações foram realizadas no início, meio e fim do período de diferimento. O delineamento experimental foi inteiramente casualizado, em esquema de parcela subdividida, com quatro repetições. A taxa de aparecimento de perfilho (TApP) foi maior no início do que no meio e fim do período de diferimento, contrariamente ao observado para o número e o peso do perfilho. A taxa de mortalidade de perfilho (TMoP) foi maior no fim do que no início e meio do período de diferimento. O índice de estabilidade (IE) de perfilhos foi semelhante no início e meio, mas inferior no fim do período de diferimento. A área foliar do perfilho foi maior no meio, em comparação ao início e fim do diferimento. A dose de N não influenciou a TApP, a TMoP e o IE. O dossel adubado com 200 kg ha^{-1} de N apresentou maiores peso e número de perfilhos, em comparação ao dossel adubado com 50 kg ha^{-1} de N. O N aumenta o número e o peso de perfilhos, mas não modifica a dinâmica do perfilhamento durante o período de diferimento do capim-marandu. O perfilhamento e a percentagem de lâmina foliar viva do perfilho diminuem com o aumento do período de diferimento do capim-marandu.

Palavras-chave: *Brachiaria brizantha*. Composição morfológica. Índice de estabilidade. *Urochloa brizantha*.

Introduction

In addition to the low forage production in autumn and winter, there is also greater senescence of tropical forage grasses (R. M. Carvalho et al., 2016), due, among other factors, to the water scarcity prevailing at that time. Thus, the structure of the pasture, understood by the way in which the pasture is made available to grazing animals (P. C. F. Carvalho, 2013), becomes unfavourable for animal consumption and performance at this time (Euclides, Montagner, Barbosa, Valle, & Nantes, 2016).

To partially minimise the negative effects of low forage yield and inadequate pasture structure during winter months, pasture deferment can be utilised (Silva, Montagner, Euclides, Queiroz, & Andrade, 2016). This management strategy consists of excluding from grazing an area of pasture at the end of the period of highest pasture growth (late summer and/or early autumn in the Southeast and Midwest of Brazil), postponing forage harvest by the animal to the winter.

A deferred forage grass pasture is formed by a population of tillers, which are its development units. The number of tillers in the pasture is determined by the balance between tiller appearance and mortality, which is modified over the deferment period (Santos et al., 2018). In this sense, the balance between tiller appearance and mortality rates is generally positive only during the beginning of the deferment period (Sousa et al., 2019).

The morphological characteristics of individual tillers also vary according to their stage of development. Vegetative basal tillers generally have longer leaf and stem lengths and a higher number of dead leaves when the deferment period is long (Santos et al., 2017). In addition, the number of vegetative tillers decreases, while the number of reproductive tillers increases with the deferment period (Vilela et al., 2013).

In addition to controlling the duration of the deferment period, nitrogen fertilisation is an important management strategy that can be adopted to modulate tiller population dynamics and individual tiller growth during the deferment period

(Alves et al., 2019). Nitrogen stimulates tillering as long as the pasture leaf area index is low, a common situation when the pasture is deferred for a short time (Santos, Fonseca, Balbino, Silva, & Monnerat, 2009). However, with the long deferment period, the positive effect of nitrogen on tillering may not occur due to greater self-shading within the canopy (Santos et al., 2017). The limiting climate, usually common at the end of the deferment period, can also restrict tillering.

Nitrogen fertilisation increases the growth rate of tillers (Alves et al., 2019). However, the rapid development of fertilised tillers worsens its morphological composition due to the higher stem growth and leaf senescence that occurs during the deferment period (Sousa et al., 2012). Thus, to avoid the formation of a deferred pasture structure that is inadequate for grazing and limiting animal performance, it is appropriate to adjust the deferment period according to the nitrogen fertiliser dose applied to the pasture (Santos & Fonseca, 2016).

Given the above, we tried to test the following hypotheses: i) the greater availability of nitrogen in the soil increases the appearance of tillers and improves the structural characteristics of tillers only when the canopy remains deferred for a short period; and ii) when the deferment period increases, nitrogen has no effect on tillering and, moreover, the tiller structure becomes limiting to the grazing animal. Thus, our objective was to understand how nitrogen fertilisation and deferment period modify the tillering dynamics and structural characteristics of the individual tillers of *Brachiaria brizantha* syn. *Urochloa brizantha* cv. Marandu.

Materials and Methods

The experiment was carried out between October 2013 and June 2014 at Capim Branco Experimental Farm, at the Federal University of Uberlândia, Uberlândia - MG (18º53'19"S, 48°20'57" W and 863 metres of altitude).

The climate of the region is Aw, tropical savannah with dry winter season, with an average annual temperature and precipitation of 22.3ºC and 1,584 mm (Alvares, Stape, Sentelhas, Gonçalves, & Sparovek, 2013). Climatic data during the experimental period were obtained from a meteorological station located 200 m from the experiment site (Figure 1A). Average temperature and total rainfall were used to calculate the monthly soil water balance (Thornthwaite & Mather, 1955), considering a soil water storage capacity of 60 mm (Figure 1B).

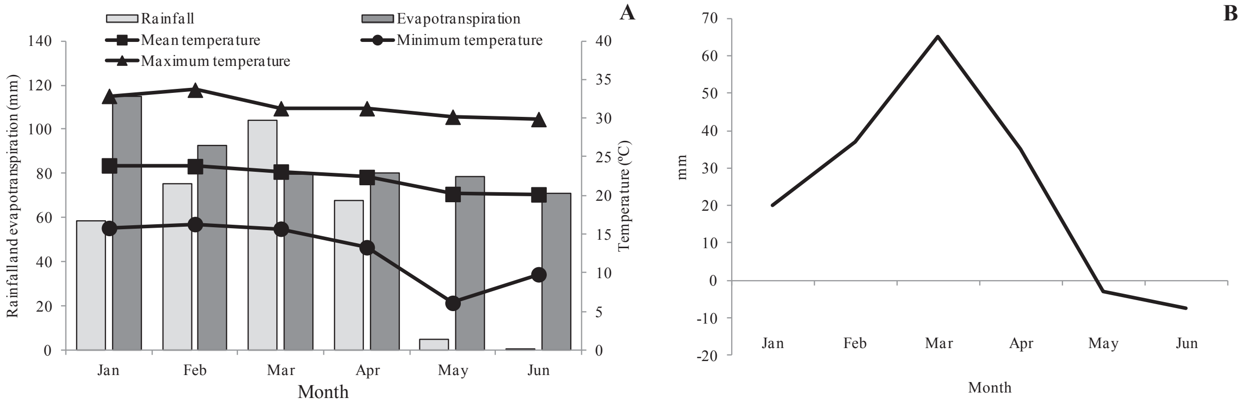

Figure 1. Monthly rainfall, evapotranspiration and average mean, minimum and maximum air temperature (A); and monthly soil water balance (B) from January to June 2014.

The soil of the experimental area was classified as Dystrophic Dark Red Latosol (Empresa Brasileira de Pesquisa Agropecuária [EMBRAPA], 2006). Prior to the implementation of the experiment, the soil was sampled for chemical analysis, in a layer from 0 to 20 cm, which presented the following characteristics: pH em H_2O: 5.5; P: 1.3 mg dm^{-3} (Mehlich-1); K: 75 mg dm^{-3}; Ca^{2+}: 1.7 $cmol_c$ dm^{-3}; Mg^{2+}: 1.1 $cmol_c$ dm^{-3}; Al^{3+}: 0.0 $cmol_c$ dm^{-3} (KCl 1 mol L^{-1}) and P-rem: 11.7 mg dm^{-3}. Based on the results, liming was not required. On January 10, 2014, 50 kg ha^{-1} of K_2O and 50 kg ha^{-1} of P_2O_5 were applied, using potassium chloride and simple superphosphate as sources.

The experimental area consisted of a pasture with *Brachiaria brizantha* syn. *Urochloa brizantha* cv. Marandu (marandu palisadegrass), which was established in 2000 and which had good grass cover. In this area, eight plots of 9 m² each were marked, in which the marandu palisadegrass was kept at a height of 30 cm (Silva et al., 2013) from October 2013 to March 2014. For this, weekly cuts were made and excess forage was removed from the interior of the plots. From 03/15/2014 to 06/15/2014, all plots remained freely growing, uncut, in order to simulate the deferred canopy.

Two nitrogen (N) fertilisation strategies were evaluated: a low dose, corresponding to 50 kg ha^{-1} of N applied on 03/15/2014, and a high dose consisting of 200 kg ha^{-1} of N, split into three applications prior to the deferment period (80 kg ha^{-1} on 01/10/2014; 70 kg ha^{-1} on 02/17/2014; and 50 kg ha^{-1} on 3/15/2014). Urea was used as a source of fertiliser and fertilisation occurred in the late afternoon. Each fertilisation strategy was implemented in four plots.

To evaluate the tillering dynamics, at the beginning of the deferment period (03/15/2014), two rings were demarcated with an area of 0.07 m² per plot, using a 30 cm PVC ring, which was fixed to the soil with metal clamps. All tillers were counted and marked with coloured plastic coated wire. Subsequently, every 30 days and until the end of the deferment period, the new tillers were counted and marked with plastic coated wire of different colours to identify each tiller's generation. With these data, we calculated the appearance (TAR) and mortality (TMR) rates of tillers (Sbrissia et al., 2010). The balance (BAL) between the TAR and TMR was also calculated in each month, by subtracting the variables. The stability index (SI) of the tiller population was calculated by the equation SI = TSR (1 + TAR) (Bahmani, Thom, Matthew, Hooper, & Lemaire, 2003), where TSR corresponds to tiller survival rate and was calculated as the difference between 100 and TMR. All of these characteristics of the tiller population dynamics were evaluated at the beginning (1 to 30 days), middle (31 to 60 days) and end (61 to 90 days) of the deferment period.

At the beginning (first day), middle (45th day) and end (90th day) of the deferment period, characterisation of the individual tillers of marandu palisadegrass was performed. For this, 50 tillers per plot were randomly harvested, and their live leaf blades, dead leaf blades and living stems were separated. The leaf blade region that showed no signs of senescence (green organ) was incorporated into the live leaf blade fraction. The leaf blade region with yellowing and/or necrosis was incorporated into the dead leaf blade fraction. Subsamples of the morphological components of the tillers were placed in paper bags, dried in a forced ventilation oven at 65°C for 72 hours and weighed. With these data, the percentages of the morphological components and the average tiller weight were calculated.

To determine the leaf area of the tillers, 40 leaf blades were harvested from each plot. The ends of each leaf blade were cut to an approximately rectangular shape. Lengths and widths were measured to estimate the area of each leaf blade segment. Then, the rectangular segments of the leaf blades were placed in paper bags and placed in a forced ventilation oven at 65ºC for 72 hours and weighed after this period. With the leaf segment area and weight data, the specific leaf area (SLA in cm^2 mg^{-1}) was calculated. The leaf area of each tiller

(LAT) was calculated by the following equation: LAT = live leaf blade mass of tiller x SLA.

The numbers of vegetative and reproductive tillers were only determined at the end of the deferment period by counting the tillers present within a 25 cm by 50 cm rectangular frame, in two locations per plot. Tillers with inflorescence were considered reproductive and those without a flag leaf or inflorescence were considered vegetative.

Data were subjected to analysis of variance according to a completely randomised design and split plot scheme in time. The nitrogen fertilisation strategies corresponded to the plots. The deferment periods were the subplots. Data were checked for prerogatives to perform the analysis of variance. All analyses were performed at a significance level of up to 5% probability for the occurrence of type I error; once significant effects were detected, the means were compared by Tukey test.

Results and Discussion

Except for the response variables related to the morphological composition of the tillers, all other characteristics evaluated in this study were influenced ($P < 0.05$) in isolation by the fertilisation strategy and the deferment period.

Tiller appearance rate (TAR) was higher at the beginning than in the middle and at the end of the deferment period, while the tiller mortality rate (TMR) was higher at the end compared to the beginning and middle of the deferment period. (Table 1). At the beginning of the deferment period, due to the lower canopy height, it is likely that marandu palisadegrass presented a higher incidence of light at the base of the plants. The higher quantity and better quality of light stimulate the development of basal buds in new tillers (Deregibus, Sanchez, & Casal, 1983), which favours the increase in TAR. However, with the development of the forage canopy in the middle and at the end of the deferment period, shading increased within the canopy, which probably inhibited tillering (Matthew, Assuero, Black, & Sackville Hamilton, 2000). Moreover, in this condition of greater self-shading, many younger and smaller tillers are shaded by older and larger tillers, which causes the death of the first (Sousa et al., 2013). As a result of the low TAR, added to the higher TMR at the end of the deferment period, the balance between TAR and TMR was negative and the SI was lower in this period (Table 1).

Table 1
Characteristics of tiller and tillering dynamics during the deferment period of nitrogen(N)-fertilized marandu palisade grass

Characteristic	Deferment period			MSE	N (kg ha^{-1})		MSE
	Beginning	Middle	End		50	200	
TAR	10.5 a	7.8 b	6.4 b	1.0	8.9 A	7.5 A	0.5
TMR	4.7 b	2.7 b	8.3 a	1.4	6.5 A	3.9 A	0,9
BAL	5.8 a	5.1 a	-1.9 b	2.1	2.4 A	3,6 A	0.4
SI	1.05 a	1.05 a	0.98 b	0,02	1.02 A	1,03 A	0.004
TN	944 b	1,026 a	1,031 a	24.4	846 B	1,153 A	108.5
Weight	0.8 b	1.1 a	1,1 a	0.1	0.9 B	1.1 A	0.1
LA	43.9 b	64.8 a	50.8 b	5.3	41.2 B	60.1 A	6.7

TAR: tiller appearance rate (% in 30 days); TMR: tiller death rate (% in 30 days); BAL: balance between tiller appearance and death (% in 30 days); SI: stability index; TN: tiller number m^{-2}; Weight: tiller weight (g); LA: tiller leaf area (cm); MSE: mean standard error. For each characteristic, means followed by the same letter on the line do not differ by Tukey's test (P> 0.05).

When SI is 1, the tiller population remains stable. SI values below 1 indicate that the emergence of new tillers is not sufficient in relation to their mortality to maintain population density. On the other hand, values greater than 1 indicate an upward trend in the tiller populations (Bahmani et al., 2003). In this context, it can be stated that there was only instability of the tiller population in the deferred marandu palisadegrass canopies at the end of the deferment period. These results are similar to those obtained by Sousa et al. (2013), in which the SI of basal tillers of *Brachiaria brizantha* syn. *Urochloa brizantha* cv. Piatã was larger than one unit only at the beginning of the deferment period (0 to 30 days). After this initial period, all SI values were below one unit.

It is important to highlight that, although variable during the deferment period, the values of TMR were low magnitude (Table 1), compared to other research studies with marandu palisadegrass managed in continuous stocking, such as that of Caminha et al. (2010) and Sbrissia et al. (2010), who observed TMR during the fall and winter of 19% and 25.5%, respectively. This shows that tillers had high survival in the deferred marandu palisadegrass canopies. Higher tiller survival may be an ecological strategy for nutrient conservation during times when the climate is limited to pasture (Sbrissia et al., 2010), as well as under soil water stress (Figure 1B), where the absorption of nutrients through the plant via mass flow and/or diffusion is hampered (Novaes & Smyth, 1999). Moreover, the high survival of tillers was fundamental to maintaining the population stability of tillers during the deferment period. Even with a decrease in SI at the end of the deferment period, its value (0.98) was very close to one unit (Table 1), which indicates that the tiller population was not compromised.

The high TAR at the beginning of the deferment period caused the tiller population density to increase from the beginning to the middle of this period, but the number of tillers remained similar at the middle and end of the deferment period (Table 1).

Regarding the tiller weight, its values were lower at the beginning of the deferment period. During the deferment period, the tillers produce new leaves and elongate the leaf and stem, which contribute to the increase in tiller weight from the beginning to the middle of the deferment period (Table 1). It is noteworthy that at the beginning of the deferment period the climatic condition was favourable to tiller growth (Figure 1). In addition, competition for light may have intensified from the beginning to the end of the deferment period, which also increases stem elongation (Carnevalli et al., 2006) and, in effect, tiller weight. In fact, in the canopy fertilised with 200 kg ha^{-1} of N, tillers were constituted by more stems in the middle and end of the deferment period, compared to the beginning (Table 2). On the other hand, from the middle to the end of the deferment period, the tiller weight did not increase, but remained stable (Table 1). It is possible that the higher average age of tillers in deferred canopies from the middle of the end of deferment period contributed to this response pattern, since it is known that old tillers grow less than young tillers (Paiva, Silva, Pereira, Mesquita, & Guarda, 2011).

The higher leaf growth rate of the tillers at the beginning of the deferment period caused the leaf area to increase from the beginning to the middle of the deferment period (Table 1), a response pattern that was similar to that observed for the percentage of live leaf blades of the tillers fertilised with 50 kg ha^{-1} of N (Table 2). The increasing leaf area of tillers increases the leaf area index and, consequently, increases light interception by forage canopy, a premise for photosynthesis and forage production. However, from the middle to the end of the deferment period, the tiller leaf area decreased, and its percentage of dead leaf blade increased in the canopy fertilised with 200 kg ha^{-1} N (Table 2), which may be a consequence of the larger shading within the canopy (Carnevalli et al., 2006), as well as by drier weather (R. M. Carvalho et al., 2016). In this condition, it is likely that many leaves received less light than their light compensation point, which results in a respiration rate higher than their photosynthetic rate (Taiz & Zeiger, 2013) and, in effect, causes leaf senescence. In this context, Santos, Fonseca, Gomes, Balbino and Magalhães (2010), working with *Brachiaria decumbens* cv. Basilisk, also found that leaf senescence intensified after a 45 day deferment period, resulting in increased dead material mass in deferred pastures.

Table 2
Morphological composition of deferred and nitrogen fertilized marandu grass tillers (N)

Dose of N (kg ha^{-1})	Deferral Period			MSE
	Beginning	Middle	End	
		Live Leaf Blade (%)		
50	27,2 bB	31,6 aA	24,8b A	1,7
200	32,6 aA	35,2 aA	25,5 bA	2,5
		Live stem (%)		
50	41,9 aA	40,6 aA	43,5 aA	0,7
200	40,5 bA	44,8 aA	44,8 aA	1,2
		Dead Leaf Blade (%)		
50	31,0 aA	27,9 aA	31,7 aA	1,0
200	26,9 aB	20,1 bB	29,8 aA	2,5

MSE: mean standard error. For each characteristic, means followed by the same letter on the line do not differ by Tukey's test (P> 0.05).

Regarding the effects of nitrogen (N), it was found that nitrogen fertilisation did not change the characteristics of tillering dynamics (Table 1) during the deferment period. This response pattern occurred because the leaf area index and, in effect, the shading within the marandu palisadegrass canopy probably increased during the deferment period. In this condition, the positive effect of N on TAR becomes null or less pronounced (Santos et al., 2009). This factor may have contributed to the absence of N effects on tillering dynamics characteristics (Table 1). Sousa et al. (2019) also found that nitrogen fertilisation did not change the descriptive characteristics of tillering dynamics during the deferment period of *Brachiaria brizantha* syn. *Urochloa brizantha* cv. Piatã. According to these authors, climatic conditions restricting plant growth in late fall and winter, when piatã palisadegrass remained deferred, had a prevalent inhibitory effect on tillering, nullifying the possible N stimuli on this process.

It is possible that the positive effects of N on tillering occurred before the deferment period, when the nitrogen fertilisation was split in the 200 kg ha^{-1} N fertiliser canopy and the marandu palisadegrass was low (30 cm). Therefore, since the beginning of the tillering dynamics evaluation, at the beginning of the deferment period, the tiller population density was higher in the canopy under 200 kg ha-^{1} of N compared to that fertilised with 50 kg ha^{-1} of N (Figure 2). The largest tiller number of canopy fertilised with 200 kg ha^{-1} of N remained throughout the experimental period when compared to the canopy fertilised with 50 kg ha^{-1} of N (Table 1).

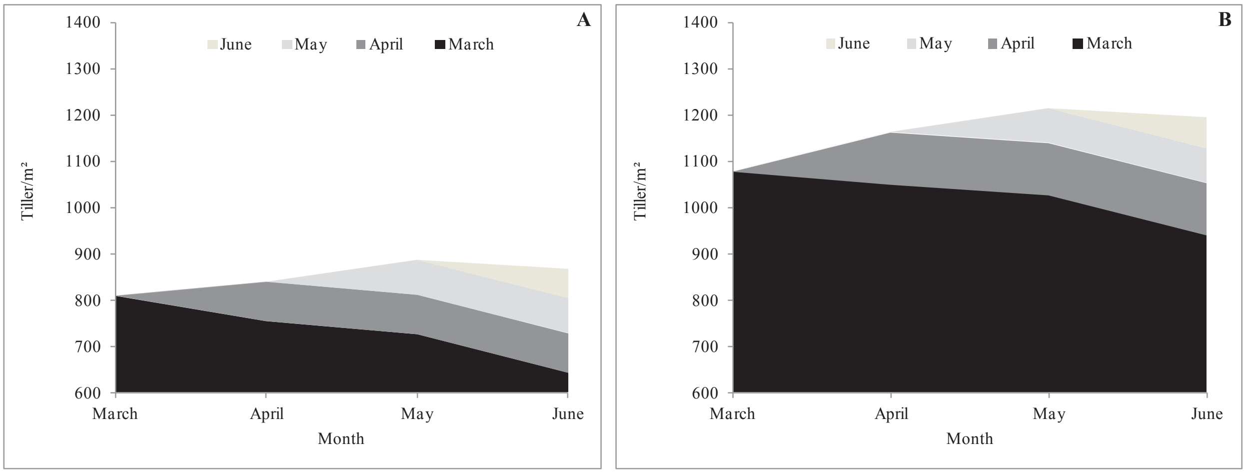

Figure 2. Variation in the number of tillers generations during the deferment period of marandu palisadegrass fertilized with 50 (A) or 200 kg ha^{-1} (B) of nitrogen.

The response patterns of the numbers of different tiller generations during the deferment period were similar between canopies, with the number of tillers rising from March to May and decreasing in June 2014 (Figure 2). However, the magnitude of variations in the number of different tiller generations during the deferment period fluctuated between canopies, occurring more markedly in that managed with 200 kg ha^{-1} N (Figure 2).

Throughout the deferment period, the number of tillers was higher in marandu palisadegrass fertilised with 200 kg ha^{-1} of N, compared to that fertilised with 50 kg ha^{-1} of N, as shown in Figure 2. Sousa et al. (2013) also found an increase in the number of total tillers in the deferred canopy of *Brachiaria brizantha* syn. *Urochloa brizantha* cv. Piatã fertilised with 150 kg ha^{-1} of N, compared to the canopy without nitrogen fertilisation. The higher population density of vegetative tillers in the canopy fertilised with 200 kg ha^{-1} of N can be attributed to the fact that N increases the leaf appearance rate of tropical forage grass. When a new leaf appears on the plant, a new axillary bud appears, with potential to develop in tillers (Santos et al., 2011).

Regarding reproductive tillers, the opposite response pattern ($P < 0.05$) occurred (68 and 106 tillers m^{-2} in the canopies fertilised with 200 and 50 kg ha^{-1} of N, respectively). Fernandes and Rossiello (1995) and Cunha, Rossiello, Carvalho and Almeida (2008) also found the same response pattern. These authors argued that N deficiency causes forage plants to reproduce earlier, shortening their life cycle and reproducing earlier.

Fertilisation with 200 kg ha^{-1} of N resulted in higher weight forage canopies and leaf area of tillers, compared to the canopy that received 50 kg ha^{-1} of N (Table 1). This may have been due to the positive effect of N on leaf elongation and appearance, as well as stem elongation (Paiva et al., 2011; Alves et al., 2019). The greater elongation and leaf appearance also justifies the higher percentage of live leaf blade during the beginning of the deferment period in the canopy fertilised with 200 kg ha^{-1} N, compared to canopy with 50 kg ha^{-1} N (Table 2).

With the highest N dose, there was a lower percentage of dead leaf blade in tillers during the beginning and middle of the deferment period (Table 2). Possibly, in environments with moderate availability of growth factors (temperature, water, light, etc.), as seen during the initial half of the deferment period, N increases the leaf lifespan. Garcez et al. (2002), working with *Panicum maximum* cv. Mombaça, also verified an increase in leaf lifespan with N fertilisation. According to these authors, the mechanism of action of N in prolonging leaf lifespan may be associated with maintaining its higher photosynthetic capacity for longer periods.

Some practical implications of the results obtained in our work are the following: (i) the concomitant increase in tiller number and weight with the application of higher N dose in the deferred forage canopy (Table 1) contributes to the increase of commonly observed forage mass in deferred pastures fertilised with N (Sousa et al., 2012); (ii) the higher number of tillers in the deferred and fertilised canopy with 200 kg ha^{-1} of N (Table 1) may also result in pasture with higher forage density, which may increase the bite mass of grazing animals (P. C. F. Carvalho, 2013); (iii) the higher tiller weight in the deferred canopy and fertiliser with higher N dose (Table 1) can make the deferred pasture more predisposing to tipping, with negative effects on pasture structure and grazing efficiency; and (iv) the long deferment period increases weight and worsens the morphological composition of tillers; therefore, reducing this period constitutes an effective management strategy to improve the pasture structure (Santos, Fonseca, & Sousa, 2016).

Based on the results presented, our hypothesis was partially proven. As hypothesised, when the deferment period increases, N has no effect on tillering, and the structure of tillers generally becomes more limiting to grazing animals (Table 2). However, N did not increase the appearance of tillers at the beginning of the deferment period, although it improved the structural characteristics of tillers when the canopy remained deferred for a short period (Table 2).

Conclusions

Nitrogen application increases population density and canopy tiller weight, but does not modify tillering dynamics during the *Brachiaria brizantha* syn. *Urochloa brizantha* cv. Marandu deferment period. The tillering and the percentage of live leaf blade of the tillers decrease with the increase of the deferment period of *Brachiaria brizantha* syn. *Urochloa brizantha* cv. Marandu.

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