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Reduction of sward height in the fall/winter as strategy to optimize tillering in *Urochloa brizantha* syn. *Brachiaria brizantha*

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SUMMARY

The evaluation of tillering dynamics is important to understand the effects of defoliation strategies and climate on forage production and perenniality of the sward. Therefore, the objective of this study was to identify defoliation strategies that optimize the tillering of marandu palisadegrass through the year. Three defoliation strategies were evaluated: sward with 15 cm in fall/winter and 30 cm in spring/summer; 45 cm in fall/winter and 30 cm in spring/summer; and 30 cm during the entire experimental period. Tiller appearance (TAR), mortality (TMR), and survival (TSR) rates; the balance (BAL) between TAR and TMR; stability index (SI); and tiller density (TD) were evaluated monthly and grouped into the seasons: winter, early spring, late spring, and summer. A completely randomized design with four replicates was adopted. In summer and early spring, TAR, SI, and TD were higher than in winter and late spring. Winter was characterized by unfavorable climatic conditions to plant growth, such as low precipitation and temperature, and in summer there was a short period of rainfall scarcity. The defoliation strategies in fall/winter did not influence tillering dynamics. The marandu palisadegrass with 15 cm in fall/winter showed a greater TD than that with 45 cm. To increase TD, marandu palisadegrass can be maintained at 15 cm in fall/winter, and at 30 cm in summer.

ADDITIONAL KEYWORDS

Defoliation management.
Season of the year.
Tiller.
Marandu palisadegrass.

Redução da altura do dossel no outono/inverno como estratégia para otimizar o perfilhamento do *Urochloa brizantha* syn. *Brachiaria brizantha*

RESUMO

A avaliação da dinâmica de perfilhamento é importante para compreender os efeitos das estratégias de desfolhação e clima na produção de forragem e perenidade do pasto. Dessa forma, objetivou-se identificar estratégias de desfolhação que otimizem o perfilhamento do capim-marandu durante o ano. Três estratégias de desfolhação foram avaliadas: dossel com 15 cm no outono/inverno e 30 cm na primavera/verão; 45 cm no outono/inverno e 30 cm na primavera/verão; dossel com 30 cm durante todo período experimental. Mensalmente, foram avaliadas as taxas de aparecimento (TApP), mortalidade (TMoP) e sobrevivência (TSoP) de perfilhos, o balanço (BAL) entre a TApP e a TMoP, o índice de estabilidade (IE) e a densidade populacional de perfilhos (DPP), e foram agrupados nas épocas: inverno, início de primavera, final de primavera e verão. Adotou-se o delineamento inteiramente casualizado, com quatro repetições. O inverno foi caracterizado por condições climáticas desfavoráveis para o crescimento das plantas, como a baixa precipitação e temperatura, e no verão, houve um veranico. No verão e início da primavera, houve maiores TApP, IE e DPP, em relação ao inverno e ao fim da primavera. As estratégias de desfolhação não influenciaram a dinâmica do perfilhamento. O capim-marandu com 15 cm no outono/inverno apresentou maior DPP do que com 45 cm. Para aumentar a DPP, o capim-marandu pode ser mantido com 15 cm no outono/inverno e 30 cm na primavera/verão.

PALAVRAS CHAVE ADICIONAIS

Manejo da desfolhação.
Estação do ano.
Perfilho.
Capim-marandu.

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INTRODUCTION

The genus *Urochloa* syn. *Brachiaria* is the most commonly used for the establishment of pastures in Brazil, which makes it of great importance for the national livestock. Within this genus of forage plants, there is effective participation of *Urochloa brizantha* syn. *Brachiaria brizantha* 'Marandu' (palisadegrass). According to Barbosa (2006), there are 60 million hectares of pastures formed by marandu palisadegrass, which represents 65% of the pasture area planted in the north region and 50% in the center-west region of Brazil. These data reinforce the importance of studying the dynamics of growth and perennialization of marandu palisadegrass as basis for its proper management (falho *et al.*, 2012).

Pastures are composed of plant populations, whose growth units are the tiller (Hodgson, 1990). Although the pasture is perennial, its tillers have a limited lifespan, usually shorter than one year (Matthew *et al.*, 2000). Thus, to ensure the perenniality and growth of the plant population in the pasture, the number of dead tillers must be compensated for by the emergence of new tillers.

In this sense, evaluations of the tillering demographic patterns (Portela *et al.*, 2011), associated with measurements of the plant development (Giacomini *et al.*, 2009) and of the grazing animal (Hernandéz-Garay *et al.*, 2014), have been crucial to the identification and recommendation of appropriate defoliation strategies for tropical forage grasses. Based on this knowledge, the amplitude of heights recommended for the management of the marandu palisadegrass pasture under continuous stocking is 20 to 40 cm during the seasons with climate favorable to plant growth (Sbrissia *et al.*, 2010; Da Silva *et al.*, 2013). In this range, the pasture displays high rates of forage accumulation and has favorable structure to the forage intake and performance of grazing cattle.

However, the development of the marandu palisadegrass is influenced by the interaction between seasons of the year and pasture-management strategies (Sbrissia and Da Silva, 2008; Caminha *et al.*, 2010; Lara and Pedreira, 2011). This fact indicates that the pasture management should be contextualized to the seasons of the year aiming to optimize forage production, because a single management action would not be sufficient and advantageous under different abiotic conditions (Santos *et al.*, 2013).

Maintaining the marandu palisadegrass lower during the fall and winter, compared with the spring and summer, could increase the incidence of light at the base of the plants, and would thus stimulate tillering, as compared with the maintenance of the marandu palisadegrass at a constant height and within the recommended range throughout all seasons of the year (Sbrissia and Da Silva, 2008). In contrast, greater senescence might occur with the pasture taller in the seasons with adverse climate to the plant (Santos *et al.*, 2011a), which would increase the accumulation of dead tissues at the plant base, with consequent reduction in the amount of incident light on the basal buds, a factor that may inhibit the appearance of new tillers (Matthew *et al.*, 2000; Martuscello *et al.*, 2009), especially in the spring.

In this scenario, the knowledge of the tillering pattern, of its variation between the seasons of the year and in response to the defoliation strategies, makes it possible to identify management strategies that optimize the dynamics of appearance and mortality of tillers, which is the basic condition to ensure the stability and productivity of the plant population in the pasture (falho *et al.*, 2012). Therefore, this study was conducted to identify defoliation-management strategies that optimize the tillering of marandu palisadegrass during the seasons of the year.

MATERIAL AND METHODS

The experiment was conducted from March 2013 to March 2014, on the Capim Branco farm, belonging to the Faculty of Veterinary Medicine of the Federal University of Uberlândia, in Uberlândia, MG State, Brazil. The approximate geographic coordinates of the experiment site are 18°30′ S latitude and 47°50′ W longitude, at an altitude of 776 m (a.s.l.). The climate in the region of Uberlândia, according to the Köppen (1948) classification, is a Cwa altitude tropical type, with mild and dry winters and well-defined dry and rainy seasons. The average annual temperature is 22.3 ºC, between 23.9 and 19.3 ºC mean maximum and minimum, respectively. The average annual precipitation is 1,584 mm.

The experiment was developed on a pasture covered with *Urochloa brizantha* syn. *Brachiaria brizantha* cv. Marandu (palisadegrass), established in the year 2000 on a Red Latosol distrofic, clayey, managed with cattle and without degradation characteristics, in which 12 plots (experimental units) with an area of 12 m^2 each, were delimited. A border area of 0.5 m was discarded;

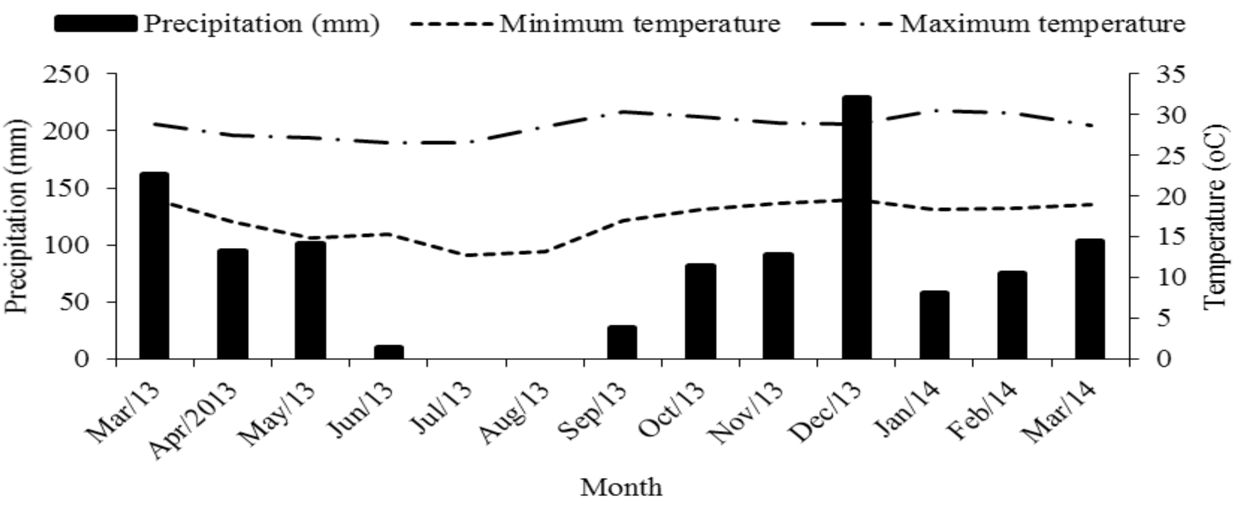


Figure 1. Monthly mean minimum and maximum temperatures and precipitation from March 2013 to March 2014 (Médias mensais de temperaturas mínima e máxima diárias e precipitação pluvial durante março de 2013 a março de 2014).

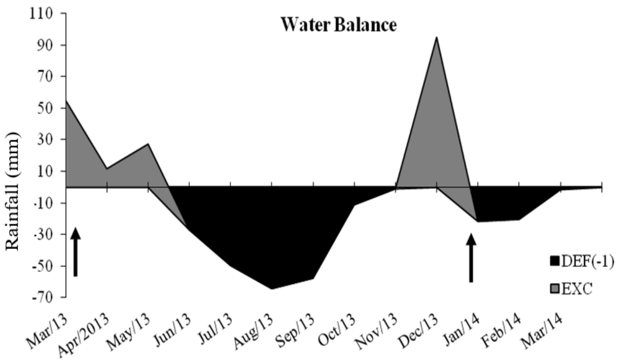


Figure 2. Summary of the water balance in the soil from March 2013 to March 2014. Arrows indicate the time when fertilization was applied. DEF (-1) = Deficit; EXC = Excess (Balanço do extrato hídrico no solo durante março de 2013 a março de 2014. As setas indicam as épocas em que foram feitas as adubações. DEF (-1) = Déficit; EXC = Excesso).

the ground area for evaluation of each experimental period was 8.75 m^2.

Information referring to the climatic conditions during the experimental period was monitored at the meteorological station, located approximately 200 m from the experimental area **(figures 1** and **2)**.

Before the implementation of the experiment, soil samples from the 0-10 cm layer were collected, and the chemical characteristics were: pH in H_2O - 6.1; P - 9.4 mg/dm^3 (Mehlich-1); K^+ - 156 mg/dm^3; Ca^{2+} - 5.5 $cmol_c/dm^3$; Mg^{2+} - 1.7 $cmol_c/dm^3$; Al^{3+} - 0.0 $cmol_c/dm^3$(KCl 1 mol/L); effective CEC - 7.6; CEC at pH 7.0 - 10.3; and base saturation -74%. Based on these results, 70 kg/ha P_2O_5 and 50 kg/ha N and K_2O were applied in February 2013. These same amounts were applied again in January 2014. Urea, single superphosphate, and potassium chloride were used as fertilizers, by the broadcasting method.

Three defoliation management strategies were evaluated, characterized by the heights at which the marandu palisadegrass was maintained during the fall and winter (15, 30, or 45 cm). In the other seasons of the year (spring and summer), the marandu palisadegrass was maintained at 30 cm. Thus, in one of the strategies the marandu palisadegrass was maintained at 30 cm during the entire experimental period, according to the recommendations of Sbrissia and Da Silva (2008). The second strategy corresponded to the maintenance of the marandu palisadegrass at 15 cm in the fall and winter and at 30 cm in spring and summer. The third strategy consisted of maintaining the marandu palisadegrass at 45 cm in the fall and winter and at 30 cm in spring and summer.

The experimental period in which the evaluations occurred was divided, based on the similar patterns of the response variables, into the following seasons: winter (July, August, and September 2013), early spring (October 2013), late spring (November and December 2013), and summer (January and February 2014). The experimental design was completely randomized, in a split-plot arrangement, with four replicates.

In March 2013, mechanical cuts were made using pruning shears, in order to implement the target heights for the fall and winter, according to the treatment. From this period, the heights began to be monitored — once weekly in the fall and winter, and twice weekly in spring and summer. The sward height was measured in 10 points of the ground area of each plot, using a graduated ruler. The excess forage cut and over the plants was removed manually after each cut. Thus, in each season of the year, the plants were maintained under relatively constant conditions, through frequent mechanical defoliations.

The period from March to June 2013 was considered the adaptation of the plants to the heights. In the beginning of July 2013, the tillering dynamics started to be evaluated in two 0.07 m^2 areas per experimental unit. These areas were delimited using a PVC ring with 30 cm in diameter fixed to the soil by metal clasps. All tillers were initially marked with one color, named base generation (BG). After 30 days, the number of live tillers within the ring originating from the BG was counted, and the dead ones were calculated by the difference. The new tillers that emerged every 30 days were marked with different colors, counted, and named first generation (G1), and thus successively every 30 days. With these data, the tiller appearance (TAR), mortality (TMR), and survival (TSR) rates were calculated, expressed in percentage, during 30 days. The TAR corresponded to the number of new tillers (last generation marked), multiplied by 100, and divided by the number of total existing tillers (generations marked previously); TMR consisted of the total number of dead tillers in the last marking, multiplied by 100 and divided by the total number of tillers marked in the previous generations. Tiller survival rate was obtained by subtracting TMR from 100%. The balance between TAR and TMR in each time was calculated by the subtraction of these variables. Based on the original data of count of tillers from the base generation, monthly variation curves on the number of tiller generations in the pastures were generated each month, and the total number of tillers per square meter in the tillering dynamics evaluation area was also calculated.

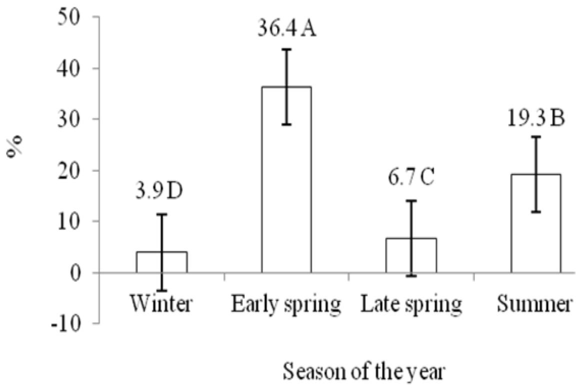
The tiller population stability index was calculated using the equation proposed by Bahmani *et al.* (2003): Fp/Ip = TSR (1 + TAR), where Fp/Ip corresponds to the current or final tiller population (fp), expressed as a percentage of the original or initial tiller population (Ip) at a given evaluation period.

For the analysis of the data, the results were first grouped according to the times of the year (winter, early spring, late spring, and summer). Initially, the dataset was analyzed to check if it met the presuppositions of the analysis of variance (normality and homogeneity). For the statistical presuppositions to be met, the response variable tiller mortality rate had its data transformed using the squared root. The data were analyzed using the MIXED (mixed models) procedure of SAS® (Statistical Analysis System) version 9.2. The matrix of variance and covariance was chosen using Akaike's Information Criterion (Wolfinger, 1993). When appropriate, the treatment means were calculated using the *LSMEANS* statement, and and comparisons made with *PDIFF* based on a Student t test and a 5% significance level.

RESULTS AND DISCUSSION

None of the marandu palisadegrass tillering pattern traits were influenced by the interaction between defoliation strategies and season of the year (p> 0.05). Of these two factors, the defoliation strategy affected tiller density only, whereas the season of the year influenced all the response variables.

Only the season of the year did not affect the tiller appearance rate (TAR) in the marandu palisadegrass (p< 0.0001) **(figure 1)**. Tiller appearance rate had its lowest value in the winter and the highest in the early spring. In the late spring, TAR was also low, but higher than that observed in the winter. In the summer, TAR increased again, but not at the same magnitude as that observed in the early spring **(figure 3)**.



Means followed by the same letter do not differ (p> 0.05).

Figure 3. Tiller appearance rate in the marandu palisadegrass according to the season of the year. Vertical bars correspond to standard error of the mean (Taxa de aparecimento de perfilho do capim-marandu de acordo com a época do ano. As barras verticais correspondem ao erro padrão da média).

The lower TAR in the winter occurred due to the unfavorable climatic conditions to plant growth, such as low precipitation and temperature **(figures 1** and **2)**. Because the minimum temperatures obtained in this period were below the lower threshold, which is 18.6 ºC for marandu palisadegrass (Rodrigues, 2004), plant growth was impaired. Water restriction also affect the tiller appearance, as it reduces the plant photosynthesis rate (Taiz and Zeiger, 2012). One of the effects of water restriction on the forage grass is the loss of leaf area via senescence, which reduces photosynthesis in the sward, and hence tillering (Santos *et al.*, 2011b).

The tiller mortality (TMR) and survival (TSR) rates were not influenced by the defoliation strategies applied to the marandu palisadegrass (p = 0.3057 and p = 0.3151, respectively). Only the season of the year influenced TMR (p< 0.0001) and TSR (p< 0.0001). A higher TMR was reported in the late spring. In the winter, TMR was lower than in the summer, while there was no difference compared with the early spring **(figure 4A)**. Overall, a response pattern contrary to TMR occurred with TSR, which was greater in the summer **(figure 4B)**.

In the winter, as a way to compensate for the low TAR **(figure 3)**, tiller survival rate (TSR) was higher **(figure 4A)**. This offsetting contributes to maintaining perenniality, and, in part, the stability of the tiller population (Carvalho *et al.*, 2000; Sbrissia *et al.*, 2010; Portela *et al.*; 2011). Moreover, the increased tiller lifespan in the winter is a means of preserving the resources (nutrients), which is important in dry soils, where the absorption of nutrients by the plant is hindered.

The balance between the appearance and mortality of tillers (BAL) was influenced only by the season of the year (p< 0.0001). A higher BAL value was reported in the early spring, and lower values in the late spring. The balance was lower in the winter as compared with the summer **(figure 5**).

The tiller population stability index (SI) was also influenced only by the season of the year (p< 0.001), and showed a similar response pattern to that found for BAL. In ascending order, the SI values during the times of the year occurred in the late spring, winter, summer, and early spring **(figure 6**).

Even with the elevation in TSR in the winter **(figure 4B)**, the balance between tiller appearance and mortality (BAL) was negative **(figure 5**), i.e., the number of tillers that emerged was lower than the number of tillers that died. The tiller population stability index (SI) was also lower than one in the winter **(figure 6)**, i.e., the tillers that emerged in the winter were insufficient to replace those that had died (Bahmani *et al.*, 2003). As a consequence, the tiller density was lower in the winter **(figure 7A)**.

The highest tiller appearance rate occurred in the early spring, when the climatic conditions were favorable, with increased precipitation and higher temperatures, as compared with the previous season **(figure 1)**. The higher incident solar radiation stimulates tillering, whereas, at a low level, the development of buds on tillers is reduced (Matthew *et al.*, 2000; Giacomini *et al.*, 2009). Moreover, irrespective of the plant metabolic pathway, some enzymes of photosynthesis are activated by light, and so, ration is a decisive factor for plant growth (Taiz and Zeiger, 2012). The higher TAR in the early spring **(figure 3)** was responsible for the high and positive BAL **(figure 5)**, as well as for the high SI, greater than one **(figure 6)**, indicating that the tillers that emerged were sufficient to replace and increase the population of tillers that had diet in this period **(figure 7A)**.

Good climatic conditions were still present in the late spring **(figures 1** and **2)**, but there was a reduction in TAR as compared with the beginning of this season **(figure 3)**. The high tillering rate in the early spring probably caused the sward to become denser, which might have generated greater shading at the base of the plants, inhibiting the appearance of tillers. This fact resulted in a negative BAL **(figure 5)**, as well as a SI below 1.0 **(figure 6)**, demonstrating instability and reduction of the tiller population in this period **(figure 7A)**.

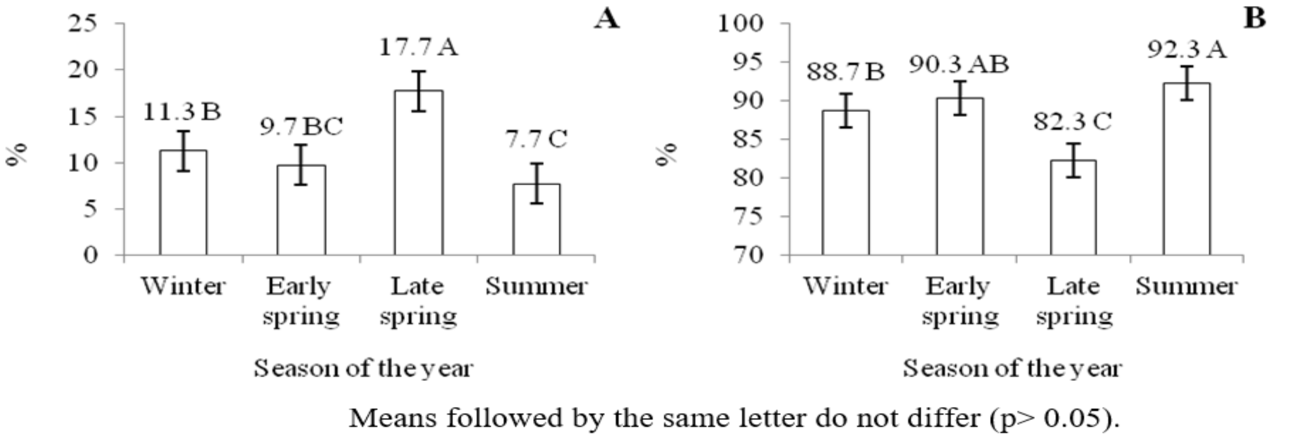


Figure 4. Tiller mortality (A) and survival (B) rates in the marandu palisadegrass according to the season of the year. Vertical bars correspond to standard error of the mean (Taxas de mortalidade (A) e de sobrevivência (B) de perfilhos do capim-marandu de acordo com a época do ano. As barras verticais correspondem ao erro padrão da media.).

The tiller density was influenced by the season of the year (p=0.0026) and defoliation strategy (p=0.0478). In the winter and late spring, the number of tillers was lower relatively to the early spring and summer **(figure 7A)**. The marandu palisadegrass managed with 15 cm in the fall and winter showed a larger number of tillers than that managed with 45 cm in these seasons **(figure 7B)**.

In the summer, the tiller appearance rate increased again, with positive consequences on the tiller density **(figure 7A)**, due to the favorable conditions of this season **(figures 1** and **2)**. Another factor that must have stimulated tiller emergence in the summer was the fertilization applied on that season. The availability of nutrients is decisive to plant growth. In fact, Fagundes *et al.* (2006) and Moraes *et al.* (2006) found a positive effect of N fertilization on the tiller density of *Brachiaria decumbens* pasture. In this context, Silva *et al.* (2009) observed that fertilization with nitrogen increased the number of tillers per plant compared with the control, which was not fertilized.

The seasonal pattern of the tiller density observed in this study **(figure 7A)** was also found by Lara and Pedreira (2011), who quantified twice as many tillers in the summer than in the winter in cultivars Marandu, Xaraés, Arapoty and Capiporã, of *Urochloa brizantha* (Syn. *Brachiaria brizantha*), and in cultivar Basilisk, of *U. decumbens* (Syn. *B. decumbens*).

Greater tiller renewal is common under favorable climate conditions to pasture growth (spring and summer) (Paiva *et al.*, 2011), which results in a high TMR, and consequently low TSR. This response pattern occurred in the late spring **(figures 4A** and **4B)**. It is likely that the tillers that emerged before and during the winter reached the end of their natural life cycle at the end of spring. On the other hand, the lower precipitation that occurred in the summer **(figures 1** and **2)** affected the tillering process of the sward, which did not occur in a maximized manner, as was expected. Thus, the plant probably adopted the strategy of maintenance of existing the existing tillers, thereby ensuring its longer survival **(figure 4B)**.

It should be stressed that, overall, a higher TAR occurred in the early spring **(figure 3)**, whereas the greatest TMR was observed in the late spring **(figure 4A)**. These results demonstrate that, in the spring, when the climate is once again favorable to growth, the plant primarily prioritizes the emergence of new tillers to, then, trigger the mortality of older tillers. This may be the strategy of marandu palisadegrass to ensure the stability of the tiller population during the period of transition between contrasting climatic conditions.

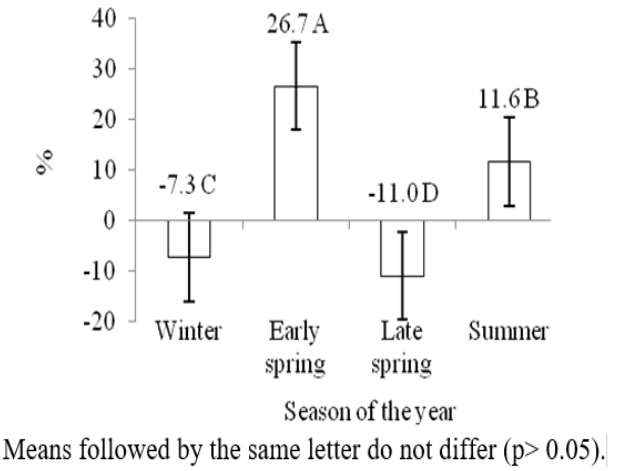
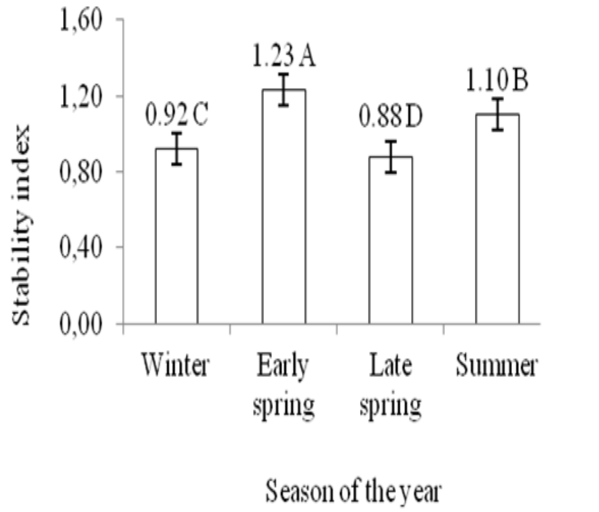


Figure 5. Balance between appearance and mortality of tillers in the marandu palisadegrass according to the season of the year. Vertical bars correspond to standard error of the mean (Balanço entre aparecimento e mortalidade de perfilhos do capim-marandu de acordo com a época do ano. As barras verticais correspondem ao erro padrão da média)

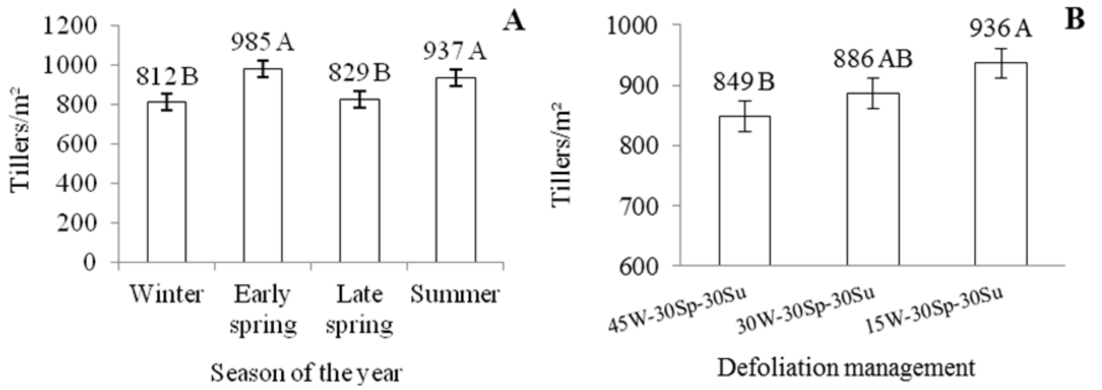
The TAR did not vary between the evaluated defoliation strategies. It was expected that, in sward with a lower height in the fall and winter, there would be a higher TAR in the spring. The smaller amount of plant biomass, typical of the lower sward in the winter, would result in a lower demand for growth factors such as light and water, which would improve the plant's carbon balance (Davies *et al.*, 1988) and consequently decrease leaf senescence. Thus, a smaller amount of dead material would be present by the end of winter, which would allow for greater incidence of light at the plant base, which in turn would promote the appearance of new tillers in the early spring (Portela *et al.*, 2011). However, in plants taller in the fall and winter, the opposite response pattern was expected; in other words, a greater amount of dead material with inhibition of tillering, due to their greater demand for light and water, which are necessary to maintain the high biomass of these plants in a time with restriction of growth factors (Sbrissia *et al.*, 2010).

The high tillering in the early spring, even in the plants maintained tall (45 cm) in the fall and winter **(figure 3)**, might have been due to the rapid lowering of 33% of the vertical stratum of this plant — from 45 cm to 30 cm in the early spring. This management might have generated a high and rapid variation in the luminous environment of the sward, and consequently stimulated tillering. On the other hand, the lack of greater tillering in the early spring in the plants with 15 cm in the fall and winter was probably caused by the increased shading within the sward during the early spring, in which there was a 100% increase in the height of the marandu palisadegrass — from 15 to 30 cm.



Means followed by the same letter do not differ (p> 0.05).

Figure 6. Tiller population stability index in the marandu palisadegrass according to the season of the year. Vertical bars correspond to standard error of the mean (Índice de estabilidade da população de perfilhos do capim-marandu de acordo com a época do ano. As barras verticais correspondem ao erro padrão da média).

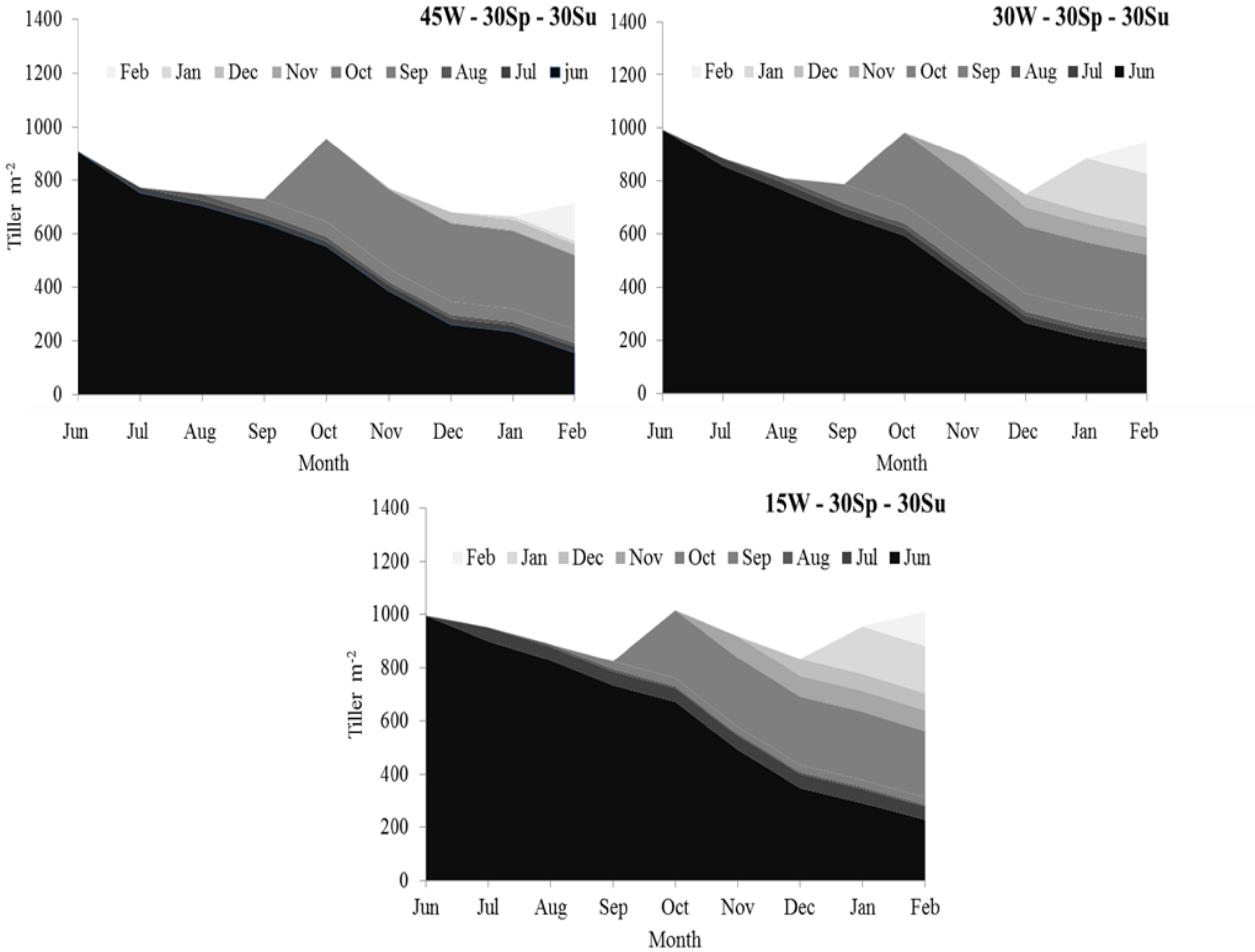


45W-30Sp-30Su: sward with 45 cm in the winter and 30 cm in spring and summer; 30W-30Sp-30Su: sward with 30 cm in winter, spring and summer; 15W-30Sp-30Su: 15 cm in the winter and 30 cm in spring and summer.

Means followed by different letters differ (p< 0.05).

Figure 7. Tiller density of the marandu palisadegrass according to season of the year (A) and defoliation management (B).Vertical bars correspond to standard error of the mean (Densidade populacional de perfilhos do capim-marandu de acordo com a época do ano (A) e o manejo da desfolhação (B). As barras verticais correspondem ao erro padrão da media).

Despite the lack of effects of the defoliation strategies on the tillering dynamics traits, it was found largest number of tillers occurred when the marandu palisadegrass was maintained lower (15 cm) in the fall and winter, regardless of the evaluated season of the year **(figure 7B)**. Lowering the plant to 15 cm three months after the beginning of the evaluations in the winter, during the previous fall (adaptation period) probably favored the appearance of tillers, especially in the fall, which is the time when the climatic seasons were not yet completely restrictive to plant growth **(figures 1** and **2)**. When the pasture is maintained with a shorter height, there is greater incidence of light at the plant base, which results in the activation of a greater number of buds, which originate the tillers (Giacomini *et al.*, 2009). Thus, at the beginning of the evaluation in the winter, these plants showed a larger number of tillers, which remained high during the subsequent times. In contrast, in the grass with greater heights in the fall and winter (30 and 45 cm), there was a lower incidence of light at the base of the plants, hindering the activation of the buds in new tillers, and thus resulting in a lower number of tillers. These factors justify the fact that the marandu palisadegrass with 15 and 30 cm in the fall and winter showed a larger number of tillers from the base generation at the beginning of the experiment (July 2013) as compared with the plant with 45 cm **(figure 8)**.



W-30Sp-30Su: 15 cm in the fall and winter and 30 cm in spring and summer; 30W-30Sp-30Su: 30 cm in the fall, winter, spring, and summer; 45W-30Sp-30Su: 45 cm in the fall and winter and 30 cm in spring and summer.

Figure 8. **Number of generations of tillers in the marandu palisadegrass during the seasons of the year and managed at different heights in fall and winter** (Número das gerações de perfilhos do capim-marandu durante as estações do ano e manejados com diferentes alturas durante o outono e inverno).

The base generation of tillers predominated during the winter, having special participation in the total tiller population until October. Because the TAR was low during the winter, the plants that emerged in this period had low contribution in the sward **(figure 8)**.

For all defoliation strategies evaluated, the increase in number of tillers occurred in the early spring. In the late spring, there was a decrease in tiller density. In the summer, the number of tiller/m^2 did not reach similar levels to those at the beginning of spring **(figure 8)**. It is noteworthy that the generation of tillers that emerged in the fall contributed significantly to the total population in the months of spring and summer, especially when the marandu palisadegrass was managed with 45 cm in the fall and winter **(figure 8)**.

In this sense, *Urochloa brizantha* syn. *Brachiaria brizantha* cv. Marandu presents higher tiller appearance rates, higher tiller stability index, and a larger number of tillers in the summer and early spring as compared with winter and late spring. To increase tiller density, *Urochloa brizantha* syn. *Brachiaria brizantha* 'Marandu' may be managed with 15 cm in the fall and winter, and 30 cm in spring and summer.

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