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# Initial height and nitrogen fertilisation on deferred pastures of marandu palisadegrass

# Altura inicial e adubação nitrogenada em pastos diferidos de capim-marandu

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**Highlights:**
With high nitrogen dose, the high height deferred canopy had a greater number of dead tillers than the low one.
In the high height deferred canopy there were more long tillers than in the low deferred canopy.
Nitrogen increased the number of large tillers (>40 cm) of deferred marandu palisadegrass.
With 80 kg/ha nitrogen, the higher initial height resulted in increased litter mass.
With no nitrogen fertilisation, there was a higher NDF content in the high height deferred canopy than in the low one.

## Abstract

In deferred pastures, nitrogen fertilisation and pasture height at the beginning of the deferment period modify the structure and nutritive value of forage. This work was conducted to determine the nitrogen (N) doses and sward heights that were adequate for the deferment of *Brachiaria brizantha* cv. Marandu syn. *Urochloa brizantha* cv. Marandu (marandu palisadegrass). Two sward heights (15 and 30 cm) and four N rates (0, 40, 80,120 kg/ha) at the beginning of the deferment period were evaluated in a randomised block design and a factorial scheme with three replications. At the end of the deferment period, the numbers of live and dead tillers, the numbers of tillers with different sizes, the masses of live leaf lamina, dead leaf lamina, live stem and dead stem, the litter mass and the crude protein and neutral detergent fibre contents of the forage were evaluated. With nitrogen fertilisation, there was an increase in the masses of live leaf and live stem in the deferred canopy. With the application of 80 kg/ha of N, the litter mass was higher in the deferred canopy with a height of 30 cm, in relation to that with a height of 15 cm. The highest canopy presented greater stem mass and worse nutritional value when compared to the lowest one. In order to improve forage characteristics, marandu palisadegrass can be deferred by 15 cm and fertilised with 80 kg/ha N. When marandu palisade grass is deferred to 30 cm, nitrogen doses lower than 80 kg/ha can be applied.
**Key words:** *Brachiaria brizantha*. Deferment of pasture. Nitrogen fertilisation. Nutritive value. Pasture structure. *Urochloa brizantha*.

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## Resumo

Em pastagens diferidas, a adubação nitrogenada e a altura do pasto no inicio do período de diferimento modificam a estrutura e o valor nutritivo da forragem. Esse trabalho foi conduzido para determinar as doses de nitrogênio (N) e as alturas do dossel mais adequadas para o diferimento da *Urochloa brizantha* cv. Marandu (capim-marandu). Duas alturas do dossel (15 e 30 cm) e quatro doses de N (0, 40, 80,120 kg/ha) no inicio do período de diferimento foram avaliadas, em delineamento de blocos casualizados e esquema fatorial, com três repetições. Ao final do período de diferimento foram avaliados os números de perfilhos vivos e mortos, os números de perfilhos com diferentes tamanhos, as massas de lâmina foliar viva, lâmina foliar morta, colmo vivo e colmo morto; a massa de serrapilheira e os teores de proteína bruta e fibra em detergente neutro da forragem. Com a adubação nitrogenada, houve incremento das massas de lâmina foliar viva e de colmo vivo nos dosséis diferidos. Com aplicação de 80 kg/ha de N, a massa de serrapilheira foi maior no dossel diferido com 30 cm, em relação àquele com 15 cm. O dossel mais alto apresentou maior massa de colmo e pior valor nutritivo, se comparado ao mais baixo. Para melhorar as características da forragem, o capim-marandu pode ser diferido com 15 cm e adubado com 80 kg/ha de N. Quando o capim-marandu é diferido com 30 cm, doses de nitrogênio inferiores a 80 kg/ha podem ser aplicadas.

**Palavras-chave:** Adubação nitrogenada. *Brachiaria brizantha*. Diferimento da pastagem. Estrutura do pasto. Valor nutritivo. *Urochloa brizantha*.

## Introduction

Pasture deferral consists of selecting and excluding a given pasture area from grazing in the late summer or early autumn in the Southeast and Midwest regions of Brazil. Thus, forage production occurs in pasture that will be used under grazing only in the period of forage shortage during winter (Euclides, Macedo, Zimmer, Medeiros, & Oliveira, 2007). In Brazil, this strategy has proven to be a viable alternative, as it is considered a low cost and easily adopted technique (Santos, Fonseca, Balbino, Monnerat, & Silva, 2009a).

The most suitable forage grasses for pasture deferment management are those that present low stem growth, good green leaf retention in winter, high forage production rate and reduced flowering during autumn, among other factors (Euclides et al., 2007). In this context, most grasses of the genus *Brachiaria* syn. *Urochloa*, such as *Brachiaria brizantha* cv. Marandu syn. *Urochloa brizantha* cv. Marandu (marandu palisadegrass), are adequate.

In deferred pastures, nitrogen fertilisation can be used to increase forage production during the deferment period, since nitrogen increases the growth rate of grass (Alexandrino, Vaz, & Santos, 2010). In addition, nitrogen application at the beginning of the deferment period can also stimulate tillering and partially compensate for the negative effect of deferment period on tiller population density, provided that this period is not long (Santos, Fonseca, Balbino, Monnerat, & Silva, 2009b).

Another management strategy in deferred pastures is to vary the pasture height at the beginning of the deferment period. Higher pasture height at the beginning of the deferment period, although providing higher forage mass in the dry season, may result in deferred forage with poorer nutritional values, due to the increased amounts of dead and stem forage in the deferred pasture (Sousa et al., 2012). Therefore, the lowering of the pasture, performed near the beginning of the deferment period, may provide forage with better nutritional value, due to the removal of old tissues and the stimulation of tillering at the beginning of the deferment period.

Both nitrogen fertilisation and pasture height variation at the beginning of deferral can be used together to obtain deferred pasture with adequate mass and structure (Teixeira et al., 2011; Sousa et al., 2012). In this sense, the hypothesis with this research is that nitrogen fertilisation can provide greater live leaf mass at the end the deferment period of pasture with smaller height. These pastures could also have a lower number of dead tillers, a smaller population of long tillers, and an increased live leaf blade mass. These structural characteristics, in turn, can improve the nutritional value of the deferred pasture. Thus, understanding the effects and possible interactions between nitrogen fertilisation and pasture height variation at the beginning of the deferment on the characteristics of the deferred forage canopy are relevant.

The objective of this research was to test the previously mentioned hypothesis and to generate recommendations for pasture height(s) and nitrogen dose(s) at the beginning of the deferment period that result in *U. brizantha* cv. Marandu with adequate structure and nutritional value for animal production in the Brazilian Cerrado region.

## Material and Methods

The experiment was conducted in the pasture area of *Urochloa brizantha* cv. Marandu (marandu palisadegrass), established in 2000, located at the Capim-Branco Experimental Farm, at the Federal University of Uberlândia, in Uberlândia, Minas Gerais. Prior to the beginning of this experiment, the marandu palisadegrass pasture was managed in continuous stocking with cattle.

The geographical coordinates of the place are 18°30' south latitude and 47°50' west longitude, with an altitude of 863 m. The climate of the region is Aw, tropical savannah with dry winter season. The average annual temperature and precipitation are 22.3°C and 1,584 mm, respectively (Alvares, Stape, Sentelhas, Gonçalves, & Sparovek, 2013). Information regarding weather conditions during the experiment was recorded at the Meteorological Station located 200 m from the experimental area (Figure 1).

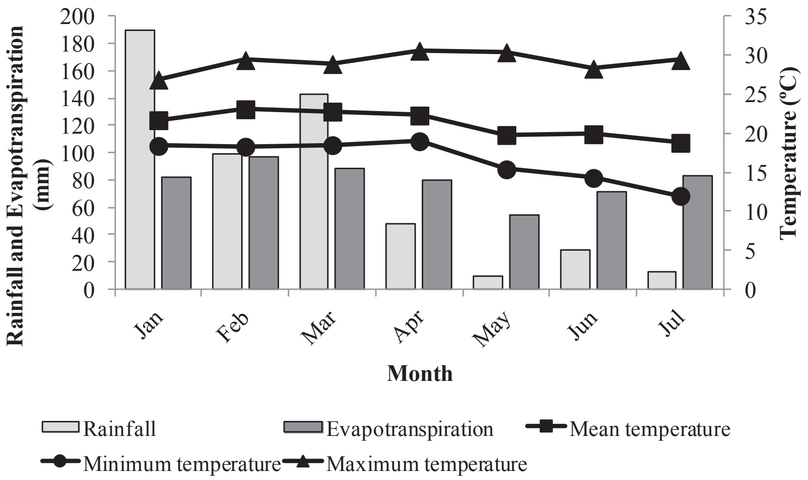


**Figure 1.** Rainfall, Evapotranspiration and Monthly average daily temperatures during the period from January to July 2012, referring to the trial period.

Prior to the implementation of the experiment, soil samples were also taken to analyse the fertility level in the 0-20 cm layer, with the following results: pH ($H_2O$): 6.1; P: 2.5 (Mehlich-1) and K: 94 mg/dm³; $Ca^{2+}$: 3.1; $Mg^{2+}$: 1.3; $Al^{3+}$: 0.0 $cmol_c/dm^3$ (KCl 1 mol/L). According to this result, phosphate (50 kg/ha of $P_2O_5$ as simple superphosphate) and potassium (70 kg/ha of $K_2O$ as potassium chloride) fertilisers were made in February 2012, according to Cantarutti, Alvarez and Ribeiro (1999) for a low technology system.

Two canopy heights (15 and 30 cm) and four nitrogen (N) doses (0, 40, 80 and 120 kg/ha of N) were evaluated at the beginning of the deferment period. A completely randomised block design in a 2 x 4 factorial scheme with three replications was used. The 6 $m^2$ (2 x 3 m) plots were allocated to the pasture area after the animals were removed on 03/15/2012. On this date, the marandu grass pasture had an average height of 30 cm. After randomisation of the treatments in the plots, the heights corresponding to 15 and 30 cm were established using pruning shears. Nitrogen fertiliser rates were applied after height adjustment. Agricultural nitrogen was used as a nitrogen source in a single dose and in the late afternoon.

From 03/15/12 to 06/22/12 (99 days), the plots remained deferred and, at the end of the deferment, all evaluations were made in the useful area (3.75 $m^2$) of each plot. Tiller population density was determined by taking two samples per plot at points representing the average canopy height. All of the tillers contained within a 0.125 $m^2$ rectangular frame were harvested at ground level. All tillers were packed in plastic bags and taken to the laboratory, where they were separated into live and dead tillers and quantified. The distinction between live and dead tillers was based on their senescence, in which fully necrotised stem tillers were classified as dead.

In the same sample of live tillers, previously separated, the counting of tillers with different sizes was performed. The length of the tillers was measured by extending them on a table, which had in one of its edges a graduation in centimetres. After this measurement the tillers were separated and counted in the following classes: 0 to 10 cm, 10 to 20 cm, 20 to 40 cm, 40 to 60 cm and tillers larger than 60 cm (Santos et al., 2011a).

To determine the mass of the forage morphological components, all tillers contained within a 0.25 $m^2$ square were cut at soil level in two areas representative of the average condition of the canopy in each plot. The samples were placed in a plastic bag and weighed in the laboratory. From each sample, two subsamples were taken; one was weighed, placed in a paper bag and put in a forced ventilation oven at 65ºC for 72 hours, while the other subsample was separated into live leaf blade (LLB), live stem (LS), dead leaf blade (DLB) and dead stem (DS). Inflorescences and green leaf sheaths were incorporated into the LS fraction. Those leaf blades that showed no signs of senescence (green organ) were also incorporated into the LLB fraction. The parts of the stem and senescent leaf blades (with yellowing and/or organ necrosis) were incorporated into the DS and DLB fractions, respectively. After separation, the morphological components were weighed and dried in a forced-air oven at 65°C for 72 hours, and then their weights quantified.

The litter evaluation was done by collecting all of the dead material that was contained in the area where the tillers were cut to evaluate the morphological components mass. All dead and loose tissue from the pasture which was on the soil surface was considered litter. The samples were weighed and dried in a forced air oven at 65°C for 72 hours and then their weights quantified.

In the forage mass samples, the dry matter (DM), neutral detergent fibre (NDF) and crude protein (CP) contents were determined according to the techniques described by Detmann et al. (2012).

All statistical analyses were performed at a level of 5% probability of the occurrence of type I error. For the nitrogen dose factor (quantitative factor), regression analyses were performed, with the selection of models that best fit the data within each pasture height evaluated. For this, the coefficient of determination and the significance of the regression coefficients, tested by the t-test, were evaluated. For pasture height (qualitative factor), the Tukey test was applied for each nitrogen dose studied. Regression equations to describe relationship between live tiller number and large tiller number (greater than 40 cm) were also generated.

## Results and Discussion

All characteristics were influenced by the interaction between the factors studied (pasture height and nitrogen dose).

The number of live tillers showed positive and linear response patterns in the 15 cm canopy and a quadratic response pattern in the 30 cm canopy at the beginning of the deferment, as a function of N dose. In the canopy fertilised with 120 kg/ha of N, higher number of live tillers was observed when it was managed with 15 cm, compared to those with 30 cm (Table 1). Alexandrino, Nascimento, Mosquin, Regazzi and Rocha (2004), working with the same forage plant in a greenhouse, found that increasing the N dose also increased the number of live tillers. This result can be explained by the fact that N positively influences the development of basal buds in tillers (Matthew, Assuero, Black, & Sackville Hamilton, 2000). Another factor that may justify the higher number of live tillers in the lower deferred canopy (15 cm) and which received the highest N dose concerns the fact that N increases tiller survival. Nitrogen may have increased tiller survival, as it has been shown in some studies that this nutrient increases leaf life and the number of live leaves of individual tillers (Garcez et al., 2002), especially under climate conditions that are less favourable to pasture development, such as those prevailing in the fall, when pasture deferment occurred. This possible higher survival of tillers in 15 cm canopies and fertilisers with higher N doses may also have been the cause of the lower number of tillers dead in these deferred pastures (Table 1).

**Table 1**
**Numbers of live and dead tillers in marandu palisasdegrass canopy managed with varying heights and nitrogen doses at the beginning of the deferment period**

| Height (cm) | Nitrogen Dose (kg/ha) | | | | Equation | $r^2$ |
|---|---|---|---|---|---|---|
| | 0 | 40 | 80 | 120 | | |
| | | | | Live Tiller/m² | | |
| 15 | 613a | 689a | 662a | 783a | $\hat{Y}$= 614.7 + 1.2008*N | 0.76 |
| 30 | 619a | 634a | 596a | 535b | $\hat{Y}$= 620.12 + 0.7071*N - 0.0119*$N^2$ | 0.99 |
| | | | | Dead Tiller/m² | | |
| 15 | 613a | 339a | 281a | 225b | $\hat{Y}$= 547,87 - 3.0533*N | 0.84 |
| 30 | 485b | 315a | 319a | 367a | $\hat{Y}$= 478.8 - 4.98*N + 0,0342*$N^2$ | 0,96 |

For each characteristic, means followed by the same letter in the column do not differ (P> 0.05) by Tukey test; * Significant by the t test (P <0.05).

In the 30 cm deferred canopy, N quadratically influenced the number of live tillers, with the maximum value occurring when 30 kg/ha of N were applied. From this dose, the reduction in the number of live tillers may have been caused by greater shading in the initially higher pasture (30 cm), added to the possible higher growth during the deferment period, especially when high N doses were applied. The lower amount of light incident at the base of plants inhibits tillering. In fact, Santos et al. (2011b) found a 35% decrease in the number of live tillers when *Urochloa decumbens* cv. Basilisk had its height increased from 10 to 40 cm. When 120 kg/ha of N was applied, the largest number of live tillers occurred in the lower canopy (15 cm) compared to the high canopy (30 cm) (Table 1), because the base of the low canopy plants possibly received a higher light incidence, which stimulates pasture tillering (Carvalho et al., 2000; Sbrissia & Silva, 2008).

When no nitrogen fertiliser was applied, the 15 cm deferred canopy had a higher number of dead tillers than the 30 cm deferred one (Table 1). Possibly, the greater elimination of the apical meristems of tillers in more intensely lowered canopies led to the death of tillers (Santos, Fonseca, Gomes, Silva, & Pimentel, 2010a). With the application of a high dose of N (120 kg/ha of N), the canopy with an initial height of 30 cm presented a higher number of dead tillers compared to the one deferred with a height of 15 cm (Table 1). This may have been because the taller canopies generally have more competition for light than low ones. Thus, there is greater shading in the canopy and, as an effect, the increased death of smaller tillers (Sousa et al., 2013). The occurrence of a higher number of dead tillers in the deferred canopies allows us to infer that they tend to have worse nutritional value, because this class of tillers has only dead leaves and stems, which are morphological components with limited nutritional value compared to live tissues (Santos et al., 2008).

The relationship between the number of live tillers and the number of dead tillers increased with N application in the 15 cm deferred canopy; however, in the 30 cm deferred canopy, this response pattern did not occur (Figure 2). Considering that the presence of dead tiller in the pasture impairs its structure, it is possible to infer that the positive effect of N on the deferred canopy structure occurs only when the canopy height at the beginning of the deferral is low.

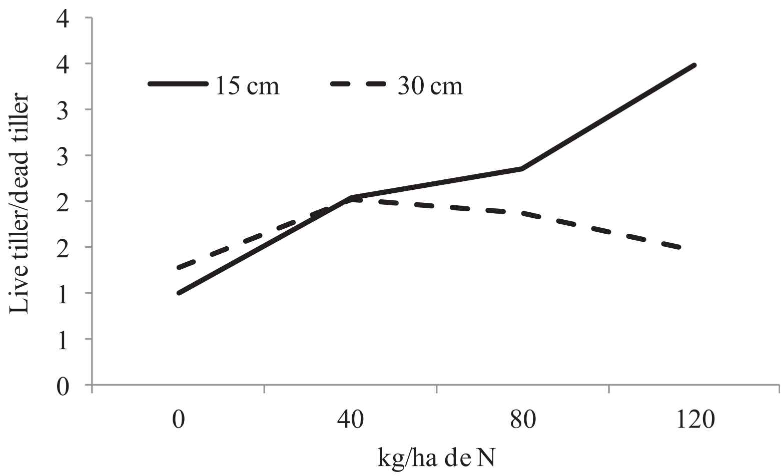


**Figure 2.** Relationship between the number of live tillers and the number of dead tillers in 15 or 30 cm deferred marandu palisadegrass canopies, as a function of nitrogen fertilization.

It is important to know the size of live tillers present in the deferred pasture, as this characteristic may be related to the nutritional value of the pasture, as pasture with live and large tillers (greater than 40 cm) possibly has lower nutritional value compared to those pastures with higher tiller size (less than 40 cm). This is because larger tillers have a greater amount of structural and lignified tissue (stem). This condition is necessary for the stem to properly support the highest tiller weight. Longer tillers are also older in general, and therefore have a higher number of dead leaves (Santos et al., 2009b), which contributes to the worsening nutritional value of the pasture (Santos, Fonseca, Balbino, Silva, & Monnerat, 2010b). In this sense, in a 30 cm deferred canopy, an increased amount of long tillers

(>40 cm) was observed compared to in the 15 cm deferred canopy (Table 2). Otherwise, in the 15 cm deferred canopy, there were more small tillers (<40 cm). With the higher canopy lowering, more light falls on the base of the plants, which stimulates the emergence of small tillers (Matthew et al., 2000). However, in higher canopies at the beginning of the deferment period, greater shading within the canopy generates more light competition between tillers. In this condition, it is possible that smaller tillers die due to shading caused by the larger tillers (Matthew et al., 2000).

It was also found that N increased the number of large tillers (>40 cm) of deferred marandu palisadegrass (Table 2). Nitrogen increases the growth of individual tillers (Santos et al., 2009b) which, when they reach larger sizes, become predominant in deferred and fertilised canopies. This can be confirmed by the effect of N on increasing leaf and stem elongation in tropical grasses. In this sense, Alexandrino et al. (2010) found that *U. brizantha* cv. Marandu showed a higher leaf elongation rate with N application. This is because N increases the production of new cells in the apical tiller meristem (Volenec & Nelson, 1984).

**Table 2**
**Numbers of live tillers of different sizes in marandu palisadegrass canopies managed with varying heights and nitrogen doses at the beginning of the deferment period**

| Height (cm) | Nitrogen dose (kg/ha) | | | | Equation | $r^2$ |
|---|---|---|---|---|---|---|
| | 0 | 40 | 80 | 120 | | |
| | | | | Number of tillers from 0 to 10 cm/m² | | |
| 15 | 21 | 8 | 1 | 3 | $\hat{Y}$ = 17.733 - 0.1567*N | 0.79 |
| 30 | 5 | 1 | 0 | 3 | $\bar{Y}$ = 2 | - |
| | | | | Number of tillers from 10 to 20 cm/m² | | |
| 15 | 232a | 173a | 37a | 32a | $\hat{Y}$ = 229.07 - 1.84*N | 0.90 |
| 30 | 21b | 21b | 25a | 12a | $\bar{Y}$ = 20 | - |
| | | | | Number of tillers from 20 to 40 cm/m² | | |
| 15 | 441a | 457a | 384a | 352a | $\hat{Y}$ = 459.87 - 0.8533*N | 0.80 |
| 30 | 361a | 304a | 289a | 81b | $\hat{Y}$ = 387.2 - 2.1367*N | 0.81 |
| | | | | Number of tillers from 40 to 60 cm/m² | | |
| 15 | 11b | 44b | 188b | 344a | $\hat{Y}$ = - 24. 933 + 2.86*N | 0.94 |
| 30 | 233a | 317a | 293a | 256a | $\hat{Y}$ =238.07+ 2.385*N - 0.019*$N^2$ | 0.89 |
| | | | | Number of tillers larger than 60 cm/m² | | |
| 15 | 0b | 8b | 25b | 85b | $\hat{Y}$ = -11.333 + 0.6833*N | 0.84 |
| 30 | 31a | 67a | 69a | 232a | $\hat{Y}$ = 8.6667 + 1.5167*N | 0.76 |

For each characteristic, means followed by the same letter in the column do not differ (P> 0.05) by Tukey test; * Significant by the t test (P <0.05).

When the canopy was deferred with 15 cm, there was a linear and positive relationship between the numbers of live (Y) and large tillers (X) in the deferred pastures ($\hat{Y}$ = 506.8 + 0.3177X, $R^2$ = 0.86). This demonstrates that the benefit of applying N in increasing the number of live tillers should be understood with caveats. The increased number of live tillers is important because it represents more growth units in the pasture, thus having the potential to increase forage production. However, when these live tillers become larger, pasture nutritional value is lost, which is undesirable. On the other hand, when the pasture was deferred with 30 cm, the relation between number of live tillers (Y) and number of large tillers (Y) was linear and negative ($\hat{Y}$ = 860.78-0.3251X, $R^2$ = 0.49), that is, in these pastures, when the doses of N were increased, there was a decrease in the number of live tillers, but they became larger (>40 cm). This indicates that initially high pastures that receive high doses of N may have a very limited structure and nutritional value to animal consumption and performance.

The higher live stem mass with the increase in N dose can be explained by the increase in the number of live tillers per unit area and, mainly, by the greater number of long tillers in those fertilisers with higher N doses, because heavier tillers have more developed stems as a way to ensure the support of the leaves (Santos et al., 2009b). In addition, N may also have stimulated greater canopy development, which generated greater intraspecific light competition among individual tillers. As a consequence, during the deferment period, the tillers were longer and had a greater amount of support tissue, as they lengthened their stems in order to raise their younger leaves to the apex of the canopy, where there is a greater availability of solar radiation.

In general, the N application resulted in an increase in live leaf blade mass in the deferred canopies (Table 3). This result is also due to the fact that N promotes an increase in the number of live tillers in deferred pastures (Table 1), as previously discussed.

**Table 3**
**Morphological componentes masses in marandu palisadegrass managed with heights and nitrogen doses varying at the beginning of the deferment period**

| Height (cm) | Nitrogen dose (kg/ha) | | | | Equation | $r^2$ |
|---|---|---|---|---|---|---|
| | 0 | 40 | 80 | 120 | | |
| | | | | | Live Leaf Blade (kg/ha of DM) | |
| 15 | 1243a | 1951a | 2360a | 2353a | $\hat{Y}$ = 1236.78 + 22.76*N - 0.1116*$N^2$ | 0.99 |
| 30 | 1795a | 1966a | 2137a | 2291a | $\hat{Y}$ = 1798.51 + 4.1468*N | 0.99 |
| | | | | | Dead Leaf Blade (kg/ha of DM) | |
| 15 | 952b | 1219a | 1226a | 1236a | $\bar{Y}$ = 1158.43 | - |
| 30 | 1516a | 1320a | 1299a | 1420a | $\bar{Y}$ = 1388.86 | - |
| | | | | | Live Stem (kg/ha of DM) | |
| 15 | 822b | 1832a | 1878a | 2177a | $\hat{Y}$ = 1060.9983 + 10.2739*N | 0.80 |
| 30 | 2132a | 2431a | 2638a | 2963a | $\hat{Y}$ = 2135.95 + 6.7502*N | 0.99 |
| | | | | | Dead stem (kg/ha of DM) | |
| 15 | 1627a | 1310a | 1543a | 1406a | $\bar{Y}$ = 1471.61 | - |
| 30 | 2208a | 1719a | 2767a | 1185a | $\bar{Y}$ = 1969.91 | - |

For each characteristic, means followed by the same letter in the column do not differ (P> 0.05) by Tukey test; * Significant by the t test (P <0.05).

It is important to know the use of high doses of N, such as 120 kg/ha of N, may result in N loss due to volatilisation as a result of the time of application, where there is usually a shortage of rainfall and low soil moisture. If this happens, the possible benefit of higher deferred pasture production may not be obtained.

The fact that dead tissue mass (dead leaf blade plus dead stem) was not influenced by N fertilisation may be explained by the effect of N on prolonging tiller life during autumn and winter. Thus, the increased senescence, which is natural in more developed pastures due to the application of N, may not have occurred during the deferment period of marandu palisadegrass, as observed by Garcez et al. (2002) in a study with mombaça grass.

Only when N was not applied were lower stem and dead leaf masses found in the 15 cm deferred canopy than in the 30 cm deferred canopy (Table 3). With greater initial height, in general, there is greater competition for light in the canopy, which causes greater stem elongation of the marandu palisadegrass; this means that the younger leaves are exposed at the apex of the pasture and thus have access to greater solar radiation. In this process, shading also occurs in the lower portion of the pasture, especially in the older leaves. This causes an increase in leaf senescence (Carnevalli et al., 2006; Congio et al., 2019), which may account for the greater dead leaf blade mass in the 30 cm deferred canopy than in the 15 cm canopy when N was not applied (Table 3).

When the canopy was fertilised with 80 kg/ha of N, the higher initial height resulted in increased litter mass (Table 4), due to the greater shading of the lower portion of the canopy and, consequently, senescence and an increase of dead material in the soil. Litter is an important source of nutrients for pasture, where its deposition and decomposition play a continuous role in the supply of nutrients to the plant (Costa, Silva, & Ribeiro, 2013).

**Table 4**
**Litter mass in marandu palisadegrass managed with heights and nitrogen doses varying at the beginning of the deferment period**

| Height (cm) | Dose de nitrogênio (kg/ha) | | | | Equation | $r^2$ |
|---|---|---|---|---|---|---|
| | 0 | 40 | 80 | 120 | | |
| 15 | 3832a | 3979a | 3815b | 4505a | $\bar{Y}$ = 4032.53 | - |
| 30 | 5583a | 5826a | 6272a | 4964a | $\bar{Y}$ = 5661.22 | - |

Means followed by the same letter in the column do not differ (P> 0.05) by Tukey test.

Crude protein (CP) content was not influenced by canopy height at the beginning of deferment period (Table 5). It is possible that the restrictive climatic conditions prevailing at the time at which the pasture is available (dry season) have avoided the effects of sward height on this characteristic. The effect of N fertilisation on the percentage of CP was quadratic in the 15 cm canopy at the beginning of the deferment, reaching the minimum point (3.76%) when 49 kg/ha of N was applied (Table 5). The crude protein content remained below 7%, a limit proposed by Van Soest (1994) as being necessary to maintain the nutritional requirements of ruminal microorganisms. Therefore, when animals are kept on deferred pastures, supplementation is recommended, which consists of providing nutrients that are deficient in forage as a way of increasing the consumption and performance of animals kept on these pastures (Hoffmann et al., 2014), such as the supply of protein salt.

**Table 5**
**Contents of crude protein and neutral detergent fiber of marandu palisadegrass canopies managed with varying heights and nitrogen doses at the beginning of the deferment period**

| Height (cm) | Nitrogen dose (kg/ha) | | | | Equation | $r^2$ |
|---|---|---|---|---|---|---|
| | 0 | 40 | 80 | 120 | | |
| | | | | Crude Protein (% DM) | | |
| 15 | 4.7a | 3.8a | 3.8a | 5.2a | $\hat{Y} = 4.73 - 0.0394^*N + 0.0004^*N^2$ | 0.99 |
| 30 | 4.5a | 4.2a | 6.1a | 3.5a | $\bar{Y} = 4.6$ | - |
| | | | | Neutral Detergent Fibre (% DM) | | |
| 15 | 76.3b | 75.5a | 77.9a | 77.3a | $\bar{Y} = 76.6$ | - |
| 30 | 80.3a | 76.1a | 78.7a | 76.7a | $\bar{Y} = 78.0$ | - |

For each characteristic, means followed by the same letter in the column do not differ (P> 0.05) by Tukey test;
* Significant by the t test (P <0.05).

Without N application, there was a higher percentage of neutral detergent fibre (NDF) in canopies with an initial height of 30 cm, compared to those of 15 cm. This result can be explained by the larger numbers of long tillers (>40 cm) in the deferred canopy with a higher initial height. In general, longer tillers have a higher stem percentage, a structural organ and a high fibre percentage (Santos et al., 2010b). The range of NDF content was from 75.5 to 80.3%, which can be considered high and would tend to limit animal consumption. This can be inferred because, according to Van Soest (1994), NDF is the food constituent that most consistently relates negatively to ingestion because it is associated with rumen space occupancy and has a lower rate of disappearance in the digestive tract.

It is emphasised that studies should be performed to verify whether the effects demonstrated in this work will occur under grazing conditions. In addition, knowledge of the effects of nitrogen fertilisation and pasture height at the beginning of the deferment period on forage yield and animal performance is important before definitive recommendations are made.

## Conclusion

To improve the structure of *Urochloa brizantha* cv. Marandu, it is recommended that the pasture be managed at a height of 15 cm at the beginning of the deferment period, with the application of nitrogen doses from 80 to 120 kg/ha. On the other hand, when *Urochloa brizantha* cv. Marandu has a height of 30 cm at the beginning of the deferment period, nitrogen doses below 80 kg/ha are recommended.

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