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THE SWARD HEIGHT AT THE EARLY STOCKPILING PERIOD MODIFIES THE STRUCTURAL CHARACTERISTICS OF MARANDU PALISADEGRASS UNDER CONTINUOUS STOCKING

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Abstract
The control of sward height at the early stockpiling period influences the structural characteristics of stockpiled sward in winter. So, we conducted this work on the Cerrado region of Brazil based on the hypothesis that the reduction of pasture height at the beginning of stockpiling period results in: (i) lower stock of forage mass; and (ii) higher live leaf mass, but lower stem mass in stockpiled pasture during the winter. The treatments were four sward heights (15, 25, 35, and 45 cm) at early stockpiling period of marandu palisadegrass (*Brachiaria brizantha* syn. *Urochloa brizantha* cv. Marandu). The experiment was conducted in a completely randomized design, with three replications (paddocks with 800 m²). The stockpiled swards were evaluated during the grazing period in winter on days 7 (beginning), 45 (middle) and 90 (end). The vegetative tiller number (VEGT), live leaf mass (LLM) and leaf area index (LAI) were greater in the 15 cm stockpiled pasture than the other treatments. Greater heights (35 and 45 cm) at stockpiling resulted in greater forage mass than lower heights (15 and 25 cm). The VEGT, LLM, number of reproductive tillers, live stem mass, forage mass and LAI values were higher at the beginning than at the end of the grazing period. Our hypothesis has been proven, so that the reduction of sward height of the marandu palisadegrass at the beginning of the stockpiling period results in lesser forage mass, but with better structural characteristics.

Keywords: *Brachiaria brizantha* syn. Falling index. Forage mass. Morphological composition. *Urochloa brizantha*. Tiller number.

1. Introduction

Seasonality in the forage production from pastures is a common characteristic of several countries that have, at a given time of the year, restrictive climatic conditions to the growth of forage plants. Among the various options to supply the animals' food demand in these periods, the technique of stockpiling of pasture has been highlighted as a strategy to allow forage accumulation to be used during the most critical time of the year (Añez-Osuna et al. 2015; Nave et al. 2016; Silva et al. 2016).

In countries with temperate climate, the adoption of stockpiling has been proven to be more economical than the use of preserved forage foods, such as hay or silage, or even the adoption of confinement (Añez-Osuna et al. 2015; Bakelaar et al. 2016; Nave et al. 2016; Sechler et al. 2017). In these countries, the low night temperatures, associated with the short days of late summer and autumn, induce less deposition of fibrous tissues, while providing canopies with a high percentage of leaf, factors that result in forage with high nutritional value, particularly when stockpiling implantation is preceded by nitrogen fertilization (Franzluebbers and Poore 2020).

In the Cerrado region, Midwest of Brazil, the main limiting factor for pasture growth in late summer and autumn is the water scarcity in the soil, due to low rainfall. At these times of the year, there is also a reduction in the photoperiod, but, in general, temperatures are not low enough to restrict the growth of pasture in early autumn. These climatic conditions during the period in which the pasture remains in the absence of grazing trigger changes in the pasture morphological composition, in addition to inducing the emission of reproductive stems throughout the stockpiling period (Santos et al. 2010a). These factors have negative implications for the amount and nutritional value of the pasture that will be used by the animals in the dry and winter period (Silva et al. 2016; Afonso et al. 2018), especially if we consider that tropical forage species lose nutritional value more quickly, compared to temperate species (Moore and Moot 1973).

However, several research studies demonstrate that the adoption of pasture management strategies, such as nitrogen fertilization (Amorim et al. 2019a), the length of the stockpiling period (Santos et al. 2009) and the lowering of canopy to start of stockpiling (Vilela et al. 2013), significantly change the pasture condition at the beginning of stockpiling, being also able to modulate the mass and morphological composition of pasture at the end of stockpiling period (Amorim et al. 2019b). Among these management factors, the impact of pasture height at the moment of stockpiling on the pasture structure at the end of stockpiling is still not well defined. For example, Amorim et al. (2019b) observed that nitrogen fertilization and the length of stockpiling period had a greater impact on the tillering of mulato grass than the pasture height at the beginning of stockpiling. Likewise, Vilela et al. (2013) observed that the adoption of heights between 20 and 40 cm at the beginning of stockpiling had little effect on the structural characteristics of piatã grass tillers. However, Rodrigues et al. (2015) reported that the stem elongation rates were significantly higher in pastures of stockpiled marandu palisadegrass with greater height, in addition to resulting in a lower vegetative tillers number and a greater reproductive tillers number at the beginning of stockpiling period. Silva et al. (2020) also pointed out that it is common to adopt stockpiling in areas constituted of surplus pasture underutilized in the previous water period, which implies zero control of pasture height at the beginning of stockpiling.

These facts reinforce the importance of understanding the effect of height to stockpiling on the structural characteristics of tropical grasses submitted to stockpiling. In this sense, the reduction of sward height at the beginning of the stockpiling period would be positive, as the old forage is removed, thereby allowing a greater incidence of light at the base of the plants, that stimulates tillering (Sousa et al. 2012a). However, the adequate height(s) to initiate stockpiling of marandu palisadegrass in the Brazilian Cerrado region is unknown.

We hypothesized that: (i) the reduction of sward height at the beginning of stockpiling period results in a lower stock of forage mass in the winter; and (ii) this management action reduces the number of reproductive tillers and the falling of plants, as well as increases the number of vegetative tillers and the live leaf mass of stockpiled pasture. Thus, the objective of our study was to investigate the effects of sward height at early stockpiling period on structural characteristics of marandu palisadegrass during the grazing period, in winter.

2. Material and Methods

The study was conducted from January to September of 2013 at the Capim-Branco Experimental Farm, on Federal University of Uberlandia, Uberlandia, MG, Brazil (18°30’S, 47°50’W; 863 masl). The experimental site is located in the Cerrado biome of Brazil. The climate in the experimental area is classified as Aw (Tropical Savannah) (Alvares et al. 2013), with a well-defined dry season (April to September), and rainy season (October to March). The climatic conditions were monitored during the experimental period (Table 1).

Table 1. Mean air temperatures, mean solar radiation, mean monthly precipitation and evapotranspiration during the experimental period.

Period	Mean air temperature (°C)			Solar radiation (Mj day^{-1})	Rainfall (mm)	Evapotranspiration (mm)
	Mean	Minimum	Maximum			
Jan-Mar/2013[1]	22.73	18.75	28.68	245.75	152.35	39.73
Apr-Jun/2013[2]	20.70	15.67	27.07	413.37	68.73	66.47
Jul-Sep/2013[3]	20.73	14.58	28.03	495.45	9.35	84.68

[1]period prior to stockpiling; [2] stockpiling period; [3]grazing period.

The study was conducted in a marandu palisadegrass (*Urochloa brizantha* syn. *Urochloa brizantha* cv. Marandu) pasture subdivided into twelve paddocks (experimental units) with 800 m^2 each. The experiment was conducted in a completely randomized design, with four treatments and three replications. The treatments were swards heights (15, 25, 35 and 45 cm) at the early stockpiling time.

At the beginning of the experiment, a soil sample removed from the 0-20 cm layer exhibited the following parameters: pH (H_2O), 6.1; P, 4.5 mg dm^{-3} (Mehlich-1); K^+, 138.8 mg dm^{-3}; Ca^{2+}, 5.5 cmol$_c$ dm^{-3}; Mg^{2+}, 1.9 cmol$_c$ dm^{-3}; Al^{3+}, 0.0 cmol$_c$ dm^{-3} (KCl 1 mol L^{-1}); CEC effective, 7.3; CEC at pH 7.0, 10.2; and base saturation, 72 %. Experimental units received 50 kg ha^{-1} of P_2O_5 and 50 kg ha^{-1} of N in January, and 70 kg ha^{-1} of N in March, according to Cantarutti et al. (1999).

All pastures were managed by continuous stocking with sheep (*Ovis aries*) with 33$\pm$6 kg from January to March, and a variable stocking rate was used to maintain the desired average sward heights according to the treatments. The criterion used to measure the sward height consisted of the distance from the soil surface to the highest living leaf of the canopy. The monitoring of sward height was performed twice a week on 30 points per paddock. Average sward height on paddocks was allowed to vary by 10% around the target, with animals being added or removed when the upper or lower limit of the range, respectively, was close to being reached (da Silva et al. 2013).

The stockpiling period in which the paddocks were without animals was 79 days, beginning on 3 Apr 2013. After the stockpiling period, the grazing period began in all pastures. The pastures were managed with continuous stocking and a fixed stocking rate using the crossbred sheep Santa Inês x Dorper. The allocation of the animals to the paddocks was performed to maintain the same initial stocking rate (2.8 AU ha^{-1}). The sheep were four months old and had an initial mean weight of 26$\pm$4 kg. The grazing period was 96 days and ended on 25 September 2013.

All evaluations of stockpiled pastures were performed at the beginning (seventh day), middle (45th day), and at the end (90th day) of the grazing period. The sward height was measured along a zigzag path at 30 points per paddock using a graded ruler, and had the same criterion as described above. Then, the stretched plant height was measured at the same points by stretching the grass tillers vertically and recording the distance from the ground level to the apex of the tillers. The pasture falling index was calculated using the quotient between the stretched plant height and pasture height (Santos et al. 2009).

The numbers of vegetative and reproductive tillers were determined by counting all of the tillers contained within a 25 cm by 50 cm rectangle at three points per paddock, and at sites where the plants were of the same average grass height as pasture. The live tillers that showed inflorescence were classified as reproductive, whereas those that had no inflorescence were classified as vegetative.

The mass of the morphological components of the pastures was evaluated in three locations representative of the average sward height in each paddock. At each sampling site, all of the tillers contained within a 0.25 m^2 square were harvested at ground level. Each sample was packed in a plastic bag, weighed and split into two parts. One of the subsamples was weighed, oven dried at 65°C for 72 hours and then re-weighed. The other subsample was separated into live leaf, live stem, dead leaf and dead stem, placed in a forced-air oven at 65°C for 72 hours, and then re-weighed. The dry mass of the morphological components of the pasture was estimated using these data.

To determine the leaf area index (LAI), 60 leaf blades were randomly collected from each paddock. The leaf ends were cut and discarded to obtain a segment with an approximately a rectangular shape. The width and thickness of each rectangular segment of the leaf blade were measured, and the leaf areas of the segments were obtained by multiplying these dimensions. Then, the blade segments were placed in a forced-air oven at 65°C for 72 hours and weighed. The specific leaf area, in $cm^2\ g^{-1}$, was calculated and the LAI was obtained by multiplying the specific leaf area by the live leaf mass of the sward.

The data set were grouped as follow: beginning (seventh day of the grazing period); middle (45th day of the grazing period); end (90th day of the grazing period). The data set was analyzed to check if it met the presuppositions of the analysis of variance (additivity, independence of the errors, normality of the errors and homogeneity of variance of the errors). For the statistical presuppositions to be met, the response variable falling index had its data transformed using the squared root. Then, analysis of variance was performed in a completely randomized design using the MIXED procedure of SAS® (Statistical Analysis System) version 9.2. The matrix of variance and covariance was chosen using Akaike's Information Criterion (Wolfinger 1993). The applied model included the fixed effects of the pasture heights, day of the grazing period, and their interactions. The day of the grazing period was considered repeated measures. Means were compared, when appropriated, with Tukey test ($p < 0.05$).

3. Results

Of all the eleven variables evaluated, eight were influenced separately (no interaction) by the sward height, and the grazing period (Table 2). The number of reproductive tiller (Figure 1) and the dead leaf mass (Figure 2) were influenced by the interaction between the sward height and the grazing period.

Table 2. Significance for effects of sward height, grazing period and interactions of these factors for response variables assessed in marandu palisadegrass.

Variables	Factor		
	Sward height	Grazing period	Sward height x Grazing period
SH	0.0006	<0.0001	0.7011
SPH	<0.0001	<0.0001	0.0551
FI	0.0991	0.4104	0.9907
VT	0.0030	0.0009	0.0801
RT	0.1666	0.3012	0.0018
FM	0.0006	<0.0001	0.1001
LLM	0.0440	0.0012	0.0864
LSM	0.0076	0.0005	0.0759
DLM	0.0590	0.1122	<0.0001
DSM	0.0038	0.0422	0.0882
LAI	<0.0001	<0.0001	0.0977

SH: pasture height; SPH: stretched plant height; FI: falling index; VT: vegetative tiller; RT: reproductive tiller; FM: forage mass; LLM: live leaf mass; LSM: live stem mass; DLM: dead leaf mass; DSM: dead stem mass; LAI: leaf area index. Values in bold indicate statistical significance.

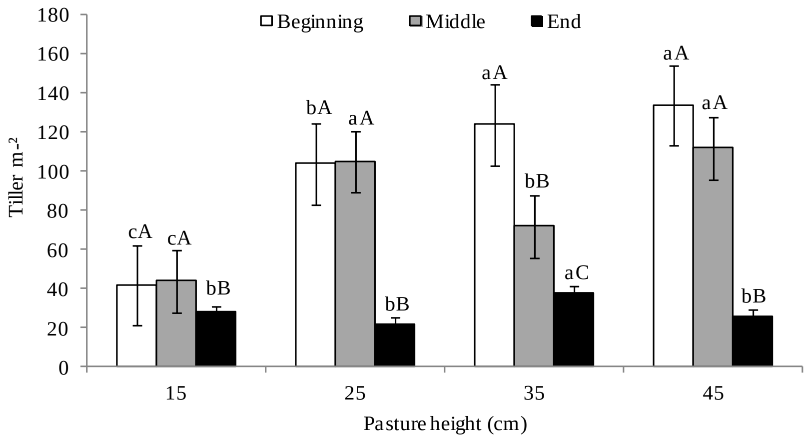

Figure 1. Number of reproductive tillers during the grazing period of marandu palisadegrass pasture with variable heights at the start of the stockpiling period. Based on the Tukey test ($p < 0.05$), uppercase letters compare the grazing period within each pasture height, and lowercase letters compare the pastures height within each grazing period. Standard error of the mean: 12,2.

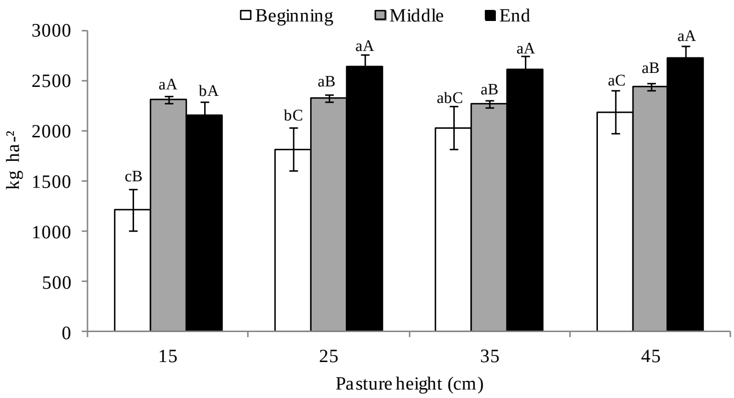

Figure 2. Dead leaf mass during the grazing period of marandu palisadegrass pasture with variable heights at the start of the stockpiling period. In each chart, uppercase letters compare the grazing period within each pasture height, and lowercase letters compare the pasture height within each grazing period, based on the Tukey test ($p < 0.05$). Standard error: 119,1.

The stockpiled pastures with 35 and 45 cm heights presented greater forage mass, sward height and stretched plant height than the stockpiled pastures with 15 and 25 cm. However, the falling index did not vary among the stockpiled grasses (Table 3). The 15 cm stockpiled pasture presented greater vegetative tiller numbers, live leaf masses and leaf area index but lower live and dead stems masses than the other stockpiled pastures (Table 3).

Table 3. Characteristics of stockpiled pastures of marandu palisadegrass with height variations at the stockpiling period.

Characteristic	Pasture height (cm)				SEM
	15	25	35	45	
Sward height (cm)	22^b	29^b	41^a	43^a	5.0
Stretched plant height (cm)	32^d	42^c	50^b	62^a	6.3
Falling index	1.5	1.5	1.3	1.5	0.1
Vegetative tiller (number m^{-2})	776^a	630^b	584^c	562^c	48.1
Forage mass (kg ha^{-1} de DM)	6457^c	7979^b	9028^a	8928^a	596
Live leaf mass (kg ha^{-1} de DM)	151^a	1178^b	1053^b	1098^b	105.1
Live stem mass (kg ha^{-1} de DM)	2095^c	2509^b	3310^a	3155^a	283.4
Dead stem mass (kg ha^{-1} de DM)	964^b	2046^a	2433^a	2265^a	330.6
Leaf area index	1.53^a	1.01^b	0.8^c	0.89^c	0.2

For each characteristic, means followed by different letters differs based on the Tukey test ($p < 0.05$); DM: dry matter; SEM: standard error of the mean.

Most of the characteristics presented a reduction in their values from the beginning to the end of the grazing period, with the exception of the falling index and the dead stem mass (Table 4).

Table 4. Characteristics of stockpiled pastures of marandu palisadegrass during the grazing period.

Characteristic	Grazing period			SEM
	Beginning	Middle	End	
Sward height (cm)	44^a	33^b	25^c	5.5
Stretched plant height (cm)	58^a	47^b	35^c	6.6
Falling index	1.5	1.4	1.4	0.03
Vegetative tiller (number m^{-2})	735^a	740^a	440^b	99.2
Forage mass (kg ha^{-1} de DM)	9568^a	8381^b	6344^c	941
Live leaf mass (kg ha^{-1} of DM)	2789^a	786^b	59^c	816.3
Live stem mass (kg ha^{-1} of DM)	3447^a	2937^b	1919^c	449.1
Dead stem mass (kg ha^{-1} of DM)	1668^b	2286^a	1829^b	185.1
Leaf area index	2.59^a	0.46^b	0.19^c	0.76

For each characteristic, means followed by different letters differ based on the Tukey test ($p < 0.05$); DM: dry matter; SEM: standard error of the mean.

The number of reproductive tillers was greater at the beginning and middle compared to the end of the grazing period in the 15, 25 and 45 cm stockpiled pastures. In the 35 cm stockpiled pasture, the number of reproductive tillers decreased with the grazing period (Figure 1). In the beginning of the grazing period, the number of reproductive tillers was greater in the 35 and 45 cm pastures, intermediate in the 25 cm pasture and inferior in the 15 cm pasture. In the middle of the grazing period, the number of reproductive tillers was greater in the 25 and 45 cm pastures, intermediate in the 35 cm pasture and lower in the 15 cm pasture. At the end of the grazing period the 35 cm stockpiled pasture showed greater number of reproductive tillers than the other pastures (Figure 1).

At the beginning of the grazing period, the dead leaf mass was lower in the 15 cm stockpiled pasture than in the other pastures. In the middle of the grazing period, this response variable did not vary among the stockpiled pastures. At the end of the grazing period the dead leaf mass was lower in the 15 cm stockpiled pasture compared to the other pastures (Figure 3). Regarding the grazing period, the dead leaf mass increased from the beginning to the end of this period (Figure 3).

4. Discussion

The sward height at early stockpiling period affects important structural characteristics of pasture after the stockpiled period, such as forage mass (Silva et al. 2015), morphological composition of forage (Afonso et al. 2018), tiller number (Vilela et al. 2013), and leaf area index (Sousa et al. 2013) of stockpiled pasture. In this sense, tall pastures at the beginning of the stockpiling period (35 and 45 cm) showed higher heights during winter use (Table 3). There was also an increase in forage mass with increasing sward height at beginning of stockpiling period (Table 3), which was also observed by Vilela et al. (2013) and Silva et al. (2015) in studies with grasses of the *Brachiaria* syn. *Urochloa* genus.

As the heights of both, the sward and the stretched plants, were greater in the tall, stockpiled pastures, the falling index of the plants did not vary (Table 3). It was hypothesized that falling index would be higher in stockpiled pastures with higher initial heights, because taller plants are heavier and tend to fall more during the stockpiling and grazing periods. However, this did not occur. The marandu palisadegrass has more rigid and less flexible stem, when compared with other *Brachiaria* species, such *B. decumbens* and *B. humidicola*. This is the reason why, even with increase in sward height and stretched plant height (Table 3), the falling index did not change with the increase of sward height at beginning of stockpiling period. Moreover, the short stockpiling period to which the marandu palisadegrass was subjected (79 days) also contributed to the absence of plant falling. In this sense, Sousa et al. (2012b), in a work with *Brachiaria brizantha* cv. Piatã, also observed that the falling index was not affected by the sward height at early stockpiling period, presenting mean values of 1.12.

The 15 and 25 cm stockpiled pastures presented similar height in the winter, in the same way as 35 and 45 cm stockpiled pastures (Table 3). However, 15 and 25 cm stockpiled pastures presented different values of the other morphological characteristics, except for the falling index (Table 3). These results demonstrate that the morphological characteristics of the forage canopy may be different, even in pastures with the same average height.

The 45 cm stockpiled pasture presented lower number of vegetative tiller than 15 cm stockpiled pasture (Table 3). Because tall pastures intercept lighter (Carnevalli et al. 2006; Braga et al. 2008), self-shading is more intense in these locations, which may inhibit tillering (Deregibus et al. 1983). Vilela et al. (2013) also obtained lower vegetative tiller numbers in *Brachiaria brizantha* cv. Piatã stockpiled for 85 days at 40 cm height compared to the same species stockpiled at 20 cm height. Additionally, most of the vegetative tillers may have developed into reproductive tillers in the tall, stockpiled pastures, following the normal phenological cycle of the grass (Eloy et al. 2014). This scenario would explain the greater number of reproductive tillers in the tall pastures (35 and 45 cm), during the beginning of the grazing period, when compared to the short pasture (15 cm) (Figure 1). The occurrence of a greater number of reproductive tillers worsens the stockpiled pasture structure, because these tillers present a longer stem, a greater number of dead leaves and a lower number of live leaves (Santos et al. 2010b). In this context, with the greater development and flowering of the grass in the tall, stockpiled pastures, the forage plant lengthened the stem and increased the senescence, with a consequent increase in the live and dead stem masses (Table 3).

The 15 cm stockpiled pasture possibly presented lower leaf senescence due to lower shading inside the canopy (Carnevalli et al. 2006). This phenomenon could explain the greater leaf area index and live leaf mass of the 15 cm stockpiled pasture in relation to the other pastures (Table 3). The greatest live leaf mass in the stockpiled pasture is advantageous for the pasture animal production (Santos et al. 2008; Nave et al. 2010; Santos et al. 2013). In contrast, greater competition for light in the tall, stockpiled pastures, reported by Sousa et al. (2013), increase the leaf senescence rate, with a consequent reduction in the leaf area index and live leaf mass. Under intense shading conditions, the photosynthesis of the youngest and most shaded leaves, located in the basal part of pasture, is lower than its respiratory rates. Thus, the leaf enters a negative carbon balance with consequent senescence (Parsons et al. 1983).

The higher population density of vegetative tillers in the 15 cm stockpiled pasture was the predominant factor in determining changes in the other structural characteristics of this stockpiled canopy (Table 3). For example, it is known that canopies with a lower sward height throughout the water season have a greater number of younger tillers, but with a smaller size (Sbrissia et al. 2010; Paiva et al. 2011; Portela et al. 2011). Considering that young tillers have a high live leaf percentage and low dead leaf and stem percentages (Santos et al. 2018), the high number of vegetative and younger tillers in the 15 cm stockpiled pasture resulted in greater leaf mass and leaf area index, as well as lower masses of live and dead stems (Table 3). The fact that the young tillers are also lighter, with a shorter stem (Carvalho et al. 2019), also justifies the lower values of forage mass and height of the 15 cm stockpiled pasture (Table 3).

With regard to changes in structural characteristics during the stockpiling period, it is worth noting that, for most of the response variables, there were no significant interactions between the pasture height at the beginning of stockpiling and the grazing period. This indicates that the differences between canopy heights recorded in Table 3 persisted throughout the period grazing.

The forage mass and the heights of the sward and the stretched plants decreased with the increase in the grazing period (Table 4) due to forage intake by the sheep at a time of year (winter), in which the climatic conditions were unfavorable for pasture regrowth. During the grazing period, from June to September, the minimum temperature was below 15°C (Table 1). According to McWilliam (1978), the ideal temperature range for the growth of tropical grasses is 30 to 35ºC, and growth is severely impaired with temperatures between 10 to 15ºC. Moreover, rainfall was low, and evapotranspiration was high during the grazing period (Table 1); this scenario is indicative of water stress, which also impairs plant growth.

The reduction of the vegetative and reproductive tiller numbers from the beginning to the end of the grazing period occurred as a result of the mortality of these tillers during the winter, due to the adverse climate for the plants (Sbrissia et al. 2010). During the grazing period, the animals may also have consumed the inflorescence of the reproductive tillers, causing their decrease during this period. Moreover, the consumption of the apical meristems of the vegetative tillers by grazing animals can also cause tiller mortality (Matthew et al. 2000).

The selective consumption of live leaf by sheep (Afonso et al. 2018), together with the absence or minimal regrowth of pastures during the winter (Pessoa et al. 2016), also caused a decrease in the live leaf mass and leaf area index during the grazing period (Table 4). Notably, the leaf area index and live leaf mass values were insignificant at the end of the grazing period (Table 3).

During the grazing period, the live stem mass and the live leaf mass reduced due to the senescence of these components of the plant. This fact resulted in the great dead stem mass value in the pastures (Table 3) and in the increase of dead leaf mass during the grazing period (Figure 2). In this case, when faced with a low supply of live leaves, such as occurred in stockpiled pastures at the end of the grazing period (Table 4), the sheep could consume the dead leaves (Afonso et al. 2018).

The greater forage mass values obtained at the beginning of the grazing period (Table 4) showed that the stockpiled pasture resulted in adequate forage mass in the pasture during the winter to meet the demands of the herd. This fact was also reported by other research (Euclides et al. 2007; Silva et al. 2016) and is important for a Brazilian grazing system, where there is usually shortage of forage during the winter.

The results of our study demonstrate that sward height control at the beginning of the stockpiling period represents an effective management strategy to modulate the characteristics of stockpiled sward in winter. As we hypothesized, the increasing sward height at beginning of the stockpiling period results in greater forage mass in winter. However, this forage mass is constituted by morphological components of worse nutritive value (stem and dead material) and this tall pasture contains more reproductive tiller. A contrary response pattern occurs in shorter pastures at the beginning of the stockpiling period. In this context, the choice of the initial sward height depends on the characteristics of the production system. If the animal category to be fed in the winter season is more nutritionally demanding, the sward height should be reduced at the beginning of stockpiling period. In addition, the longer forage shortage period (dry season) or the larger number of animals to be kept in the stockpiled pasture, the more forage mass should be stored in the stockpiled pasture, which can be achieved by adopting a tall sward of the beginning of stockpiling period.

Our results also demonstrated that, regardless of the sward height at the beginning of stockpiling period, the structural characteristics of pasture become unfavorable for the animals in the middle and end of the grazing period, in winter. In this sense, it is important to adopt management strategies to avoid the decrease of animal performance during the middle and the end of the grazing period, such as the supply of concentrate to the animals kept in the stockpiled pasture (Euclides et al. 2007). In this case, the adoption of supplementation with concentrate at increasing levels throughout the grazing period of stockpiled pasture could be an appropriate alternative.

5. Conclusions

To ensure greater forage mass in winter on the Cerrado region of Brazil, it is recommended that the *Brachiaria brizantha* syn. *Urochloa brizantha* cv. Marandu be stockpiled with 35 and 45 cm at the beginning of stockpiling period. To generate stockpiled sward with more live leaf mass e less live and dead stem masses in winter on the Cerrado region of Brazil, it is recommended that the *B. brizantha* cv. Marandu be stockpiled with 15 and 25 cm at the beginning of stockpiling period.

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