Original Research Article

Nitrogen fertilization of Marandu palisade grass under different periods of deferment

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ABSTRACT

The goal with this study was to evaluate the morphological characteristics, nutritive value and the forage dry matter (DM) accumulation of *Brachiaria brizantha*cv. Marandu in different stages of deferment under nitrogen fertilization levels.The experimental design was a randomized block in split-plot, with three replicates. Plot treatments corresponded to two levels of fertilization (with and without). Split-plot treatments corresponded to four deferment periods (March, April, May, June). Plant height and forage DM accumulation increased (P = .05), while the leaves percentage decreased according to the deferral months. Regarding the fertilization, the percentage of leaves was lower (P= .05) with nitrogen use. The DM content was higher (P = .05) in pastures deferred for a longer time. The neutral detergent fibre~~er~~ (NDF) content increased due to fertilization and greater deferral period. The crude protein(CP) level decreased as the deferral periods increased. Nitrogen fertilization proved to be viable for the production of good quality forage. The reduction in the deferment period produces forage with better morphological composition and nutritive value.

Keywords: Crude Protein; percentage of leaves; plant height.

1. INTRODUCTION

Cattle production in grazing systems is one of the most economical and profitable alternatives~~,~~ since it is rationally explored. However, in tropical regions, the availability of forage is not regular throughout the year, due to climatic variation, which limits the productive potential of the forage and causes the seasonality of the animal production [1].

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One of the management strategies used to reduce the forage deficit during the dry season is the pasture deferment, which aims to reserve the excess of forage produced at the end of the summer, to be used during the dry season [2]. The forage plants most indicated to this practice present low accumulation of stalks and good retention of green leaves, which results in smaller reductions in nutritive value over time, highlighting grasses of the *Brachiaria* genus [3].

Greater efficiency with this strategy can be obtained with the use of nitrogen fertilizers, since nitrogen (N) has a positive effect on dry matter production, specifically on leaf percentage and nutritional value [4]. Applying N at the end of the summer season can be an alternative to compensate the deleterious effect of the deferment period, becoming fundamental in the pasture production process, since the N from the organic matter mineralization may not be enough to meet the forage demand.

However, the pasture deferment promotes longer rest periods, which added to the environmental conditions, result in important changes, especially in the pasture structure. The evaluation of the structural and nutritional composition of the deferred pasture is important, since it is determinant for the growth dynamics and competition in the plant community, as to the grazing animal's ingestion behaviour [5].

The goal was to evaluate the morphological characteristics, nutritive value and forage accumulation of Brachiaria brizantha cv. Marandu under different periods of deferment with nitrogen input, in order to determine the most appropriate deferral strategy for the Mato Grosso Cerrado region.

2. MATERIAL AND METHODS

The trial was carried out in the Campo Verde-MT, located at 15º 48 ' South and 55º 26' West of Greenwich, the average altitude of 745 m. The climate, according to the classification of Köppen, is Aw type, characterized by two well-defined seasons: dry (April to September) and rainy (October to March). The average annual rainfall was 2007 mm, and the maximum and minimum temperatures were 24.7 and 19.6 °C, respectively. The soil of the experimental area is an Oxisol of medium texture with flat relief.

At the experiment beginning, soil were sampled in the 0 to 20 cm layer, and the results of which were: pH ($CaCl_2$) = 5.4; Organic matter = 24.1 g dm^{-3}; P = 4.9 mg dm^{-3}; K = 170 cmolc dm^{-3}; Ca = 1.0 cmolc dm^{-3}; Mg = 0.7 cmolc dm^{-3}; H + Al = 4.2 cmolc dm^{-3}; Sum of basis = 2.1 cmolc dm^{-3}; Cation exchange capacity = 6.3 cmolc dm^{-3}; Base saturations (%) = 33.8; Sand = 733 g kg^{-1}; Silt = 66 g kg^{-1}; Clay = 201 g kg^{-1}. According to the results of the soil analysis and the recommendations [6], it was applied 250 kg ha^{-1} of limestone filler; 167 kg ha^{-1} of single superphosphate; 750 kg ha^{-1} of ammonium sulphate. There was no need to apply potassium fertilizers. During the evaluation period, the climatic data were monitored in the experimental area (Figure 1).

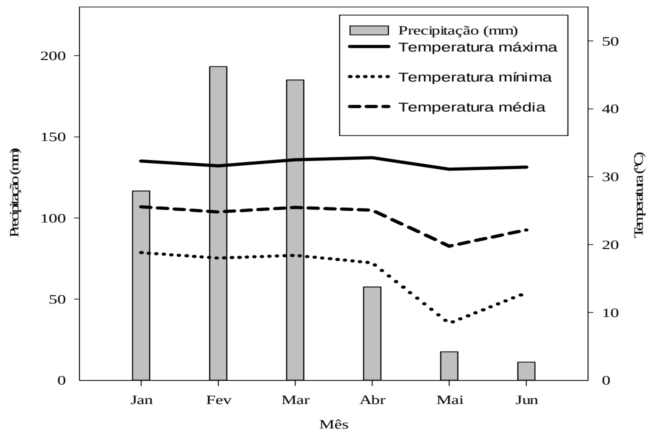

Fig. 1. Monthly averages of precipitation, maximum, minimum, mean temperature and monthly water balance during the experimental period.

The experimental design was a randomized block in split-plot, with three replicates. Plot treatments corresponded to two levels of fertilization (with and without). Split-plot treatments corresponded to four deferment periods (March, April, May, June). The deferment beginning of the marandu palisadegrass was carried out in February. The total area of the plot and the split-plot was 16.0 m^2 and 4.0 m^2, respectively.

The evaluated characteristics were: dry matter yield (kg DM ha^{-1}), the percentage of leaves (%), plant height (cm), the content of crude protein (CP), neutral detergent fibreer (NDF), total digestible nutrients (TDN) and in vitro dry matter digestibility (IVDMD). At the implementation day, a uniformity cut was performed at 10 cm of the soil, using a costal mower, followed by the application of the fertilizers in a single dose. For treatments determination, the use period of pastures deferred in Campo Verde-MT region was taken into account.

The forage samples were collected before the animal's entrance. At the respective cutting dates, the plant's heights were measured using a graduated ruler, from the soil level up to the insertion of the last leaf, into ten representative tillers of each split-plot. The same sampling was done to determine the leaves percentage, separating the live material of the dead material and the leaf blade wasere. The forage cuts of the marandu palisadegrass to determine the green mass yield were made at 20 cm of the soil level, with the harvesting of all the biomass cut. The green mass was weighed at sight on a 1.0 g weighing scale. The leaf and forage samples were packed in perforated, weighted and identified paper bags.

To determine the dry matter (DM) content, the samples were pre-dried in a forced circulation oven at 55 ºC for 72 hours. Afterwards, the material was weighed and ground using a stationary mill with a sieve of 1.00 mm. Then, samples (3 g) of this material were taken to an oven at 105ºC for determination of DM (final drying) [7]. The dry matter yield (kg DM ha^{-1}) was obtained by multiplying the green mass yield estimates by the respective DM content.

In the forage samples, the neutral detergent fiber (NDF) and crude protein (CP) contents were determined according [8]. Equations adapted from [9]were used for the determination of total digestible nutrients (TDN) and in vitro digestibility of dry matter (IVDMD), respectively: TDN = 83.79-0.4171 x NDF (R^2 = 0.82; P = .01); IVDDM = (TDN = 6.12) / 0.851 (R^2 = 0.72, P = .01). Data were submitted to analysis of variance and the means were compared by the Scott Knot test, adopting 5% of significance level, according to the methodology described by [10], using SAEG software.

3. RESULTS AND DISCUSSION

The marandu palisadegrass had lower plant height only in March, regardless of whether or not nitrogen fertilization was used (P= .05) (Table 1). For the other months of deferment, higher plant height was observed with N application, and there was no difference between the deferment of May and June (P= .05).

As for the forage mass (kg DM ha^{-1}), using or not nitrogen fertilization, the months of May and June presented higher values (P= .05). Like for the plant height, nitrogen fertilization provided higher forage mass (kg DM ha^{-1}) than without application in all periods (P= .05), being more significant in the months of May and June. However, deferred pasture had a significant reduction in the leaves percentage in longer deferment (P= .05). In April, it was observed a significant reduction of leaves percentage with the application of N, which was not observed for other months (P= .05).

Table 1. Plant height, forage mass and percentage of leaves of marandu palisadegrass according to the periods of use and nitrogen fertilization, Campo Verde-MT.

Nitrogen fertilization	Period of use				CV (%)
	March	April	May	June	
		Plant height (cm)			
Without	17.00 aC	27.33 bB	40.33 bA	41.33 bA	(a)= 7.00
With	22.67 aC	78.00 aB	110.00 aA	110.00 aA	(b)= 10.02
		Forage mass (kg MS/ha^{-1})			
Without	653.90 aB	1.433.19 bB	2.450.96 bA	3.141.64 bA	(a)= 24.89
With	1.305.94 aC	4.416.62 aB	12.220.98 aA	11.593.52 aA	(b)= 16.88
		Percentage of leaves (%)			
Without	100.00 aA	67.04 aB	51.76 aC	49.81 aC	(a)= 2.79
With	100.00 aA	45.75 bB	44.67 aB	43.66 aB	(b)= 6.41

Means followed by the same letter, lowercase in the column and upper case in the row, do not differ by the Scott-Knott test up to 5% probability. CV: Coefficient of variance.

The authors [11] and [12] also found, in deferred pastures of *Brachiariasp.*, an increase in height due to the stem elongation rate, which developed larger tillers, especially when N was applied. Tiller competition for light is a relevant factor at the forage height, especially over time, since variations in the leaf area index and light interception cause changes in the canopy light environment and in tillering of the deferred pasture [13]. Thus, deferment time and nitrogen fertilization should be carried out carefully due to a direct influence on forage accumulation, since such strategies may alter the final forage quality, by the higher percentage of stem and the reduction of the leaf blades number [14].

The forage mass at the two study conditions was above 2000 kg DM ha^{-1}[15], which is considered the minimum limit to not restrict the animal intake in the pasture, however, the fertilization provided an increase of 199.71, 308.16, 496.59 and 369.02, respectively to the evaluated periods, which confirms that N acts directly in the cell division, accelerating the forage growth rates [16].The forage mass accumulated in N treatments were higher than observed by [17] (7,665 kg of DM ha^{-1}) and [14] (7,997 kg of DM ha^{-1}) in pastures of *Brachiaria decumbens* cv. Basilisk with application of N, deferred respectively in 116 and 95 days. These results can be explained by the climatic variations and the period in which the trials were developed. Regarding the experiment, the rainfall occurred in March, together with the high temperatures during the period, may have increased the N use by plants.

The pasture deferment for a shorter period generated little amount of forage. On the other hand, it has a high percentage of leaves, a fact that can be attributed to the effect of compensation between forage mass and the development of basal buds in new tillers, accentuated mainly by the N application [18]. Without the addition of N, the forage mass increased from 653.90 to 3,141.64 kg DM ha^{-1}, and with the N application, the value of 1,305.94 increased to 12,220.98 kg DM ha^{-1}. Contradictory effect was obtained by [19] that found similar mass of leaves from the deferral beginning to the quantity obtained at the end of the analyzed period. The author [20] verified that the green leaf blade in *B. decumbens* pastures decreased from 1,638 to 891 kg DM ha^{-1} during the pasture period use in autumn due to the increase in stem length and maintenance of the live leaves number in the vegetative tillers. More attention must be paid to the grass quality for animal grazing, considering that the green leaf blade is the morphological component with the best nutritive value [21].

The DM content of marandu palisadegrass increased during the deferment periods (P = .05), with higher value for June, with or without the use of N. Regarding nitrogen fertilization, March and April presented initially higher DM content (P = .05), but the final period of use (June) the previous result reversed, in which nitrogen fertilization resulted in higher DM content (P = .05) (Table 2).

The CP levels of the marandu palisadegrass were higher in the deferral of March independently of the nitrogen fertilization use (P = .05). However, the remaining months in deferral presented significantly reduced values. The NDF content presented an increase (P = .05) as a function to the deferment period with nitrogen fertilization.

Table 2. Contents of dry matter (DM), crude protein (CP) and neutral detergent fiber (NDF) in the forage of marandu palisadegrass according to the use periods and nitrogen fertilization, Campo Verde-MT

Nitrogen fertilization	Period of use				CV (%)
	March	April	May	June	
Dry matter content – DM (%)					
Without	24.51 aB	20.96 aB	22.59 aB	30.44 bA	CV (a)= 17.76
With	17.57 bC	16.35 bC	26.38 aB	35.91 aA	CV(b)= 10.06
Crude protein content - CP (% MS)					
Without	7.92 aA	7.92 aA	6.45 aB	5.95 aC	CV (a)= 2.04
With	8.29 aA	7.71 aB	6.27 aC	5.73 aD	CV(b)= 6.27
Neutral detergent fiber content - NDF (%)					
Without	74.17 aB	76.01 aA	73.78 aB	77.22 aA	CV (a)= 1.43
With	67.89 bC	75.01 aB	73.77 aB	77.92 aA	CV(b)= 1.74

Means followed by the same letter, lowercase in the column and upper case in the row, do not differ by the Scott-Knott test upto 5% probability. CV: Coefficient of variance.

The values obtained in the treatment with N possibly occurred because the fertilization added to the rains that occurred in March extended the vegetative phase of the marandu palisadegrass, and with this they maintained the dry matter content low, comparing to the treatment without nitrogen fertilization. From the moment that the plant started the maturation process, the greater participation of reproductive structures resulted in an increase in DM contents, and this phenomenon may also have been potentiated by N and by the water deficit. According to [22], nitrogen fertilization provides an increase in the production of plant reproductive structures, reflecting the reduction of the leaf:stem/reproductive structure ratio, and consequently increasing the DM content of the whole plant.

Higher CP content was observed in the initial period of use (March). Thus, it can be observed that the CP content was positively associated with the percentage of leaves, and negatively with the NDF contents. From the month of May (60 days of deferment) the CP content was lower than 7%, becoming a limiting factor in the analysed forage [23].

Decreases in CP contents, during the deferment period, were also observed for deferred *B. decumbens* pastures in February and March [24]. Due to the maturation of plant tissues, the concentration of potentially digestible components, including soluble carbohydrates, protein, minerals and other cellular contents, tends to decrease. In contrast, indigestible fractions that limit intake and animal performance have a greater presence [25].

Deferred pasture for long periods usually presents a higher mass of dead forage, a fraction that is more fibrous and with lower nutritional value, as a result of~~from~~ senescence. However, at the treatments without the use of nitrogen fertilization, an unexpected result was obtained, since it was expected an increase in NDF during the periods of use, as the percentage of leaves decreased, and the participation of stems increased. The author [24] verified that stem length correlated negatively with CP percentages, and positively with NDF contents.

The mean value of NDF for the treatment without the use of N during March was 74.17, which was greater (P = .05) than treatments that N was used, with a value of 67.89 %. [26]found a NDF decrease with increasing N doses throughout the year, possibly because this nutrient stimulates the growth of new tissues, with high protein content and lower levels of structural carbohydrates and lignin. However, nitrogen fertilization in high doses, together with favourable climatic conditions, can accelerate plant maturity and senescence, limiting the beneficial effect of nitrogen fertilization on NDF values, since the percentage of the cell wall in the dry matter is inversely correlated with CP values.

It was observed that NDT and IVDDM of marandu palisadegrass in March were higher with N application (P=.05), with respective values of 55.47% and 57.99%. However, there was a significant reduction of the same characteristics with the use of N in the last period of deferral use (Table 3).

Table 3. Estimation of total digestible nutrients (TDN) and in vitro digestibility of dry matter fiber (IVDDM) in the forage of marandu palisadegrass as a function of the use periods and nitrogen fertilization, Campo Verde-MT

Nitrogen fertilization	Period os use				CV (%)
	March	April	May	June	
	Total digestible nutrients – TDN (%)				
Without	52.85 bA	52.09 aA	52.51 aA	51.58 aA	CV (a)= 0.84
With	55.47 aA	53.01 aB	53.02 aB	51.29 aC	CV(b)= 1.02
	***In vitro* digestibility of dry matter - IVDDM (% DM)**				
Without	54.91 bA	54.01 aA	54.51 aA	53.42 aA	CV (a)= 0.96
With	57.99 aA	55.11 aB	55.11 aB	53.07 aC	CV(b)= 1.16

Means followed by the same letter, lowercase in the column and upper case in the row, do not differ by the Scott-Knott test up to 5% probability. CV: Coefficient of variance.

According to the advance in the deferment periods evaluated, there was a decrease in green leaf blades and an increase in fibrous material in the forage mass, so the NDT and IVDDM values, as well as the CP, decreased due to the increase of the fibrous components that interfere in digestibility and nutritional value, and limit animal intake [27]. The plant maturation increases the fibrous constituents (NDF, ADF and lignin) that have a negative correlation with digestibility and intake [28].

Regarding to nitrogen, during the experiment, a change in the pasture structure was noticed, which causes the reduction of NDT and IVDDM, similar to [4], that evaluated the nutritive value of Massai guineagrass submitted to 121 days deferment and N doses, and verified that the favourable environmental condition together with nitrogen fertilization, accelerated plant senescence and increased reproductive tillers, which limited the beneficial effect of fertilization on the cell wall components.

Based on the results obtained from the forage morphological and chemical composition of the simulated grazing samples, it is proposed not to prolong the use of marandu palisadegrass deferred pastures if the goal is to obtain high animal performance. Otherwise, if the goal is a more discrete weight gains or just weight maintenance, the pasture could be used for a longer period. Another technique to prevent the animals from consuming lower quality forage is to carry out deferment in a partial way, thus using deferred areas at different times during the dry season.

4. CONCLUSION

1. Nitrogen fertilization is a viable strategy to produce good quality forage of marandu palisadegrass to be used in the dry season.

2. The reduction in the deferment period of marandu palisadegrass produces forage with better morphological composition and nutritive value.

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