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Defoliation management affects biomass flow and gas exchange in *Megathyrsus maximus* BRS Tamani grass managed under cutting

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Abstract: The objective was to evaluate the effects of defoliation management in biomass flow and gas exchange in Tamani grass pasture managed under cutting. A randomized complete block design in a 2 x 3 factorial arrangement was adopted, with two defoliation frequencies (DF; 85 and 95% interception of photosynthetically active radiation) and three defoliation intensities (DI; 0.8, 1.3, and 1.8 of residual leaf area index), with four replications. The study was conducted in 2019. Leaf and stem elongation rates, leaf temperature, photosynthesis/stomatal conductance ratio, photosynthesis/ transpiration ratio, and relative chlorophyll index were not affected by defoliation strategies or their interactions. Leaf senescence rate was not influenced by DF, but there was an effect on the lowest DI with an average value of 1.21 cm tiller^{-1} day^{-1}. The total number of leaves, phyllochron, and tiller population density showed interaction between DF and DI. Defoliation frequency influenced the number of new live leaves per tiller (1.75 and 2.23 leaves tiller^{-1} for DF of 85% and 95%, respectively). Forage accumulation rate was not affected by the defoliation strategies, with values ranging from 247.82 kg DM ha^{-1} to 334.97 kg DM ha^{-1}. The variables leaf photosynthesis rate, leaf transpiration rate, carbon dioxide concentration in the leaf, and stomatal conductance differed only between defoliation frequencies. Under the soil and climate conditions of the present study, Tamani grass should be managed with a defoliation frequency of 85% interception of photosynthetically active radiation and a residual leaf area index of 0.8.

Keywords: Active radiation; Forage accumulation; Leaf area index; Morphogenesis; Photosynthetic efficiency.
Abbreviations: DI_defoliation frequencies; DI_defoliation intensities; IPAR_interception of photosynthetically active radiation; LAIr_residual leaf area index; LER_leaf elongation rate; SER_stem elongation rate; FAR_forage accumulation rate; LSR_leaf senescence rate; TPD_tiller population density; CV_coefficient of variation.

Introduction

Ruminant production systems in Brazil use pastures as the main source forage. However, improper pasture management can lead to ecological damage and economic losses, making efficient and sustainable management essential to ensuring good animal performance (Cutrim Júnior et al., 2010). When morphophysiological characteristics of forage plants are associated with grazing management strategies, there are increases in pasture productivity and longevity (Fulkerson and Slack 1994). Studies evaluating the combination of different defoliation frequencies and intensities are important to define the optimal management of the forage plant, in addition to allowing the evaluation of its regrowth capacity (Korte et al., 1982). The effects of defoliation can be determined by the part of the plant that is removed by grazing or cutting (defoliation intensity) and the time interval between successive defoliations (defoliation frequency) (Harper, 1977; Crawley, 1983).

The duration of the rest period of pastures managed under rotational grazing should be as short as possible, without compromising forage plant regrowth or pasture longevity. This approach minimizes forage losses caused by leaf senescence and excessive stem production (Cândido et al., 2005). The control of defoliation through frequency and intensity has generated responses in terms of morphogenetic characteristics and gas exchange in tropical grasses (Cutrim Júnior et al., 2010; Chaves et al., 2018; Martuscello et al., 2019).

The maximization of biomass production, up to the genetic productive potential of forages plants, depends on specific conditions such as photosynthetically active radiation, humidity, nutrient availability, temperature, and management. These characteristics are responsible for: leaf emission rate, leaf expansion rate, and leaf lifespan, although they can be affected by the environment (temperature), water and nutrient availability (Nabinger and Pontes 2001). In this context, understanding the morphogenic responses of forage plants to different frequencies and intensities of defoliation becomes a useful tool for their correct management when subjected to intermittent grazing (Chaves et al., 2018).

Cutrim Júnior et al. (2013), evaluating the biomass flow of Tifton 85 under different managements strategies, reported that the leaf and stem elongation rate change according to grazing intensity. In contrast, Chaves et al. (2018) found that the morphogenic variables of Canarana grass are mimnially influenced by defolation frequency and intensity. Meanwhile, Zanine et al. (2012), studying Aruana grass, observed that the morphogenic characteristics of this grass are strongly affected by defoliation management.

Understanding the gas exchanges responses of forage plants in intensive management systems under different combinations of defoliation frequency and intensity is essential for a better understanding of the forage production process and for establishing different techniques aimed at maximizing the biological efficiency of the plant, allowing the definition of strategic pasture management.

Based on this context, the hypothesis is that the biomass flow and gas exchange of Tamani grass are not affected by combinations of defoliation frequency and intensity. Thus, the objective was to evaluate the biomass flow and gas exchange of Tamani grass under two frequencies (85 and 95% interception of photosynthetically active radiation - IPAR) and three defoliation intensities (0.8; 1.3 and 1.8 of residual leaf area index - LAIr).

Results and Discussion

Biomass flow

Five regrowth cycles were observed for treatments with a defoliation frequency (DF) of 85% IPAR, and four cycles for treatments with a defoliation frequency of 95% IPAR. The recommended management goals for Tamani grass were achieved (Table 1). For the residual leaf area index (LAIr), a coefficient of determination of 0.92 was observed (Figure 2A), while the interception of photosynthetically active radiation (IPAR) showed an 89.69% adjustment relative to the recommended values (Figure 2B).

The leaf elongation rate (LER) and stem elongation rate (SER) were not affected ($P>0.05$) by the different pasture management strategies or by the interaction between defoliation frequency and intensity, with averages of 6.48 and 0.12 cm day^{-1} tiller^{-1}, respectively (Table 2). The similar response was observed for the forage accumulation rate (FAR), which average of 239.62 kg DM ha^{-1}.

Understanding the leaf elongation rate (LER) is crucial in biomass flow studies, as higher LER values indicate a greater photosynthetically active leaf area, resulting in increased forage accumulation. The observed response for the forage accumulation rate (FAR) is attributed to the fact that LER was not affected by the treatments, given its significant influence on FAR.

The fact that LER was not affected by the adopted management practices indicates that the residual leaf area indices (LAIr) were well adjusted, ensuring high photosynthetic activity in the remaining leaves and facilitating carbon fixation (Cutrim Júnior et al., 2013). According to Castro (1999), the development of the photosynthetic apparatus is strongly influenced by light conditions, with significant increases in leaf blade length observed in various species under reduced light availability.

Although no effect of management on SER was observed, a high variation was noted in the field data (CV = 79.93%), which likely contributed to the lack of significant treatment effects.

The high variation in SER in the treatments was possibly also influenced by the atypical precipitation patterns during the experiment. Although Tamani grass has low stem production (Vasconcelos et al., 2020), its etiolation may be affected by the light deprivation inside the canopy and the consequent reduction in the red/far-red ratio that is perceived by phytochrome in the plant (Taiz and Zeiger 2013), altering its active form and triggering the elongation process.

It is important to note that the stem elongation rate directly impacts the pasture structure, preventing an increase in the light extinction coefficient due to the greater distance between leaves (Sugiyama et al., 1985; Lopes et al., 2014). However, with increase stem participation, there is a reduction in the quality of the forage produced, as well as in the use of this fraction by the animals (Cândido et al., 2006; Silva et al., 2007).

Pastures managed with a LAir of 1.8 showed a higher leaf senescence rate (LSR) ($P<0.05$). The phyllochron exhibited an interaction ($P<0.05$) between defoliation frequency and intensity, with lower values observed in pastures managed with 85% interception of photosynthetically active radiation (IPAR) and an RLAI of 1.8 (Table 2).

The result for LSR was expected, as the increase in LSR is related to the higher residual LAI or reduction in defoliation frequency (Lemaire, 2001). LSR can be used as an indicator to adjust the defoliation intensity (DI). Therefore, more severe defoliation intensities result in a smaller residual leaf area, meaning fewer leaves enter senescence. However, lighter defoliation intensities and longer rest periods can accelerate the senescence process of the first expanded leaf blades (Lopes et al., 2013).

The lower phyllochron for pastures managed with 85% IPAR may be related to the fact that pastures with higher defoliation frequency tend to produce a greater number of tillers, which are smaller due to intraspecific competition. This may reduce the time between the emergence of two consecutive leaves, consequently leading to a shorter period, in days, for this phenomenon to occur. Similar results were observed by Cutrim Júnior et al. (2010), who studied Tanzania grass, verified

Table 1. Recommended and achieved management targets for *Megathyrsus maximus* cv. BRS Tamani subjected to two defoliation frequencies (IPAR) and three defoliation intensities (LAIr) in the pre-defoliation condition

Defoliation intensities (LAIr)	Defoliation frequencies (IPAR%)		Mean
	85	95	
Residual leaf area index (CV=7.23%)			
0.8	0.88	0.87	0.87C
1.3	1.29	1.27	1.28B
1.8	1.82	1.78	1.81A
Mean	1.33a	1.31a	
Interception of photosynthetically active radiation (%, CV=1.34%)			
0.8	85.56Bb	94.70Aa	90.13
1.3	85.64Bb	94.27Aa	89.96
1.8	87.52Ab	94.75Aa	91.14
Mean	86.24	94.58	

CV: coefficient of variation; Means followed by distinct letters, uppercase in the column and lowercase in the row, differ from each other by Tukey's test (P<0.05).

Table 2. Biomass flow and forage accumulation rate in *Megathyrsus maximus* cv. BRS Tamani pastures subjected to different grazing management strategies

Defoliation intensities (LAIr)	Defoliation frequencies (IPAR%)		Mean
	85	95	
Leaf Elongation Rate (cm day^{-1} tiller^{-1}, CV=30.94%)			
0.8	5.99	6.50	6.25$^{n.s.}$
1.3	6.54	6.49	6.51$^{n.s.}$
1.8	6.96	6.45	6.70$^{n.s.}$
Mean	6.50$^{n.s.}$	6.48$^{n.s.}$	
Stem Elongation Rate (cm day^{-1} tiller^{-1}, CV=79.93%)			
0.8	0.08	0.10	0.09$^{n.s.}$
1.3	0.12	0.12	0.12$^{n.s.}$
1.8	0.13	0.15	0.14$^{n.s.}$
Mean	0.11$^{n.s.}$	0.12$^{n.s.}$	
Leaf Senescence Rate (cm day^{-1} tiller^{-1}, CV=65.99%)			
0.8	0.53	0.72	0.63B
1.3	0.79	0.89	0.84B
1.8	1.35	1.07	1.21A
Mean	0.89$^{n.s.}$	0.89$^{n.s.}$	
Phyllochron (days leaf^{-1}, CV=20.97%)			
0.8	5.41Aa	5.17Aa	5.29
1.3	4.63Aa	5.19Aa	4.91
1.8	4.49Ab	5.68Aa	5.08
Mean	4.84	5.35	
Leaf Lifespan (days, CV=15.47%)			
0.8	8.73	11.77	10.25$^{n.s.}$
1.3	8.15	11.07	9.61$^{n.s.}$
1.8	7.23	11.16	9.19$^{n.s.}$
Mean	8.03b	11.33a	
Number of New Live Leaves (leaves tiller^{-1}, CV=16.03%)			
0.8	1.69	2.35	2.02$^{n.s.}$
1.3	1.85	2.25	2.05$^{n.s.}$
1.8	1.70	2.08	1.89$^{n.s.}$
Mean	1.75b	2.23a	
Forage Accumulation Rate (kg DM ha^{-1}, CV=37.91%)			
0.8	270.96	247.82	259.39$^{n.s.}$
1.3	287.45	293.82	290.63$^{n.s.}$
1.8	334.97	296.77	315.87$^{n.s.}$
Mean	297.79$^{n.s.}$	279.47$^{n.s.}$	

CV: coefficient of variation; n.s.: no significance. Means followed by distinct letters, uppercase in the column and lowercase in the row, differ from each other by Tukey's test (P<0.05).

Table 3. Physiological characteristics of cv. BRS Tamani pastures subjected to different *Megathyrsus maximus* grazing managements.

Defoliation intensities (LAIr)	Defoliation frequencies (IPAR%)		Mean
	85	95	
Leaf photosynthesis rate (μmol m^{-2} s^{-1}, CV=18.36%)			
0.8	24.41	22.09	23.25$^{n.s.}$
1.3	26.67	21.06	23.87$^{n.s.}$
1.8	24.48	22.02	23.25$^{n.s.}$
Mean	25.19a	21.72b	
Leaf transpiration rate (mmol m^{-2} s^{-1}, CV=21.94%)			
0.8	4.62	4.47	4.54$^{n.s.}$
1.3	5.03	4.02	4.53$^{n.s.}$
1.8	4.89	4.45	4.67$^{n.s.}$
Mean	4.85a	4.31b	
CO_2 concentration in leaf (ppm, CV=19.84%)			
0.8	197.25	178.00	187.63$^{n.s.}$
1.3	197.92	169.42	183.67$^{n.s.}$
1.8	187.25	174.67	180.96$^{n.s.}$
Mean	194.14a	174.03b	
Stomatal conductance (μmol m^{-2} s^{-1}, CV=67.15%)			
0.8	0.33	0.31	0.32$^{n.s.}$
1.3	0.46	0.27	0.36$^{n.s.}$
1.8	0.42	0.28	0.35$^{n.s.}$
Mean	0.40a	0.28b	
Leaf temperature (°C, CV= 7.22%)			
0.8	36.05	35.83	35.94$^{n.s.}$
1.3	35.89	35.62	35.75$^{n.s.}$
1.8	36.26	36.12	36.19$^{n.s.}$
Mean	36.07$^{n.s.}$	35.85$^{n.s.}$	
Photosynthesis/transpiration ratio (dimensionless, CV=67.15%)			
0.8	5.55	5.31	5.43$^{n.s.}$
1.3	5.37	5.70	5.53$^{n.s.}$
1.8	5.08	5.02	5.05$^{n.s.}$
Mean	5.34$^{n.s.}$	5.34$^{n.s.}$	
Photosynthesis/stomatal conductance ratio (dimensionless, CV=67.15%)			
0.8	79.10	78.09	78.60$^{n.s.}$
1.3	72.39	86.70	79.55$^{n.s.}$
1.8	72.62	83.42	78.02$^{n.s.}$
Mean	74.71$^{n.s.}$	82.74$^{n.s.}$	
Relative chlorophyll index (SPAD unit, CV=67.15%)			
0.8	28.39	27.46	27.93$^{n.s.}$
1.3	28.91	29.32	29.12$^{n.s.}$
1.8	28.34	28.33	28.33$^{n.s.}$
Mean	28.55$^{n.s.}$	28.37$^{n.s.}$	

CV: coefficient of variation; n.s.: no significance. Means followed by distinct letters, uppercase in the column and lowercase in the row, differ from each other by Tukey's test (P<0.05).

interaction between DF and DI, with lower phyllochron values when the canopy was managed with DF of 85% IPAR and LAIr of 1.8.

It was found that the leaf lifespan was influenced only by defoliation frequency, with leaves in pastures managed with 85% IPAR having a shorter lifespan than those managed with 95% IPAR. Defoliation intensity did not affect (P>0.05) the lifespan of Tamani grass leaves (Table 2). The variable number of new live leaves was affected (P<0.05) only by defoliation frequency, with pastures managed with 85% IPAR showing a lower value (Table 2).

The number of new live leaves per tiller results from the product of leaf lifespan and phyllochron, making it a relatively stable genotypic characteristic in the absence of nutritional deficiencies. It is important to highlight that this variable is relevant in pasture management, as leaves represent the highest quality fraction of the forage, being the fraction most selected by animals during grazing (Lopes et al., 2014).

Gas Exchange

The leaf photosynthesis rate, leaf transpiration rate, leaf carbon dioxide concentration, and stomatal conductance were influenced (P<0.05) only by defoliation frequencies, with higher values observed for these variables in pastures managed with 85% IPAR (Table 3). The variables leaf temperature, photosynthesis/transpiration ratio, photosynthesis/stomatal

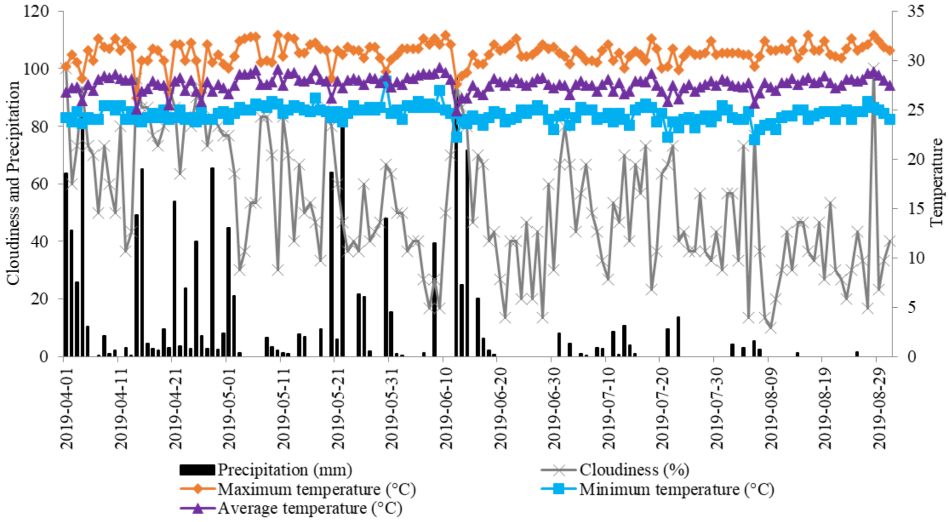

Figure 1. Climatic data collected during the experimental period.

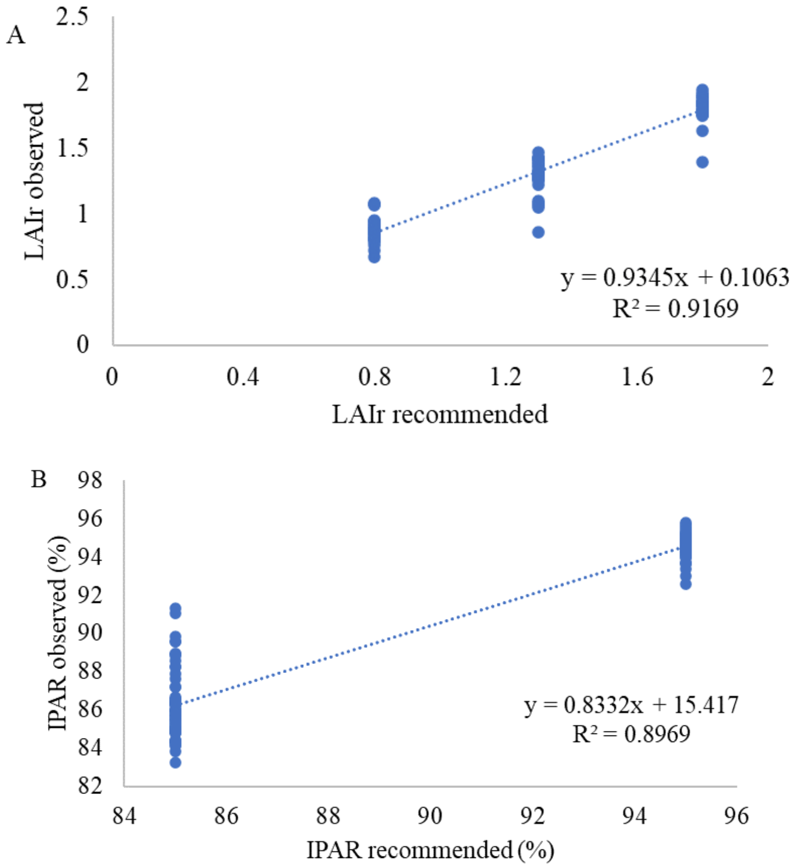

Figure 2. Relationship between the residual leaf area indexes (LAIr; A) and the interceptions of photosynthetically active radiation (IPAR; B) recommended and observed throughout the execution of the experiment.

conductance ratio, and relative chlorophyll index showed no interaction effect between the factors, nor the frequency or intensity of defoliation, with average values of 35.93 °C for leaf temperature, 5.33 for photosynthesis/transpiration ratio, 78.36 for photosynthesis/stomatal conductance ratio, and 28.46 SPAD units for the relative chlorophyll index (Table 3).

The response of the leaf photosynthesis rate is likely due to the greater renewal of leaf blades and reduced mutual shading between them. The reduction in the photosynthetic rate in plants subjected to shading may be related to the lower chlorophyll ‘a/b’ ratio, as plants that develop in environments with lower light intensity tend to have a higher proportion of chlorophyll ‘b’ (Baig et al., 2005). According to Alexandrino et al. (2011) and Santos et al. (2011), younger pastures, such as pastures managed with 85% IPAR, exhibit higher renewal of leaf blades and greater photosynthetic efficiency. In pastures managed with lower grazing frequency, a higher photosynthesis rate was observed, indicating the superiority of this genotype in terms of photosynthetic capacity.

The higher leaf transpiration rate observed in forage plants managed with a frequency of 85% IPAR likely occurred due to the higher concentration of carbon dioxide in the leaves of these plants. Forr the plant to absorb CO_2 from the environment, it inevitably loses water due to the increase stomatal opening. However, when this loss is reduced, there are also restrictions

on CO_2 input, as observed in treatments with a 95% IPAR, presenting lower transpiration and, consequently, a reduction in Ci, indicating interdependence between CO_2 assimilation and water consumption (Larcher, 2006). According to Conrado et al. (2021), older plants become more efficient in water use, reducing transpiration loss, which may justify the lower E in plants managed with 95% IPAR.
The leaf temperature response may be linked to the leaf transpiration rate. Although the transpiration rate was higher with the frequency of defoliation, the observed values indicate a greater demand for water by the plants, which contributed to delay the heating of the leaves.
The photosynthesis/transpiration ratio represents water use efficiency, quantitatively expressing the response of gas exchange in the leaf at the time of field measurement. The results demonstrate that the treatments were subjected to equal water availability conditions and, consequently, did not differ in terms of water use efficiency.
The relationship between leaf photosynthesis rate and stomatal conductance has ecological importance. If the photosynthesis rate and stomatal conductance vary proportionally and linearly, the internal concentration of CO_2 and water use efficiency likely remain constant to optimize gas exchange (Schulze and Hall, 1982). In this study, although the internal CO2 concentration varied with defoliation frequencies, the photosynthesis/stomatal conductance ratio did not differ, indicating that stomatal conductance does not explain the reduction in photosynthesis efficiency and, consequently, the internal CO2 concentration at 95% IPAR frequencies.
The relative chlorophyll index is a non-destructive method for predicting nitrogen deficiency in plants and indirectly represents the synthesis of chlorophylls (photosynthetic pigments) at the end of the grass growth period, which are responsible for capturing light energy (Taiz and Zeiger, 2013). In this study, the results of the relative chlorophyll index were as expected and demonstrate that the fertilization management during the experiment was effective, ensuring that all treatments responded uniformly to the nitrogen dose of 600 kg ha^{-1} $year^{-1}$.

Materials and Methods

Local, treatments and experimental desing

The experiment was conducted at the Teaching and Research Unit in Forage – NEEF/DZ/CCA/UFC, which is part of the Federal University of Ceará, located at a latitude of 3°45'47" S and a longitude of 38°31'23" W. According to the classification of Köppen (1936), the region is characterized by an Aw' climate (rainy tropical with summer precipitation). The soil is classified as Typical Eutrophic Yellow Argisol (Santos et al., 2018). The climate data for the experimental period were obtained at the Agrometeorological Station of the Federal University of Ceará, located on the Pici Campus (Figure 1). The experimental was carried out in 2019.
A randomized block design with four replications (2.5 x 5 m plots) was adopted, in a 2x3 factorial arrangement, totaling 24 experimental units. The treatments consisted of the combinations of two defoliation frequencies (85 and 95% interception of photosynthetically active radiation - IPAR) and three defoliation intensities (0.8, 1.3 and 1.8 residual leaf area index - LAIr).

Pasture management and traits measured

The experimental area was allocated in approximately 408 m^2 with *Megathyrsus maximus* cv. Tamani grass established in 2017, subdivided into 24 plots of 12.5 m^2 each. Before the experimental period, soil samples were collected at a depth of 0 to 20 cm and take to the Soil and Water Laboratory (UFC/FUNCEME) at the Federal University of Ceará, Pici Campus, for soil chemical characterization.
The chemical analysis of the soil revealed the following characteristics: P: 4.0 mg dm^{-3}; K: 15.64 mg dm^{-3}; Al^{3+}: 0.10 cmol dm^{-3}; pH in water: 5.5; Ca^{2+}: 1.00 cmol dm^{-3}; Mg^{2+}: 0.70 cmol dm^{-3}; SB: 2.0 cmol dm^{-3}; cation exchange capacity: 2.5 cmol dm^{-3}; organic matter: 5.48 g kg^{-1}; base saturation: 80%. Based on the soil analysis, fertility correction was performed according to the recommendation of the Soil Fertility Commission of the State of Minas Gerais (CFSEMG, 1999) for grasses with high productive potential
Nitrogen fertilization was applied at a dose equivalent to 600 kg ha^{-1} $year^{-1}$ of N, using urea (45% N) as the nitrogen source, under a micro-sprinkler irrigation depth of 6 mm per day (Vasconcelos et al., 2020). The fertilization was divided across all defoliation cycles, with the first installment applied after cutting and the second in the middle of the cycle.
For monitoring pre- and post-cut conditions, the PAR-LAI analyzer model AccuPAR LP-80 (Decagon Devices Inc.®) was used. The evaluations of IPAR and LAIr were conducted between 11:00 AM and 1:00 PM. Readings were taken at two sampling points per experimental unit in both pre-cut and residual conditions.
To monitor the biomass flow of Tamani grass, five tillers per plot were marked with wire rings and colored tapes for easy identification, and the area around the tillers was demarcated with a rod. The emergence, elongation and senescence of leaf blades and stems were recorded to estimate their respective rates. Evaluations were conducted every three days using a ruler graduated in centimeters.
The length of the expanded blade was obtained as the distance from the ligule to its apex, while that of emerging blades was measured from its apex to the last exposed ligule. The length of the senescent portion was determined by the difference between the length of the leaf blade and the remaining green portion. Stem elongation was calculated as the difference in the distances from the ligule to the base of the tiller of the last expanded leaf in the first and last readings, divided by the observation period.
To express linear growth in terms of weight growth, the respective conversion factor was estimated. To this end, when the pre-cutting target was reached, five tillers were randomly collected per plot and separated into stem, senescent leaf blade

and emerging leaf blade. After separation, the sum of the length of its recorded components from each fraction was obtained, which was then stored in paper bags, identified and subjected to drying in a forced ventilation oven at 55 ºC until constant weight. In this way, it was possible to obtain the gravimetric indexes (weight per unit length) for the emerging leaf blade (a1), adult leaf blade (a2) and stems (b). Thus, the forage accumulation rate (FAR) during the rest period was estimated from the leaf elongation rate (LER), the stem elongation rate (SER) and the tiller population density (TPD), according to the equation (Davies, 1993):

$$FARi = [(LER * a1) + (SER * a2)] * TPDi$$

were,

FARi = forage accumulation rate during rest period i (kg DM ha^{-1});

LER = leaf blade elongation rate (cm day^{-1} tiller);

a1 = weight index per unit length for emerging leaf blade (g cm^{-1});

SER = stem elongation rate (cm day^{-1} tiller);

a2 = weight index per unit length for stem (g cm^{-1});

TPD = tiller population density (tillers ha^{-1}).

The lifespan of the leaves was estimated based on the values of their leaf appearance rates (inverse of the phyllochron) and number of leaves per tiller, as described by Chapman and Lemaire (1993).

The physiological parameters of the pasture were evaluated using an infrared CO_2 analyzer (Infra-Red Gas Analyzer - IRGA, model LCI BioScientfic), while the relative chlorophyll index was measured with a chlorophyll meter (Chlorophyll Meter SPAD-502). The evaluations were conducted when the pastures reached the pre-cutting condition according to the treatment, in the morning period, between 9:00 and 11:00 AM, on two newly expanded leaf blades per experimental unit.

Examined variables were: leaf photosynthesis rate (μmol m^{-2} s^{-1}), leaf transpiration rate (mmol m^{2} s^{-1}), leaf temperature (°C), leaf carbon dioxide concentration (ppm), stomatal conductance (μmol m^{-2} s^{-1}), photosynthesis/transpiration ratio (water use efficiency), photosynthesis/conductance ratio (intrinsic water use efficiency) and relative chlorophyll index (SPAD units).

Statistical analysis

The data were subjected to analysis of variance and mean comparison tests. Interactions were analyzed when significant using the F test at a 5% probability level. For mean comparisons, the Tukey test was used at a 5% probability level. The GLM procedure from the SAS computer program (SAS, 2002) was used to assist with the statistical analysis.

Conclusion

Tamani grass should be managed with a defoliation frequency of 85% of the interception of photosynthetically active radiation, while maintaining a residual leaf area index of 0.8, without negatively effecting leaf elongation rate, leaf lifespan, number of new live leaves, forage accumulation and physiological characteristics.

Conflict of interest

The authors declare that no conflict of interests exists.

References

Alexandrino E, Cândido MJD, Gomide JA (2011) Fluxo de biomassa e taxa de acúmulo de forragem em capim Mombaça mantido sob diferentes alturas. Rev Bras Saúde Prod Anim. 12:59-71.

Baig MJ, Anand A, Mandal PK, Bhatt RK (2005) Irradiance influences contents of photosynthetic pigments and proteins in tropical grasses and legumes. Photosynthetica. 43:47-53.

Cândido MJD, Gomide CAM, Alexandrino E, Gomide JA, Pereira WE (2005) Morfofisiologia do dossel de *Panicum maximum* cv. Mombaça sob lotação intermitente com três períodos de descanso. Rev Bras Zootecn. 34:338-347.

Cândido MJD, Silva RG, Neiva JNM, Facó O, Benevides YI, Farias SF (2006) Fluxo de biomassa em capim-tanzânia pastejado por ovinos sob três períodos de descanso. Rev Bras Zootecn. 35:2234-2242.

Castro CRT, Garcia R, Carvalho MM, Couto L (1999). Produção forrageira de gramíneas cultivadas sob luminosidade reduzida. Rev Bras Zootecn. 28:919-927.

Chapman DF, Lemaire G (1993) Morphogenetic and structural determinants of plant regrowth after defoliation. Paper presented in International Grassland Congress, Austrália, 95-104, 1993.

Chaves DR, Cândido MJD, Furtado RN, Pompeu RCFF, Maranhão TD (2018) Morphogenesis of canarana grass with two frequencies and two defoliation intensities. Arch Zootec. 67:396-402.

Comissão De Fertilidade Do Solo Do Estado De Minas Gerais – CFSEMG (1999) Recomendações para uso de corretivos e fertilizantes em Minas Gerais - 5ª Aproximação. 5 ed. Viçosa: UFV.

Conrado JA, Lopes MN, Cândido MJD, Santos Neto CF, Morais LF, Torres AFF, Nascimento DR, Carneiro MSS (2021) Characterization of *Brachiaria decumbens* 'Basilisk' pasture subjected to flexible grazing by sheep. Chil J Agric Res. 81:338-350.

Crawley MJ (1983) Herbivory: The dynamics of animal-plant interactions. Blackwell Scientific, Oxford.

Cutrim Júnior JAA, Cândido MJD, Valente BS, Carneiro MSS, Carneiro HAV, Cidrão PML (2010) Fluxo de biomassa em capim-tanzânia sob três frequências de desfolhação e dois resíduos pós-pastejo. Rev Bras Saúde Prod Anim. 11:618-629.

Cutrim Junior JAA. Cavalcante ACR, Cândido MJD, Silva GL, Oliveira LEV, Vasconcelos ECG, Mesquita TMO (2013) Biomass flow in Tifton-85 bermudagrass canopy subjected to diferente management strategies under rotational grazing with dairy goats. R. Bras. Zootec. 42:77-86.

Davies A (1993) Tissue turnover in the sward. In: Davies RD, Baker RD, Grant SA, Laidlaw AS (eds) Sward Measurement Handbook, 2nd ed, London, British Grassland Society.

Fulkerson WJ, Slack K (1994) Leaf number as a criterion for determining defoliation time for *Lolium perenne*. 1. Effect of water soluble carbohydrates and senescence. Grass Forage Sci. 49:373-377.

Harper JL (1977) Population biology of plants. Academic Press, London.

Köppen W (1936) Das geographische System der Klimate. In: *Handbuch der Klimatologie*, Berlin: Gebrüder Borntraeger.

Korte CJ, Watkin BR, Harris W (1982) Use of residual leaf area index and light interception as criteria for spring-grazing management of ryegrass dominant pasture. N Z J Agric Res. 25:309-319.

Larcher W (2006) Ecofisiologia vegetal. São Carlos: RiMa.

Lemaire G (2001). Ecophisiology of grasslands: dinamic aspects of forage plant populations in grazed swards. Paper presented at the 19th International Grassland Congress, São Pedro, 11-21, 2001.

Lopes MN, Cândido MJD, Pompeu RCFF, Silva RG, Lacerda CF, Bezerra ML (2014) Características morfogênicas de dois tipos de perfilhos e produção de biomassa do capim-massai adubado com nitrogênio durante o estabelecimento. Biosci. J. 30:666-677.

Lopes MN, Cândido MJD, Pompeu RCFF, Silva RG, Lopes JWB, Fernandes FRB, Lacerda CL, Bezerra FML (2013) Response of biomass flow in Massai grass to nitrogen fertilization during the establishment and regrowth. Rev. Ceres. 60:363-371.

Martuscello JA, Rios JF, Ferreira MR, Assis JA, Braz TGS, Cunha DNFV (2019) Production and morphogenesis of BRS tamani grass under different nitrogen rates and defoliation intensities. Bol Ind Anim. 76:1-10.

Nabinger C, Pontes LS (2001) Morfogênese de plantas forrageiras e estrutura do pasto. In: Pedreira CGS, Silva S (eds) A Produção Animal na Visão dos Brasileiros, FEALQ, Piracicaba.

Santos HG, Jacomine PKT, Anjos LHC, Oliveira VA, Lumbreras JF, Coelho MR, Al-meida JA, Araújo Filho JC, Oliveira JB, Cunha TJF (2018) Sistema brasileiro de classificação de solos. Brasília, Embrapa.

Santos MER, Fonseca DM, Braz TGS, Silva SP, Gomes VM, Silva GP (2011) Características morfogênicas e estruturais de perfilhos de capim-braquiária em locais do pasto com alturas variáveis. Rev Bras Zootecn. 40:535-542.

SAS Institute (2002) SAS system for windows. Version 9.0. Cary: SAS Institute Inc.

Schulze ED, Hall A (1982) E. Stomatal responses, water loss and CO_2 assimilation rates of plants in contrasting enviroments. In: Lange OL, Nobel PS, Osmond CB, Ziegler H (Eds) Physiological plant ecology: II. Water relations and carbon assimilation. Berlin, Spring-Verlag.

Silva RG, Cândido MJD, Neiva JNM, Lôbo RNB, Silva DS (2007) Características estruturais do dossel de pastagens de capim-tanzânia mantidas sob três períodos de descanso com ovinos. R. Bras. Zootec. 36:1255-1265.

Sugiyama S, Yoneyama M, Takahashi N, Gotoh K (1985) Canopy structure and productivity of *Festuca arundinaceae* Schreb, swards during vegetative and reproductive growth. Grass Forage Sci. 40:49-55.

Taiz L, Zeiger E (2013) Fisiologia vegetal, 5rd ed, Artmed, Porto Alegre.

Vasconcelos ECG, Candido MJD, Pompeu RCFF, Cavalcante ACR, Lopes MN (2020) Morphogenesis and biomass production of 'BRS Tamani' guinea grass under increasing nitrogen. Pesqu Agropecu Bras. 55:e012350.

Zanine GD, Santos GT, Sbrissia AF (2012) Frequencies and intensities of defoliation in Aruana guineagrass swards: morphogenetic and structural characteristics. R. Bras. Zootec. 41:1848-1857.