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IMPACTS OF GRAZING MANAGEMENT STRATEGIES ON FORAGE CANOPY STRUCTURE IN MULTI-SPECIES PASTURES DURING THE WET-DRY TRANSITION PERIOD

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Summary

The condition of pastures during the wet-dry transition period reduces livestock production since there is an increase in dead material and a reduction in green tissues. This study evaluated the influence of grazing management strategies on the structure of the forage canopy during the wet-dry transition period. The pastures were composed of Aruana guineagrass (*Megathyrsus maximum* Syn. *Panicum maximum* cv. Aruana) and three legumes: Macrotyloma (*Macrotyloma axillare),* Calopo *(Calopogoinum mucunoides),* and Stylo (*Stylosanthes macrocephala + Stylosanthes capitata*). The treatments corresponded to four forage canopy heights (15, 30, 45, and 60 cm), and the grazing management strategies involved steady or variable stocking rates with sheep. The experiment was conducted in a randomized complete block design with four replications totaling 16 experimental units (paddocks). The masses of grass leaf blades and stems were higher at heights of 45 and 60 cm (P = 0.002), while the proportion of dead material was smaller in these than in the short pastures (15 and 30 cm) (P = 0.0497). There was an increase in the proportion of dead material over the dry-water transition period. The presence of grass and legume leaves was higher in the upper stratum of tall pastures (45 and 60 cm) and the proportion of legumes did not differ between grazing management strategies (P > 0.05). The strategies were represented by canopy heights of 45 to 60 cm and showed more leaf mass, less dead material, and better pasture structure, so these parameters can be used during the wet-dry transition period.

Keywords

Canopy height, continuous stocking, forage legumes, intercropped pasture, *Panicum maximum* cv. Aruana

IMPACTOS DAS ESTRATÉGIAS DE MANEJO DO PASTEJO NA ESTRUTURA DO DOSSEL FORRAGEIRO EM PASTOS MULTIESPÉCIES NO PERÍODO DE TRANSIÇÃO ÁGUAS-SECA

Resumo

A condição dos pastos durante o período de transição águas-seca é limitante para a produção animal na medida em que há aumento de material morto e redução de tecidos verdes. Objetivou-se com este trabalho avaliar a influência de estratégias de manejo do pastejo na estrutura do dossel forrageiro durante o período de transição águas-seca. Os pastos foram formados de gramínea Megathyrsus maximum (Syn. Panicum maximum) cv. Aruana (Capim-Aruana) e leguminosas: Macrotyloma axillare (Macrotyloma), Calopogonium mucunoides (Calopogônio) e Stylosanthes macrocephala + Stylosanthes capitata (Estilosantes cv. Campo Grande). Os tratamentos corresponderam a quatro alturas de dossel forrageiro compreendendo as estratégias de manejo do pastejo de 15, 30, 45 e 60 cm mantidos sob lotação contínua e taxa de lotação variável com ovinos. O delineamento foi em blocos completos casualizados com quatro repetições totalizando 16 unidades experimentais (piquetes). As massas de folhas e colmos de gramínea foram superiores nas alturas de 45 e 60 cm (P = 0,002), enquanto a proporção de material morto foi menor nestes em relação aos pastos baixos (15 e 30 cm) (P=0,0497). Houve aumento da proporção de material morto ao longo do período de transição águas-seca. A presença de folhas de gramínea e de leguminosas foi maior no estrato superior de pastos altos (45 e 60 cm) e a proporção de leguminosas não diferiu entre as estratégias de manejo do pastejo (P > 0,05). Estratégias de manejo do pastejo representadas por alturas de dossel de 45 a 60 cm apresentaram mais folhas e menos material morto e melhor estrutura de pasto e podem ser utilizadas durante o período de transição águas-seca.

Palavras-chave

altura do dossel, leguminosas forrageiras, lotação contínua, Panicum maximum cv. Aruana, pasto consorciado

INTRODUCTION

The condition of pastures during the wet-dry transition periods limits animal production since there is an increase in the mass and proportion of dead material, reducing the green tissues in the forage canopy (ALVIAREZ et al., 2020). This occurs even in areas of great biological diversity and variability, such as the Atlantic Forest biome, characterized by a hot and humid climate, with well-distributed rainfall, which can reach 2500 mm per year, and with an average temperature of 22 °C. In addition, during this period, dead tissues predominate in the upper stratum of the forage canopy, considered the grazable stratum (HODGSON, 1990), compared to the wet period.

The strategic increase of nitrogen via fertilization in tropical pastures during the end of the rainy season is a sustainable technique that increases forage production and the presence of green leaves in the forage canopy (SILVEIRA et al., 2016). Another way of providing nitrogen in this period is to include forage legumes in the pasture system, because through biological nitrogen fixation and decomposition of organic matter (DEPABLOS et al., 2021), this can result in nitrogen inputs ranging from 72 to 86 kg/ha year (NOTARIS et al., 2020) or even 150 kg/ha year (SANTOS et al., 2023), thereby increasing grass production (BRAGA et al., 2020).

In multispecies pastures with more than one species of forage legume, the presence of these plants is better distributed throughout the year at different stages of phenological development. The synergy between the species leads to a difference in the use of the resources available in the environment (NAEEM et al., 1994; SPHEN et al., 2000).

The use of grazing management strategies based on forage canopy height targets under continuous stocking can increase leaf maintenance and generate a distribution of botanical and morphological components in the forage canopy that favors the forage intake process (TONTINI et al., 2021). The greater presence of leaves and the lesser presence of stems and dead material increase the forage intake of grazing animals (SILVA et al., 2013), so this canopy structure should be targeted among the available options.

In this study, we hypothesized that among the grazing management strategies employed during the wet-dry transition period, there would be a range of heights that improved the structure of the forage canopy, in the sense of reducing the proportion of dead material and increasing the presence of leaves in the forage mass and the upper stratum of the forage canopy. We thus evaluated the influence of grazing management strategies on the structure of the forage canopy during the wet-dry transition period in multi-species pastures with grasses and forage legumes under continuous grazing.

MATERIAL AND METHODS

The site, experimental design and treatments

The experiment was conducted at the Instituto de Zootecnia in Nova Odessa, São Paulo State, Brazil, located at the approximate geographical coordinates of 22º 42' south latitude, 47º 18' west longitude and 528 m altitude. According to the Köppen classification, the region's climate is characterized as humid mesothermal, subtropical with a dry winter, type Cwa, with average temperatures below 18 °C in the colder months and above 22 °C in the warmer season. The average annual rainfall in the municipality is 1270 mm (30% occurring between May and September), and during the experimental period, between April and June, there was monthly rainfall between 20 and 22 mm and maximum temperatures between 26.5 and 29.7 °C and minimum

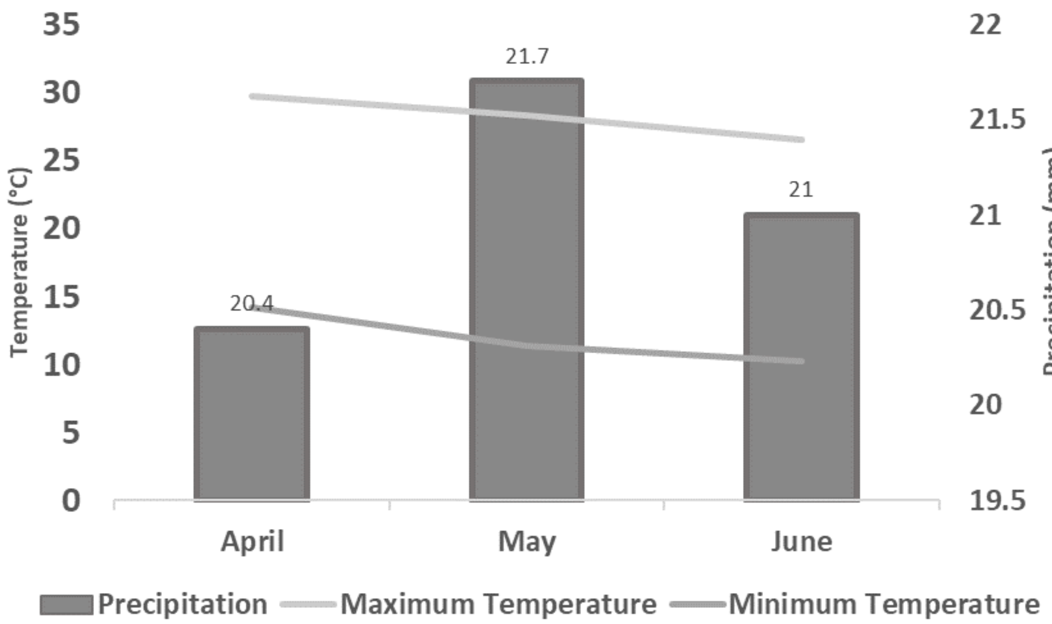

Figure 1. Meteorological data during the experimental period (April to June 2021), obtained from the São Paulo State Agrometeorological and Hydrological Portal.

temperatures between 10.2 and 14.2 °C (Figure 1).

The weather data for the experimental period (Figure 1) were collected from the São Paulo State Agrometeorological and Hydrological Portal. The soil in the experimental area is classified as Ultisol. In August 2019, we collected 20 soil samples at a depth of 0-20 cm, carried out in transects throughout the experimental area (20,000 m^2), to represent the entire area. The samples were homogenized and sent for the laboratory analysis. The results of the analyses shown at the depth of 20 cm: pH ($CaCl_2$) : 5,4; P: 44 mg.dm^3; S: 6 mg.dm^3; B: 0,26 mg.dm^3; Cu: 1,3 mg.dm^3; Fe: 59 mg.dm^3; Mn: 13,7 mg.dm^3; Zn: 4,1 mg.dm^3; M.O: 44 g.dm^3; Ca: 56 mmolc.dm^3; Mg: 39 mmolc.dm^3; K: 175,5 mmolc.dm^3; Al: 0 mmolc.dm^3; H+Al: 20 mmolc.dm^3; CTC: 11,95 mmolc.dm^3; Base Saturation (V%): 83. The interpretation of the results showed there was no need for fertilization in the area, since according to Pereira et al. (2018), all the nutrients were sufficient to support grass with high nutritional values.

At sowing, simple superphosphate fertilizer was added in the amounts of 7.9, 3.5 and 2.0 kg/ha of P for legume sowing, Aruana guineagrass and legume reseeding, respectively. No nitrogen fertilization was carried out during planting or the experimental period. The soil was sampled and analyzed annually and there was no need to replenish nutrients, since they were present in an adequate range for good pasture production.

The pasture was formed of the species *Megathyrsus maximum* (Syn. *Panicum maximum*) cv. Aruana (Aruana guineagrass) and the forage legumes *Macrotyloma axillare* (Macrotyloma), *Calopo mucunoides* (Calopo) and a physical mixture of 80% *Stylosanthes macrocephala* + 20% *Stylosanthes capitata* called Stylosanthes Campo Grande (Stylo).

Pasture establishment began in October 2019, first with the direct planting of forage legumes in a mixture of 18.0 kg/ha, 6.0 kg of Macrotyloma, 8 kg of Calopo and 4 kg of Stylo, as proposed by Colozza et al. (2002), based on seed germination and size. This ratio aimed to achieve legume proportions between 20 and 40% of the forage mass. After establishment of the legumes, in February 2020 the Aruana guineagrass was planted using a quantity of 20 kg/ha, which was mixed with 90 kg of simple superphosphate to facilitate its dispersal at a distance. This was done so that there would be no interference/competition between the species of interest, contributing to the success of the establishment. In the area there was large presence of invasive plants (weeds), so it was necessary to reseed the plants of interest in November 2020 with Aruana guineagrass (3.5 kg/ha of commercial seeds) and a mixture of 1.0 kg/ha of seeds of each of the legumes.

The treatments consisted of four grazing management strategies: maintaining the forage canopy at heights of 15, 30, 45 and 60 cm through continuous stocking and variable stocking rates with sheep. These targets were chosen to generate a range of forage canopy structures in an attempt to reach the extremes of very severe (15 cm) and very lenient (60 cm) defoliation. When canopy structure control is used as a management strategy, what varies over different years is the magnitude of the values, which are maintained in terms of leaf mass, dead material, and legumes between treatments, making it possible to indicate the use of these strategies for this pasture in the dry-water transition period.

The experiment had a randomized complete block design with four replications (experimental units of approximately 500 m² each), totaling 16 paddocks. In addition to the paddocks, an additional area of 1,000 m² was formed to be grazed by the regulatory animals when they were outside the experimental area. The study was approved by the Ethics Committee on the Use of Animals (CEUA) under protocol no. 284-19. Forty-eight mixed-breed female sheep were used for grazing, with an average weight of 40 ± 5.3 kg.

Two animals constantly remained in each paddock, while the other animals, called regulators, were placed in the experimental units as soon as the canopy reached a value of 10% above the target height of that treatment, and were removed at 10% below this level. Hence, the stocking rate was variable, following the "put and take" method (MOTT and LUCAS, 1952) to control the grass heights of the grazing management targets.

Grazing by the animals began in December 2020, when the pastures had forage canopy heights of 55, 61, 59 and 62 cm, and total forage mass equivalent to 3575, 4528, 4080 and 4411 kg of dry matter per hectare, respectively for the 15, 30, 45 and 60 cm strategies. The canopy heights determined as targets were implemented from January to March 2021 and the evaluations of the wet-dry transition period were carried out from April to June 2021.

The experimental conditions were monitored through weekly forage canopy height assessments, using a measuring stick or sward stick (BARTHRAM, 1985) at 50 points, with the average being considered the forage canopy height of that experimental unit (Figure 2).

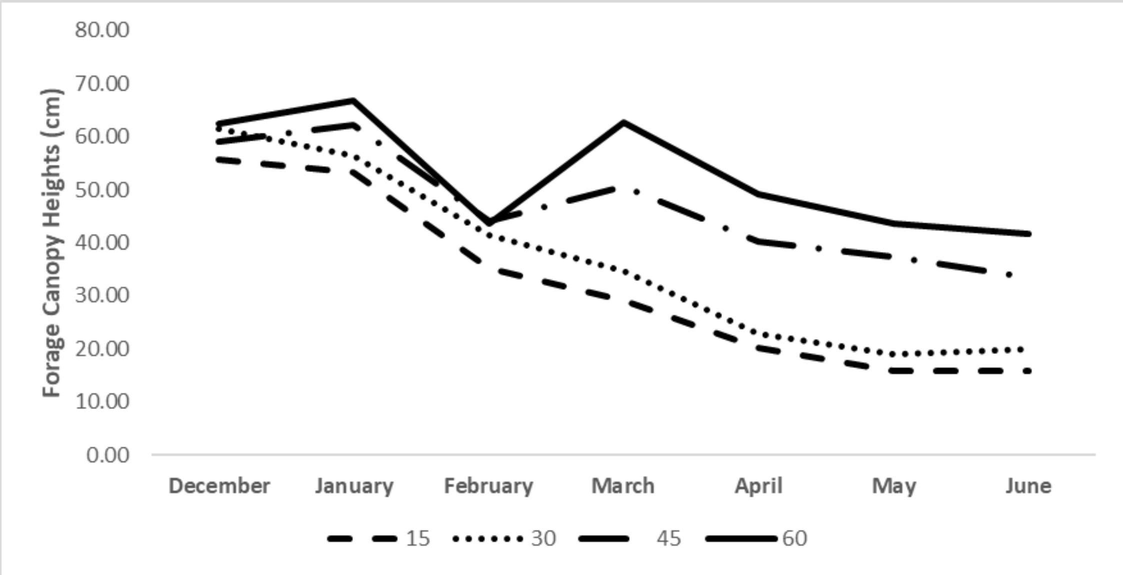

Figure 2. Experimental conditions monitored from the time the treatments were established until the end of the evaluation period.

EVALUATIONS

Forage mass and botanical and morphological composition

Forage mass was obtained by cutting three 0.25 m² (0.5 x 0.5 m) areas per experimental unit (paddock) at ground level. The field samples were weighed, standardized and divided into two subsamples, where the first subsample was weighed and dried in a forced-air oven at 55°C for 72 hours or until constant weight, and the result was used to determine the dry matter of the forage used to calculate the total forage mass (kg/ha of dry matter). The second subsample was obtained by standardizing equal parts of each of the three field samples, removing an aliquot of these materials, standardizing and manually separating the botanical components: Aruana guineagrass and all the legumes grouped; then each component separated into leaves (leaf blades for grasses and leaflets + petioles + stipules for legumes), stems (stem + leaf sheaths for grasses and branches for legumes); and dead material. The components were packed in paper bags and placed in a forced-air oven to obtain the dry matter. The dry weight values were used to calculate the proportion (%) of each component in the dry matter of the harvested forage, independently for grasses and legumes.

Vertical distribution of botanical and morphological components in the forage canopy

Evaluations of the spatial distribution of the morphological components of the forage canopy were carried out using the "inclined point quadrat" method (LACA and LEMAIRE, 2000; WARREN WILSON, 1960), every month with a minimum of 50 touches, which could be carried out at more than one reading station per paddock, in which the measurements were counted until contact with ground level, even when the minimum reading value was exceeded. The rod of the device was positioned with an inclination of 32.5° between its plane of penetration inside the canopy and the plane of ground level (WARREN WILSON, 1960). The device was placed at points that represented the average condition of the treatments at the time of sampling, allowing the vertical positioning of the forage mass to be described as the graduated rod was introduced into the canopy. After each touch, the plant tissue was carefully removed from the tip of the rod so that the evaluation process could continue until a new touch occurred. This procedure was repeated until the tip of the stem touched the ground, a point that generated the last stem height reading and served as a reference value for calculating the effective heights of the touches made with the ground. The height at which each touch occurred was recorded from the readings taken on the stem, graduated in centimeters. The morphological components were classified as grass leaves, legume leaflets, grass stems, legume branches and dead material. The results were expressed as the proportion of touches on each component and were grouped into two strata: upper (above half the target canopy height of the management strategy) and lower (below half the target canopy height of the management strategy).

Statistical Analysis

Analysis of variance was carried out using PROC MIXED in the SAS (Statistical Analysis System) statistical package (SAS, 2005), version 9.1. The effects of grazing management strategies, evaluation months and their interactions were considered fixed and the effect of blocks was considered random. The significance level adopted for the analysis of variance was 5%. The means of the main effects and the interactions were compared using the Tukey test.

RESULTS

Forage mass and proportion of botanical and morphological components

For total forage mass and total grass mass, there was an effect of grazing management strategies and months. Total forage mass was higher in the taller pastures (45 and 60 cm) than in the 15 cm pastures, while the 30 cm strategy did not differ from the others (Table 1). The total mass of grass was also higher in the taller pastures and lower in the shorter pastures (15 and 30 cm), which differed from each other (Table 1). Total forage mass was lowest in April and total grass mass was highest in May, which differed from the others (Table 1). There was no difference ($P > 0.05$) between the months evaluated and the grazing management strategies for total legume mass, with an average value of 224 ± 117.3 kg/ha DM.

For grass leaf mass, there was a significant effect of grazing management strategies and months. The 60 cm grazing management strategy had the highest values compared to the 15 and 30 cm strategies, while the 45 cm strategy did not differ from

Table 1. Total forage mass and mass of botanical and morphological components for the grazing management strategies throughout the experimental period.

Months	Grazing management strategies 15	30	45	60	Mean	SE	p-Value Treat	Mon.	Int.*
	Total Forage Mass (kg/ha)					329,2	0,002	<0,0001	0,26
April	3833	5426	5960	6802	5505 B				
May	6365	7921	9439	10325	8517 A				
June	5852	6631	9764	9207	7863 A				
Mean	5350 b	6659 ab	8388 a	8778 a					
	Total Grass Mass (kg/ha)					296,8	0,002	0,0008	0,11
April	2138	3649	4270	4566	3656 B				
May	2843	3190	6054	6331	4604 A				
June	1796	1807	4898	4517	3254 B				
Mean	2259 b	2882 b	5074 a	5138 a					
	Leaf Grass Mass (kg/ha)					59,8	0,002	0,0006	0,39
April	506	404	808	1098	704 B				
May	904	771	1002	1436	1028 A				
June	661	641	762	888	738 B				
Mean	690 b	605 b	857 ab	1141 a					
	Stem Grass Mass (kg/ha)					276,7	0,002	0,003	0,02
April	1632 Aa	3245 Aa	3462 Ba	3469 Ba	2952				
May	1939 Ab	2419 ABb	5052 Aa	4894 Aa	3576				
June	1136 Ab	1166 Bb	4135 ABa	3628 ABa	2516				
Mean	1569	2277	4216	3997					
	Dead Material Mass (kg/ha)					200,2	0,501	<0,0001	0,29
April	1616	1659	1372	2058	1676 C				
May	3418	4328	3339	3345	3607 B				
June	3823	4819	4612	4393	4412 A				
Mean	2952	3602	3108	3265					

Caption: Uppercase letters differ from each other ($P < 0.05$) in the column and lowercase letters differ from each other in the row.

the others (Table 1). The month of May had the highest grass leaf mass compared to the others (Table 1). For the mass of grass stems, there was an effect of the interaction between management strategies and evaluation months. The highest value was found for the 45 cm strategy in May and the lowest was for the 15 cm strategy in June (Table 1).

There was no difference (P > 0.05) in the mass of leaflets or the mass of legume branches between management strategies and months, with average values of 122 ± 52 and 102 ± 36 kg/ha of DM, respectively. For the mass of dead material, there was a significant effect of the months, with values rising throughout the experimental period, with the lowest value in April and the highest in June (Table 1).

For the proportion of components, expressed as a function of total forage dry mass, there was an effect of grazing management strategies and months for the proportion of grass leaves, where the 15, 45 and 60 cm strategies had the highest proportions compared to the 30 cm strategy, which did not differ from the 45 cm strategy (Table 2). For the months of evaluation, April had the highest value compared to June (Table 2).

Table 2. Proportion of botanical and morphological components in the forage mass, for the grazing management strategies throughout the experimental period.

Mon-ths	Grazing management strategies				Mean	SE	p- Value		
	15	30	45	60			Treat	Mon	Treat*mon
	Leaf Grass Proportion(%)					0,9	0,010	0,039	0,265
April	14	7	13	16	13 A				
May	14	10	10	14	12 AB				
June	10	10	8	10	9 B				
Mean	13 a	9 b	10 ab	13 a					
	Stem Grass Proportion (%)					5,2	0,014	<0,0001	0,008
April	39 Aa	57 Aa	55 Aa	51 Aa	51				
May	29 ABb	29 Bb	50 ABa	47 Aab	29				
June	18 Bb	16 Bb	41 Ba	39 Aa	39				
Mean	29	34	49	45					
	Grass Proportion(%)					2,4	0,008	<0,0001	0,083
April	53	65	68	67	63 A				
May	43	38	60	61	50 B				
June	28	26	49	49	38 C				
Mean	42 c	43 bc	59 a	58 ab					

Caption: Uppercase letters differ from each other (P < 0.05) in the column and lowercase letters differ from each other in the row.

The proportion of grass stems and dead material components (P=0.0497) (Figure 3) showed an effect of the management strategies x months interaction. The proportion of grass stems was highest for the 30 cm strategy during April (Table 2) and the highest proportion of dead material was found in the 30 cm strategy during June (Figure 3). There was no difference (P> 0.05) in the proportion of legume leaves and branches in the forage mass, with average values of 2 ± 0.8 and 1.5 ± 0.6% respectively.

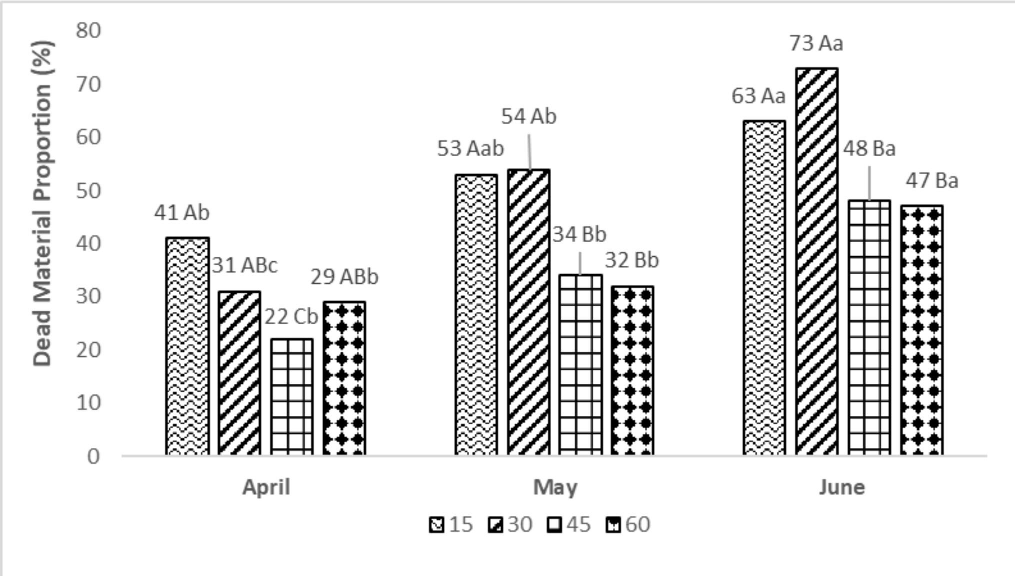

Figure **3.** Proportion of dead material in the forage mass between the grazing management strategies of 15, 30, 45 and 60 cm in April to June 2021. Uppercase letters differ between grazing management strategies and lowercase letters differ between evaluation months.

Vertical distribution of the botanical and morphological components of the forage canopy

Regarding the distribution of botanical and morphological components along the forage canopy (Figure 4), the lower stratum concentrated the highest proportion of touches of all morphological components of the forage canopy (grass leaves, legume leaves, grass stems, legume branches and dead material), with touches of dead material in this stratum accounting for 43 to 50% of the total touches in the forage canopy (Figure 4). In the lower stratum, there was a greater presence of grass leaves in the lower pastures (Figures 4 A and 4 B) compared to the higher pastures (Figures 4 C and 4D). For the grass stem component, there was a similar proportion of touches among the grazing strategies (Figure 4). Legumes (leaf + branch) were present in the lower stratum in all management strategies, with values of 3; 4; 6; and 4% of total touches for the 15, 30, 45 and 60 cm management strategies, respectively.

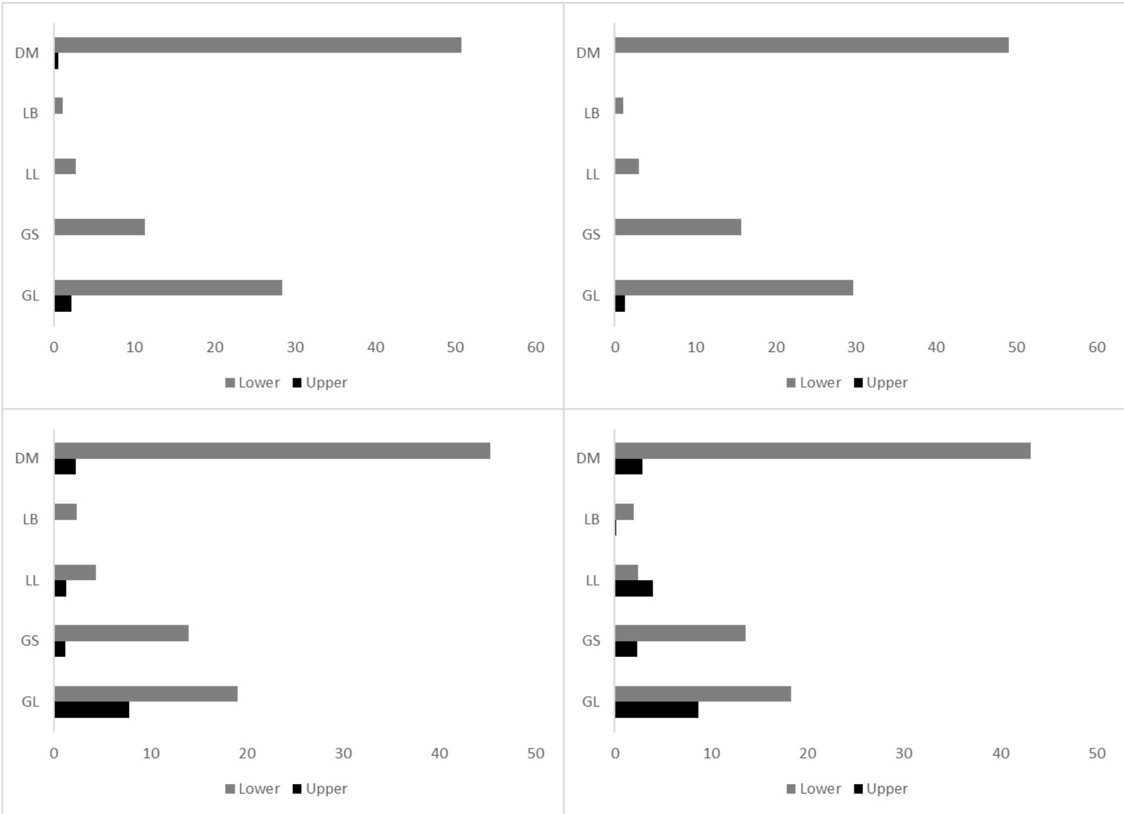

Figure 4. Vertical distribution of botanical and morphological components intercropped pastures composed of Aruana guineagrass and forage legumes in the fall at four pasture heights (A) 15 cm (B) 30 cm (C) 45 cm and (D) 60 cm. Legend: For the vertical axis: GL (Grass Leaf), GS (Grass Stem), LL (Legume Leaf), LB (Legume Branch) and DM (Dead Material). For the horizontal axis: Proportions of morphological components in the lower and upper strata (%).

In the upper stratum of the forage canopy, there was a lower proportion of touches compared to the lower stratum for all components (Figure 4 D). Shorter pastures showed no touches of grass stems, legume leaflets or legume branches, while taller pastures had the presence of these components. Grass leaves were present in all the management strategies, with a greater presence in the taller pastures, where the proportion of legumes was lower than in the lower stratum (Figure 4), while they were not present in the shorter pastures.

DISCUSSION

Due to the less favorable climate conditions for plant growth (Figure 1), inherent to the period of the year evaluated, forage canopy heights decreased throughout the experimental period, but there were differences in canopy heights among the grazing management strategies (Figure 2).

Taller pastures had greater total forage mass than shorter pastures, a relationship that has already been described for monoculture pastures (SILVA et al., 2013; TERRA et al., 2020), as well as multi-species pastures of Marandu palisadegrass (*Brachiaria brizantha* cv. Marandu) and Calopo (ALVIAREZ et al., 2020).

The total forage mass had higher values than those described in the monoculture pastures of Aruana guineagrass (SCHMITZ et al., 2021). Higher total forage mass in the wet-dry transition period results in a greater mass of leaves available for grazing, reducing the impact of the seasonality of plant and animal production in this period (SANDERSON et al., 2016). The use of different plant species in pastures increases forage mass values, with a positive correlation between increased species diversity and increased forage production and pasture stability (PEMBLETON et al., 2015; MUELLER et al., 2016).

The masses of grass leaves and of grass stems were higher in the taller pastures throughout the experimental period (Table 1), while the mass of dead material was similar among the grazing strategies. Since the leaves are more nutritious and easier to grasp during grazing, the condition with a higher mass of grass leaves in the taller pastures is fundamental to maintaining nutrient intake during the wet-dry transition period. These results were also observed by Neto et al. (2020) for *Panicum maximum* cv. Aruana and Massai and for *Brachiaria brizantha* cvs. Marandu and Piatã, and by Silva et al. (2022) for Marandu palisadegrass.

There was a reduction in the proportion of grasses and an increase in dead material in the forage canopy over the months of evaluation (Table 2 and Figure 3). There was little variation in the proportion of grass leaves among the grazing management strategies, and only the 30 cm pastures were shorter than the others (Table 2). On the other hand, the proportion of grass stems at the start of the experimental period was similar with respect to the management strategies and increased in the taller pastures.

The greater mass and proportion of the stems in these pastures can hinder the grazing process, since stems are harder for animals to grasp and chew (IRIGOYEN et al., 2023). However, in this study, the presence of stems was concentrated in the lower strata, which reduced their negative effect during grazing (Figures 4 C and 4 D).

The mass and proportion of legumes and their components (leaves and branches) were similar between grazing management strategies and months, indicating stability in the presence of legumes in the pasture, even as the dry period progressed (Figure 1). However, the total mass of legumes can be considered low compared to that described by Dos Santos et al. (2023) in pastures intercropped with Marandu palisadegrass and Desmodium (*Desmodium ovalifolium*), which was between 35% in the pre-grazing condition and 51.5% in the post-grazing condition in forage mass, and those reported for Marandu palisadegrass and forage peanut by Tamele et al. (2018), of approximately 304 kg/ha of dry matter. This was probably because the legume species selected had their flowering period during this dry-water transition period, and the production of seeds by these plants thus reduced their vegetative development, impacting their mass values and consequently their proportion in the forage mass.

The proportion of total leguminous plants ranged from 1.5 to 2.8% in this study. These results are below those recommended by Spain and Pereira (1985) of 20 to 40% of the total forage mass, and those described by Gerdes et al. (2020) for Aruana guineagrass and Macrotyloma or Perennial soybean (*Neonotonia wightii*) pastures, with proportions of 43.2 and 31.9% respectively in the total forage mass, during the period from October to January. In addition, even with legume participation in the forage mass below that recommended in the literature, studies have reported contributions in the contribution of nitrogen, such as in oats (*Avena sativa* L.) and white clover (*Trifolium repens* L.), with 7.44% legume presence (BARRETA et al., 2020) and Coastcross grass (*Cynodon dacytlon* L. Pers. Cv. Coastcross-1) and vetch (Vicia sativa L.), with 8.8% legumes (AGUIRRE et al., 2014). For taller pastures, there was a greater presence of grass leaves and legume leaflets in the upper stratum compared to shorter pastures.

The vertical distribution of morphological components can influence forage consumption since grazing animals tend to consume the forage available in the upper stratum of the forage canopy (GLIENKE et al., 2016), more specifically leaves (TESK et al., 2018). This is an important aspect to consider, especially in drier periods. De Mattos et al. (2023) reported that pastures with a higher nitrogen intake and greater leaf area had a greater presence of leaves and less dead material in the upper stratum compared to the others. Shorter pastures had more dead material in both the lower and upper layers of the forage canopy (Figures 4 A and 4 B), but in all management strategies there was a higher proportion of dead material and stems in the lower layer.

The distribution of legumes was similar between the grazing management strategies in the lower stratum, but in the upper stratum, legumes were only present in the taller pastures, while the shorter pastures had no touches of legumes. Unlike our findings, Alviarez et al. (2020) reported a greater presence of Calopo leaves in the intermediate stratum (50 to 75% of canopy height) and upper stratum (75 to 100% of canopy height) in pre-grazing during the wet-dry transition period, but in that study the pastures were managed under rotational stocking, which may have influenced the vertical position of the legumes in the forage canopy.

Grazing management strategies influenced the botanical and morphological composition of the forage mass and its vertical distribution in the forage canopy. Shorter pastures, especially at 15 cm, had lower masses of grass leaves and grass stems, and masses of dead material similar to the taller pastures, resulting in a higher proportion of dead material. The mass of legumes during the period evaluated was not affected by the management strategies, but there was a greater presence of legumes in the upper stratum of the forage canopy in taller pastures. These pastures had a higher proportion of leaves and a lower proportion of dead material compared to shorter pastures. For these reasons, pastures with these species should be managed at 45 to 60 cm under continuous stocking during the wet-dry transition period.

CONCLUSION

Grazing management strategies involving forage canopy heights of 45 to 60 cm provided forage structure with more leaf mass in the stratum that could be grazed by animals and a lower proportion of dead material compared to pastures with heights of 15 and 30 cm, so they can be used during the dry-water transition period.

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