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Full Length Article

Effects of Conventional or Slow-release Urea on Productivity, Tillering, Water use Efficiency and Chemical Composition of Tropical Grasses

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Abstract

Nitrogen (N) is an essential nutrient for growth and plant physiology; but a lot of the N is lost during metabolization, especially by N volatilization. This study aimed to evaluate the effects of slow-release urea fertilizer on productivity, nutritive value, and morphological characteristics of *Urochloa* gender grasses. The study was designed as a randomized complete block in a factorial scheme (4 × 3) with five repetitions where four grasses and three treatments were used. The grasses were: *Urochloa brizantha* cv. Braúna (BR), *Urochloa brizantha* cv. BRS Paiaguás (PA), *Urochloa decumbens* cv. Basilisk (BA) and *Urochloa* hybrid cv. Camello (CA) and the treatments were: *i*) no fertilizing [control (CTRL)]; *ii*) conventional fertilizer (CF) applied to achieve 128 kg/ha of N from conventional urea, and *iii*) slow-release urea (SF) [128 kg/ha of N from urea coated by 1-3% of H_2SO_4]. Forage accumulation rate was greater by 27.6% in the CF and SF treatments compared to CTRL ($P < 0.01$). Leaf production (DM basis) was greater for CA and PA on CF and SF treatments but were similar in CTRL treatment ($P = 0.01$). An interaction for dry matter content between grass and fertilizer treatment was observed ($P < 0.01$). The *U. brizantha* cv. Braúna had greater forage production and tiller population density. The BRS Paiaguás had a greater proportion of green leaves and dry leaf mass. Slow-release urea did not increase the forage yield, but the leaf yield was greater in *U. decumbens* cv. Basilisk. Additionally, slow-release urea increased the water-use efficiency in *U. decumbens* cv. Basilisk and *U. brizantha* cv. Braúna.

Keywords: Crude protein; Forage mass; Gradual release fertilizers; Nitrogen; Water use efficiency

Introduction

Urochloa spp. have different nitrogen (N) dynamics, including potential nitrification rate and potential mineralization of the N (Vázquez *et al*. 2020). Genotype-environment interaction is responsible for the production of tropical grasses, and a significant amount of N is needed to achieve high dry matter (DM) productivity (Aleme *et al*. 2023; Wahab *et al*. 2024).

Nitrogen improves DM yield and nutritive value stimulating forage tillering, leaf growth and photosynthetic process (Yasuoka *et al.* 2018). Nevertheless, depending on N source, the losses to the atmosphere can be overrated and the forage productivity decreased due to reduced N efficiency use. Dimkpa *et al*. (2020) observed elevated losses by volatilization until 18 days after urea application compared with other N sources, representing 5 to 15% of the N applied (Cameron *et al*. 2013), contributing to the increase of nitrous oxide (N_2O) in the atmosphere (Cassim *et al*. 2024).

The N sources generally used included urea (44-46% N), ammonium sulfate (21% N) and ammonium nitrate (33% N) (Fonseca *et al.* 2022). Nevertheless, the sources can decrease the N uptake and increase the N losses, depending on the quantity applied (Dawood *et al*. 2023).

Some technologies are available to decrease these losses such as nitrification inhibitors, urease inhibitors, polymer-coated or controlled-release fertilizers (Lam *et al*. 2019; Pan *et al*. 2022). However, Silva *et al*. (2024) did not

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observe difference between N source (ammonium nitrate, urea or ammonium nitrate with calcium and sulfur) in forage accumulation rate. In this context, with the aim of increasing the N efficiency use, slow-release urea made from seaweed waste (Galindo *et al.* 2018), known as Sulfammo has been used. The goal of slow-release fertilizers is to increase grass nutrient uptake by supplying nutrients to the soil over a longer period compared to the conventional fertilizers (Yamamoto *et al.* 2016).

However, Lima *et al*. (2016) testing conventional urea or stabilized urea in *Urochloa ruziziensis* also did not observe influence of urea source in forage production and chemical composition. On the other hand, Nunes *et al.* (2022) observed that the application of slow-release urea influenced positively the agronomic, morphological, and physiological characteristics of the *Megathyrsus. maximum* cv. Mombasa; although, to our knowledge, studies with *Urochloa* gender are scarce using slow-release fertilizing.

The hypothesis of the current study was that slow-release N source would increase the productivity and nutritive value of the *Urochloa* gender. The study aimed to evaluate the impacts of fertilization with conventional fertilizing or slow-release N source on the productivity, nutritive value, and morphological characteristics of *Urochloa* gender.

Materials and Methods

Experimental area

The study was carried out in December 2021 to January 2023 at Forage and Pastures experimental field of the State University of Southwest Bahia [(UESB) Vitória da Conquista - BA] (14º52'58.66" S; 40º47'33.839" W). According to Köppen's classification, the climate of the region is tropical, with rainy in summer and dry period in winter (Cwb). The hydric balance, rainfall, average, maximum, and minimum temperature, the cloudiness and solar radiation during the experimental period are presented below (Fig. 1 and 2).

The soil was classified as a Yellow Red Latosol sandy loam texture (Santos *et al.* 2018). The determination of the soil chemical composition (0 to 20 cm depth) was performed collecting 25 samples randomly using a probe type auger (Soloteste®, Bela Vista, SP, Brazil). Then, the samples were used to make a composite unique sample and was taking 200 g of soil for further analysis.

The average of the soil pH into H_2O from three readings was performed using a digital pH meter (Tecnapon mPA-210, Piracicaba, SP, Brazil). The concentration of P, potassium (K) and sodium (Na) was determined according to the methodology described by Mehlich (1984). The calcium (Ca), magnesium (Mg), and aluminum (Al) were measured by potassium chloride (KCl) at 1 N and hydrogen (H) using solution of calcium chloride ($CaCl_2$; 0.01 *M*) and buffer solution SMP (Shoe-Maker, McLean and Prat) (Shoemaker *et al.* 1961) (Table 1).

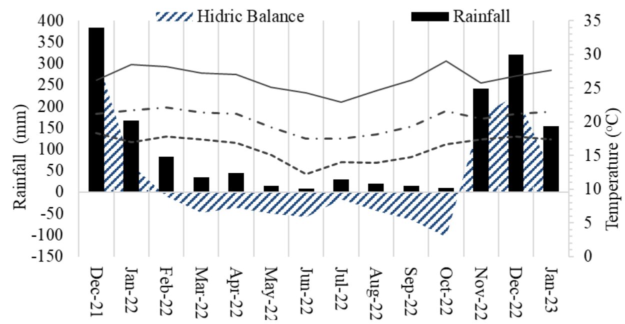

Fig. 1: Hydric balance, rainfall, maximum, average and minimum temperature during the experimental period

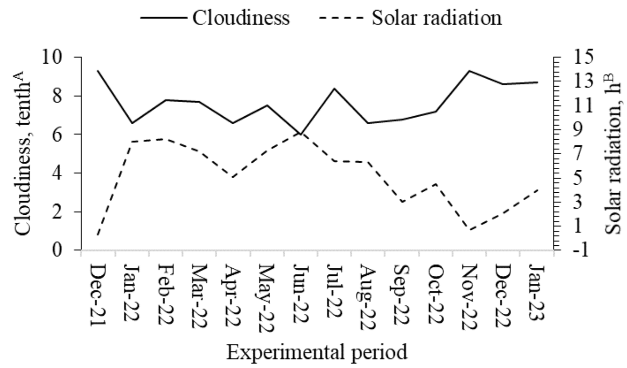

Fig. 2: Cloudiness and solar radiation during the experimental period; [A]Number of hours that the solar disk is visible; [B]Indication of cloud cover in the sky fraction. On the scale, 0 to 10, where 0 is cloudless and 10 is completely covered

Study design and fertilizing treatments

The study was designed using a randomized complete block design in a factorial scheme (4 × 3) with five repetitions where four grasses and three treatments were used. The grasses were: *Urochloa brizantha* cv. Braúna (BR), *U. brizantha* cv. BRS Paiaguás (PA), *U. decumbens* cv. Basilisk (BA) and *U.* hybrid cv. Camello (CA) and the treatments were: *i*) no fertilizing [control (CTRL)]; *ii*) conventional fertilizer (CF) applied to achieve 128 kg/ha of N from conventional urea, and *iii*) slow-release urea (SF) [128 kg/ha of N from urea coated by 1-3% of H_2SO_4; Timac Agro®, Porto Alegre, Brazil]. The grasses were sown in areas with five repetitions each in December 2021. The size of each plot was 64 m^2 (8 × 8 m), with plots spaced 1-m apart. The broadcast method of fertilizing was used based on the chemical composition of the soil at the start of the study according to recommendations of the Soil Fertility Commission of the Minas Gerais State (Ribeiro *et al.* 1999; Santos *et al.* 2010). The recommended dosage of N for the CF treatment was 128 kg/ha of N corresponding to 284.5 kg/ha of conventional urea and 595 kg/ha for the SF treatment (Sulfammo meta 21 plus 3 kg of Top-phos; Timac Agro®, Porto Alegre, Brazil) corresponding to 128 kg/ha of slow-release urea. To achieve the same level of soil N was

Table 1: Soil chemical characterization

pH	P	K^+	Ca^{2+}	Mg^{2+}	Al^{3+}	H^+	Na^+	SB	t	T	V	OM
(H_2O)	mg/dm^3			------------------------	Cmol$_c$/dm^3	-----------------------					%	mg/dm^3
5.7	8	0.49	1.5	0.8	0.1	1.7	–	2.8	2.9	4.6	61	10

Note: pH: potential of hydrogen; P: phosphorus; K: potassium cation; Ca: calcium cation; Mg: magnesium cation; Al: aluminum cation; H: hydrogen cation; Na: sodium cation; SB: sum of exchangeable bases; t: effective cation exchange capacity; T: cation exchange capacity at pH 7.0; V: base saturation; OM: organic matter; SB: $Ca^{2+} + K^+ + Mg^{2+} + Na^+$; t: SB + Al^{3+}; T: t + H^+; V: (SB/T) × 100; H_2O: water

included 3.0 kg of Top-phos with the same slow-release N technology in the Sulfammo meta 21.

The P supply occurred on the day of sowing and the K and N when 70% of the plants covered the soil (Ribeiro *et al.* 1999). However, the N application was performed in three periods when the soil was covered by 70% of plants (50 kg/ha of N), 50 kg/ha of N after the first harvest, and 28 kg/ha of N at the fifth harvest. The canopy height was measured at leaf curvature. The height pre-cut and residue were determined according to the recommendation for each grass: 50/25 cm for *U. brizantha* cv. Braúna, 40/20 cm for *U.* hybrid cv. Camello, and 30/15 cm for *U. decumbens* cv. Basilisk and *U. brizantha* cv. BRS Paiaguás (Fonseca and Martuscello 2022). The mean harvest cycle was 85, 69, 69 and 87 days for *U. brizantha* cv. Braúna, *U. decumbens* cv. Basilisk, *U. brizantha* cv. BRS Paiaguás and *U.* hybrid cv. Camello, respectively, comprising five cut cycles for the *U. decumbens* cv. Basilisk, *U. brizantha* cv. BRS Paiaguás and six for *U. brizantha* cv. Braúna and *U.* hybrid cv. Camello.

Data collection and calculations

The forage yield was determined by collecting two samples per plot randomly using a square frame (1 m^2) where all forage above of the residue height was taken. The tiller population density (TPD) was measured by counting the basal tillers inside the frame of a known area (Sbrissia and Silva 2008).

The leaf: stem ratio was measured by the separation of the morphological components into leaf, stem, dead material, and inflorescence. Further, forage samples were dried in a forced ventilation oven (55ºC), and ground (Wiley mill; A. H. Thomas, Philadelphia, PA, USA) through a 1 mm screen sieve for performing the chemical composition analysis.

The forage accumulation rate (kg of DM per ha/d) was calculated dividing the DM production in the period by the regrowth days. The water-use efficiency (WUE) was estimated by dividing the forage DM per the rainfall accumulated during the period until the harvest moment (Souza *et al.* 2016). The DM (method 930.15), crude protein (CP; method 990.03) and ash concentrations were determined according to AOAC International (2012).

Statistical analysis

Normality of the residues (Shapiro-Wilk; $P > 0.05$) and the homogeneity of the variances (Lilliefors test; $P > 0.05$) were evaluated before the model fitting. The responses that violated these assumptions were subjected to transformation using the Box-Cox procedure (Box and Cox 1964) of SAS. Data were analyzed using the PROC MIXED of SAS version 9.3 (SAS/STAT, SAS Institute Inc., Cary, NC, USA). The model considered as fixed effects the grass and the fertilizer treatment and the interaction between grass and fertilizer treatment and block was the random effect. The Kenward-Roger procedure was used to determine the degrees of freedom of the denominator for testing the fixed effects. The least square means of the grass and fertilizer treatment were compared by Tukey test considering $P \leq 0.05$.

Results

U. decumbens cv. Basilisk and *U. brizantha* cv. Braúna had greater forage yield compared to *U.* hybrid cv. Camello and *U. brizantha* cv. BRS Paiaguás ($P < 0.01$). Additionally, CF and SF increased the forage DM yield similarly; but were greater than the CRTL ($P = 0.02$). Interesting, leaf production (DM basis) was greater for the *U.* hybrid cv. Camello and *U. brizantha* cv. BRS Paiaguás in CF and SF but were similar in CTRL (P = 0.01). Stem yield was greater in CF treatment compared to SF and CTRL ($P < 0.01$). Besides, an interaction was observed in dead material yield ($P = 0.01$). Forage accumulation rate was greater by 27.6% in the CF and SF compared to CTRL ($P < 0.01$). Leaf accumulation rate increased by fertilizer treatment ($P < 0.01$) (Table 2).

An interaction for DM concentration between grass and fertilizer treatment was observed ($P < 0.01$). The *U.* hybrid cv. Camello and *U. brizantha* cv. BRS Paiaguás had greater ash concentration compared to *U. decumbens* cv. Basilisk and *U. brizantha* cv. Braúna. Ash concentration was not influenced by fertilizer treatment ($P = 0.94$) or interaction ($P = 0.11$). Interesting, the CP concentration of the *U. decumbens* cv. Basilisk was greater compared to the others in SF treatment ($P < 0.01$) (Table 3).

Leaf:stem ratio was greater for *U. brizantha* cv. BRS Paiaguás in CTRL and SF, but similar for all grasses in CF treatment ($P = 0.04$). Fertilizer treatments increased the TPD, but interaction was not detected ($P = 0.15$). An interaction between grass and fertilizer treatment was observed ($P = 0.02$) where *U. decumbens* cv. Basilisk had greater WUE in the CF, while *U. decumbens* cv. Basilisk and *U. brizantha* cv. Braúna were greater in SF (Table 4).

Discussion

The hypothesis was that slow-release urea would increase the forage yield by releasing more slowly the nutrient in the soil, especially N compounds, reducing losses by

Table 2: Productivity (kg DM/ha) and accumulation rate (kg DM/ha/day) of total forage dry matter and morphological components of the *Urochloa* grasses and different fertilizing treatments

	CTRL				CF				SF					*P*-value		
Item	BA	BR	CA	PA	BA	BR	CA	PA	BA	BR	CA	PA	SEM	G	F	G×F
FY	1841.6^{aB}	1962.8^{Ab}	1797.2^{bB}	1518.2^{bB}	2414.6^{aA}	2229.5^{aA}	1665.7^{bA}	1759.6^{bA}	2330.3^{aA}	2166.0^{aA}	1728.3$^{bu;A}$	1800.6^{bA}	291.2	<0.01	0.02	0.25
LY	1016.5	804.4	1011.2	981.0	1172.5^{a}	822.7^{c}	877.6^{bc}	1094.1^{ab}	1251.7^{a}	1021.2^{ab}	830.9^{b}	1134.5^{a}	93.59	<0.01	0.06	0.01
SY	757.4^{abB}	905.2^{aB}	741.1^{bcB}	467.8^{cB}	1052.9^{abA}	1220.8^{aA}	785.2^{bcA}	648.6^{cA}	858.4^{abAB}	1125.3^{aAB}	773.0^{bcAB}	716.2^{cAB}	74.29	<0.01	<0.01	0.57
DMY	149.1	136.5	99.8	93.5	272.6^{a}	76.4^{b}	84.6^{b}	49.2^{b}	159.2^{a}	138.7^{a}	83.7^{ab}	30.4^{b}	78.15	<0.01	0.60	0.01
FAR	22.1^{b}	27.1^{b}	20.8^{b}	22.2^{b}	33.1^{a}	32.3^{a}	25.6^{a}	27.9^{a}	27.7^{a}	32.2^{a}	27.4^{a}	29.1^{a}	6.49	0.36	<0.01	0.38
LAR	12.1^{abB}	10.3^{cB}	11.6^{bcB}	13.9^{aB}	15.9^{abA}	11.3^{cA}	12.9^{bcA}	17.2^{aA}	16.3^{abA}	13.2^{cA}	14.4^{bcA}	18.6^{abA}	3.17	<0.01	<0.01	0.59
SAR	9.27^{abB}	12.8^{aB}	11.0^{bB}	7.15^{bB}	14.8^{abA}	18.2^{aA}	11.3^{bA}	10.0^{bA}	13.7^{abA}	15.7^{aA}	12.8^{bA}	11.6^{bA}	3.70	<0.01	<0.01	0.49

Note: BA: *Urochloa decumbens* cv. Basilisk; BR: *Urochloa brizantha* cv. Braúna; CA: *Urochloa* hybrid cv. Camello; PA: *Urochloa brizantha* cv. BRS Paiaguás; CTRL: Control; CF: conventional fertilizer; SF: slow-release fertilizer; FY: total forage yield; LY: leaf yield; SY: stem, yield; DMY: dead material yield; IY: inflorescence yield; FAR: forage accumulation rate; LAR: leaf accumulation rate; SAR: stem accumulation rate. SEM: standard error of the mean; *P*-value: G: grass effect; F: fertilizing treatment effect; G × F: grass-fertilizing interaction effect; Means followed by same lower letter in the row compare grasses within fertilizing treatments and capital letters in the row compare the fertilizing treatments for each grass by Tukey test ($P < 0.05$)

Table 3: Chemical composition (%) of grasses differing by fertilizer treatments

	CTRL				CF				SF					*P*-value		
Item	BA	BR	CA	PA	BA	BR	CA	PA	BA	BR	CA	PA	SEM	G	F	G×F
DM	305.9^{a}	290.8^{a}	266.6^{b}	293.7^{a}	302.0^{a}	279.3^{b}	261.7^{b}	236.9^{c}	306.8^{a}	287.3^{a}	258.7^{b}	247.9^{b}	31.21	<0.01	<0.01	<0.01
Ash	64.2^{b}	64.7^{b}	74.9^{a}	68.8^{a}	62.3^{b}	61.7^{b}	73.9^{a}	73.9^{a}	63.1^{b}	61.3^{b}	74.8^{a}	72.2^{a}	4.01	<0.01	0.94	0.11
CP	128.1^{a}	105.1^{b}	121.8^{a}	99.1^{b}	130.5^{a}	110.5^{b}	117.0^{ab}	123.3^{ab}	137.2^{a}	113.9^{b}	119.5^{b}	119.7^{b}	10.26	<0.01	<0.01	<0.01

Note: BA: *Urochloa decumbens* cv. Basilisk; BR: *Urochloa brizantha* cv. Braúna; CA: *Urochloa* hybrid cv. Camello; PA: *Urochloa brizantha* cv. BRS Paiaguás; CTRL: Control; CF: conventional fertilizer; SF: slow-release fertilizer; DM: dry matter; CP: crude protein; SEM: standard error of the mean; *P*-value: G: grass effect; F: fertilizing treatment effect; G × F: grass-fertilizing interaction effect. Means followed by same lower letter in the row compare grasses within fertilizing treatments and capital letters in the row compare the fertilizing treatments for each grass by Tukey test ($P < 0.05$)

Table 4: Leaf: stem ratio, tiller population density (tiller/m^2) and water use efficiency (kg of DM/mm) of the *Urochloa* grasses and different fertilizing treatments

	CTRL				CF				SF					*P*-value		
Item	BA	BR	CA	PA	BA	BR	CA	PA	BA	BR	CA	PA	SEM	G	F	G×F
LSR	1.74^{b}	1.09^{b}	1.57^{b}	2.62^{a}	1.31	1.14	1.35	1.95	2.08^{ab}	1.15^{b}	1.75^{ab}	2.30^{a}	0.25	<0.01	<0.01	0.04
TPD	753.2^{bB}	1128.2^{aB}	742.1^{bcB}	638.6^{cB}	819.5^{bA}	1315.2^{aA}	723.1^{bcA}	699.7^{cA}	752.1^{bA}	1319.6^{aA}	743.1^{bcA}	675.1^{cA}	74.3	<0.01	<0.01	0.15
WUE	18.1	23.9	18.0	19.9	26.1^{a}	21.1^{ab}	17.2^{b}	18.6^{b}	23.8^{a}	24.7^{a}	15.2^{b}	16.1^{b}	7.68	<0.01	0.77	0.02

Note: BA: *Urochloa decumbens* cv. Basilisk; BR: *Urochloa brizantha* cv. Braúna; CA: *Urochloa* hybrid cv. Camello; PA: *Urochloa brizantha* cv. BRS Paiaguás; CTRL: Control; CF: conventional fertilizer; SF: slow-release fertilizer; LSR: leaf:stem ratio; TPD: tiller population density; WUE: water use efficiency; SEM: standard error of the mean; *P*-value: G: grass effect; F: fertilizing treatment effect; G × F: grass-fertilizing interaction effect Means followed by same lower letter in the row compare grasses within fertilizing treatments and capital letters in the row compare the fertilizing treatments for each grass by Tukey test ($P < 0.05$)

volatilization (Motasim *et al*. 2024). However, in this current study, slow-release urea did not improve the forage yield. When in soil solution, urea is hydrolyzed to ion nitrate (NO_3^-) and ammonium (NH_4^+), but some ammonia (NH_3) is lost to the atmosphere, reducing the urea use-efficiency (Motasim *et al*. 2024).

The plant uptake occurs in the ions NO_3^- and NH_4^+ forms. Nevertheless, the coated urea could reduce this hydrolysis and make available the N to the plant for a longer time. Unfortunately, in the current study it was not possible to evaluate these ions directly; so, it is not feasible to state with certainty that the coated urea was not enough to delay the urea hydrolysis. Likewise, the forage yield of *U. brizantha* cv. Xaraés and *U. ruziziensis* were not influenced by the slow-release urea in study performed by Rodrigues *et al*. (2023) and Lima *et al*. (2016), respectively. The greater forage yield of the *U. brizantha* cv. Braúna is due to the contribution of leaves on the morphological composition and greater management height that possibly contributes to keep the leaf residual area contributing to a greater leaf photosynthesis.

The forage growth is attributed to the leave efficiency to convert the solar radiation photosynthetically active into photo-assimilated (Taiz *et al.* 2017). This happened with the *U. brizantha* cv. Braúna, where the leaf production was greater compared to the *U. decumbens* cv. Basilisk (263 kg/ha) and *U.* hybrid cv. Camello (284 kg/ha) and like *U. brizantha* cv. BRS Paiaguás.

The leaf production differed between grasses, depending on N source. The *U. brizantha* cv. Braúna had lower leaf production in the CF treatment while was like to *U. decumbens* cv. Basilisk and *U. brizantha* cv. BRS Paiaguás in SF treatment, suggesting that some grasses can be benefited by the slow-release urea resulting in lower CP concentration in *U. brizantha* cv. Braúna. The reasons for that are unclear, but it seems that the plant improved the N uptake in the SF as reported by McDonald *et al*. (2014) that observed an increase in N uptake explain 98% of the variation in DM yield.

In the current study, the rains were intense during the study, increasing the leaching and N losses (Nascente *et al.* 2012). For this reason, the results in forage yield could be improved by the SF during greater rainfall as reported by Lima *et al*. (2016).

Great DM concentration of *U. brizantha* cv. Braúna in the SF treatment, but not in the CF can suggests more availability of nutrients when slow-release urea was applied. DM concentration has a linear relationship with nutrients concentration in the plant. In this context, the slow-release urea seems to have increased the nutrient uptake, and consequently, the DM concentration. Lima *et al*. (2016) observed that slow-release urea was effective to improve the CP concentration of *U. ruziziensis*. In the current study, *U. decumbens* cv. Basilisk had a great CP concentration due to the great leaf yield.

The contrast in production and DM accumulation between grasses can be explained by differences in morphology since WUE was not influenced by grasses. Physiologically, the grasses used in the current study produced 19.8 kg of DM for each liter from the rainfall. Nevertheless, the Braúna and Camello grasses had 22.0 kg of DM for each liter of water, behavior similar to the observed by Silva *et al.* (2020) evaluating the Braúna, BRS Paiaguás, and Piatã grasses under the influence of soil water availability, where the Braúna had a greater potential to convert water into DM. Grasses with a better WUE had greater possibility of drought tolerance (Mårtensson *et al*. 2017). In the present study, the different response of the grasses depending on fertilizer treatments can be explained by the different grass response to the water soil availability (Scarfó *et al*. 2024).

Fertilization impacts the tillering (Bergoli *et al.* 2019), resulting in a linear increase of forage production according to the N incremented in the soil (Paciullo *et al.* 2017). In the current study, the fertilizing treatments increased TPD (Toit 2014) that can be explained by the increase of N in the plant (Zhong *et al.* 2002). In addition to fertilization, TPD affects their own emergence and survival by causing changes in light quality and intensity (Bos 1998; Evers *et al*. 2006), enhancing stem elongation and modifying canopy structure. This behavior is best observed in the present study in *U. brizantha* cv. Braúna which had the greatest TDP.

According to Sun *et al.* (2008), the soil water availability and air temperature influence directly the grass response to N fertilization, being difficult estimate this N response in the grass due to the soil's ability to provide N and because the difference for N requirement (Salvador *et al.* 2023). In addition, there is a complex soil-environment-plant-management interaction.

In the present study, no influence of fertilization was observed on productivity of tropical grasses. This can be explained by the rainfall concentration in a short period associated with persistent cloudiness and low solar radiation possibly caused some leaching, reducing the N availability for the grass. When the N quantity is not limited, the light competition becomes more important to the development and growth of vegetal tissues (Irving 2015). Fernandes *et al.* (2015) and Galindo *et al.* (2018) evaluated sources of fertilizers in Mombasa grass (*Megathyrsus maximum*), comparing Sulfammo and urea, and other sources reported similar behavior with the present study.

Conclusion

U. brizantha cv. Braúna cultivar had greater forage production and tiller population density. The BRS Paiaguás cultivar had a greater proportion of green leaves and dry leaf mass. Slow-release urea did not increase the forage yield, but the leaf yield was greater in *U. decumbens* cv. Basilisk. Additionally, slow-release urea increased the water-use efficiency in *U. decumbens* cv. Basilisk and *U. brizantha* cv. Braúna.

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Author Contributions

BLPR, LMGN, JMSA, ADSS, ACS and JDJN: study design, field and laboratory analyzes and writing of the manuscript. ASS and JD: data analysis and interpretation. MSP and OLL: writing and reviewing the manuscript.

Conflicts of Interests

No potential conflict of interest was reported by the authors.

Data Availability

Data presented in this study will be available on a fair request to the corresponding author.

Ethics Approval

Not applicable to this paper.

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