http://dx.doi.org/10.1590/1678-4162-12989

***Arq. Bras. Med. Vet. Zootec.*, v.75, n.6, p.1155-1164, 2023**

Structural and productive differences between deferred braúna, cayana and sabiá grasses

[*Diferenças estruturais e produtivas entre os capins braúna, cayana e sabiá diferidos*]

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ABSTRACT

The aim of this study was to identify differences in morphogenesis, structure, and forage accumulation rate of *Urochloa brizantha* cv. MG13 Braúna, from *Urochloa* cv. Cayana and *Urochloa* cv. Convert 330 (sabiá grass) during the deferment period. The experimental design was completely randomized, with four replications in experimental plots of 12.25m^2. The evaluations took place for two years, 2021 and 2022. The deferment period was 90 days. Phyllochron (PHY) and leaf senescence rate (LSR) were lower at the beginning of deferred, contrary to leaf elongation rate (LER) and population density tillers (PDT). Stem growth rate (SGR) was higher in 2021 and at the beginning of deferment. Leaf growth rate (LGR) and total growth rate (TGR) were higher at the beginning of deferment. The braúna grass presented higher PDT. The SGR and the TGR of cayana grass are superior to those of braúna grass. The braúna grass produces a canopy consisting of lighter and denser byts, compared to other weeds. In Uberlândia, MG, braúna grass with an initial height of 30cm produces less stem, while cayana grass produces more forage during deferral.

Keywords: growth, morphogenesis, senescence, *Urochloa* syn. *Brachiaria*

RESUMO

O objetivo deste estudo foi identificar diferenças nos padrões de morfogênese, de estrutura e de taxa de acúmulo de forragem da Urochloa brizantha *cv. MG13 Braúna, da* Urochloa *cv. Cayana e da* Urochloa *cv. Convert 330 (capim-sabiá), durante o período de diferimento. O delineamento experimental foi inteiramente ao acaso, com quatro repetições, em parcelas experimentais de 12,25m^2. As avaliações ocorreram por dois anos, 2021 e 2022. O período de diferimento foi de 90 dias. O filocrono (FIL) e a taxa de senescência foliar (TSF) foram menores no início do diferimento, contrariamente à taxa de alongamento foliar (TAlF) e à densidade populacional de perfilhos (DPP). A taxa de crescimento de colmo (TCC) foi maior em 2021 e no início do diferimento. As taxas de crescimento de folha (TCF) e a taxa de crescimento total (TCT) foram maiores no início do diferimento. O capim-braúna apresentou maior DPP. A TCC e a TCT do capim-cayana são superiores às do capim-braúna. O capim-braúna produz um dossel constituído por perfilhos mais leves e mais densos, em comparação aos demais capins. Em Uberlândia, MG, o capim-braúna com altura inicial de 30cm produz menos colmo, enquanto o capim-cayana produz mais forragem durante o diferimento.*

Palavras-chave: crescimento, morfogênese, senescência, Urochloa *syn.* Brachiaria

INTRODUCTION

In Brazil, livestock activity is based on pastures with tropical forage grasses, which is a determining factor of the competitiveness of Brazilian beef in the international market. According to the Brazilian Association of Meat Exporting Industries (ABIEC), pastures occupy 163.1 million hectares in Brazil, with a stocking rate of 0.9AU/ha (Beef…, 2022). However, in tropical regions the seasonality of forage production limits the performance of herds at certain times of the year (Stranssburg *et al.*, 2014). Thus, grazing management should be planned to manage the supply and demand of forage in the scarcity period.

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Submitted: February 24, 2023. Accepted: July 26, 2023.

Through grazing management strategies, such as deferment of pastures, it is possible to balance the supply and demand of forage during the scarcity period. The deferment of pastures is relatively simple, practical, and low cost. However, when poorly maintained, the deferred pasture is characterized by a structure limiting the consumption and animal performance, with high masses of stems and dead tissues, low percentage of live leaves, and occurrence of tipping of plants (Santos *et al*., 2020). To avoid these problems, deferred pasture must be properly managed.

In addition, the choice of the appropriate forage grass is also fundamental for success with the deferment technique. The cultivars of the *genus Urochloa* are suitable for deferment, because they present characteristics such as low size, fine stem and good growth rate during the autumn months, a period in which deferment usually occurs. Some cultivars still have little flowering in autumn, which is also appropriate for deferment (Santos *et al*., 2022).

Currently, there is a great diversity of cultivars of forage grasses of the genus *Urochloa in* the national market. However, many do not yet have their productive characteristics known in detail under deferment, such as the cultivars MG13 Braúna, Cayana and Convert 330 (sabiá grass). Therefore, the evaluation of the new cultivars of *Urochloa* at the level of forage and at the level of forage canopy allows the identification of forage grasses suitable for use under deferment conditions (Stranssburg *et al*., 2014).

In this context, the new grass braúna, cayana and sabiá probably present different morphogenic, structural and productive characteristics under the deferment. But this information is still nonexistent in the scientific environment, which is why this work was developed to evaluate the morphogenesis, structure, and rate of forage accumulation of braúna, cayana and thrush weeds over the deferment period.

MATERIALS AND METHODS

The work was conducted from October 2020 to September 2022, at the Experimental Capim-branco Farm, at the Faculty of Veterinary Medicine of the Federal University of Uberlândia (UFU), in Uberlândia, MG. The geographical coordinates of the experiment site are 18°30' south latitude and 47°50' west longitude of Greenwich, and its altitude is 776m. The Region of Uberlândia has Cwa climate, high altitude tropical, with mild and dry winter, and well-defined dry and rainy seasons (Alvares *et al*., 2013). The climatic data of the two experimental years were monitored in a meteorological station, located about 500m from the experimental area (Fig. 1).

The relief of the experimental area is flat, and the soil was classified as Dystrophic Dark Red Latosol (Santos *et al*., 2018). In mid-October 2020, soil samples composed in the experimental area were collected in the 0 to 20cm layer, whose results were: pH: 5.6; P: 7.9mg.dm^{-3} (Mehlich^{-1}); K: 182mg. dm^{-3}; Ca: 2.75 cmol$_c$.dm^{-3}; Mg^{2+}: 0.86cmol$_c$. dm^{-3}; Al^{3+}: 0.05cmol$_c$.dm^{-3} (KCL 1mol/L); and P-rem: 3.7mg.dm^{-3}. Based on the results of soil analysis and according to the recommendations of Cantarutti *et al*. (1999), for a medium-level technological system, it was not necessary to make liming and potassium fertilization.

Phosphate fertilization was performed in November, with the application of 50kg.ha^{-1} of P_2O_5 in the form of simple superphosphate, in the time of the sowing. As for nitrogen fertilization, 100kg.ha^{-1} of N in the form of urea was applied, divided into two plots of 50kg.ha^{-1} of N, the first being applied on 02/19/2021 and the second installment applied on 03/23/2021. Urea was diluted in three liters of water and distributed with the aid of a watering can in each plot, to better standardize the application. The fertilizations were made in the late afternoon and in cover. In 2022 the phosphate fertilizer (50kg.ha^{-1} of P_2O_5) was in the form of simple superphosphate and nitrogen fertilization (100kg.ha^{-1} of N), in the form of urea. Nitrogen fertilization was divided into two plots, the first dose of nitrogen fertilizer (50kg.ha^{-1}) on 19/02/2022. Phosphate fertilization was applied in cover with the application of the second portion of nitrogen fertilizer on 03/23/2022, similar to that performed in the first experimental year.

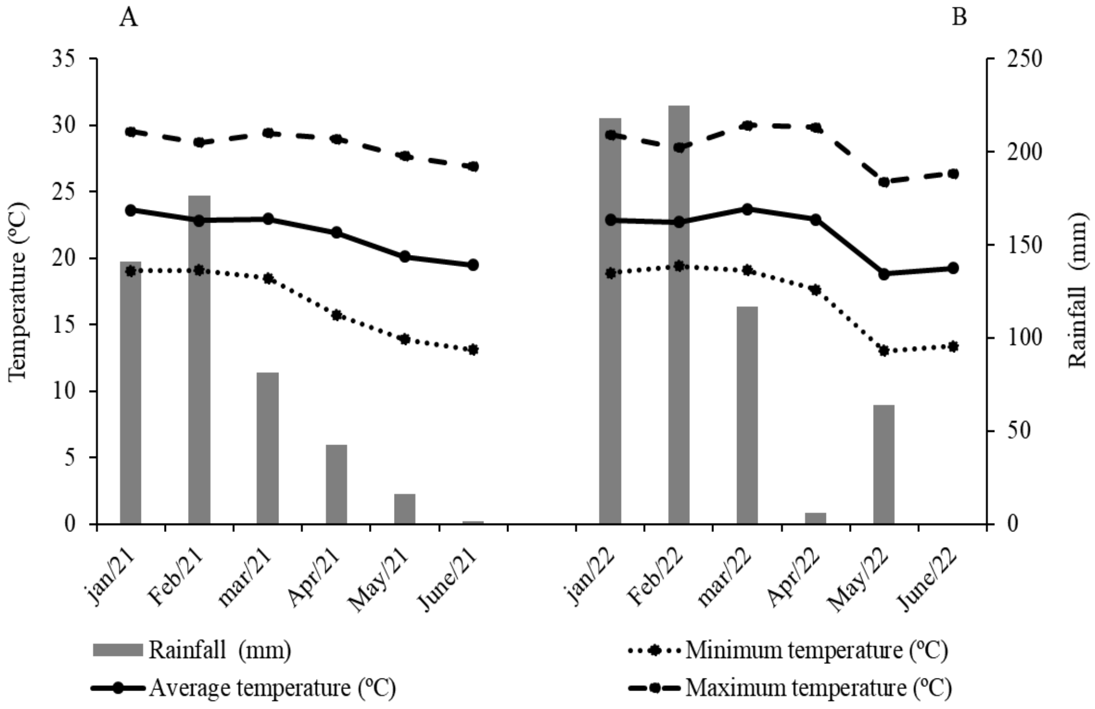

Figure 1. Average monthly temperatures and rainfall during the experimental period from January to June 2021 (A) and 2022 (B).

The experimental area comprised 12 experimental plots (experimental units) each measuring 12.25m² (3.5m x 3.5m). In these, plant sowing occurred at the end of November 2020, using a sowing rate of 6.0kg.ha^{-1} of seeds with a cultural value of 64% and the sowing depth was 3cm. Sowing was adopted in lines with a spacing of 30cm between the lines.

After sowing, the plants remained in free growth until they reached the height of 30cm. This height was maintained by means of weekly cuts using pruning shears until March 20, 2021, when the deferral period began. This ended on June 18, 2021, totaling 90 days. The cut forage was removed of the plots. On October 7, 2021, a cut of the plants was made in all plots at 8cm height. Then, the plants remained in free growth until they reached 30cm in height. This time was maintained until March 20, 2022, when the new 90-day deferment period began, ending on June 18, 2022.

The experiment was conducted in a completely randomized design, with four replications and in a subsubdivided plot scheme. The plots corresponded to three cultivars: *Urochloa brizantha* cv. MG 13 Braúna, *Urochloa* cv. Cayana and *Urochloa* cv. Convert 330 (sabiá-grass). The subplot sums were the deferment periods: beginning and end. And the subplots consisted of the two experimental years: 2021 and 2022.

All evaluations occur in the useful area of the plot of 9m², with 0.5m of surround. In the two experimental years, morphogenesis was evaluated during the deferment period in two cycles, from the 1st day to the 45th day (beginning of deferment) and from the 46th to the 90th day (end of deferment). In each evaluation cycle, ten tillers per plot were marked with identified loops, totaling 120 tillers under evaluation. With each new cycle, a new group of planters was selected, following the proportion of vegetative and reproductive tillers of each experimental unit for evaluation. With the graduated ruler, measurements of the length of all leaf blades and the stems of tillers were measured once a week. The measurement of the length of the fully expanded leaves was made from the tip of the leaf to its ligule. For the expanding leaves, the same procedure was adopted, but the ligule of the last expanded leaf was considered as a measurement reference. For senescent leaves, the length corresponded to the distance from the point at which the senescence process advanced to the ligule. The size of the stem was measured from the soil surface to the youngest leaf ligule completely expanded. According to the methodology described by Santos *et al*. (2011), the following variables were calculated: phyllochron (PHY), leaf elongation rate (LER), stalk elongation rate (SER) and leaf senescence rate (LSR).

The population density of tillers (PDT) was evaluated at the beginning (1st day of deferment), in the middle (45º deferment day) and at the end (90º deferment day) in the two experimental years, with the aid of a rectangular frame of 25cm by 50cm (0.125m^2), which was placed at two points per experimental unit. The rectangles were colocated in a position parallel to the sowing lines, where PDT counting was performed at two representative points per experimental unit. Within these frames, the live tillers were quantified and classified into vegetative and reproductive. The vegetative tillers were those without visible inflorescence, while the reproductive tillers corresponded to those with visible inflorescence.

To express the growth and senescence rates of leaf blades and stems in kg. ha^{-1}.day^{-1} of dry matter, conversion factors were generated. On the last day of each morphogenic evaluation cycle, 30 tillers per plot were collected at the ground surface level, which were placed in identified plastic bags and taken to the laboratory. The tillers had the lengths of leaf blades and stems measured similarly to that performed in the field. Subsequently, all leaf blades and stems (stems plus sheaths) were manually separated, grouped according to the plot of origin, and taken to the greenhouse for 65°C for 72 hours. After drying, the morphological components were weighed, and their masses divided by their respective total lengths. Thus, the conversion factors (conversion factor living leaf blade, CFLLB, and conversion factor for live stem, CFLS) (in mg/cm) used to transform the values obtained with the readings carried out in the field (which were expressed in cm.tiller^{-1}.day^{-1}) to the unit of mg.tiller^{-1}.day^{-1}. By multiplying the values of growth and senescence of leaf blades and pseudostems, expressed in mg.tiller^{-1}.day^{-1}, by the average live tiller population density (tiller/ha) in each experimental unit, was possible to obtain the rates (in kg.ha^{-1}.dia^{-1}): leaf blade growth: daily increase in leaf blade mass per unit area; stem growth: daily increase in pseudo stem mass per unit area; total growth: sum of leaf blade and pseudo stem growth rates; and leaf blade senescence: daily mass of leaf blade that has seized per unit area.

The data were previously tested, ensuring that they met the basic prerogatives for parametric variance analysis. For this, evaluations of the normality of the data were performed bythe Shapiro-Wilk tests; Kolmogorov-Smirnov and Anderson-Darling; while the Bartett test was used to study the homogeneity of the data. SER values; CFLS; CFLLB; LGR and TGR were transformed and analyzed with Friedman's nonparametric tests; Kruskal and Dunn. For statistical analysis, the program R was used.

RESULTS

Of the 11 response variables evaluated, only phyllochron (PHY), leaf elongation rate (LER) and leaf senescence rate at canopy level (LSR) were influenced by interactions between the factors studied. The other response variables were influenced by factors in isolation. The variables population density tiller (PDT), conversion factor for live leaf blade (CFLLB), conversion factor for live stem (CFLS), leaf growth rate at canopy level (LGR) and total growth rate at canopy level (TGR) were influenced by the factor "grass". The variables PHY, LER, stem elongation rate (SER), PDT, LGR, stem growth rate at the canopy level (SGR), TGR and LSR were influenced by the factor "deferment period". The factor "experimental year" influenced five response variables: PHY, SER, leaf senescence rate at the level of individual (LSR), SGR and LSR (Table 1).

Table 1. Coefficient of variation and significance for the effects of grass (G), deferment period (P), experimental year (Y) and its interactions for the evaluated response variables

Variable*	Factor**							
	G	P	Y	G x P	G x Y	P x Y	G x P x Y	SEM
PHY	0.1351	0.0001	0.0365	0.1356	0.0870	0.0001	0.5747	4.91
LER	0.2987	0.0001	0.3158	0.2554	0.2945	0.0001	0.3958	0.190
SER	0.4536	0.0010	0.0010	n.e	n.e	n.e	n.e	0.060
LSR	0.2250	0.2260	0.0223	0.6691	0.9748	0.1042	0.2904	0.080
PDT	0.0003	0.0384	0.8790	0.7314	0.0615	0.9690	0.6236	2.800
CFLLB	0.0010	0.1025	1	n.e	n.e	n.e	n.e	0.001
CFLS	0.0000	0.1025	0.1025	n.e	n.e	n.e	n.e	0.003
LGR	0.1614	0.0000	0.2207	n.e	n.e	n.e	n.e	3.200
SGR	0.0067	0.0003	0.0002	0.9681	0.0818	0.5018	0.2444	6.650
TGR	0.0361	0.0002	0.6831	n.e	n.e	n.e	n.e	5.300
LSR	0.0945	0.0215	0.0005	0.1248	0.9332	0.0100	0.5155	10.920

*Significant ($P<0.05$); PHY: phyllochron (day); LER: leaf elongation rate (cm.tiller^{-1}.day^{-1}); SER: stem elongation rate (cm.tiller^{-1}.day^{-1}); LSR: leaf senescence rate (cm.tiller^{-1}.day^{-1}); PDT: population density tiller (tiller.m²); CFLLB: conversion factor for live leaf blade (mg.cm^{-1}); CFLS: conversion factor for live stem (mg.cm^{-1}); LGR: leaf growth rate (kg.ha^{-1}.day^{-1} DM); SGR: stem growth rate (kg.ha^{-1}.day^{-1} DM); TGR: total growth rate (kg.ha^{-1}.day^{-1} DM); LSR: leaf senescence rate (kg. ha^{-1}.day^{-1} DM); ** G: grass; P: deferment period; Y: experimental year; SEM: standard error of the mean; n.e: not evaluated (nonparametric tests were performed for these variables).

The PHY was lower at the beginning, when compared to the end of the deferment period. At the beginning of the deferment period, PHY was lower in 2021 than in 2022. At the end of the deferment period, PHY was lower in 2022 than in 2021 (Table 2).

LER was higher at the beginning of deferment compared to the end of this period. The LER at the beginning of deferment was higher in 2021 than in 2022, a pattern of response contrary to that observed at the end of the deferment period (Table 2).

The forage canopy LSR and 2021 m was higher at the end, in relation to the beginning of deferment period. However, in 2022 there was no difference between the deferment periods for the LSR. At the beginning of deferment period there was no difference between the experimental years for the. But at the end of deferment period, the LRS was higher in 2021 than in 2022 (Table 2).

Table 2 - Phyllochron, leaf elongation rate and leaf senescence rate of cayana, sabiá and braúna grasses, as a function of the experimental year and the deferment period

Year	Deferment period		SEM
	Beginning	End	
	PHY (day)		
2021	17.2 b B	40.0 a A	4.91
2022	23.6 b A	31.1 a B	
	LER (cm.tiller.day^{-1})		
2021	1.021 a A	0.180 b B	0.19
2022	0.815 a B	0.489 b A	
LSR (kg. ha^{-1}.day^{-1} DM)			
2021	72.5 b A	109.3 a A	10.92
2022	63.8 a A	63.1 a B	

SEM: standard error of the mean; For each characteristic, mean followed by the same lowercase letter in the row and uppercase in the column do not differ from each other ($P>0.05$).

The PDT of cayana grass (1693 tillers.m^{-2}) was the same as that of the sabiá grass (1500 tillers.m^{-2}) and both were lower than the PDT presented by the braúna grass (2331 tillers.m^{-2}). PDT also decreased from 1912 tillers.m^{-2} at the beginning of deferment to 1768 tillers.m^{-2} at the end of the deferment period (coefficient of variation of 23.8%).

Cayana and sabiá grasses showed no differences for CFLLB and CFLS, which were higher when compared to braúna grass. For SGR and TGR, cayana grass presented a higher value than braúna grass, with sabiá grass presenting values similar to other grasses under deferment (Table 3).

Table 3. Conversion factors (mg/cm) for the living leaf blade (CFLLB) and live stem (CFLS), as well as stem growth (SGR) and total growth rates (TGR), in kg.ha.day^{-1} DM, of deferred cayana, sabiá and braúna grasses

Grass	CFLLB	CFLS	SGR	TGR
Cayana	0.007 A	0.013 A	40.2 A	114.4 A
Sabiá	0.007 A	0.012 A	25.1 AB	85.8 AB
Braúna	0.004 B	0.005 B	17.6 B	64.1 B
SEM	0.001	0.003	6.65	14.57

SEM: standard error of the mean; For each characteristic, mean followed by the same letter did not differ from each other (P>0.05).

SER was higher in 2021 compared to 2022. When compared by deferment period, the SER was higher at the beginning than at the end of this period. LGR and TGR were higher at the beginning of the deferment period than at the end of this period. SGR was higher in 2021 compared to 2022. When compared by deferment period, SGR was higher at the beginning than at the end of this period. LRS was higher in 2021 compared to 2022 (Table 4).

Table 4. Leaf, stem. and total growth rates, in kg.ha.day^{-1} DM, stem elongation rate and leaf senescence rate, in cm.perfilho.day^{-1}, of cayana, sabiá and braúna grasses during the deferment period in two experimental years

Variable	Year		Deferment period		SEM
	2021	2022	Beginning	End	
LGR	57.6 a	64.0a	83.0 a	38.6 b	3.20
SGR	35.8 a	18.9 b	37.4 a	17.3 b	8.45
TGR	93.4 a	82.8 a	120.4 a	55.8 b	5.30
SER	0.218 a	0.100 b	0.222 a	0.096 b	0.06
LSR	0.79 a	0.64 b	0.754 a	0.675 a	0.08

SEM: standard error of the mean; For each characteristic and factor, means followed by the same letter do not differ by the F test (P>0.05).

DISCUSSION

PDT is a genetic characteristic and greatly influenced by environmental conditions and pasture management. In this context, among the three grasses evaluated, braúna grass formed a denser forage canopy in tillers, when compared to cayana and sabiá grasses during the 90-day deferment period. The higher PDT of braúna grass indicates that this grass forms pastures with high potential for soil cover. In fact, according to Souza *et al*. (2021), evaluating the *Urochloa decumbens* cv. Basilisk, *Urochloa brizantha* cultivars MG13 Braúna, Marandu, MG-5 Vitória, MG-4, *Urochloa humidicola* cv. Comum and *Urochloa ruziziensis* cv. Ruziziensis, in pots and under sections 5 cm above ground level at 41 days interval, the cultivar MG13 Braúna presents tillering capacity much higher than the other cultivars evaluated in the same condition.

In addition, the higher population density of tillers can also generate pastures with higher volumetric density of forage, which has implications on the consumption of grazing animals. For the same volume of bit, the denser the pasture, the greater the mass of the bit, a characteristic positively correlated with the daily consumption of forage by grazing animals (Benvenutti *et al*., 2009).

However, the braúna grass tillers were smaller in size, with leaf blades and thinner stems, which is why the conversion factors, in mg.cm^{-1}, of the living leaf blade and the live stem were lower in the braúna grass, compared to cayana and sabiá grasses (Table 3).

These results can be explained by considering the "law of self-thinning", which describes a compensation between the size and population density of tillers (Sbrissia and Silva, 2008), so that pastures with a higher number of tillers have lighter tillers, as occurred with the braúna grass. On the other hand, pastures with lower population density of tillers have heavier tillers, as verified with cayana and sabiá grasses, under deferment. Thus, the braúna grass, denser and less robust, has a pasture structure or morphology distinct from cayana and sabiá grasses, while the latter have greater morphological similarity.

The LER at the tiller level and the LGR at the forage canopy level did not vary between the braúna, cayana and sabiá grasses under 90 days deferment. But the SGR was higher in the deferred canopies of cayana and sabiá grasses than in the braúna grass canopy (Table 3). This happened, because cayana and sabiá grasses expressed more intense flowering during the deferment period, compared to braúna grass. In fact, the percentages of tillers in reproductive stage were 2.3%, 16.25% and 15.55% for braúna, cayana and sabiá grasses at the end of the 90-day deferment period, respectively (means for the two experimental years, data not presented).

When the tiller passes from the vegetative stage to the reproductive stage, there is an intense stretching of the stem to expose the inflorescence at the top of the canopy and, therefore, facilitate the dispersion of seeds. Although this is an important ecological strategy for plants, from the zootechnical point of view, this fact can result in negative effects. A pasture in which the tillers are in the reproductive stage has worse nutritional value because the stem has worse nutritional value. Moreover, the stem can also limit the deepening of the bit of grazing animal, which has deleterious consequences for the consumption of forage by the animal (Benvenutti *et al*., 2009).

In this sense, the deferred pastures of cayana and sabiá grasses, when compared to the deferred pasture of braúna grass, because they have higher proportions of reproductive tillers and have higher SGR, could be destined, during the dry season, to the less nutritionally demanding animal categories. Otherwise, the deferred pasture of braúna grass, because it has less reproductive tillers and has lower stem production, may be indicated for use in the dry months for more nutritionally demanding categories of animals.

In view of the above, the higher production of stem of cayana and sabiá grasses, when compared to braúna grass during the deferment period (Table 4), is a limiting characteristic of these forage grasses for use under deferred grazing.

According to Santos *et al*. (2021a), working with pre-deferment lowering strategies for *Urochloa brizantha* cv. Marandu, the abrupt lowering of marandu grass to 15cm at the beginning of deferment resulted in a canopy differed with adequate structure in winter. In this context, the strategy of abrupt lowering of cayana and sabiá grasses to 15cm prior to deferment could be applied strategically to minimize stem elongation and decrease the number of tillers reaching the reproductive stage. Thus, cayana and sabiá gresses could meet animals of greater nutritional requirement when deferred.

The highest TGR at the canopy level presented by cayana grass, compared to the grass-braúna (Table 4) demonstrates the higher potential for forage production of cayana grass during the deferment period. This characteristic is important because it positively influences the stocking rate in deferred pasture during the months of its use in winter.

Other authors also argue about the need to choose forage grasses resistant to spittlebugs, due to the ecological and economic complexity of pest insect control (Guitierrez *et al*., 2011; Silva *et al*., 2017). Therefore, it is recommended that, in a region with a history of incidence of spittlebugs, a grass tolerant to the insect be used for deferment (Silva *et al*., 2017).

It is noteworthy that, in this study, the braúna, cayana and sabiá grasses were evaluated only during the deferment period (90 days), which occurred in the autumn months. Therefore, all the information presented in this paper refers only to the autumn months and, thus, cannot be extrapolated to the other seasons.

However, the grass remains in the production system throughout all months of the year. Therefore, evaluations of forage production and pasture structure should be evaluated at all seasons when choosing a forage grass to be used in the pastoral system.

Regarding the deferment period and the experimental year, its effects on the response variables were mainly consequences of the different climatic conditions between the beginning and the end of the deferment period, as well as between the experimental years 2021 and 2022 (Fig. 1).

According to the meteorological data records, the mean temperature and rainfall were 22.8ºC and 64.6mm at the beginning and 20.0ºC, 17.6mm at the end of deferment period of 2021. In 2022, the average temperature and rainfall were 26.6ºC and 52.8mm at the beginning and 19.0ºC and 63.7mm at the end of deferment period. Thus, it is observed that the climatic condition was more favorable at the beginning, compared to the end of deferment period, except when comparing the final deferment periods between experimental years, where the end of 2022 occurred considerable rains in May near the end of the deferment period. Therefore, at the beginning of deferment the PHY was lower, while the values of LER, PDT, SER, LGR, SGR, TGR and LSR were higher when compared to the end of deferment period (Tab. 3, 4 and 5).

In the work of Santos *et al*. (2021b), with four cultivars *of Urochloa brizantha* (Marandu, BRS Piatã, Xaraés and BRS Paiaguás) submitted to two years of deferment, similar responses were observed. In this study, the PHY was higher, while the LER was minor in the final deferment period, due to the more restrictive conditions to the development of new leaves at the end of the deferment period.

Rodrigues *et al*. (2015), evaluating deferred marandu grass with two heights (15 and 45 cm) for 90 days, also found higher PHY values at the end of the deferment period, but higher LER and SER at the beginning of deferment period. These results are similar to those observed in this study.

Tropical forage grasses are sensitive to low temperatures because their metabolic processes of photosynthesis and respiration are regulated by stimulating environmental temperature. Thus, tropical forage grasses, when exposed to low environmental temperatures, have growth close to zero or zero (Strassburg *et al*., 2014; Habermann *et al*., 2019).

Therefore, the production of forage in the dry season reduces, due to environmental limitations, such as water scarcity in the soil and low luminosity and temperature (Santos *et al*., 2020). In this condition, the plant enters a state of numbness, the metabolism is slower and, consequently, the processes involved in the emergence of new tissues take a greater fraction of time (Habermann *et al*., 2019).

The water deficit also increases leaf senescence, as well as the increase in soil water deficit, the rate of appearance of planters tends to be lower than the mortality rate of planters, due to increased competition for water and light among the planters (Habermann *et al*., 2019).

The grass tillering potential depends on the leaf emission velocity. In fact, the shorter the time interval for the emergence of two consecutive leaves, which in turn will produce gems potentially capable of originating new tiller, the smaller the phyllochron and the greater the tillering potential of the forage grass (Wilhelm and Mc Master, 1995). Therefore, in general, there was a contrary response pattern between the phyllochron and the population density of tiller in this study.

Regarding the experimental years, there was lower rainfall volume during the deferment period of 2021 (82.2mm) than in the same period of 2022 (116.5mm). However, in 2021 the experimental units had approximately four months to be implanted. Consequently, the tiller who composed the forage canopy in the first experimental year could have a smaller age than the tiller in 2022. According to Brito *et al*. (2022), the pattern of development of young tillers (up to two months of life), mature (between two and four months of life) and old (age greater than four months of life) under deferment is different, where young tillers have higher leaf growth and shorter stem length, compared to mature and old tillers. This may justify the higher growth of forage grasses, in general, in the first experimental year, compared to the second experimental year. In fact, in 2021, the values of LSR, LER (at the beginning of deferment), SER, SGR and LSR (at the end of deferment) were higher, but the PHY at the beginning of deferment was lower, compared to 2022 (Tab. 3, 4 and 5)

In 2022 there was a higher volume of rainfall at the end of the deferment period, mainly in May (Fig. 2). This fact may have resulted in the higher value of TAlF, as well as in the lower value of FIL at the end of deferment period of 2022, in relation to the end of deferment period of 2021 (Table 3).

These results demonstrate that the stage of development of forage cultivar and the climate, variable between the years, have great effect on the development of forage grasses under deferment. As the pasture management man has no control over the climate, this is an important risk factor and impacts the productive responses of forage plants managed under deferment conditions.

CONCLUSIONS

Under the deferment period of 90 days during autumn and with an initial height of 30cm, the MG13 Braúna produces a canopy consisting of lighter tiller, but denser, compared to cayana and convert 330 cultivars (sabiá grass).

In the region of Uberlândia, MG, the MG13 Braúna produces less stem during the 90-day period in autumn, compared to the Cayana and Convert 330 (sabiá grass), when managed with a height of 30cm at the beginning.

In the region of Uberlândia, MG, cayana produces more forage during the 90-day period in autumn, compared to the MG13 Braúna, when managed with a height of 30cm at the beginning.

ACKNOWLEDGEMENTS

To the members of testhfor (Forage Hypothesis Testing Group) of the Federal University of Uberlândia for their contributions during the field trial.

This work was carried out with the support of the Coordination for the Improvement of Higher Education Personnel - Brazil (CAPES).

REFERENCES

ALVARES, C.A.; STAPE, J.L.; SENTELHAS, P.C. *et al*. Köppen’s climate classification map for Brazil. *Meteorol. Z.*, v.22, p.711-728, 2013.

BEEF report - Perfil da pecuária no Brasil 2022. São Paulo: ABIEC, 2022. Available in: https://www.abiec.com.br/publicacoes/beef-report-2022/. Accessed in: 16 Jan. 2023.

BENVENUTTI, M.A.; GORDONA, I.J.; POPPI, D.P. *et al*. The horizontal barrier effect of stems on the foraging behaviour of cattle grazing five tropical grasses. *Livest. Sci.*, v.126, p.229-238, 2009.

BRITO, A.A.; ADORNO, L.C.; NOVAIS, V.S. *et al*. Morphogenesis of age groups of marandu palisadegrass tillers during the stockpiling period. *Acta Sci. Anim. Sci.*, v.44, p.e53901, p.1-7, 2022.

CANTARUTTI, R.B.; MARTINEZ, H.E.P., CARVALHO, M.M. *et al*. Pastagens. In RIBEIRO, A.C.; GUIMARÃES, P.T.G.; ALVAREZ, V.H. (Eds.). *Recomendação para o uso de corretivos e fertilizantes em Minas Gerais.* 5.ed. p. Viçosa, MG: CFSEMG, 1999. p.43-60.

GUTIERREZ, A.P.; PONTI, L.; HODDLE, M. *et al*. Geographic distribution and relative abundance of the invasive glassy-winged sharpshooter: effects of temperature and egg parasitoids. *Environ. Entomol.*, v.40, p.755-769, 2011.

HABERMANN, E.; OLIVEIRA, E.A.D.; CONTIN, D.R. *et al*. Warming and water deficit impact leaf photosynthesis and decrease forage quality and digestibility of a C4 tropical grass. *Physiol. Plant*., v.165, p.383-402, 2019.

ROBINSON, A.P.; HORROCKS, R.D.; PARKER, D.D.; ROBERT, D.F. Quality of stockpiled pasture and hay forages. *Forage Grazingl.*, v.5, p.1-11, 2007.

RODRIGUES, P.H.M.; ALVES, L.C.; SOUZA, W.D.; SANTOS, M.E.R. *et al.* Morfogênese do capim-marandu diferido com alturas variáveis. *Encicl. Biosfera*, v.11, p.1352-1364, 2015.

SANTOS, A.D.; FONSECA, D.M.; SOUSA, B.M.L.; SANTOS, M.E.R. *et al.* Pasture structure and production of supplemented cattle in deferred signalgrass pasture. *Ciênc. Anim. Bras.*, v.21, p.e-43578, 2020.

SANTOS, H.G.; JACOMINE, P.K.T.; ANJOS, L.H.C. *et al. Sistema brasileiro de classificação de solos.* 5.ed. Brasília, DF: Embrapa Solos, 2018. 356p.

SANTOS, M.E.R.; FERREIRA, I.C.; CARVALHO, B.H.R. *et al.* Morphogenesis of stockpiled Marandu, Piatã, Xaraés and Paiaguás brachiariagrass cultivars. *Arq. Bras. Med. Vet. Zootec.*, v.73, p.1413-1421, 2021b.

SANTOS, M.E.R.; FONSECA, D.M.; BRAZ, T.G.S. *et al.* Características morfogênicas e estruturais de perfilhos em locais do pasto de capim-braquiária com alturas variáveis. *Rev. Bras. Zootec.*, v.40, p.535-542, 2011.

SANTOS, M.E.R.; ROCHA, G.O.; CARVALHO, B.H.R. *et al.* Does the lowering strategy before the stockpiling period modify the marandu palisade grass production and structure? *Arq. Bras. Med. Vet. Zootec.*, v.73, p.1403-1412, 2021a.

SANTOS, M.E.R; MORAES, F.R.; ROCHA, G.O. *et al.* How does the condition of the pasture in late winter influence the plant and animal responses in the subsequent seasons? *Rev. Biosc.*, v.38, p.e38022, 2022.

SBRISSIA, A.F.; SILVA, S.C. Compensação tamanho: densidade populacional de perfis em pastos de capim-marandu. *Rev. Bras. Zootec.*, v.37, p.35-47, 2008.

SILVA, S.E.B.; AUAD, A.M.; MORAES, J.C. *et al.* Biological performance and preference of Mahanarva spectabilis (Hemiptera: Cercopidae) for feeding on different forage plants. *J. Econ. Entomol.*, v.110, p.1877-1885, 2017.

SOUZA, R.A.; CARVALHO, R.G.; PIMENTEL, A.J.B. *et al.* Desempenho produtivo e qualidade nutricional de forrageiras do gênero Urochloa no Oeste da Bahia. *Agrarian*, v.14, p.392-403, 2021.

STRASSBURG, B.B.N.; LATAWIEC, A.E.; BARIONI, L.G. *et al.* When enough should be enough: improving the use of current agricultural lands could meet production demands and spare natural habitats in Brazil. *Global Environ. Change*, v.28, p.84-97, 2014.

WILHELM, W.W.; Mc MASTER, G.S. Importance of the Phyllochron in studying development and growth in grasses. *Crop Sci.*, v.35, p.1-3, 1995.