v. 5, n. 6, 2025

Journal of Agricultural Sciences Research

Acceptance date: 06/08/2025

MORPHOLOGICAL COMPOSITION AND PRODUCTIVITY OF *Urochloa decumbens* UNDER DIFFERENT DELAY TIMES

Vinicius Valim Pereira
Minas Gerais State University - UEMG/
Divinópolis Unit
Divinópolis/MG
https://lattes.cnpq.br/2312563045238679

Estela Campos Branquinho
Minas Gerais State University - UEMG/
Divinópolis Campus
Divinópolis/MG
http://lattes.cnpq.br/5356465890651427

Fernando Augusto Soares
Minas Gerais State University - UEMG/
Divinópolis Campus
Divinópolis - MG
https://lattes.cnpq.br/5715242073438322

Larissa Alice Ramos de Melo
Minas Gerais State University - UEMG/
Divinópolis Campus
Divinópolis - MG

Flávia Maria da Fonseca
Minas Gerais State University Divinópolis Unit/MG

Gustavo Augusto Fonseca
State University of Minas Gerais - UEMG/
Divinópolis/MG Unit

Angélica das Dores Fonseca
Minas Gerais State University -Divinópolis/ MG

Marco Túlio Carvalho da Silva
Minas Gerais State University - Divinópolis / MG
http://lattes.cnpq.br/7075552543277195

Abstract: Pasture-based animal production in Brazil faces challenges related to seasonality, nutritional value, and forae elongation. Pasture deferral is a crucial management practice for optimizing forage productivity and quality. This study aimed to evaluate the morphological components and productivity of *Urochloa decumbens* under different deferral times. The experiment was conducted in Divinópolis, Minas Gerais, from April to July 2025, using a completely randomized design with four replicates. Three deferral times (30, 60, and 90 days) were applied in 9 m² plots, with initial cutting at 20 cm and nitrogen fertilization (70 kg/ha of N). The green mass (GM) and percentages of leaf blade (%LB), culm (%COL), dead material (%DM), and inflorescence (%INF) were evaluated. The results indicated that green mass productivity did not differ significantly between the 30-day (763.89 kg GM/ha) and 60-day (694.45 kg GM/ha) deferral times, but deferral for 90 days resulted in lower productivity (305.84 kg GM/ha), representing a reduction of approximately 60% and 56% compared to 30 and 60 days, respectively. This reduction was attributed to unfavorable climatic conditions (low precipitation and temperature) during the experimental period. Regarding morphological components, the highest %LAM was observed at 60 days (44.27%), while the lowest was at 90 days (26.34%). The %COL was higher at 30 days (38.05%) and lower at 90 days (10.86%). The %MM increased significantly with the prolongation of the deferral (3.88% at 30 days to 47.95% at 90 days), due to senescence and light restriction in the lower layers of the canopy. The %INF decreased only in the 90-day deferral (14.86%). It is concluded that the 30-day deferral strategy, started late, provides better accumulation of forage and leaf blades, with a lower percentage of dead material, being a viable alternative for the dry season.

Prolonged deferral (90 days) significantly compromises pasture productivity and quality.
Keywords: Tropical forage; Pasture management; Green mass; Morphological components

INTRODUCTION

Brazil has unique opportunities for pasture-based animal production. However, the lack of knowledge of morphological and physiological characteristics related to the productivity of forage plants under grazing has led to advances that are far below expectations.

The importance of pastures can be easily characterized, since they constitute the basis of cattle production systems, which highlights their importance and the need to seek management practices that result in greater efficiency of these systems (FREITAS et al., 2005).

Problems such as seasonal production (EUCLIDES et al. 1993), limited nutritional value (HUMPHREYS, 1986), and rapid culm elongation during the reproductive period (SANTOS et al. 1997) can directly affect pasture utilization and, consequently, animal performance and productivity.

MURIITHI et al. (2021) observed that the application of adaptive management strategies, including the evaluation of pasture cultivars adaptable to climate variations, can lead to significant improvements in cattle production.

Several morphophysiological aspects are involved in light interception by plants. Some correspond to aspects related to the spatial organization of leaves, by the density of vegetation cover, horizontal and vertical distribution between leaves, and leaf angle. Others correspond to functional aspects that depend on plant and environmental factors such as age, leaf type and size, light saturation, and fluctuations in light intensity and quality (BERNARDES, 1987).

Practical studies suggest that for *Brachiaria decumbens*, the deferral interval can vary from 30 to 60 days, depending on environmental conditions and the management history of the system. During this period, the plant's physiological mechanisms—such as carbohydrate accumulation and the formation of new tillers—are optimized, contributing to greater resilience and better post-grazing recovery (EMBRAPA GADO DE LEITE, 2007).

Proper management of tropical pastures is essential to ensure sustainable forage production and animal performance. In particular, *Urochloa decumbens* stands out for its high productivity and adaptation to various tropical environments. Within this context, deferral is a management practice that can influence the morphogenic characteristics of the crop, such as height, plant density, and tiller vigor, directly reflecting on the quantity and quality of green mass available for grazing.

Therefore, good deferral promotes:

Increased green mass and improved leaf structure: The increase in plant density and height resulting from deferral periods favors the formation of more homogeneous tillers, improving forage utilization by animals. Balance between growth and nutritional quality: Although longer periods allow for the formation of greater biomass, there is a risk of loss of nutritional value due to leaf senescence, which is why management should be adjusted according to the physiological response of the crop (HEUZÉ et al., 2019).

In summary, controlled deferral can be considered a viable practice for improving the structure and productivity of pastures, such as *Urochloa decumbens*, provided that management times and techniques are properly monitored and adjusted to the specific conditions of each production system.

Urochloa decumbens, commonly known as *Brachiaria decumbens*, is a tropical grass of great importance for forage production in hot and humid regions. Its popularity is due to its adaptability, high productivity, and nutritional properties that favor the development of efficient and sustainable animal production systems (LIMA, et al, 2018).

It is known for its hardiness and adaptability to various agroclimatic conditions, making it a preferred choice for rotational grazing systems. According to Heuzé et al. (2017), *Urochloa decumbens* stands out for its substantial dry matter production and advantageous nutritional profile, with adequate protein and digestibility levels, which favor ruminant performance.

Deferral management is crucial to maximize forage yield and pasture quality. In a study on the chemical composition and nutritional value of Brachiaria cultivars, NGUKU et al. (2016) demonstrated how cutting time influences the nutritional composition and degradation efficiency of forage.

Deferral management in pastures is a crucial tool for the sustainability of forage production systems, especially in tropical regions. Deferral is understood as the interval between grazing or cutting and the resumption of activity, allowing plants to reach a physiological state conducive to regrowth, contributing both to the maintenance of nutritional quality and to the maximization of dry matter production (SANTOS, 2022).

Another benefit of deferral is the recovery of pastures in the early stages of degradation, due to the recovery of soil cover, leaf area, and organic reserves in the pasture (ANDRADE, 2020).

In the case of *Urochloa decumbens*, a species widely used in rotational grazing systems, deferral management is important due to its agronomic characteristics and direct impact on forage performance. According to Diniz et al. (2002), well-planned deferral can optimize production, ensuring adequate levels of green matter and better digestibility for animals. Oliveira et al. (2012) emphasize that, for *Urochloa decumbens,* it is essential to identify the balance between the time required for regrowth and the preservation of nutritional quality, avoiding pasture aging by increasing the amount of dead material.

Therefore, the objective was to evaluate the morphological components and productivity of *Urochloa decumbens* under different deferral times.

MATERIALS AND METHODS

The experiment was set up in an area of approximately 150 $m^2$of established *Urochloa decumbens* pasture. The treatments evaluated were three deferral times (30 days, 60 days, and 90 days) in a completely randomized design with four replicates. Each experimental unit measured 3 m x 3 m, totaling$^{9\ m^2}$for a total of 12 experimental units.

The experiment was conducted in an area located in the district of Santo Antônio do Campos (Ermida) belonging to Divinópolis/ MG, from April 2025 to July 2025. Ermida is located in the Central-West region of Gerais.

The experimental area is located at the following coordinates: 20°07'41.3"S 44°58'23.3"W. In the area before the plots were demarcated, soil samples were taken at a depth of 0-20 cm for chemical characterization, Table 1.

All plots were cut to the same height at the beginning of the deferral, around 20 cm, so that they were all at the same initial height, and nitrogen fertilization was carried out with the application of 70 kg/ha of N in the form of urea, in a single application.

All plots were deferred on April 20, 2025, and collections were made at 30 days (May 20, 205), 60 days (June 20, 2025), and 90 days (July 20, 2025).

Climatic variables were obtained from an automatic weather station near Divinópolis

Prof.	P[1]	M.O.	pH	H+Al	Ca[2]	Mg[2]	K[1]	SB[3]	CTC[4]	V[5]
cm	mg/dm³	g/dm³	H2O		----------------------	mmolc/dm^{-3}	-------------------			%
0	13	36	4.9	52	19	8	2.1	29	81	3

Table 1 - Chemical characterization of the experimental area, depth of 0-20 cm, at the beginning of the experimental period.

Source: Soil and Leaf Analysis Laboratory, UEMG Passos Unit. [1]Extracted by Melich; [2]Ca and Mg - extracted with KC lmol L^{-1}; [3]Sum of bases; [4]Cation exchange capacity; [5]Percentage of base saturation.

Month	Tmax (°C)	Tmin (°C)	Tmed (°C)	Precipitation (mm)
March	34	23	15.	114.6
April	32.1	24.1	13.8	6
May	30	9.6	22.8	0
June	26	13	18	6
July	24	13	18.5	0

Table 1 - Average values of maximum temperature (Tmax), minimum temperature (Tmin), average temperature (Tmed) and precipitation, from January to July 2025**.**

Deferral time (days)	**Productivity (kg MV/ha)[1]**
30	763.89[a]
	694.45[a]
90	305.84[b]

[1] Averages followed by different lowercase letters in the column differ by Tukey's test (P<0.05);

Table 2 - Green mass productivity at different deferral times.

Delay time (days)	**%LAM[1]**	**%COL[1]**	**%MM[1]**	**%INF[1]**
30	38.89[b]	38.05[a]	3.88[c]	20.68[b]
60	44.27[a]	24.87[b]	10.92[b]	20.45[b]
90	26.34[c]	10.86[c]	47.95[a]	14.86[c]

[1] Averages followed by different lowercase letters in the column differ according to the Tukey test (P<0.05);

Table 3 - Percentage of leaf blade (%LAM), percentage of culm (%COL), percentage of dead material (%MM) and percentage of inflorescence (%INF).

(A564) through the Meteorological Database of the National Institute of Meteorology (INMET).

Green mass (GM) data were collected at the end of each deferral period (30, 60, and 90 days) from the entire area of each plot at a height of 20 cm above ground level, simulating the exit height for *Urochloa Decumbens*.

All forage samples were weighed to determine green mass (GM). Two sub-samples of forage were removed for separation of the morphological components of the forage, with manual separation of the components, obtaining the leaf blade (LF), pseudostem (PC), dead material (MM), and inflorescence (INF) fractions, which were weighed green.

Based on these values, the percentage of each component was estimated: leaf blade percentage (%LAM), culm percentage (%COL), dead material percentage (%MM), and inflorescence percentage (%INF) for statistical analysis.

The data will be submitted to statistical analysis according to the deferral times at a significance level of 5% (of the coefficients according to the Tukey test).

MATERIALS AND METHODS

When evaluating production (MV), no difference (P<0.05) was found for the 30- and 60-day deferral strategies. However, the 90-day deferral strategy showed the lowest value compared to the other two treatments (Table 2).

A reduction of around 60% and 56% in production and MV was observed in 90 days compared to 30 days and 60 days, respectively.

This reduction can be attributed to unfavorable weather conditions for the accumulation of green mass in the forage (Table 1). TEIXEIRA, et al (2011), evaluating different deferral times in decumbens, found values around 900 kg/ha in 45 days of deferral during the winter period.

The recommended deferral period is generally from December to April (SANTOS & BERNADI, 2005).

According to FAGUNDES, et. al. (2006), lower production in autumn and winter was a consequence of low temperatures and reduced rainfall, which reduced the emergence of new leaves, with possible inhibition of new tillers, and led to a subsequent reduction in pasture production. The same authors also observed that the variation in production with the time of year reflects variations in the accumulation rate, such that about 29% of total production in the experimental period (185 days) was concentrated in the summer; 22% in the fall; 12% in the winter and 37% in the spring.

BRAGA, et al (2009), evaluating grazing from April to June, July to September, and October to December, observed average accumulation rates of 19.8, 14.5, and 26.2 kg DM per ha/day, respectively.

CAETANO (2018), evaluating 2x2m plots collected on March 28, 2018, obtained a productivity of *Uroclhoa decumbens* with average values of 2.49 kg of MV.

MARANHÃO, et. al. (2010), evaluating U. decumbens in autumn and winter, found yields of 687 and 185 kg DM/ha. Therefore, deferral compared to a continuous grazing area without fertilization becomes more efficient in terms of productivity.

The percentages of morphological components can be seen in Table 3.

There was a difference (P<0.05) for (%LAM), (%COL), and (%MM) between the three deferral times. However, there was only a significant difference in (%INF) in the 90-day treatment; 30 and 60 days did not have a statistically significant difference, Table 3.

In (%LAM), the deferral time of 60 days showed the highest value and 90 days the lowest value. In (%COL), the highest value was 30 days and the lowest was 90 days of deferral. In (%MM), there was an increase as the number of deferral days increased. And in (%INF), there was a reduction in the longest deferral time, which was 90 days.

The highest (%LAM) in the 60-day deferral period can be explained by the longer time for growth and formation of the forage canopy, which reached a greater height compared to the days. As the canopy increases, the culm also elongates to seek a larger area and light incidence, also causing an increase in (%MM), due to light restriction in the lower regions of the forage canopy and the scarcity of rainfall, reduction in temperature, and photoperiod. Therefore, when evaluating the three morphological components (%LAM), (%COL), and (%MM), the 30-day period has the highest percentage of leaf blades and, therefore, the highest amount of available nutrients. Inflorescence decreased only in the 90-day deferral period due to the death of tillers and greater accumulation of (%MM) 47.95 in this treatment.

The changes in the morphological characteristics of the pasture resulted in changes in its nutritional value. Both the deferral and grazing periods resulted in a decrease in the morphological component of the pasture with a higher concentration of crude protein and lower neutral detergent fiber content, which is the leaf blade (SANTOS et al., 2008).

According to Ludlow & Ng (1977), leaf expansion is one of the physiological processes most sensitive to water deficit, as it interrupts the elongation of leaves and roots long before the processes of photosynthesis and cell division are affected. This occurs because cell division and, mainly, cell growth are processes that are extremely sensitive to cell turgor.

EUCLIDES, et. al. (2007), evaluating the deferral of Uroclhoa decumbens, observed a reduction in green mass and leaf blade with deferral beginning in March compared to February. Another relevant factor is the reduction in precipitation and temperature in early May, the period when the deferral occurred.

The higher percentage of %INF causes an increase in lodging of tillers, which can be understood as the inability of the culm to support the weight of the tiller. The fall of the plant is related to the etiolation of the culm during the deferral period due to competition for light between the tillers. According to SANTOS et al., 2010, lodging has a strong positive correlation with the number of reproductive and dead tillers in the canopy, but a negative correlation with the number of live tillers. Therefore, a high %INF is characteristic of a deferred canopy.

EUCLIDES et al. (2000), evaluating the percentage of leaves in decumbent pasture during the dry season without deferral, observed average values of around 19.2% and 38.4% of green mass. Even when delayed, beginning in May, deferral promotes a higher percentage of leaf blade when used for a period of 30 to 60 days.

Regarding %COL, tropical forage plants, the culm fraction, which is important for growth, interferes with canopy structure and competition for light. Pinto et al. (2001) observed that, in plants of the genus *Cynodon* under continuous stocking, approximately 60 to 75% of growth came from culm elongation, and not just from leaf expansion.

With prolonged deferral, there is an increase in internodes, a higher proportion of senescent material, and fewer active tillers, as described by Santos et al. (2010), who found a 55% reduction in the leaf:stem ratio in deferrals above 80 days.

Variations in %COL determine changes in the structure and morphological composition of pasture, resulting from changes in environmental conditions, especially rainfall, light, and temperature, depending on the season (Hotsonyame & Hunt, 1998).

The deferral time increased (%MM), while the winter water deficit reduced this variable. Restriction of aerial growth is a form of resource "economy," with changes in carbon partitioning and distribution patterns in the plant (PEREIRA, et. al. 2011).

Deferral leads to the accumulation of mature culms and dead material and a decrease in leaf availability, with a consequent decrease in consumption and animal performance.

Water deficit during the deferral period increases leaf senescence. According to Wolfe et al. (1988), dry soil cannot provide enough nitrogen to meet the crop's growth needs, and nitrogen from inside the plant is redistributed from older leaves to growth points.

It is worth noting that the 30-day deferral showed only 3.88% dead material, thus highlighting that short deferral periods can have positive effects on the accumulation of leaf blades and culms.

TEIXEIRA et al., 2011, deferring from March 21 to June 24, found values ranging from 700 to 360 kg of dead material/ha when evaluating increasing doses of nitrogen. These values, in relation to the total percentage of forage, correspond to around 10.5 to 5% of dead material. Therefore, short deferral periods (30 and 60 days) are close to or even shorter than the data from other deferral studies.

The sustainability of forage production systems requires a balance between the rest period of the pasture and the period necessary for the plant to reach an optimal stage of growth. Studies such as those by Diniz et al. (2002) and Oliveira et al. (2012) indicate that inadequate deferral intervals can lead to reduced nutritional quality, compromising the efficiency of the system and, consequently, increasing feed supplementation costs.

Urochloa decumbens is a rustic forage plant adapted to stressful conditions, but its productivity is intrinsically linked to climatic conditions. In autumn and especially in winter, there is a metabolic slowdown in the plant, resulting in lower biomass accumulation.

CONCLUSION

The 30-day deferral strategy with late start provides better accumulation and forage and leaf blades and a lower percentage of dead material, and can be used as an alternative for drought. Increasing the deferral time to 90 days reduced both productivity and the percentage of leaf blades. Further studies could evaluate the use of increasing doses of nitrogen to determine its influence on deferral times.

ACKNOWLEDGMENTS

To the Animal Nutrition and Pasture Study Group (GNAFOR) at the State University of Minas Gerais-Divinópolis-MG.

REFERENCES

ANDRADE, C. M. S. **Técnicas de replantio de falhas nas pastagens**. Rio Branco, AC: Embrapa Acre, 2020. 16 p. (Embrapa Acre – Circular Técnica, 72).

BERNARDES, M. S. Fotossíntese no dossel das plantas cultivadas. In: CASTRO, P. R. C.; FERREIRA, S. O.; YAMADA, T. (Org.). **Ecofisiologia da produção agrícola**. Piracicaba: Potafos, 1987. p. 13–48.

BRAGA, G. J.; PORTELA, J. N.; PEDREIRA, C. G. S.; LEITE, ET AL. Herbage yield in Signalgrass pastures as affected by grazing management. **South African Journal of Animal Science**, v. 39, p.130-132, 2009. doi: 10.4314/sajas.v39i1.61168.

CAETANO, J. G. Avaliação de produtividade de gramíneas forrageiras do gênero Brachiaria. DE LIMA, R. O., VENDRUSCOLO, M. C., & DALBIANCO, A. B. (2020). Características agronômicas do capim BRS Piatã submetido a doses de nitrogênio e cortes. **Pubvet**, *15*, 168. 2018.

DINIZ, V. J.; SANTOS, R. M.; MOREIRA, L. F. Manejo rotacionado e produtividade em pastagens de capim ruziziensis. **Ciência Rural**, Jaboticabal, v. 32, n. 5, p. 1234–1242, 2002.

EUCLIDES, V.P.B.; FLORES, R.; MEDEIROS, R.N. et al. Vedação de pastos de Brachiaria cv.Basilisk e Marandu, na região do Cerrado. **Pesquisa Agropecuária Brasileira,** v.42, n.2, p. 273- 280, 2007.

EUCLIDES, V.P.B. et al. Consumo voluntário de Brachiaria decumbens cv. Basilisk e Brachiaria brizantha cv. Marandu sob pastejo. **Revista Brasileira de Zootecnia**, v.29, n.6, p.2200-2208, 2000 (Suplemento 2)

EUCLIDES, V.P.B.; ZIMMER, A.H.; VIEIRA, A. Evaluation of Brachiaria decumbens and Brachiaria brizantha under grazing. In: INTERNATIONAL GRASSLAND CONGRESS, 17., 1993, Rockhampton. Proceedings... Palmerstone North: New Zealand Grassland Association, 1993, p.1997-1998.

EMBRAPA GADO DE LEITE. **Manejo e produção de pastagens**. Brasília, DF: Embrapa, 2007.

FAGUNDES, J.L.; FONSECA, D.M.; MORAES, R.V. et al Avaliação das características estruturais do capim-braquiária em pastagens adubadas com nitrogênio nas quatro estações do ano. **Rev. Bras. Zootec**., v.35, p.1-5, 2006.

FREITAS, K. R.; ROSA, B.; RUGGIEIRO, J. A.; NASCIMENTO, J. L.; HEINEMAN, A. B.;

FERREIRA, P. H.; MACEDO, R. Avaliação do capim-mombaça (Panicum maximum) submetido a diferentes doses de nitrogênio. **Acta Scientiarum. Agronomy**, v. 27, n. 1, p. 83–89, 2005.

HEUZÉ, V.; TRAN, G.; GUEVARA, E.; LEBAS, F. Brachiaria ruziziensis. **Feedipedia** – A programme by INRAE, CIRAD, AFZ and FAO, 2019.

HEUZÉ, V.; TRAN, G.; BOVAL, M.; MAXIN, G.; LEBAS, F. Congo grass (Brachiaria ruziziensis). **Feedipedia** – A programme by INRAE, CIRAD, AFZ and FAO, 2017.

HOTSONYAME, G.K.; HUNT, L.A. Seeding date, photoperiod and nitrogen effects on specific leaf area of field-grown wheat. **Canadian Journal Plant Science**, v.78, p.51-61, 1998.

HUMPHREYS, L. R.; RIVEROS, F. **Tropical pasture seed production**. 3. ed. Rome: FAO, 1986. 203 p.

HUMPHREYS, L. R. **Tropical pasture utilization. Cambridge**: Cambridge University Press, 1991. 206 p.

WOLFE, D.W., HENDERSON, D.W., HSIAO, T.C. AND ALVINO, A. (1988), **Interactive Water and Nitrogen Effects on Senescence of Maize. II**. Photosynthetic Decline and Longevity of IndividualLeaves.Agron.J.,80:865-870. https://doi.org/10.2134/agronj1988.00021962008000060005x

LIMA, D. M. et al. Morphological characteristics, nutritive quality, and methane production of tropical grasses in Brazil. **Pesquisa Agropecuária Brasileira**, Piracicaba, v. 53, p. 323–331, 2018. DOI: 10.1590/S0100-204X2018000300007.

LUDLOW, M.M.; NG, T.T. Leaf elongation rate in *Panicum maximum* var. *trichoglume* following removal of water stress. **Australian Journal of Plant Physiology**, v.42, p.263-272, 1977.

MARANHÃO, C. M. DE A.; BONOMO, P.; PIRES, A. J. V.; COSTA, A. C. P. R.; MARTINS, G. C. F.; CARDOSO, E. O. Características produtivas do capim-braquiária submetido a intervalos de cortes e adubação nitrogenada durante três estações - doi: 10.4025/actascianimsci.v32i4.8574. **Acta Scientiarum. Animal Sciences**, v. 32, n. 4, p. 375-384, 22out. 2010.

MURIITHI, C.; BEATRICE, N.; ELIUD, K.; DONALD, N.; ALFRED, M. Participatory evaluation and yield determination of climate-smart Brachiaria grasses for improving livestock production among the farmers in Embu and Meru Counties. **Asian Journal of Soil Science and Plant Nutrition**, v. 7, n. 1, p. 20–24, 2021. DOI: 10.9734/ajsspn/2021/v7i130103.

NGUKU, A. A.; MUSIMBA, N. K. R.; NJARUI, D. N.; MWOBOBIA, R. M. The chemical composition and nutritive value of Brachiaria grass cultivars at Katumancry Landre Search Station in South Eastern Kenya. Journal of Advances in Agriculture, v. 5, p. 706–717, 2016. DOI: 10.24297/jaa.v5i2.5085.

OLIVEIRA, M. V.; LIMA, A. C.; SOUZA, J. P. Manejo do diferimento em pastagens tropicais: avaliação dos impactos agronômicos e nutricionais. **Embrapa Pecuária Tropical**, 2012.

PEREIRA V.; FONSECA D.; MARTUSCELLO J.; BRAZ T.G.S.; SANTOS M.V.; CECON P.R. **Características morfogênicas e estruturais de capim-Mombaça em três densidades de cultivo adubado com nitrogênio**. Revista Brasileira de Zootecnia 12: 2681-2689. 2011.

PINTO, L.F.M.; DA SILVA, S.C.; SBRISSIA, A.F. et al. Dinâmica do acúmulo de matéria seca em pastagens de Tifton 85 sob pastejo. **Scientia Agricola**, v.58, p.439-447, 2001.

SANTOS, M. E. R.; ROCHA, G. O.; BORGES, G. S.; OLIVEIRA, D. H. M.; OLIVEIRA, D. M. Diferimento do uso da pastagem. In: SANTOS, M. E. R.; MASTUSLLO, J. A. (Org.). **Todo ano tem seca. Está preparado?** São Paulo: Reino Editorial, 2022. p. 421–446.

SANTOS, M. E. R., FONSECA, D. M. DE, OLIVEIRA, I. M. DE, CASAGRANDE, D. R., BALBINO, E. M., & FREITAS, F. P. Correlações entre número de perfilhos, índice de tombamento, massa dos componentes morfológicos e valor nutritivo da forragem em pastos diferidos de capim- braquiária. **Revista Brasileira de Zootecnia**, *39*(3), 487-493. 2010. doi: 10.1590/ S1516-35982010000300006

SANTOS, M.E.R.; FONSECA, EUCLIDES, V.P.B. et al. Valor nutritivo da forragem e de seus componentes morfológicos em pastagens de Brachiaria decumbens diferida. **Boletim da Indústria Animal**, v.65, n.4, p.303-311, 2008.

SANTOS, P.M., BERNARDI, A. e. e. **Diferimento do uso de pastagem.** In: SIMPOSIO SOBRE MANEJO DE PASTAGEM, 22, 2005, Piracicaba. Teoria e prática da produção animal em pastagens. Piracicaba: FEALQ, 2005, 95-118p.

SANTOS, P. M. **Estudo de características de Panicum maximum (Jacq.) cvs. Tanzânia e Mombaça para estabelecer seu manejo.** 62 p. Dissertação (Mestrado) – Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo, Piracicaba, 1997.

TEIXEIRA, F. A.; BONOMO, P.; PIRES, A. J. V.; SILVA, F. F. DA; FRIES, D. D.; HORA, D. S. DA. Produção anual e qualidade de pastagem de Brachiaria decumbens diferida e estratégias de adubação nitrogenada - doi: 10.4025/ actascianimsci.v33i3.10194. **Acta Scientiarum. Animal Sciences**, v. 33, n. 3, p. 241-248, 21 mar. 2011.