https://www.seer.ufal.br/index.php/revistacienciaagricola/index
ISSN: 0103-8699
Doi: 10.28998/rca.21.14274

ORGANIC FERTILIZER SOURCES IN THE DEVELOPMENT AND PRODUCTION OF TROPICAL GRASSES

Antônio Wercles Alves Lopes[1], Haroldo Soares Mota Junior[1], Victor Virginio de Sousa e Silva[1], Gynna Silva Azar[2], Jefrejan Souza Rezende[2], Fatima Cristiane Vieira Bezerra[3]

[1] Graduado em Agronomia, Universidade Estadual do Piauí (UESPI), Rodovia BR – 316, Km 299 - lado ímpar, Altamira, Picos - PI, Brasil, CEP 64602-000
[2] Professor(a) Doutor(a), Departamento de Agronomia, Universidade Estadual do Piauí (UESPI), Rodovia BR – 316, Km 299 - lado ímpar, Altamira, Picos - PI, Brasil, CEP 64602-000
[3] Graduanda em Agronomia, Universidade Estadual do Piauí (UESPI), Rodovia BR – 316, Km 299 - lado ímpar, Altamira, Picos - PI, Brasil, CEP 64602-000
***Corresponding author**: Jefrejan Souza Rezende, jefrejansouza@pcs.uespi.br

ABSTRACT: There are few studies on Organic Fertilization in pastures in Brazil, but it is of paramount importance for animal production. The aim of this work was to evaluate the development and production of *Brachiaria brizantha* cv. Marandu and *Panicum maximum* cv. Massai under organic fertilizer sources. The experiment was carried out in a shaded environment, using “shade” screens, with 50% shading. A completely randomized design was adopted in a 2 x 4 factorial scheme, with two grasses and three types of fertilizers (bovine manure, sheep manure, poultry manure) and control without fertilization, and four replicates. Two cuts were performed, where plant height, forage green and dry mass, amount of leaf blade and pseudostem (stem + sheath) were evaluated. In the last cut, root length and root dry mass were evaluated. ‘Massai’ cultivar had the highest dry mass and leaf percentage and the lowest stem percentage. ‘Marandu’ cultivar showed greater height and root length. There was influence of poultry manure, compared to control, on plant height and grass root mass. The use of poultry manure is recommended for the production of grasses under the study conditions. ‘Massai’ is the grass cultivar recommended for production.

KEYWORDS: *Brachiaria brizantha*, *Panicum maximum*, bovine manure, poultry manure, sheep manure.

FONTES DE ADUBO ORGÂNICO NO DESENVOLVIMENTO E PRODUÇÃO DE GRAMÍNEAS TROPICAIS

RESUMO: A adubação orgânica em pastagens no Brasil ainda é pouca avaliada, mas de suma importância para a produção animal. Objetivou-se com esse trabalho avaliar o desenvolvimento e produção das gramíneas *Brachiaria brizantha* cv. Marandu e *Panicum maximum* cv. Massai sob fontes de adubo orgânico. O experimento foi executado em ambiente sombreado, utilizando-se telas tipo “sombrite”, com 50% de sombreamento. Adotou-se o delineamento inteiramente casualizado em esquema fatorial (2 x 4), sendo duas gramíneas e três tipos de adubos (esterco bovino, esterco ovino, esterco cama-de-galinha) e a testemunha sem adubação, e quatro repetições. Foram realizados dois cortes, onde se avaliou a altura das plantas, massa verde e seca da forragem, a quantidade de lâmina foliar e pseudocolmo (colmo + bainha). No último corte avaliou-se o comprimento radicular e a massa seca das raízes. A cultivar Masssai apresentou maior porcentagem de massa seca e folhas e menor percentual de colmo. A cultivar Marandu apresentou maior altura e comprimento radicular. Houve influência do esterco de aves, em comparação a testemunha, na altura de plantas e massa das raízes das gramíneas. Recomenda-se o uso de esterco de aves para a produção das gramíneas, nas condições de estudo. A gramínea recomendada para a produção é a Massai.

PALAVRAS CHAVE: *Brachiaria brizantha*, *Panicum maximum*, esterco bovino, esterco cama-de-galinha, esterco ovino.

Aceito para publicação em 31/03/2023.
Publicado em 19/06/2023.

INTRODUCTION

Pasture productivity is influenced by several factors, such as soil, climate, water availability, temperature, among others, but one of the determining factors is the availability of nutrients, which are supplied to the soil via organic or mineral fertilization (Vendramini et al., 2014). With the rising cost of mineral fertilizers and the need to improve forage production gains, organic fertilizers produced in the region can be an alternative to be used in soil fertilization.

The use of organic fertilizers, in addition to improving the soil physical attributes, temperature and root penetration, is also capable of integrating organic compounds into the soil that provide nutrients to plants (Salles et al., 2017). Thus, fertilization with animal manure is a good alternative for pastures, providing high concentrations of nutrients (Silva et al., 2013), important for growth, number, weight and length of tillers and leaf area index (Barbero et al., 2015).

In this sense, Lara et al. (2015) evaluated the effects of applying poultry manure (0, 5, 10, 20, 40 and 80 t.ha-1) and mineral fertilization (120 kg.h-1 N, 100 kg.ha-1 P2O5 and 60 kg.ha-1 K2O) on the productivity of *Brachiaria brizantha* grass, and verified increase in the production of green mass of 48.7 and 84.4% and dry mass of 26.9 and 44.4% at doses of 40 and 80 t.ha-1, respectively.

Evaluating the effect of fertilization with bovine manure and a dose of mineral fertilizer on the development of *Brachiaria brizantha* cv. Marandu, and *Panicum maximum* cv. Mombaça grasses, Castro et al. (2016) observed higher growth responses for height and number of tillers using organic fertilization, for both species.

Therefore, despite its favorable composition for agricultural purposes, the use of animal manure as fertilizer still requires further studies for application in grasses in the semiarid region. Given the above, the aim of this work was to evaluate the development and production of *Brachiaria brizantha* cv. Marandu and *Panicum maximum* cv. Massai grasses grown in pots under organic fertilizer sources.

MATERIAL AND METHODS

This work was carried out at the State University of Piauí (UESPI), 'Professor Barros Araújo' campus, located in Picos-PI, semiarid region of the state of Piauí (07º04'37''S and 41°28'01"W, and 195 m a.s.l.) from August 2019 to July 2020. The climate in the region is of Bsh type - hot and semiarid, with rainy season in the summer, where rainfall reaches annual average of 696.6 mm from December to March, with the highest rainfall incidence, with relative humidity around 60% significantly decreasing during the dry season, with average annual temperature of 30.5 °C (Medeiros, 2000).

The experiment was carried out in a shaded environment, using shade screens, commercially identified for having 50% shading, 2 m above the ground, in an area of 36 m².

A completely randomized design was adopted in a 2 x 4 factorial scheme, formed by the combination of two grasses (*Brachiaria brizantha* cv. Marandu and *Panicum maximum* cv. Massai) and three types of fertilizers (poultry, bovine and sheep manure) with dose of 10 t.ha^{-1} and control, and four replicates, totaling 32 experimental units, each unit comprising a pot with volume of 8 dm³. Nitrogen, phosphorus and potassium manure compositions are shown in Table 1.

Table 1. Nitrogen, Phosphorus and Potassium composition in the manure of different domestic species. Picos, PI

Animal species	% Nitrogen	% Phosphorus	% Potassium
Poultry	1.75	1.25	0.85
Bovine	0.50	0.30	0.45
Sheep	1.00	0.25	0.60

Source: Adapted from Vieira (1984).

A soil sample was collected in the 0-20 cm layer, which was submitted to chemical and granulometric analysis at the Laboratory of the Federal University of Piauí, located in the municipality of Bom Jesus (Table 2).

According to soil analysis, liming was carried out 10 days before planting, using an amount of four grams of filler limestone per pot, according to liming and fertilization recommendations for pastures (Vilela, 2004).

Temperatures and moisture were measured through hygrothermometers placed in the environment throughout the experiment at 08:00 am and 12:00 pm. Irrigation adopted was in accordance with the water requirement of the crop and the climatic conditions of the region.

Table 2. Chemical and grain size characterization of soil sample collected in the 0-20 cm layer. Picos, PI

pH[1]	P[2]	K[3]	Ca[4]	Mg[5]	Al[6]	H+Al[7]	Sb[8]	T[9]	M[10]	V[11]	OM[12]
	$mgdm^{-3}$	---------------------$cmol_c dm^{-3}$-----------------------							----------%----------		
5.0	4.35	0.05	1.08	0.33	0.50	2.58	1.46	4.04	25.6	36.1	1.5

[1]Hydrogen potential; [2]Phosphorus; [3]Potassium; [4]Calcium; [5]Magnesium; [6]Aluminium; [7](Hydrogen + Aluminum); [8]Sum of bases; [9]Cation exchange capacity; [10]Aluminum saturation; [11]Base saturation; [12]Organic matter. Sand = 71.8%; Silt = 9.1%, Clay = 19.1%.

Sowing was performed directly in the pot, placing five seeds per pot and, seven days after emergence, thinning was performed, leaving two plants per pot (Camacho et al., 2015).

In the initial development state of plants, 500 ml.pot-1 was used, during the development of plants, the amount of water applied was increased to I000 ml.pot-1, taking into account the amount of rainfall that occurred during the period, which data were collected through pluviometer installed in the experiment.

After 35 days of cultivation, standardization cut was performed at 20 cm from the ground. Subsequently, two more cuts were performed every 35 days. Before cuts, plant height (ALT) was measured with the aid of millimeter measuring tape, taking into account the distance from the ground to the insertion of the last expanded leaf.

After cut, evaluations of the morphological components of forages were performed. For this, plant samples were collected and separated into leaf blade and pseudostem (stem + sheath). Samples were weighed to determine the total green mass (MV), being packed in paper bags and submitted to drying in an oven with forced air circulation at 65 ºC for 72 hours to determine the total dry mass (MS) (sum of masses of dry leaf blades, dry pseudostems and dead material).

From these data, leaf percentage (PF), total dry mass percentage (PMS) and stem percentage (PC) were calculated. After the last cut, roots were removed from pots and washed in running water using sieves with decreasing meshes, and then the root length (CR) was evaluated with the aid of millimeter ruler and dried in oven with forced air circulation at 65 ºC until constant weight and weighed to determine root dry mass (MR).

Data were analyzed for the existence of normality and homoscedasticity using the Shapiro-Wilk and Levene tests, respectively. Variables that did not meet these requirements were submitted to outlier removal or transformed into the logarithmic form or square root. Subsequently, data were submitted to analysis of variance by the F test at 5% probability to observe the existence of interaction between types of fertilization *versus* grasses or individual effects and averages were compared by the Duncan test at 5% probability.

RESULTS AND DISCUSSION

According to the summary of the analysis of variance (Table 3), there was an individual effect of cultivars on plant height (ALT), dry mass percentage (PMS), leaf percentage (PF), stem percentage (PC) and root length (CR) and individual effect of organic fertilizers on ALT and root mass (MR).

Table 3. Summary of the analysis of variance for plant height (ALT), green mass (MV), dry mass (MS), dry mass percentage (PMS), leaf percentage (PF), stem percentage (PC), root length (CR) and root mass (MR) of *Brachiaria brizhanta* cv. Marandu and *Panicum maximum* cv. Massai grasses grown in pots and submitted to different types of organic fertilization.

Sources of Variation	Mean Squares							
	ALT	MV[2]	MS[3]	PMS	PF[4]	PC[5]	CR[6]	MR[7]
	--cm--	--$g.pot^{-1}$--		-------------%-------------			--cm--	$g.pot^{-1}$
Cultivar (C)	322.1*	0.04ns	0.01ns	399.7*	1087.2*	31.7*	0.03*	0.04ns
Organic fertilizers (A)	124.5*	0.03ns	0.02ns	10.9ns	20.7ns	0.2ns	0.01ns	0.19*
C x A	16.6ns	0.02ns	0.02ns	10.7ns	12.4ns	0.6ns	0.01ns	0.03ns
Error	39.0	0.02ns	0.02	9.6	26.0	1.0	0.01	0.03
CV[1] (%)	13.52	9.48	12.22	10.51	6.07	24.22	3.49	12.79

*Significant by the F-test at 5% probability; ns not significant. [1]Coefficient of variation. [2, 3, 6, 7]Variables transformed into the logarithmic form, [4]Variable submitted to outlier removal, [5]Variable transformed into the square root form

In the green mass (MV) and dry mass (MS) analysis, there was no significant difference for any evaluated treatment (Table 3). Such results can be attributed to the conditions favorable to growth during the experiment from November 2019 to February 2020, a period in which favorable rainfall rates and temperatures were recorded (Figures 1, 2 and 3), which can directly interfere with morphological components, in addition to irrigation.

Figure 1. Internal (IT) and external (ET) temperatures during the experimental period

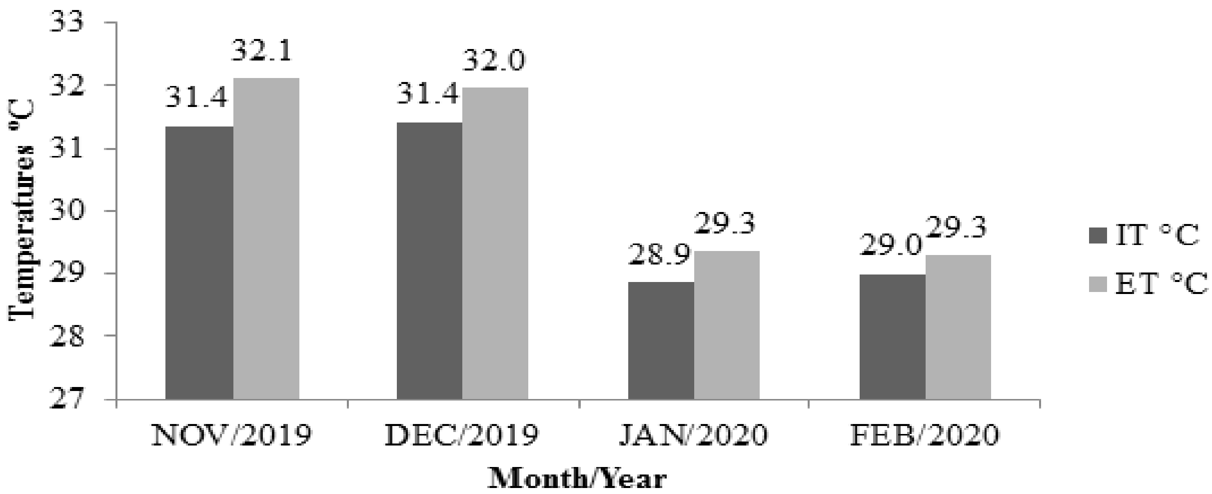


Figure 2. Relative air humidity (RH) during the experimental period

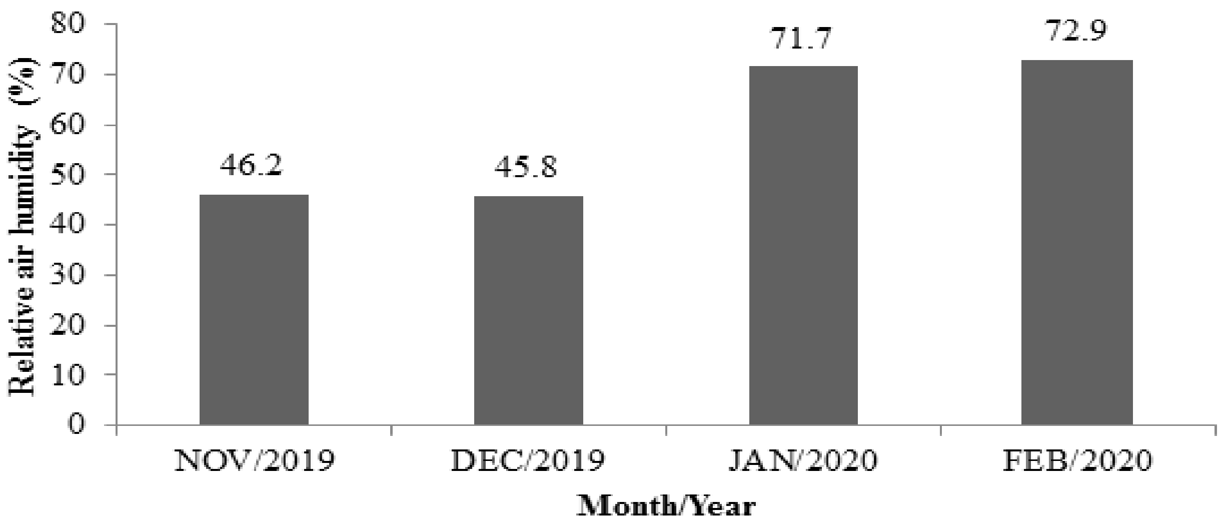
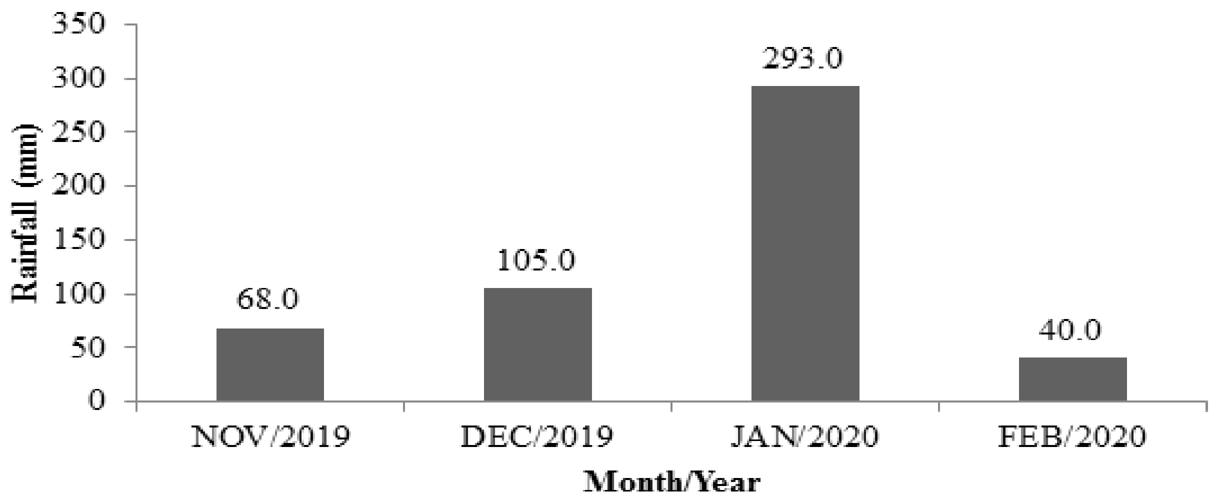


Figure 3. Rainfall during the experimental period



Climatic conditions influence the structural characteristics of forages, especially in forage accumulation, in which lower productions were evidenced by low rainfall and temperatures (Bauer et al., 2011).

Among evaluated cultivars, Marandu had the highest ALT (Table 4). The greater growth of the Marandu cultivar, in relation to Massai, can be explained by the genetic characteristics of the plant, where Marandu has cespitose growth, reaching 1.5 m (Costa et al., 2004), in addition to its good adaptation to most tropical soils (Rodrigues Júnior et al., 2015), while Massai, despite also having cespitose growth, has medium size and can reach only 60 cm in height (Valentim et al., 2001).

Table 4. Plant height (ALT), dry mass percentage (PMS), leaf percentage (PF), stem percentage (PC) and root length (CR) of *Brachiaria brizhanta* cv. Marandu and *Panicum maximum* cv. Massai grasses grown in pots and submitted to different types of organic fertilization

Cultivar	ALT	PMS	PF	PC	CR
	--(cm)--	-------------------	%------------------		---(cm)---
Marandu	49.50 a	25.84 b	76.76 b	5.16 a	1.71 a
Massai	43.05 b	33.02 a	89.35 a	3.14 b	1.64 b
SEM[1]	1.58	0.78	1.37	0.25	0.01

Equal letters in the columns do not differ by the Duncan's test at 5%. 1Standard error around the mean.

Poultry and sheep manure provided higher ALT, compared to the non-application of organic fertilizers (Table 5), not differing from bovine manure. This may be related to the substantial supply of nitrogen, phosphorus and potassium present at high concentrations in these fertilizers (Table 1), since these elements have direct and positive influence on the growth of tissues (Orico Júnior et al., 2013; Lopes et al., 2021). Among nutrients, nitrogen acts directly on photosynthesis, and is therefore essential in the constitution of proteins, nucleic acids, hormones and chlorophyll, consequently increasing plant productivity (Galindo et al., 2018).

Table 5. Plant height (ALT) and root mass (MR) of *Brachiaria brizhanta* cv. Marandu and *Panicum maximum* cv. Massai grasses grown in pots and submitted to different types of organic fertilization

Organic fertilizers	ALT	MR
	---(cm)---	$g.pot^{-1}$
Poultry	49.47 a	1.71 a
Bovine	45.66 ab	1.57 ab
Sheep	49.12 a	1.49 bc
Control	40.86 b	1.33 c
SEM[1]	2.24	0.07

Equal letters in the columns do not differ by the Duncan's test at 5%. 1Standard error around the mean.

According to Lopes et al. (2013), the result for height is associated with the elongation rate of stems, which are directly altered by the flow of nitrogen to tissues. Other studies have also found positive effect of poultry (Orrico Júnior et al., 2013; Ribeiro Júnior et al., 2015; Lopes et al., 2021) and bovine (Souza et al., 2010; Castro et al., 2016; Lopes et al., 2021) manure on forage growth.

Regarding PMS, in the comparison between grasses, the Massai grass presented the best result (Table 4). The release of nutrients to plants varies with the rate of mineralization of organic waste, which affects plants that are very responsive to nitrogen fertilization (Peixoto Filho et al., 2013). Thus, it could be inferred that the Massai grass was more responsive to fertilization in the evaluation period.

Regarding PF, there was a significant difference only when comparing grasses, in which the Massai grass had the highest mean, with increase of 12.59% (Table 4). Thus, it could be inferred that Massai grass was more effective in absorbing nutrients provided by organic fertilizers during the evaluation period, resulting in greater number of leaves (Table 4). The total number of leaves is a very important variable, as it has direct influence on dry matter production (Silva et al., 2009).

Higher PC value was observed for Marandu grass (Table 4). The amount of stem is attributed to greater canopy development, consequently, greater competition for light, which results in stem elongation stimulation (Gomes et al., 2018). However, greater stem elongation is not desirable, as it may negatively modify the leaf-stem ratio (Duarte et al., 2019). Thus, the greater amount of stem can reduce the nutritional values of the forage, as well as the acceptability by animals, since they tend to have preferences for leaves.

CR showed significant difference for cultivars, with the highest average for Marandu grass (Table 4). The *Brachiaria* species obtains greater efficiency in extracting and accumulating nutrients and this ability promotes better development and greater increase in plant production (shoot and root) in the long term (Fernades et al., 2020). According to Stumpf et al. (2016), the higher CR can be explained by the genetic characteristic of the cultivar. Root development is fundamental for the growth of forage plants, since it is the way of absorbing water and nutrients, resulting in greater productive capacity of shoots (Silva et al., 2014a).

Regarding MR, poultry manure provided higher average, compared to sheep manure and control, with increases of 14.7 and 28.6%, respectively (Table 5). Silva et al. (2014b) using poultry biofertilizer dose of 50 m^3.ha-1 observed increase in root production compared to control. These authors attributed this result to the adequate presence of nutrients, especially nitrogen, evidencing the greater availability of nutrients in poultry manure, favoring the production of roots compared to control. Sheep manure has a coating membrane, making this material more resistant to decomposition, increasing the time for nutrients to be available to crops (Figueiredo et al., 2012), which may explain this result. It is important to point out that shoots and the root system must be seen as natural, complex and dynamic means that interact and mutually influence each other in an intimate relationship of dependence, where the adequate supply of nutrients positively affects root density. However, when nutrient supply is limiting, forage MR is possibly impaired (Giacomini et al., 2005; Silva et al., 2014a).

The use of poultry manure for the production of grasses, under the study conditions, is recommended.

The grass recommended for production is the Massai cultivar.

ACKNOWLEDGMENTS

To the State University of Piauí (UESPI), for granting the structure to carry out the experiment and the Dean of Research and Graduate Studies (PROP), for the research grant.

REFERENCES

Barbero, L. M.; Basso, K. C.; Igarasi, M. S.; Paiva, A.; Basso, F. C. Respostas morfogênicas e estruturais de plantas tropicais submetidas à desfolhação. Boletim de Indústria Animal, *Nova Odessa*, **2015**, 72, 321-330.

Bauer, M. O.; Pacheco, L. P. A.; Chichorro, J. F.; Vasconcelos, L. V.; Pereira, D. F. C. Produção e características estruturais de cinco forrageiras do gênero *brachiaria* sob intensidades de cortes intermitentes. *Ciência Animal Brasileira*, **2011**, 12, 17-25.

Camacho, M. A.; Silveira, L. P. O.; Silveira, M. V. Eficiência de genótipos de *Brachiaria brizantha* Stapf. (Syn: *Urochloa brizantha*) na produção de biomassa sob aplicação de fósforo. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*, **2015**, 67, 1133-1140.

Castro, C. S.; Lobo, U. G. M.; Rodrigues, L. M.; Backes, C.; Santos, A. J. M. Eficiência de utilização de adubação orgânica em forrageiras tropicais. *Revista de Agricultura Neotropical*, **2016**, 3, 48-54.

Costa, N. L.; Gonçalves, C. A.; Oliveira, J. R. C.; Oliveira, M. A. S.; Magalhães, J. A. Resposta de Brachiaria brizantha cv. Marandu a regime de cortes. Porto velho: Embrapa Rondônia, **2004**. p 4 (Embrapa Rondônia. Comunicado Técnico, 279).

Duarte, C. F. D.; Paiva, L. M.; Fernandes, H. J.; Biserra, T. T.; Fleitas, A. C. Capim tropical manejado sob lotação intermitente, submetido a fontes de fósforo com diferentes solubilidades, associados ou não à adubação com nitrogênio. *Ciência Animal Brasileira*, **2019**, 20, 1-15.

Fernades, A. L. S.; Brachtvogel, E. L.; Reis, L. L. Produção de massa seca, volume radicular e eficiência nutricional de fósforo em *Brachiaria brizantha* cv. Marandu e Massai (*Panicum maximum x P. infestum*). *PesquisAgro*, **2020**, 2, 32-49.

Figueiredo, C. C.; Ramos, M. L. G.; Mcmanus, C. M.; Menezes, A. M. Mineralização de esterco de ovinos e sua influência na produção de alface. *Horticultura Brasileira*, **2012**, 30, 175-179.

Galindo, F. S.; Buzetti, S.; Teixeira Filho, M. C. M.; Dupas, E.; Carvalho, F. C. Manejo da adubação nitrogenada no capim-mombaça em função de fontes e doses de nitrogênio. *Revista de Ciências Agrárias*, **2018**, 41, 900-913.

Giacomini, A. A.; Mattos, W. T.; Matos, H. B.; Werner, J. C.; Cunha, E. A.; Carvalho, D. D. Crescimento de raízes dos capins aruana e Tanzânia submetidos a duas doses de nitrogênio. *Revista Brasileira de Zootecnia*, **2005**, 34, 1109-1120.

Gomes, L. S. P.; Braz, T. G. S.; Mourthé, M. H. F.; Paraíso, H. A.; Pires Neto, O. S.; Silva, F. E. G.; Pereira, L. R. F.; Almeida, B. Q. Níveis de substituição de ureia por esterco bovino na adubação de capim-marandu. *Revista de Ciências Agrárias*, **2018**, 41, 41-50.

Lara, O. Q.; Pichek, D. B.; Matt, M. P.; Souza, C. A.; Ferreira, E. Esterco de ave como alternativa à adubação convencional de *Brachiaria brizantha* no estado de Rondônia (Zona da Mata). *Archivos de Zootecnia*, **2015**, 64, 355-363.

Lopes, A. W. P.; Gêmero, C. G.; Feliciano, C. A.; Ferrante, V. L. S. B. Efeito de substratos orgânicos no desenvolvimento vegetativo de *Brachiaria Brizantha* CV. Marandu. *Revista Brasileira Multidisciplinar*, **2021**, 24, 70-77.

Lopes, M. N.; Cândido, M. J. D.; Pompeu, R. C. F. F.; Silva, R. G.; Carvalho, T. C. F.; Sombra, W. A.; Morais Neto, L. B.; Peixoto, M. J. A. Biomass flow in massai grass fertilized with nitrogen under intermittent stocking grazing with sheep. *Revista Brasileira de Zootecnia*, **2013**, 42, 13-21.

Medeiros, R. M. Estudo agrometeorológico para o Estado do Piauí. Secretaria do Meio Ambiente e Recursos Hídricos do Estado do Piauí. Semar: Teresina, PI, **2000**; v. 1, 138p.

Orrico Júnior, M. A. P.; Orrico, A. C. A.; Centurion, S. R.; Sunada, N. S.; Vargas Junior, F. M. Características morfogênicas do capim-piatã submetido a adubação com efluentes de abatedouro avícola. *Ciência Rural*, **2013**, 43, 158-163.

Peixoto Filho, U. J.; Freire, M. B. G. S.; Freire, F. J.; Miranda, M. F. A.; Pessoa, L. G. M.; Kamimura, K. M. Produtividade de alface com doses de esterco de frango, bovino e ovino em cultivos sucessivos. *Revista Brasileira de Engenharia Agrícola e Ambiental*, **2013**, 17, 419-424.

Ribeiro Junior, M. R.; Canaver, A. B.; Rodrigues, A. B.; Domingues Neto, F. J.; Spers, R. C. Desenvolvimento de *Brachiaria brizantha* cv. Marandú submetidas a diferentes tipos de adubação (química e orgânica). *Unimar Ciências*, **2015**, 24, 49-53.

Rodrigues Júnior, C. T.; Carneiro, M. S. S; Magalhães, J. A.; Pereira, E. S.; Rodrigues, B. H. N.; Costa, N. L.; Pinto, M. S. C.; Andrade, A. C.; Pinto, A. P.; Fogaça, F. H. S.; Castro, K. N. C. Produção e composição bromatológica do capim-Marandu em diferentes épocas de diferimento e utilização. *Semina: Ciências Agrárias*, **2015**, 36, 2141-2154.

Salles, J. S.; Steiner, F.; Abaker, J. E. P.; Ferreira, T. S.; Martins, G. L. M. Resposta da rúcula à adubação orgânica com diferentes 1461 compostos orgânicos. *Revista de Agricultura Neotropical,* **2017, 4, 35-40.**

Silva, A. A.; Simioni, G. F.; Lucena, A. Efeito da adubação orgânica no crescimento do capim *Brachiaria Brizantha* cv. Marandu em Parecis/Rondônia. *Enciclopédia Biosfera*, **2013**, 9, 923-932.

Silva, C. C. F.; Bonomo, P.; Pires, A. J. V.; Maranhão, C. M. A.; Patês, N. M. S.; Santos, L. C. Características morfogênicas e estruturais de duas espécies de braquiária adubadas com diferentes doses de nitrogênio. *Revista Brasileira de Zootecnia*, **2009**, 38, 657-661.

Silva, G. L. S.; Carneiro, M. S. S.; Furtado, F. M. V.; Santos, F. J. S.; Silva, M. S.; Costa, N. L.; Magalhães, J. A. Algumas considerações sobre o sistema radicular de plantas forrageiras. *PUBVET*, Londrina, **2014a**, 8, 1-22.

Silva, P. P.; Ferreira, R. S.; Teodoro, P. E.; Torres, F. E.; Arima, G. M.; Cappi, N.; Ribeiro, L. P. Resposta de cultivares de *Brachiaria brizantha* a doses de biofertilizantes de aves. *Arquivos do Instituto Biológico*, **2014b**, 81, 286-289.

Souza, R. F.; Faquin, V.; Lima Sobrinho, R. R.; Oliveira, E. A. B. Influência de esterco bovino e calcário sobre o efeito residual da adubação fosfatada para *Brachiaria brizantha* cultivada após o feijoeiro. *Revista Brasileira de Ciências do Solo*, **2010**, 34, 143-150.

Stumpf, L.; Pauletto, E. A.; Pinto, L. F. S.; Pinto, M. A. B.; Dutra Junior, L. A.; Scheunemann, T. Sistema radicular da *Urochloa brizantha*: Desenvolvimento e influência nos atributos de um solo degradado. *Interciencia*, **2016**, 41, 334-339

Valentim, J. F.; Carneiro, J. C.; Moreira, P.; Jank, L.; Sales, M. F. L. Capim Massai (*Panicum maximum* Jacq.): Nova Forrageira para a Diversificação das Pastagens no Acre. Rio Branco: Embrapa Acre, **2001**. p 16 (Embrapa Acre. Circular Técnica, 41).

Vendramini, J. M. B.; Dubeux Junior, J. C. B.; Silveira, M. L. Nutrient cycling in tropical pasture ecosystems. *Revista Brasileira de Ciências Agrárias*, **2014**, 9, 308-315.

Vilela, L. Calagem e adubação para pastagens. In: Cerrado: correção do solo e adubação. Souza, D. M. G.; Lobato, E. Embrapa-CPAC: Planaltina, Brasil, **2004**, p. 367-382.