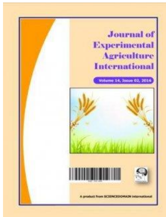

Journal of Experimental Agriculture International

35(5): 1-8, 2019; Article no.JEAI.48615
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

Dry Matter Yield and Nutritional Characteristics of Elephant-Grass Genotypes

Rafael Souza Freitas[1*], Rogério Figueiredo Daher[1], Ana Kesia Faria Vidal[1], Wanessa Francesconi Stida[1], Bruna Rafaela da Silva Menezes[2], Antonio Vander Pereira[3], Silvino Amorim Neto[4], Paulo Ricardo dos Santos[1], Verônica Brito da Silva[1] and Romildo Domingos Gottardo[1]

[1]Universidade Estadual do Norte Fluminense Darcy Ribeiro, Centro de Ciências e Tecnologias Agropecuárias, Avenida Alberto Lamego - de 960 ao fim - lado par, Parque Califórnia, CEP 28013-602, Campos dos Goytacazes-RJ, Brasil.
[2]Universidade Federal Rural do Rio de Janeiro (UFRRJ), Instituto de Ciências Biológicas e da Saúde, Departamento de Genética, km 47, 23.897-970, Seropédica, RJ, Brasil.
[3]Embrapa Gado de Leite, Rua Eugênio do Nascimento, 610, Dom Bosco, CEP 36038-330, Juiz de Fora-MG, Brasil.
[4]Centro Estadual de Pesquisas em Agroenergia e Aproveitamento de Resíduos, Av. Francisco Lamego, 134 - Guarus, Campos - RJ - CEP: 28.080-000, Brasil.

Authors' contributions

This work was carried out in collaboration among all authors. Author RSF designed the study and performed the statistical analysis. Authors AKFV, PRS and WFS managed the literature searches. Authors BRSM, VBS and RDG supported at experimental design and traits evaluations. Authors RFD, SAN and AVP reviewed the manuscript and suggested some alterations. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEAI/2019/v35i530216
Editor(s):
(1) Dr. Mohamed Fadel, Professor, Microbial Chemistry, Department Genetic Engineering and Biotechnology, Division National Research Center, Egypt.
Reviewers:
(1) Grace O. Tona, Ladoke Akintola University of Technology, Nigeria.
(2) Ufuoma Bigila Shemishere, Federal University Birnin Kebbi, Nigeria.
Complete Peer review History: http://www.sdiarticle3.com/review-history/48615

Original Research Article

Received 15 February 2019
Accepted 21 April 2019
Published 09 May 2019

ABSTRACT

In the elephant-grass germplasm, there are genotypes that show a large genetic variability differentiated by morphological, reproductive, agronomic and biochemical characteristics. As such, there is a selection of new and more adapted elephant-grass genotypes, with greater productivity

**Corresponding author: E-mail: rafael.mutum@hotmail.com;*

and nutritional quality, which can cause an increase in the forage offer, especially during the dry season. Thus, this work aimed at evaluating, throughout two years, the productive performance and nutritional value of 53 elephant-grass genotypes to produce forage in the edaphoclimatic conditions in Campos dos Goytacazes city, Rio de Janeiro State, Brazil. The experiment was composed of 53 elephant-grass accessions from *the Banco de Germoplasma da Embrapa Gado de Leite* (Germplasm Bank of Embrapa Gado de Leite), located in Coronel Pacheco city, Minas Gerais state, Brazil. It was applied the randomized complete block experimental design with 53 accessions two replications. Cuttings were performed every two months, throughout two years, totaling ten cuttings. The morpho-agronomic and bromatological characteristics were assessed, and the statistical analyses were carried out applying the Computational Applicative in Genetic and Statistics, Genes. Results indicated that there is a wide genetic variability among the elephant-grass genotypes concerning the characteristics under study. The Mineiro, Guaçu IZ-2 and Acesso 91 – EMBRAPA genotypes were those that showed to be superior to all traits evaluated simultaneously. They proved to be the most productive and with higher nutritional quality. Therefore, they are the most indicated to produce forage in the edaphoclimatic conditions of Campos dos Goytacazes city, Rio de Janeiro State.

Keywords: Pennisetum purpureum Schum.; yield characteristics; nutrients; forage genetic resources.

1. INTRODUCTION

The efficient use of forage and pasture as a staple food for animals represents one of the most secure ways to increase productivity, reducing production costs, given that animal feed represents the highest cost for livestock activity, mainly when applying additional sources of high nutritional quality. In this regard, the utilization of alternative foods at a lower cost that promote good results in animals is needed to improve the cost-benefit relation [1].

The elephant-grass (*Pennisetum purpureum* Shum.) is recognized as one of the most used forage grasses in Brazil, since it is well adapted as ration for animal feed in the form of cutting, grazing, silage and hay [2]. It is a forage with a high potential of dry matter yield per area cultivated and is also an excellent low-cost alternative to high supplementation, with positive effects on the pasture stocking rates [3].

Besides the high productive potential, the elephant-grass has a good nutritional value being its annual production of dry biomass higher than 50 t ha^{-1} in the Southeast Region of Brazil, provided that efficient genotypes are used according to the edaphoclimatic conditions favorable to the growth of the culture [4]. That has increased the interest in this grass over the past years, owing to the possibility of increasing productivity and reducing the area explored with its use for direct grazing in rotational systems [5].

There are genotypes with a great genetic variability in the elephant-grass germplasm differentiated by morphological, reproductive, agronomic and biochemical characteristics [6]. Hence, the selection of new elephant-grass genotypes with higher productivity, nutritional quality, and more adapted to the edaphoclimatic conditions can cause an increase in the forage offer, especially during the dry season. Consequently, that minimizes the effects of seasonality on production.

Given that, this work aims at evaluating the productive performance and the nutritional value of 53 elephant-grass genotypes in edaphoclimatic conditions in Campos dos Goytacazes city, Rio de Janeiro State, Brazil over two years for forage production.

2. MATERIALS AND METHODS

2.1 Experimental Location and Soil Classification

The experiment was conducted at the *Centro Estadual de Pesquisa em Agroenergia e Aproveitamento de Resíduos* (Agroenergy and Waste Management State Research Center) of PESAGRO in Campos dos Goytacazes city. It was lying between 21º19'23'' south latitude and 41º19'40'' west longitude, and altitude varying between 20 and 30 m in the municipality.

The soil is classified as Yellow Latosol with the following characteristics: pH 5.5; phosphorus (mg dm^{-3}) 18; potassium (mg dm^{-3}) 83; Ca (cmolc dm^{-3}) 4.6; Mg (cmolc dm^{-3}) 3.0; Al (cmolc dm^{-3}) 0.1; H + Al (cmolc dm^{-3}) 4.5 and; C (%) 1.6.

Table 1. Identification of the elephant-grass accessions from the *Banco de Germoplasma de Capim-Elefante* (BAG-CE) of *Embrapa Gado de Leite* released in Campos dos Goytacazes city, Rio de Janeiro State, Brazil

Genotype	Origin
Elefante de Colômbia	Colômbi
Mercker	IPEACO – Água Limpa – MG
Três Rios	Nova Odessa – SP
Napier Volta Grande	UFRRJ – Km 47
Mercker Santa Rita	UFRRJ – Km 47
Pusa Napier nº 2	Índia
Gigante de Pinda	Pindamonhangaba –SP
Napier Goiano	Goiás
Mercker S.E.A.	UFRRJ – Km 47
Taiwan A-148	UFRRJ – Km 47
Porto Rico 534-B	UFV – Viçosa – MG
Taiwan A-25	UFRRJ – Km 47
Albano	Colômbia
Híbrido Gigante da Colômbia	Colômbia
Pusa Gigante Napier	Índia
Elefante Híbrido 534-A	UFV – Viçosa – MG
Costa Rica	Turrialba
Cubano Pinda	UFRRJ – Km 47
Merckeron Pinda	UFRRJ – Km 47
Merckeron Pinda México	UFRRJ – Km 47
Mercker 86 – México	Colômbia
Taiwan A-144	UFRRJ – Km 47
Napier S.E.A.	UFRRJ – Km 47
Taiwan A-143	UFRRJ – Km 47
Pusa Napier nº 1	UFRRJ – Km 47
Elefante de Pinda	Colômbia
Mineiro	UFV – Viçosa – MG
Mole de Volta Grande	Volta Grande – SP
Porto Rico	CAMIG
Napier	Pedro Leopoldo – MG
Merckeron Comum	Pindamonhangada – SP
Teresópolis	UFRRJ – Km 47
Taiwan A-26	UFRRJ – Km 47
Duro de Volta Grande	UFRRJ – Km 47
Merckeron Comum Pinda	UFRRJ – Km 47
Turrialba	UFRRJ – Km 47
Taiwan A-146	UFRRJ – Km 47
Cameron – Piracicaba	UFRRJ – Km 47
Taiwan A-121	UFRRJ – Km 47
Vrukwona	Piracicaba – SP
P-241-Piracicaba nº 9	CNPGL
IAC – Campinas	UFRRJ – Km 47
Elef. Cachoeiro de Itapemirim	UFRRJ – Km 47
Capim-Cana D'África	EMCAPA – ES
Gramafante	-
Roxo	ESALQ – Lavras – MG
Guaçu/IZ.2	Nova Odessa – SP
Acesso 62 – EMBRAPA	Embrapa Gado de Leite
Acesso 64 – EMBRAPA	Embrapa Gado de Leite
Acesso 67 – EMBRAPA	Embrapa Gado de Leite
Acesso 68 – EMBRAPA	Embrapa Gado de Leite
Acesso 77 – EMBRAPA	Embrapa Gado de Leite
Acesso 91 – EMBRAPA	Embrapa Gado de Leite

2.2 Identification of the Elephant-grass Accessions

The experiment was composed of 53 elephant-grass accessions from the *Banco de Germoplasma da Embrapa Gado de Le*ite (Bank of Germplasm of Embrapa Milk Cattle), in Coronel Pacheco, Minas Gerais State (Table 1).

2.3 Experimental Design and Data Collection

The randomized complete block experimental design with 53 accessions and two replications was applied. Planting was made in April 2008 after preparing the soil by ploughing, harrowing, and opening 50-cm row spacing, through whole plants arranged with the base touching the apex of the next plant in furrows with 10-cm depth. Subsequently to opening of the furrows, 100 kg of P_2O_5 were incorporated to the bottom of the furrow. After 50-days planting, fertilization was complemented with top dressing application of 25 kg/ha of N. After each cutting, top dressing with 60 kg/ha of K_2O and 50 kg/ha of N was applied.

A standardization cutting was made in October 2008, and a first evaluation cutting, in December 2008. The other cuttings were made in February, April, July, October, and December 2009, also in February, April, July, and October 2010, which totalized ten cuttings, one cutting every two months throughout two years.

The following morpho-agronomic and bromatological characteristics were evaluated:

2.3.1 Morpho-agronomic

- Dry Matter Yield (DMY) – estimated by the product of the green matter weight of the whole plants (kg), weighed in suspended scale, from two square meters (2 m^2), by thepercentage of dry matter of the whole plant (% WDM) from the sampling of those plants. The final value (kg/m^2) is converted to t ha^{-1}.

2.3.2 Bromatological

- Percentage of Crude Protein (%CP) – The determination of the crude protein was performed by the Micro-Kjeldhal method, according to Silva & Queiroz [7].
- Percentage of Neutral Detergent Fiber (%NDF) – the fiber contents in neutral detergent (%NDF) were estimated in accordance with the methodology described by Silva & Queiroz [7].

2.4 Data Analysis

The analysis of variance was performed based on the mean of the plots considering the ten cuttings for the DMY trait. For the %CP and %NDF, the analysis was performed on the basis of the mean of two evaluations: one during rainy period and the other, in the dry period. All the effects were considered random for the analysis of variance. The following statistical model was applied:

Y_{ij} = μ + G_i + B_i + ϵ_{ij}, wherein
Y_{ij} = value of the i-th genotype in the j-th block;
μ = overall mean;
G_i = effect of the i-th genotype;
B_i = effect of the j-th block; and
ϵ_{ij} = experimental error.

Subsequently, the genotype means were grouped for each variable applying the Scott & Knott test [8] at 5% probability. Those statistical analyses were carried out using the Computational Application in Genetic and Statistics, Genes [9].

3. RESULTS AND DISCUSSION

3.1 Analysis of Variance

The values of the mean squares of the analysis of variance and of the experimental coefficient of variation for the morpho-agronomic (Dry Matter Yield) and bromatological (Percentage of Crude Protein and Percentage of Neutral Detergent Fiber) characteristics are displayed in Table 2.

Results showed that there were significant differences for the dry matter yield (DMY) in t ha^{-1} $cutting^{-1}$ (average of ten cuttings) and percentage of crude protein (%CP) by the F test at 5% probability. Nevertheless, for the percentage of neutral detergent fiber (%NDF) trait, it was significant at 1% probability (average of two cuttings).

Among the elephant-grass accessions evaluated, the significant differences seen concerning DMY, %CP, and %NDF prove the variability among the 53 genotypes evaluated, which enables to select the best genotypes [10-11].

Table 2. Summary of the analysis of variance of morpho-agronomic and bromatological characteristics evaluated in 53 elephant-grass genotypes. Campos dos Goytacazes, Rio de Janeiro State. 2008-2010

FV	Mean squares			
	DF	DMY	%CP	%NDF
Block	1	3.6460	0,4972	71,8660
Treatment	52	1.6698 *	0,2946*	5,3084**
Waste	52	0,9743	0,1807	2,3692
Overall		6,55	5,40	69,69
CV(%)		15,07	7,88	2,21

*** and * significant at 1 and 5% probability, respectively, by the F test; Sources of variation (FV), Dry Matter Yield (DMY t ha-1), Percentage of Crude Protein (%CP) and Percentage of Neutral Detergent Fiber (%NDF)*

The coefficients of variation of the traits evaluated are between 2.21 and 15,7%, which appears to be suitable for the experimental evaluation. The variable dry matter yield (DMY) was the one that presented the highest value for the coefficient of variation (CV). The percentage of crude protein (%CP) and the percentage of neutral detergent fiber (%NDF) traits presented CV of 7.88 and 2.21%, respectively; that was considered a low value [12]. In this way, the coefficients of variations for the bromatological characteristics proved to be low, while, for the dry matter yield (DMY), it was considered as medium.

3.2 Means Referring to DMY, CP and NDF Characteristics

The mean values of the dry matter yield (DMY), the percentage of crude protein (%CP), and the percentage of neutral detergent fiber (%NDF) per genotype and the Skott-Knott cluster at 5% probability are shown in Table 3.

Regarding the dry matter yield (DMY), the genotype means ranged from 4.704 to 8.883 t ha^{-1}, and the mean was of 5.399 t ha^{-1}; the genotypes that most stood out were Costa Rica; Guaçu/IZ.2; Elefante Híbrido 534-A; Gramafante; Mercker Comum; Mercker Comum Pinda; Mineiro; Mole de Volta Grande; Napier S,E,A.; Pasto Panamá; Porto Rico; Taiwan A -144; Taiwan A-26; Taiwan A-26; and Vruckwona Africano.

In a similar research, when assessing production and biomass quality characteristics of six elephant-grass genotypes under five different production ages, Vidal et al. [13] obtained dry matter yield ranging from 5.26 to 7.27 t ha^{-1} in eight-week age.

On the other hand, Leão et al. [14] obtained as genotype mean 4.86 t ha^{-1} when evaluating the forage production of inter-specific hybrids of elephant-grass and millet; however, the genotype that most stood out produced 9.76 t ha^{-1}; thus, it was higher than the one found in this work.

With regard to the percentage of crude protein, the age in the harvest is the most important factor that affects the crude protein content of the elephant-grass, because, as the ages of the plants increase, the dry matter yield increases, but the crude protein decreases [15].

In this work, the crude protein contents ranged from 4.59 to 6.22%. The latter were lower than the ones found by Silva et al. [16], who obtained 7.20% of crude protein when evaluating the percentage of crude protein of the elephant-grass in the 61-day age.

For the percentage of neutral detergent fiber (%NDF), percentages ranging from 68.78 to 73.05% were found, and the overall mean was of 69.69%. Similar results were encountered by Garcia et al. [17]. Lounglawan et al. [18], when evaluating the percentage of neutral detergent fiber in 60-day plants, discovered values between 73.71 and 76.49%; therefore they were higher and lower quality than the ones found in this paper.

The genotypes that showed the highest values of %NDF were Napier Goiano; Mercker Santa Rita; Teresópolis; Mercker Comum; Acesso 67 – EMBRAPA Gado de Leite; Pusa Gigante Napier; Taiwan A -144; Mercker Comum Pinda; Vrukwona; Napier Volta Grande; Napier S,E,A.; Pusa Napier no 2; and Roxo. According to Van Soest [19], the analysis of NDF is inversely related to the dry matter digestibility. Thus, it can be noticed that, for this trait, the best performance was of the genotypes that presented the lowest content percentages [14].

Table 3. Means referring to morpho-agronomic and bromatological characteristics evaluated in 53 elephant-grass genotypes

Genotypes	DMY	%CP	%NDF
Elefante de Colômbia	6.869 b	5.54 b	68.78 b
Mercker	5.047 b	5.77 a	68.68 b
Três Rios	4.704 b	5.94 a	66.92 b
Napier Volta Grande	6.489 b	5.74 a	72.19 a
Mercker Santa Rita	6.210 b	4.96 b	70.79 a
Pusa Napier nº 2	6.839 b	5.50 b	72.47 a
Gigante de Pinda	7.038 b	5.25 b	70.63 b
Napier Goiano	5.922 b	5.57 b	70.65 a
Mercker S.E.A.	5.451 b	5.29 b	67.56 b
Taiwan A-148	4.926 b	5.57 b	67.03 b
Porto Rico 534-B	6.632 b	5.26 b	69.10 b
Taiwan A-25	7.089 b	5.64 a	68.05 b
Albano	6.293 b	5.22 b	69.41 b
Híbrido Gigante da Colômbia	5.747 b	5.70 a	70.39 b
Pusa Gigante Napier	5.687 b	4.66 b	71.23 a
Elefante Híbrido 534-A	7.137 b	5.32 b	68.92 b
Costa Rica	7.366 a	5.25 b	70.20 b
Cubano Pinda	6.379 b	5.60 a	65.96 b
Merckeron Pinda	6.518 b	5.70 a	70.17 b
Merckeron Pinda México	5.689 b	5.37 b	65.22 b
Mercker 86 – México	5.128 b	4.96 b	69.43 b
Taiwan A-144	8.883 a	5.64 a	71.35 a
Napier S.E.A.	7.278 a	6.18 a	72.25 a
Taiwan A-143	6.808 b	4.76 b	68.67 b
Pusa Napier nº 1	6.424 b	5.69 a	69.22 b
Elefante de Pinda	5.678 b	4.87 b	69.23 b
Mineiro	7.364 a	5.90 a	69.53 b
Mole de Volta Grande	7.513 a	5.44 b	69.60 b
Porto Rico	8.718 a	4.59 b	67.40 b
Napier	6.557 b	6.22 a	69.40 b
Merckeron Comum	7.517 a	5.30 b	71.17 a
Teresópolis	5.908 b	4.96 b	70.91 a
Taiwan A-26	7.143 b	5.37 b	70.06 b
Duro de Volta Grande	6.013 b	4.66 b	69.55 b
Merckeron Comum Pinda	7.213 a	5.35 b	71.48 a
Turrialba	6.404 b	5.45 b	68.59 b
Taiwan A-146	6.714 b	5.25 b	68.13 b
Cameron – Piracicaba	6.722 b	5.59 b	70.12 b
Taiwan A-121	6.795 b	4.99 b	69.46 b
Vrukwona	6.442 b	5.42 b	71.89 a
P-241-Piracicaba nº 9	6.153 b	5.40 b	69.50 b
IAC – Campinas	5.988 b	5.15 b	71.86 a
Elef. Cachoeiro de Itapemirim	6.430 b	5.26 b	69.88 b
Capim-Cana D'África	6.048 b	5.19 b	70.23 b
Gramafante	7.485 a	5.43 b	70.13 b
Roxo	5.059 b	5.90 a	67.07 b
Guaçu/IZ.2	7.411 a	5.60 a	69.85 b
Acesso 62 – EMBRAPA	6.679 b	5.36 b	73.05 a
Acesso 64 – EMBRAPA	5.409 b	4.72 b	68.94 b
Acesso 67 – EMBRAPA	7.721 a	5.65 a	71.19 a
Acesso 68	6.498 b	6.15 a	70.18 b
Acesso 77 – EMBRAPA	6.377 b	5.14 b	69.70 b
Acesso 91 – EMBRAPA	8.652 a	5.76 a	70.37 b

Dry Matter Yield (DMY) in t/ha, and Percentage of Crude Protein (%CP) and Percentage of Neutral Detergent Fiber (%NDF)

4. CONCLUSIONS

There is a large genetic variability among the elephant-grass genotypes on the characteristics under study.

The Mineiro, Guaçu IZ-2 and Acesso 91 – EMBRAPA genotypes were those that showed to be superior to all traits evaluated simultaneously. They proved to be the most productive and with higher nutritional quality. Therefore, they are the most indicated to produce forage in the edaphoclimatic conditions of Campos dos Goytacazes city, Rio de Janeiro State.

ACKNOWLEDGEMENTS

To CAPES – Brazilian Federal Agency for Support and Evaluation of Graduate Education within the Ministry of Education of Brazil, FAPERJ - Carlos Chagas Filho Foundation for Research Support of the State of Rio de Janeiro and UENF - State University of Nothern Rio de Janeiro Darcy Ribeiro.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Oliveira JB, Pires AJV, Carvalho GGP, Ribeiro LSO, Cruz JF, Silva FF. Subprodutos industriais na ensilagem de capim-elefante para cabras leiteiras: consumo, digestibilidade de nutrientes e produção de leite. Revista Brasileira de Zootecnia, Viçosa. 2010;39(2):411-418.
2. Vale MB, Azevedo PV. Avaliação da produtividade e qualidade do capim elefante e do sorgo irrigados com água do lençol freático e do rejeito do dessalinizador. Holos. 2013;29:181-195.
3. Pereira AV, Auad AM, Ledo FJS, Barbosa S. *Pennisetum purpureum*. In: Fonseca D. M. Da; Martuscello JA. (Org.). Plantas Forrageiras. Viçosa: Editora UFV. 2010;1: 197-219.
4. Morais RF, Souza BJ, Leite JM, Soares LHB, Alves BJR, Boddey RM, Urquiaga S. Elephant grass genotypes for bioenergy production by direct biomass combustion. Pesquisa Agropecuária Brasileira. 2009; 44(2):133-140.
Available:http://dx.doi.org/10.1590/S0100-204X2009000200004
5. Mota VJG, Reis ST, Sales ECJ, Rocha Júnior VR, Oliveira FG, Walker SF, Martins CE, Cóser AC. Lâminas de irrigação e doses de nitrogênio em pastagem de Capim-elefante no período seco do ano no norte de Minas Gerais. Revista Brasileira de Zootecnia, Viçosa. 2010;39(6):1191-1199.
Available:http://dx.doi.org/10.1590/S1516-35982010000600005
6. Lima RS, Daher RF, Goncalves LS, Rossi DA, do Amaral Júnior AT, Pereira MG, e Lédo FJS. RAPD and ISSR markers in the evaluation of genetic divergence among accessions of elephant grass. Genetics Molecular Research. 2011;10:1304-1313.
Available:http://dx.doi.org/10.4238 / vol10-3gmr1107
7. Silva DJ, Queiroz AC. Análises de alimentos (métodos químicos e biológicos). 3.ed. Viçosa, MG: Editora UFV. 2002;235.
8. Scott AJA, Knott M. Cluster analysis method for grouping means in the analysis of variance. Biometrics. 1974;30:507-512.
9. Cruz CD. GENES - A software package for analysis in experimental statistics and quantitative genetics. Acta Scientiarum Agronomy. 2013;35:271-276.
Available:http://dx.doi.org/10.4025/actasci agron.v35i3.21251
10. Pereira AV, Machado MA, Azevedo ALS, Nascimento S, Campos AL, Lédo FJS. Diversidade genética entre acessos de capim-elefante obtida com marcadores moleculares. Revista Brasileira de Zootecnia. 2008;37:1216-1221.
11. Oliveira MLF, Daher RF, Gravina GA, Silva VB, Viana AP, Rodrigues EV, Shimoya A, Amaral Junior AT, Menezes BRS, Rocha S. Pre-breeding of elephant grass for energy purposes and biomass analysis in Campos dos Goytacazes- RJ, Brazil. African Journal of Agricultural Research. 2014;9:2743-2758.
Available:http://dx.doi.org/10.5897/AJAR2 014.8900
12. Pimentel-Gomes F. Curso de estatística experimental. 15ª ed. Piracicaba: FEALQ. 2009;451.
13. Vidal AKF, Barbé TC, Daher RF, Filho JEA, De Lima RSN, Freitas RS, Rossi DA, Oliveira ÉS, Menezes BRS, Entringer GC, Peixoto WFS, Cassaro S. Production potential and chemical composition of

elephant grass (*Pennisetum purpureum* Schum.) at different ages for energy purposes. African Journal of Biotechnology. 2017;16(25):1428-1433. Available:http://dx.doi.org/10.5897/AJB2017.16014
14. Leão FF, Cancellier LL, Pereira AV, Ledo FJS, Afférr FS. Produção forrageira e composição bromatológica de combinaçõesgenômicas de capim-elefante. Revista Ciência Agronômica. 2012;43(2): 368-375.
15. Rusdy M. Elephant grass as forage for ruminant animals. Livestock Research for Rural Development. 2016;28.
16. Silva MA, Lira MA, Santos MVF, Dubeux Junior JCB, Cunha MV, Freitas EV. Análise de trilha em caracteres produtivos de Pennisetum sob corte em Itambé, Pernambuco. Revista Brasileira de Zootecnia. 2008;37(7):1185-1191.
17. Garcia C de S, Fernandes AM, Fontes CAAC, Vieira RAM, Pimentel VAP. Desempenho de novilhos mantidos em pastagens de capim-elefante e capim-mombaça. R. Bras. Zootec. 2012;40(2): 403-410.
18. Lounglawan P, Longlawan W, Sulesombat. Effect of cutting interval and cutting height on yield and chemical composition of King Napier grass (*Penisetum purpureum* x *Pennisetum americanum*). APCBEE Procedia. 2013; 8:27–31. Available:http://dx.doi.org/10.1016/j.apcbee.2014.01.075
19. Van Soest PJ. Nutritional ecology of the ruminant. Cowallis: O. & Books. 1994;476.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle3.com/review-history/48615