Acta Scientiarum

http://www.uem.br/acta
ISSN printed: 1806-2636
ISSN on-line: 1807-8672
Doi: 10.4025/actascianimsci.v38i1.28549

Productivity and nutritional value of African Star managed with different leaf blade mass

Wagner Paris[1*], Roniclei Tonion[2], Clederson Martinello[2], Laercio Ricardo Sartor[1], Fabiana Luiza Matielo de Paula[1] and Jhone Gleison de Oliveira[2]

*[1]Programa de Pós-graduação em Zootecnia, Universidade Tecnológica Federal do Paraná, Cx. Postal 157, 85660-000, Dois Vizinhos, Paraná, Brazil. [2]Curso de Zootecnia, Universidade Tecnológica Federal do Paraná, Dois Vizinhos, Paraná, Brazil. *Author for correspondence: wagparis@yahoo.com.br; wagner@utfpr.edu.br*

ABSTRACT. Pasture management with levels of leaf blades may favor significant increase in production, and the leaves indicated an important role in plant-animal relationship, caused by photosynthesis efficiency and better quality in animal diet. Current study identifies which leaf blade mass of the African star (*Cynodon nlemfuensis* var. Nlemfuensis) provides better productivity and nutritional value. Treatments comprised different leaf blade masses: 800, 1200, 1600 and 2000 kg of dry matter ha^{-1}. The experimental design was completely randomized, with four treatments and three repetitions, totaling 12 plots with 100 m^2 each. Results indicated increase in production, in the leaf/stem ratio and in the interval days according to increase in leaf blade mass. Daily accumulation rate was similar to treatments. Crude protein decreased and fiber increased with rise in leaf blade mass and the highest forage productions were reported in the treatments 1200 and 1600 kg ha^{-1} leaf blade mass.

Keywords: Chemical composition, *Cynodon niemfuensis*, forage production, pasture management.

Produtividade e qualidade nutricional da estrela africana manejada com diferentes massas de lâminas foliares

RESUMO. O manejo da pastagem com níveis de lâminas foliares pode favorecer incrementos significativos na produção, sendo que as folhas representa um papel importante na relação planta-animal, sendo responsável pela eficiência fotossintessintética e substrato de melhor qualidade na dieta animal. Com o intuito de avaliar as massas foliares da estrela africana (*Cynodon nlemfuensis* var. Nlemfuensis), o presente trabalho teve como objetivo identificar qual massa de lâmina foliar proporciona melhor produtividade e qualidade nutricional. Os tratamentos avaliados foram as diferentes massas de lâmina foliar: 800, 1.200, 1.600 e 2.000 kg de matéria seca ha^{-1}. O delineamento experimental utilizado foi inteiramente casualizado, com quatro tratamentos e três repetições, totalizando 12 parcelas de 100 m^2 cada. Os resultados indicaram elevação na produção de colmo, na relação folha: colmo e nos dias de descanso de acordo com o aumento das massas de lâminas foliares. A taxa de acumulo diário de laminas foi semelhante para os tratamentos. Além disso ocorreu decréscimo nos teores de proteína bruta e elevação nos teores de fibra em detergente neutro e ácido. No entanto, as maiores produções de forragem foram observadas nos tratamentos 1.200 e 1.600 kg ha^{-1} de massa de lâminas foliares.

Palavras-chave: Composição química, *Cynodon nlemfuensis*, produção de forragem, manejo de pastagem.

Introduction

The beef cattle industry in Brazil evidenced several modifications in the productive system, or rather, from a traditional production system to a system featuring new technologies, such as the use of animal management depending on the availability of leaf blades to increase production efficiency. For instance, among other benefits, livestock production technologies have reduced the slaughter age of animals. Thus, decrease in the permanence of the animals on the farm, which speeds up the working capital, increases the slaughter rate (Paris et al., 2013).

Forage grass constitute the most important source of food for the production of ruminants and grasslands constitute the main and most economical way to supply the nutrients that are necessary for the ruminant's healthy growth and production (Bianchini, Rodrigues, Jorge, & Andrigueto, 2007). However, knowledge of production capacity, phenological characteristics and nutritional rates of grass forages are critical to keep many producers in the cattle industry.

The Cynodon grass species is primarily used in regions with steep terrain due to its high potential for soil coverage, according to Alencar et al. (2010) who compared different foragers species for high ground coverage.

Production and high potential rates are associated with percentage of leaves, digestibility and dry matter intake. The management of animals due to the leaf blade is one of the most important parameters because pastures with green leaves accessible at the top of the plants are those with higher nutritional quality for cattle grazing. However, there are no studies on the management of pasture utilizing leaf blades for the evaluated species. Several research works were carried out for such species as Marandu grass (Machado et al., 2008), winter pasture (Silva, Quadros, Trevisan, Martins, & Bandinelli, 2005) and pearl millet (Montagner et al., 2008). The adjustment of stocking depending on the availability of leaf blades may be an important strategy to improve the utilization of pasture, reduce degradation and provide access to animals for better food quality.

Current analysis identifies which leaf blade mass provides better productivity and nutritional rates.

Material and methods

Current study was conducted at the Federal Technological University of Paraná, campus Dois Vizinhos, Paraná State, Brazil, between October 2011 and March 2012. The experiment was carried at the experimental area of the Research and Teaching Unit of the Dairy Cattle Department (25° 44’ 57” S and 53° 03’ 41” W), altitude 534 m. The climate is predominantly transitional, humid, subtropical, mesothermal between Cfb and Cfa, according to Köppen’s classification. During the trial period, the maximum temperatures averaged 21 - 25°C and minimum between 20 and 22°C, with maximum accumulated rainfall during October 2011 at 271.8 mm and minimum 47 mm in December 2011.

The 1,800 m^2 area, divided into 12 plots of 100 m^2 each by an electric fence, had been planted with African star grass (*Cynodon nlemfuensis* var. nlemfuensis) for more than five years and constantly grazed by dairy cattle of different strains. The animals were used only for grazing up to a height of 10 cm of residue. The evaluated treatments comprised different leaf blade mass: 800, 1200, 1600 and 2000 kg of dry matter ha^{-1}, in a completely randomized design, with three replications.

At the time of the experiment, soil analysis (0-20 cm) showed pH (H2O) = 5.5; OM (%) = 3.9; Clay (%) = 54; Mehlich-P (mg dm^{-3}) = 4.5; K (cmolc dm^3) = 0.2 Ca (cmolc dm^{-3}) = 8.8; Mg (cmolc dm^3) = 3.4; H+Al (cmolc dm^3) = 3.5; effective CEC (cmolc dm^3) = 12.6; Al saturation (%) = 0.0; Bases (%) = 78.2. Nitrogen fertilization was applied by urea (45% nitrogen), with 120 kg N ha^{-1} in four applications after access to the plots by animals. Forage samples were collected when the parcels reached the mass of leaf blade according to each treatment.

The amount of leaf blades for each treatment was estimated at every pre-grazing period by cutting two samples of each plot with a 0.25 m^2 square and by botanical separation to estimate the leaf blade mass per hectare. This procedure was carried out when the blade mass could be visually estimated to be closer to each treatment. If the recommended amount of blades was not reached, the procedure was repeated a few days later. After the pre-determined mass was found, measurements of height at 15 points of each plot, forage sampling and lowering of grazing by animals were carried out.

Forage production, stem, leaf:stem ratio and accumulation rate were obtained by harvesting four representative samples, before and after each grazing, using the 0.25 m^2 square. Samples were then homogenized: one sample was used to determine the dry matter and another sample for the separation of components (leaf blades, stems and senescent material) to calculate leaf blade and stem production. Matter was dried in a forced-air drying oven at 65°C for 72 hours. Forage production for each treatment was calculated by summing the accumulation rates of each period, whilst daily accumulation rate was obtained by the difference of forage mass before the second grazing and the residual mass of the first grazing divided by the interval days.

Jersey and Holstein heifers were used to lower grazing in the predetermined 10 cm height. The heifers were milked and allocated in paddocks for 4 hours, in a single day, for the consumption of the available forage mass. The estimated stocking rate for the lowering of grazing for each treatment was obtained by the amount of leaf blades available for consumption of 2.5 kg DM 100 kg^{-1} $PVday^{-1}$.

The chemical analyses of crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF) were performed according to Van Soest and Lewis (1991), at the laboratory of food analysis of the Technological Federal University of Paraná - campus Dois Vizinhos, Paraná State, Brazil, after proportional standardization of structural components (leaf and stems) and collected periods. Data were subjected to analysis of variance ($p \leq 0.05$) and when the treatments were significant, polynomial regression was performed as a function of leaf blade mass with statistical software Statistical Analysis System [SAS] (2001).

Results and discussion

The leaf blades from 800, 1200, 1600 and 2000 kg DM ha^{-1}, showed grazing heights of 17, 25, 34 and 43 cm, respectively. Despite the linear increase in height ($p \leq 0.05$), the total forage production showed a quadratic behavior due to increasing levels of leaf blades mass (Figure 1). Managed pasture with 1600 kg ha^{-1} of leaf blade, corresponding to 34 cm of height in grazing entrance, had the highest total forage production, since this amount of blades provided a higher photosynthetic efficiency of the leaves, with better net production. For greater amounts of leaves, a greater grazing interval is required, causing aging of leaves and increases in stem production (Figure 2). Management with fewer blades showed lower production due to a smaller amount of leaf blades. The above is corroborated by Pedreira, Sollenberger, and Mislevy (1999) who evaluated the cultivar Florakirk submitted to three grazing intervals and three post-grazing residues in a two-year evaluation. Higher production and a better quality of the post-grazing height at 20 cm and a 14-day grazing interval were reported, corresponding to a mass of 1200 to 1600 kg of leaf blade in this study.

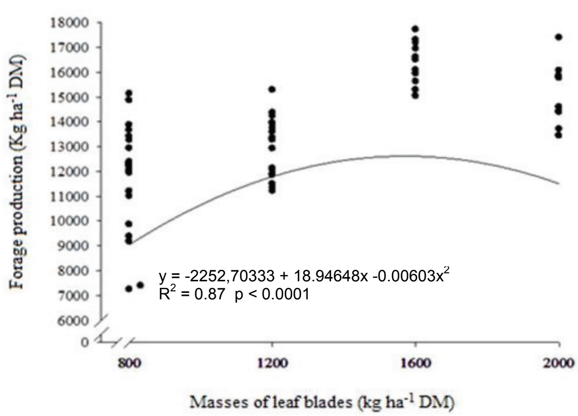

Figure 1. Forage production (kg ha^{-1} DM) in different masses of leaf blades between October and March.

Pedreira, Sollenberger and Mislevy (2000) did not observe reduction in the botanical composition of pasture, and the cultivar Florakirk was better to lower post-grazing residue (8 cm), Higher tillering revealed a more horizontal growth and kept denser the vegetal cover. However, the grazing interval to reach the luminous interception of 95% was 25 days longer than the 24 cm high residue.

The leaf blades available provide a higher photosynthetic capacity of the plant up to an amount that enables high production of leaf blades to the detriment of stem production, which in current study linearly increased with the blade mass (Figure 2) mainly for the availability over 1600 kg of leaf blade. The above was due to the difficulty for luminosity to enter the pasture canopy, causing a lower photosynthetic efficiency and producing less forage than the pastures managed with less leaf blade mass. Corroborating report by Fagundes et al. (2001), the management imposed on pastures a variation in leaf architecture and arrangement of leaves which are mainly responsible for interception of light. Therefore stem production and luminosity interception are important parameters to explain leaf blade production.

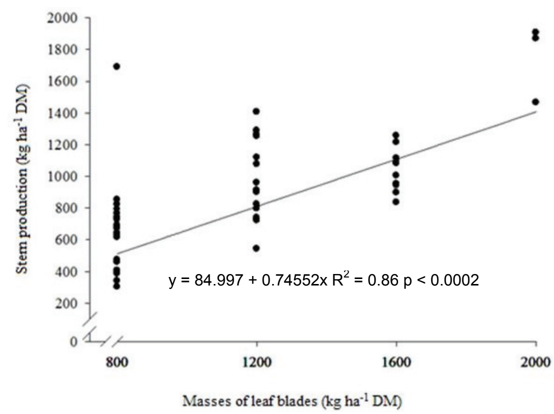

Figure 2. Stem production of the African star under different leaf blade mass from October to March.

The accumulation rate of leaves per day had no significant effect on the increase of leaf blade mass in pre-grazing, with rates close to 50 kg DM ha^{-1}day^{-1}. The above causes a high rate of support during the production cycle of forage for a lower mass of leaf blade due to the number of interval days needed for these foliar masses. In fact, grazing frequency was reduced from eight to three respectively for the highest and lowest availability of leaf blade. Lower pastures have a high amount of small tillers and low light interception. When they are isolated from animal activities, they grow in size with no proportional reduction in the number of tillers (Fagundes et al., 2001). In the case of higher pastures, the light interception is closer to high rates and different from that of lower pastures. Thus, to achieve greater amounts of leaf blades, one reaches 95% of light interception, with a drastic reduction of forage accumulation decreasing the stocking rate supported by the pasture.

The leaf : stem ratio (Figure 3) was higher for upper leaf blade mass. In their evaluation of Tifton-85, Sbrissia et al. (2003) reported that pasture growth decreased the ratio due to the need of a stem diameter for the weight of the leaves. However, the presence of leaves in an advanced phenological stage and with a major content of dry matter due to loss of water by the opening of the stomata and by the lignin process causes an increase in the ratio, even with a major production of stems.

The number of grazing interval days (Figure 4) was higher for the larger leaf blade mass and allowed 8, 6, 5 and 3 grazing to be submitted to the treatments 800, 1200, 1600 and 2000 kg of leaf blades, respectively, due to a lower net accumulation of blades for the treatments with higher forage mass. A high accumulation of stems occurs in this case. Even with an increase in forage production up to 1600 kg DM ha^{-1} after 1200 kg DM ha^{-1}, there is a rise in stem production and a decrease in the rate of leaf accumulation, which decreases the supply of leaf blade. Santos et al. (2012) evaluated leaf blade allowance of 3, 6 or 9 kg 100 kg^{-1} of body weight and failed to observe changes in the forage canopy and in the animal performance, although the grazing system was continuous.

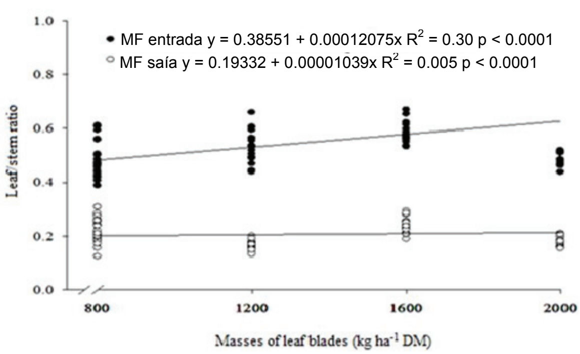

Figure 3. Leaf:stem ratio of the African star before and after grazing under different leaf blade mass between October and March.

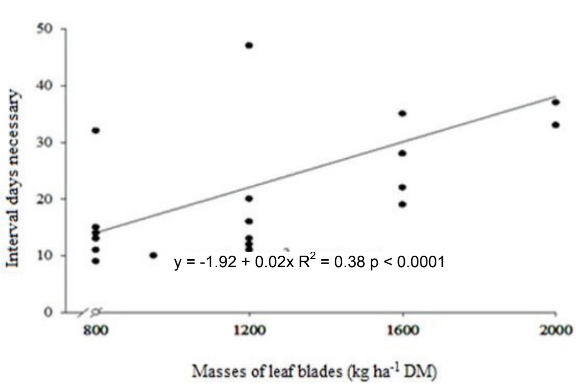

Figure 4. Interval days necessary to reach the leaf blade mass of African star, between October and March.

Crude protein (CP) rates observed in Figure 5 ranged between 143.0 g kg^{-1} for the smallest amount of available blades and 81.0 g kg^{-1} for the biggest ones. Increase of forage mass and, consequently, a greater number of interval days required to reach recommended number of leaf blades caused a dilution effect of nutrients due to the availability of older leaves for grazing.

Higher CP rates were obtained in the lowest leaf blade mass (800 kg) by greater tillering and regrowth (Gonçalves et al., 2002), with younger leaves. Oliveira et al. (2011) reported the nutritional rates of Coast-cross grass at different nitrogen levels and regrowth ages, where grazing performed at every 28 days were higher when compared to 42-day grazing due to a greater leaf : stem ratio.

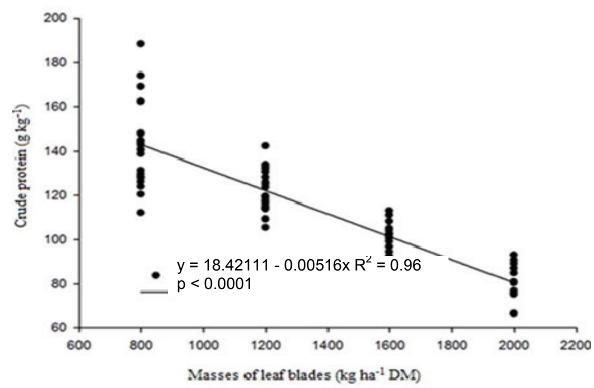

Figure 5. Crude protein (g kg^{-1}) in different leaf blade masses between October and March.

There was a positive linear response of NDF and ADF contents, with an increased leaf blade mass, ranging between 537.2 and 659.3 g kg^{-1} for NDF and between 189.3 and 291.0 g kg^{-1} for ADF (Figures 6 and 7). The higher the synthesis of fiber carbohydrates, the older is the leaf blade, with increased levels in the plant. High levels of cell wall decrease the dry matter intake of the animals, leading to less productive performances.

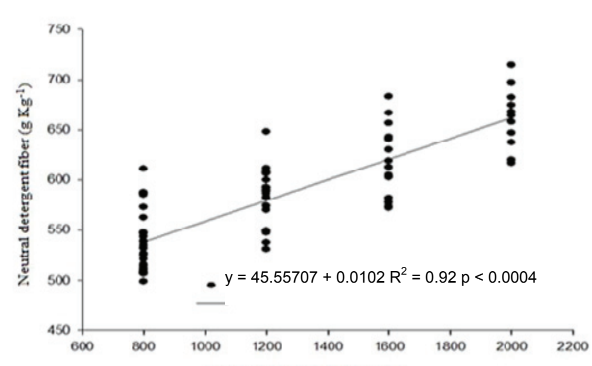

Figure 6. Neutral detergent fiber (g kg^{-1}) in different leaf blade masses between October and March.

Velásquez et al. (2010) reported that high cell wall rates increase the amount of constituent nitrogen fraction B3 (unavailable nitrogen associated with lignin). Consequently, increase in grazing interval days causes a decrease of CP contents in higher forage mass, as registered in current study. According to Gonçalves et al. (2003), cuts or grazing should be performed at shorter intervals to reduce ADF level, negatively correlated with digestibility. Gonçalves et al. (2001) compared different grasses of the genus Cynondon (Coastcross, Tifton 44, Tifton 85) and noted that quality decreased for all species evaluated with the advancement of the periods between grazing.

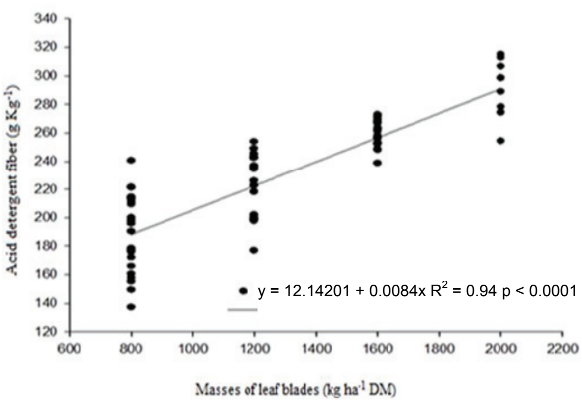

Figure 7. Acid detergent fiber (g kg^{-1}) in different leaf blade masses between October and March.

Conclusion

The management of African Star with masses of leaf blades from 1200 to 1600 kg DM ha^{-1} corresponding to pre-grazing heights 25-34 cm showed high forage production, with satisfactory nutritional quality.

Acknowledgements

The authors would like to thank the Araucaria Foundation for funding current research and CAPES for the pos doctoral scholarship.

References

Alencar, C. A. B., Coser, A. C., Martins, C. E., Oliveira, R. A., Cunha, F. F., & Figueredo, J. L. A. (2010). Altura de capins e cobertura do solo sob adubação nitrogenada, irrigação e pastejo nas estações do ano. *Acta Scientiarum. Agronomy, 32*(1), 21-27.

Bianchini, W., Rodrigues, E., Jorge, A. M., & Andrigueto, C. (2007). Importância da fibra na nutrição de bovinos. *Revista Electrónica de Veterinária, 8*(2), 1695-7504.

Fagundes, J. L., Silva, S. C., Pedreira, C. G. S., Sbrissia, A. F., Carnevalli, S. A., Carvalho, C. A. B., & Pinto, L. F. M. (2001). Índice de área foliar, coeficiente de extinção luminosa e acúmulo de forragem em pastagens de Cynodon spp. sob lotação contínua. *Pesquisa Agropecuária Brasileira, 36*(1), 187-195.

Gonçalves, G. D., Santos, G. T., Jobim, C. C., Cecato, U., Damasceno, J. C., Branco, A. F., & Silva, K. T. (2001). Determinação das frações de proteína e de carboidratos de gramíneas do gênero *Cynodon* em idades ao corte. *Acta Scientiarum. Animal Sciences, 23*(4), 789-794.

Gonçalves, G. D., Santos, G. T., Cecato, U., Jobim, C. C., Damasceno, J. C., Branco, A. F., & Faria, K. P. (2002). Produção e valor nutritivo de gramíneas do gênero *Cynodon* em diferentes idades ao corte durante o ano. *Acta Scientiarum. Animal Sciences, 24*(4) 1163-1174.

Gonçalves, G. D., Santos, G. T., Jobim, C. C., Damasceno, J. C., Cecato, U., & Branco, A. F. (2003). Determinação do Consumo, Digestibilidade e Frações Protéicas e de Carboidratos do Feno de Tifton 85 em Diferentes Idades de Corte. *Revista Brasileira Zootecnia, 32*(4), 804-813.

Machado, L. A. M., Fabrício, A. C., Gomes, A., Assis, P. G., Lempp, B., & Maraschin, G. E. (2008). Desempenho de animais alimentados com lâminas foliares, em pastagem de capim-marandu. *Pesquisa Agropecuária Brasileira, 43*(11), 1609-1616.

Montagner, D. B., Rocha, M. G., Santos, D. T., Genro, T. C. M., Quadros, F. L. F., Roman, J., ... Bremm, C. (2008). Manejo da pastagem de milheto para recria novilhas de corte. *Ciência Rural, 38*(8), 2293-2299.

Oliveira, M. A., Pereira, O. G., Ribeiro, K. G., Santos, M. E. R., Chizzotti, F. H. M., & Cecon, P. R. (2011). Produção e valor nutritivo do capim-*coastcross* sob doses de nitrogênio e idades de rebrotação. *Arquivo Brasileiro Medicina Veterinária Zootecnia, 63*(3), 694-703.

Paris, W., Marchesan, R., Prohmann, P. E. F., Menezes, L. F. G., Zanotti, J., & Hartmann, D. V. (2013). Utilização de uréia de liberação lenta em sal mineral na suplementação de bovinos de corte em pastagem de Tifton-85. *Semina: Ciências Agrárias, 34*(1), 409-418.

Pedreira, C. G. S., Sollenberger, L. E., & Mislevy, P. (1999). Productivity and nutritive value of 'Florakirk' bermudagrass as affected by grazing management. *Agronomy Journal, 91*(5), 796-801.

Pedreira, C. G. S., Sollenberger, L. E., & Mislevy, P. (2000). Botanical composition, light interception, and carbohydrate reserve status of grazed 'Florakirk' Bermudagrass. *Agronomy Journal, 92*(2), 194-199.

Santos, M. V., Kozloski, G. V., Quadros, F. L. F., Pires, C. C., Wommer, T. P., & Mônego, C. O. (2012). Animal production and canopy attributes of Cynodon pasture managed under continuous stocking with wethers at three levels of forage allowance. *Revista Brasileira de Zootecnia, 41*(1), 181-187.

Statistical Analysis System (SAS). (2001). *SAS/STAT. User's guide: statistics* (Realse 8.1) [Software]. Cary, NC: SAS Institute Inc.

Silva, A. C. F., Quadros, F. L. F., Trevisan, N. B., Martins, C. E. N., & Bandinelli, D. G. (2005). Alternativa de Manejo de Pastagem Hibernal: Níveis de Biomassa de Lâmina Foliar Verde. *Revista Brasileira*

Zootecnia, 34(2), 472-478.

Sbrissia, A., Silva, S. C., Matthew, C., Carvalho, C. A. B., Carnevalli, R. A., Pinto, L. F. M., ... Pedreira, C. G. S. (2003). Tiller size/density compensation in grazed Tifton 85 bermudagrass wards. *Pesquisa Agropecuária Brasileira, 38*(12), 1459-1468.

Van Soest, P. J., & Lewis, B. A. (1991). Methods for dietary fiber, neutral detergent fiber and polysaccharides in relation to animal nutrition. *Journal of Dairy Science, 74*(10), 3583-3597.

Velásquez, P. A. T., Berchielli, T. T., Reis, R. A., Rivera, A. R., Dian, P. H. M., & Teixeira, I. A. M. A. (2010). Composição química, fracionamento de carboidratos e proteína e digestibilidade *in vitro* de forrageiras hibernais em diferentes idades entre cortes. *Revista Brasileira Zootecnia, 39*(6), 1206-1213.

Received on July 16, 2015.
Accepted on September 14, 2015.