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METHODS FOR ESTIMATING FORAGE MASS IN MARANDU PALISADE GRASS CANOPIES

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ABSTRACT

This study compared three methods for estimating forage mass and its morphological components in canopies of *Urochloa brizantha* cv. Marandu (marandu palisadegrass). Two experiments were carried out, the first simulating deferment and the second, continuous stocking. In the first experiment, three methods for estimating forage mass (square, row, and tiller methods) were evaluated in different canopies with three initial heights (15, 30, and 45 cm). In the second experiment, two methods for estimating forage mass (square and tiller methods) were evaluated in canopies with three average heights (15, 30, and 45 cm) in summer. The experiments were conducted in a completely randomized design, in a split-plot scheme, with four replications. The plots were canopy heights and the subplots, the forage mass estimation methods. In general, taller canopies have greater forage mass. The tiller method resulted in lower total forage and senescent forage masses than the other methods. The tiller method underestimates total forage and senescent forage masses. The square and line methods are suitable to estimate the pasture total and senescent forage masses.

KEYWORDS: Canopy eight: Morphological composition: Tiller: Row seeding.

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INTRODUCTION

The correct management of pastures guarantees the sustainable productivity of the production system, as well as the conservation of environmental resources, minimizing the degradation of pastures. In this sense, knowledge about the amount of forage mass, and the best ways to estimate it are fundamental for the adoption of appropriate pasture management, for this makes it possible to properly adjust the stocking rate of a given pasture area, an action of essential management to avoid its degradation.

There are many techniques for estimating forage mass available. Some of them are classified as direct methods, being destructive, which implies the cutting of all forage within the area being sampled. Indirect or non-destructive methods, in which the forage is not cut, generally require less labor (ZANINE et al., 2006; ARRUDA, 2011). These techniques are widely used by researchers and producers in countries with greater livestock development, but in Brazil, they are not widespread or used. The direct method using known area frames is probably the best known and used in comparison to other indirect methods (ZANINE et al., 2006).

Forage mass can also be estimated by using the “line method”, which is very common for estimating forage mass in corn and sorghum crops (BASTOS, 2019). Pasture sowing in rows has been more used given the development of crop and livestock integration systems and seeders for grasses. In this context, estimating forage mass by using the line method may be appropriate and relevant during the first years after pasture formation.

Estimation of forage mass can also be performed by using the “tiller method”. Indeed, considering that the pasture consists of a population of tillers, the multiplication between the average weight and the number of tillers allows it to estimate forage mass (MEDICA et al., 2017; MARTINS et al., 2021).

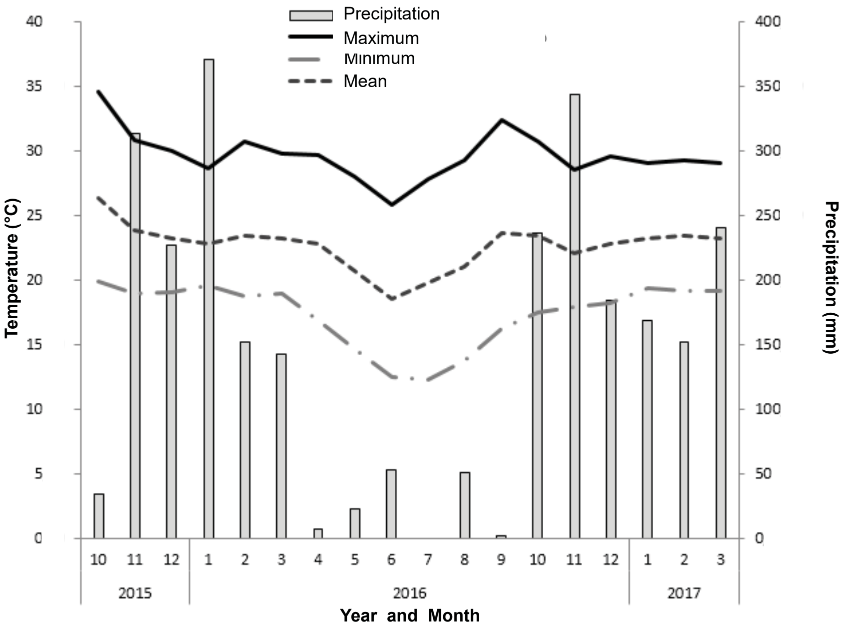
We hypothesize that the estimate of forage mass and morphological composition is similar between direct, “line” and “tiller” sampling methods. Thus, this work aims to obtain comparative information between three methods for estimating forage mass and morphological composition in marandu palisade grass (*Urochloa brizantha* cv. Marandu) canopies in dry and rainy seasons.

MATERIALS AND METHODS

Two independent experiments were carried out at the Capim-branco Experimental Farm, which belongs to the College of Veterinary Medicine of the Federal University of Uberlândia in Uberlândia, MG. The approximate geographical coordinates of the site are 18°30’ south latitude and 47°50’ west longitude of Greenwich, and its altitude is 776 m. According to the classification of Köppen (1948), the climate of the region of Uberlândia is Cwa type, tropical in altitude, with mild and dry winter, and well-defined dry and rainy seasons. The annual temperature average is 22.3º C. The annual precipitation average is 1,584 mm.

Information regarding climatic conditions during the experimental period was monitored at the meteorological station located approximately 200 m from the experimental area (Figure 1).

Figure 1 – Monthly average temperature minimum, average, and maximum daily, and rainfall from October 2015 to March 2017



The experimental area consisted of 12 experimental units (plots) of 9 m2 each, implanted by the line seeding method in November 2015, *Urochloa brizantha* cv. Marandu.

The first experiment took place from October 2015 to August 2016. From October 2015 to March 2016, the canopies were maintained through weekly cuts with pruning shears at three different heights (15, 30, and 45 cm). The excess forage cut, and leftover plants were removed from the interior of the plots after each cut. The deferral period of all canopies began on 04/01/2016 and remained in free growth for 90 days until 06/30/2016. Thus, in this experiment, three canopy heights at the beginning of the deferment period (plot) were studied, associated with three methods for estimating forage mass: square, row, and tiller, which will be described later, and corresponded to the subplot. This experiment was conducted in a completely randomized design with four replications.

The second experiment took place from October 2016 to March 2017 in the same area where the first experiment was conducted. In the second experiment, the marandu palisade grass canopies were maintained through weekly cuts with pruning shears at three different heights (15, 30, and 45 cm), simulating a continuous stocking condition, in which the pasture is maintained in a steady state. Thus, three canopy heights (plot) were studied, associated with two methods for estimating forage mass: square and tiller, which will be described later, and corresponded to the subplot. This second experiment was also conducted in a completely randomized design with four replications.

In the first experiment, forage mass estimates were made at the end of the deferral period, on 06/30/2016, in the year's dry season. In the second experiment, forage mass estimates were made in March 2017 during the rainy season.

A sampling of the forage mass by the square method was carried out with a square of known area (50x50 cm) used to harvest the forage at two points per plot, collecting all the forage close to the ground inside the frame. The samples were packed in identified plastic bags and taken to the laboratory, where they were weighed. Later, a subsample was removed. This subsample was weighed and taken to an oven for 72 hours at 65 ºC and then weighed again to estimate the percentage of dry matter and the amount of total forage mass. Another subsample was separated into the morphological components of green leaf, green stem, and senescent forage (dead material). Afterward these morphological components were placed in a forced air circulation oven and weighed again after 72 hours. These data made it possible to estimate the total forage mass and its morphological forage components. The green forage mass consisted of the sum of the green stem and green leaf masses.

The line method consisted of collecting two forage mass samples per experimental unit. At each sampling point, 1.0 linear meter of forage was cut close to the ground in the sowing line of the forage plant. The distance between rows was also measured in 10 points of the experimental unit to estimate the average spacing between rows of sowing grass. The samples were processed in the laboratory in the same way as previously described for the samples obtained with the square method. An estimate of the forage mass was obtained by multiplying the number of linear meters in the area and the forage mass per linear meter.

The estimate of forage mass by the tiller method consisted of cutting 50 tillers close to the ground in each experimental unit. The collection of tillers followed the criterion of proportionality between the existing vegetative and reproductive tillers in the canopy. For this, the number of tillers was previously counted at three random points per experimental unit by using a metallic frame with a known area (rectangle of 0.5 m x 0.25 m) and tillers were categorized into vegetative or reproductive. Those with visible inflorescence were considered reproductive tillers, while tillers without inflorescences were considered vegetative. The cut tillers were placed in identified bags and separated into their morphological components (live leaf, live stem, and dead material) in the laboratory. These morphological components were placed in a forced air circulation oven for 72 hours at 65°C, then weighed. Forage masses and their morphological components were calculated by multiplying the average individual tiller masses and the tiller population density of the forage canopy.

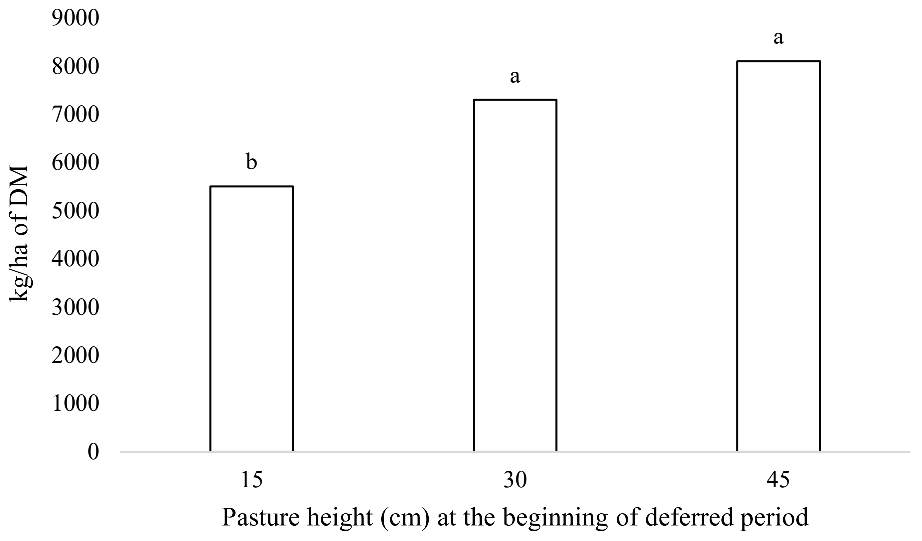
The SAS® 9.0 program for Windows was used for statistical analysis. Data from each experiment were separately analyzed. The variable "dead material" did not meet the assumptions of the analysis of variance in both experiments and, therefore, was analyzed by non-parametric statistics by using the Kruskal-Wallis test. In both experiments, the statistical analysis was performed considering that the design was completely randomized, the split-plot scheme, with four replications, so that the canopy height was the plot, and the sampling method was the subplot. The Tukey test was used with a Type I error probability of 5%.

RESULTS

FIRST EXPERIMENT

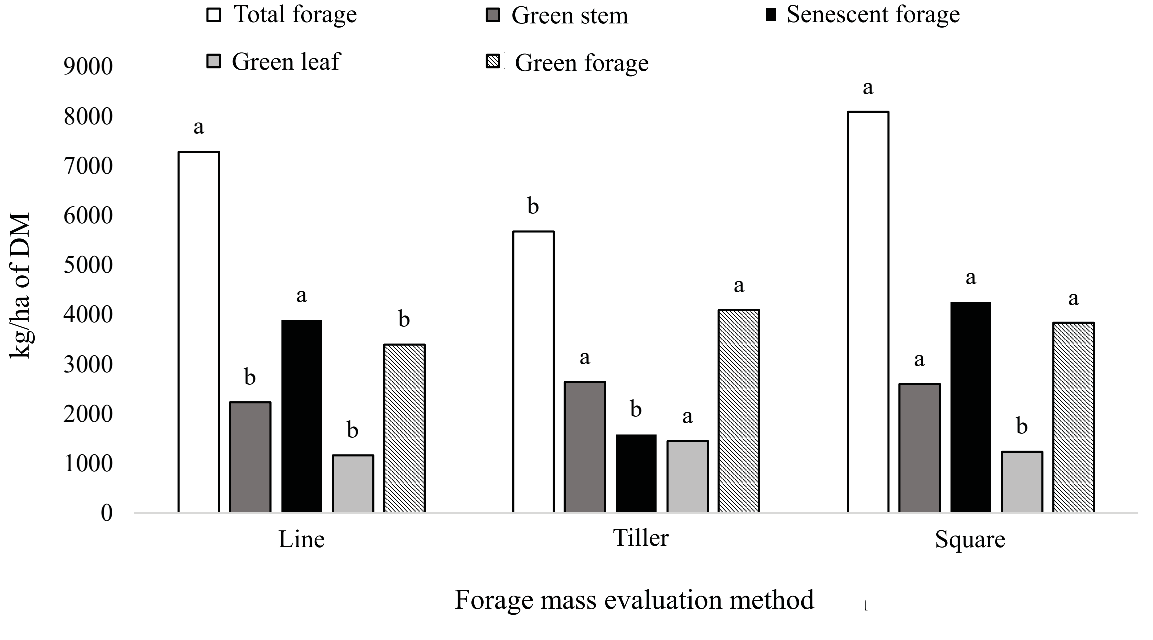
At the end of the deferral period, the estimate of total forage mass was influenced in an isolated way by the height of the canopy at the beginning of the deferral period (P= **0.0038**) (Figure 2) and by the evaluation method (**P= 0. 0040**) (Figure 3). Total forage mass was higher in the canopies deferred with 30 cm and 45 cm than in the one deferred with 15 cm (Figure 2).

Figure 2 - Total forage mass at the end of the deferral period of marandu palisade grass canopies deferred with three initial heights.



The estimates of green leaf mass (P= 0.0262), green stem (P= 0.0007), senescent forage (P= 0.0015), and green forage mass (P= 0.0048) (leaf + stem green) were influenced only by the evaluation method (Figure 3).

Figure 3 - Masses of green stem, green leaf, senescent forage, green forage, and total forage in different marandu palisade grass canopies according to the method of evaluating forage mass.

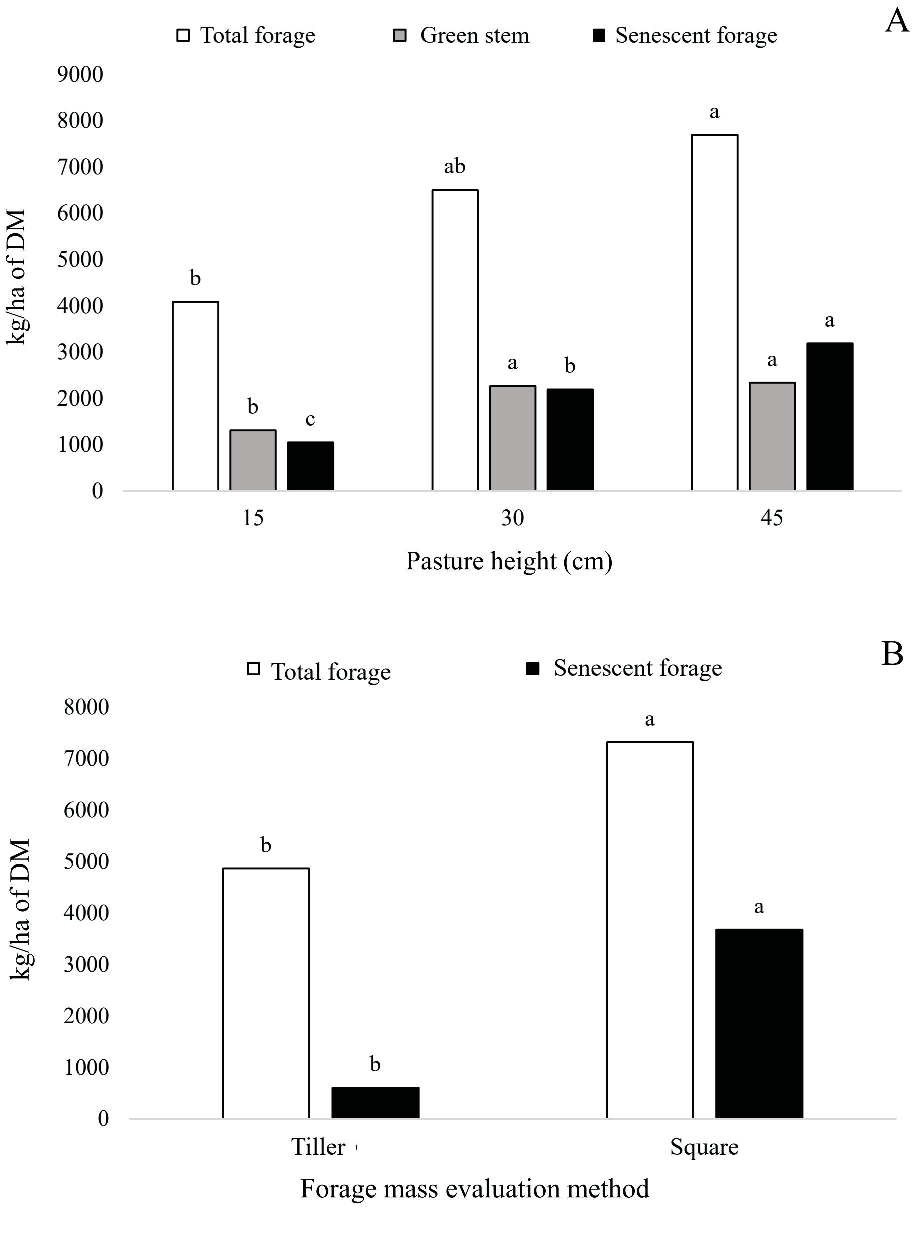


The total forage and senescent forage masses were lower when estimated by the tiller method, compared to the other methods. Such a response pattern is contrary to the one observed for green leaf mass. The green stem and forage masses were lower with the line method when compared to the tiller and square methods (Figure 3).

SECOND EXPERIMENT

Estimates of green stem mass, senescent forage, and total forage received influence from canopy height and evaluation method individually (Figure 4). Total forage mass was lower in the canopy under 15 cm than in the one managed under 45 cm, whereas the canopy maintained with 30 cm presented forage mass values similar to other canopies (Figure 4A).

Figure 4 - Green stem, senescent forage, and total forage mass in marandu palisade grass canopies maintained at three average heights (A) according to the forage mass evaluation method (B).



The green stem mass in the 15 cm canopy was lower than in the others'. The senescent forage mass was lower in the canopy under 15 cm, intermediate in the canopy at 30 cm, and higher in the managed canopy at 45 cm (Figure 4A).

The total forage and senescent forage results of the tiller method were lower than the square method's ones (Figure 4B). The masses of green leaf, green stem, and green forage, on the other hand, were not influenced (P>0.05) by the studied factors and showed mean values of 1593, 2359, and 3953 kg ha-1 of DM, respectively.

DISCUSSION

FIRST EXPERIMENT

Regardless of the method that was used to evaluate the total forage mass at the end of the deferred period, the highest value occurred in the deferred canopy with 45 cm (Figure 2). In general, the total forage mass at the end of the deferral period corresponds to the forage mass at the beginning of that period, plus the forage mass produced during the deferral period. Thus, considering that the tallest canopy has a greater forage mass (BASTOS, 2019; MARTINS et al., 2021; MEDICA et al., 2017; ZANINE et al., 2006), the greater initial forage mass may have contributed to the higher forage mass at the end of the deferral period (Figure 2).

In addition, the increase in canopy height at the beginning of the deferral period leads to greater self-shading inside the forage canopy, which causes the stalk to elongate to allocate the new leaves at the apex of the canopy, where luminosity is greater (MEDICA et al., 2017). This greater stem elongation in higher deferred canopies may also have contributed to the higher forage mass of total forage at the end of the deferred period (Figure 2).

The tiller method resulted in a lower estimate of senescent forage mass (dead material) in the deferred canopies, compared to the other methods (Figure 3). Only live tillers (most reproductive vegetative) were harvested with the tiller method. However, the forage canopy is also made up of dead tillers (MEDICA et al., 2017), which are mainly responsible for the senescent forage mass (dead material) in the pasture. Therefore, senescent forage mass was underestimated with the tiller method, which caused a lower total forage mass, compared to the other methods (Figure 3). Indeed, all tillers in the forage canopy, including dead tillers, are harvested with the square and line methods. Therefore, these last methods resulted in higher values of senescent and total forage mass, compared to the tiller method (Figure 3).

On the other hand, green leaf mass in deferred marandu palisade grass canopies was higher with the tiller method due to the factor that was previously discussed.

Considering that the square method is the most traditional method to estimate forage mass in pastures and, thus, is the standard for comparisons, we can state that the use of the line method results in forage masses total and green leaf forage is similar to the use of the square method. The tiller method is similar to the square method to estimate the masses of green stem and green forage, but not suitable to estimate masses of total forage and senescent forage in the pasture (Figure 3).

SECOND EXPERIMENT

In general, estimates of green stem, senescent forage, and total forage masses were higher in higher canopies than in lower ones (Figure 4A). This growth occurred because there is a strong and positive association between sward height and forage mass, as other authors observed in studies with grasses of the genus *Urochloa* under continuous stocking (MEDICA et al., 2017; ZANINE et al., 2006).

Regarding the methods to estimate forage mass, the tiller method resulted in lower senescent and total forage mass, when compared to the square method (Figure 4B). This result was similar to the one observed in the first experiment. Forage mass consists of all the morphological components of the pasture, both living and senescent (dead), as previously discussed. Thus, all these components (live plus dead) are collected when estimated by the square method. Only live tillers from the canopy, disregarding the dead tillers, are collected with the tiller method. For this reason, the tiller method underestimates the dead forage mass, and indeed the total canopy forage mass when compared to the square method (Figure AB).

Estimates of green leaf and green forage mass were similar between the square and tiller methods. This indicates that these two methods are appropriate to measure the live or green portion of the forage mass present in the pasture.

CONCLUSION

The tiller method underestimates the total forage and senescent forage (dead material) mass of the pasture.

The square and line methods are adequate to estimate the total forage and senescent forage (dead material) masses of the pasture.

MÉTODOS PARA A ESTIMATIVA DA MASSA DE FORRAGEM EM DOSSÉIS DE CAPIM-MARANDU

RESUMO

Este estudo comparou três métodos para a estimativa das massas de forragem e dos seus componentes morfológicos em dosséis de *Urochloa brizantha* cv. Marandu (capim-marandu). Dois experimentos foram realizados, sendo o primeiro simulando o diferimento e o segundo, a lotação contínua. No primeiro experimento, foram avaliados três métodos para estimativa de massa de forragem (métodos do quadrado, da linha e do perfilho) em dosséis diferidos com três alturas iniciais (15, 30 e 45 cm). No segundo experimento, foram avaliados dois métodos para estimativa de massa de forragem (métodos do quadrado e do perfilho) em dosséis com três alturas médias (15, 30 e 45 cm) no verão. Os experimentos foram conduzidos em delineamento inteiramente casualizado, em esquema de parcelas subdivididas, com quatro repetições. As parcelas foram as alturas dos dosséis e as subparcelas, os métodos de estimativa da massa de forragem. Em geral, os dosséis mais altos apresentam maior massa de forragem. O método do perfilho resultou em massas de forragem total e de forragem senescente inferiores aos demais métodos. O método do perfilho subestima as massas de forragem total e de forragem senescente. Para estimar as massas de forragem total e de forragem senescente do pasto, os métodos do quadrado e da linha são adequados.

PALAVRAS-CHAVE: Altura do dossel: Composição morfológica: Perfilho: Semeadura em linha.

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