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MONTHLY FORAGE ACCUMULATION IN TIFTON 85 PASTURE IN WEST CATARINENSE

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Abstract: This study aimed to measure the monthly forage accumulation rate in a Tifton 85 pasture (*Cynodon dactylon* x *Cynodon nlemfuensis* cv. Tifton 68), as well as comparing the use of two sampling methods for this purpose. The experiment was carried out in an area of 0.96 ha, located in the Municipality of Campo Erê, State of Santa Catarina, used to feed lactating cows through rotational grazing. A completely randomized design was used, with four replications, each containing three collection stations, totaling twelve collection points. Pasture sampling to determine monthly forage accumulation (AF) occurred on the last day of each month, using the "non-pairing" (NE) and "triple-pairing" (TE) methods. The annual dry matter production evaluated by the NE method reached 25.4 t/ha, with 71% of this total concentrated in five months: January to March, November and December. Daily AF ranged from 16.94 (August) to 175.84 kg/ha (January), indicating strong seasonality in forage production. The PA values estimated by the NE and TE methods were statistically similar in three seasons of the year, but there was divergence in the result for the months from October to December (spring), showing that these methods are not equivalent. The survey will be extended for another two years in order to reduce the possible erratic effect caused by the specific weather conditions of a given year.
Keywords: Sampling, growth curve, Cynodon, exclusion cage, forage production.

INTRODUCTION

Among the challenges to be faced in the management of pastoral systems are the limited control of productivity and forage stocks and the low ability to predict food availability (BARIONI et al., 2003). The lack of data on the forage production capacity and on the distribution of this production during the year become major limitations for an adequate planning of the pastoral activity, which allows the sustainability of the agricultural business (PEDREIRA et al., 2005).

In this context, the amount of available forage mass (MF) in the pasture constitutes an important variable to be measured in research work, forage management and in the conduction of livestock activity (PEDREIRA, 2002; PEDREIRA et al., 2005; CARVALHO et al, 2008). Although it is a punctual and instantaneous measure, which provides the agrostological condition at a specific moment, the MF makes it possible to measure responses that involve variation in time (PEDREIRA, 2002), and thus to evaluate the behavior of the pasture in the face of climatic, anthropic and environmental factors. others. Measuring the MF makes it possible to operationalize decision-making regarding its use, estimating the carrying capacity and guiding forage budgeting, planning of food supply and the adoption of management practices such as stocking adjustment (SALMAN et al., 2006), BARIONI et al., 2011).

Of the variables that can be estimated from the verification of the instantaneous availability of MF, forage accumulation (AF) is one of the most relevant. AF can be defined as the increase in the MF of a pasture area during a certain period, that is, the "production" of forage in a known time interval (PEDREIRA et al., 2005). In practice, PA is the net result of two concomitant and antagonistic processes: on the one hand, plant growth and, on the other hand, senescence and tissue death (PINTO et al., 2001). Thus, PA is a dynamic process, and, as it is estimated from the FM, its determination constitutes the basis of the entire pastoral system, being the key to understanding other elements, such as consumption by the animal and extraction of nutrients (PEDREIRA et al., 2005).

Although the AF assumes undeniable importance for the correct management of pasture feeding, the biggest limitation for the practice of forage budgeting is the almost complete absence of information regarding the growth curve of the main species throughout the year, in real livestock production systems. and under environmental conditions characteristic of each region (BARIONI et al., 2003; 2011). Specialists consulted by the Network of Innovation and Technological Prospecting for Agribusiness - South Regional Center (RIPA-Sul) point out that one of the priority demands of the milk production chain in Santa Catarina is the "regionalization of information on adaptation, performance, production curves and nutritional value of forage species for dairy cattle and sheep" (RIPA, 2008, p.67). Although this need was indicated more than ten years ago, apparently little has been done to remedy this deficiency, given the almost total lack of publications that bring such information, at least in the scope of the West of Santa Catarina.

The estimation of forage supply and the production curve of a forage can be carried out based on experiments to measure productivity throughout the year and/or through local data that monitor the availability of forage mass in a given condition (BARIONI et al., 2003). The present work fits simultaneously in both aspects.

The measurement of MF is carried out through the use of direct or indirect methods (destructive and non-destructive, respectively), being distinguished from each other by the fact that the former involve the cutting of forage (AGUIAR, s.d.; PEDREIRA, 2002; BARIONI et al, 2003; PEDREIRA et al., 2005; SALMAN et al., 2006; ZANINE et al., 2006; CARVALHO et al., 2008; ARRUDA et al., 2011; SILVEIRA FILHO, 2011; MACIEL et al., 2014 ; SILVA et al., 2016). Direct assessment is the most used (PEDREIRA, 2002) and the one that ensures greater precision in the results (AGUIAR, s.d.; ZANINE et al., 2006; MACIEL et al., 2014). However, it also has limitations, such as requiring more time and manpower to collect and handle samples, resulting in higher costs (SALMAN et al., 2006; ZANINE et al., 2006; ARRUDA et al., 2011; MACIEL et al., 2011; MACIEL et al, 2014).

The FM evaluation methods, whether direct or indirect, when performing the measurement of instantaneous availability, are the way to determine the AF. In non-grazed areas, the AF occurred in a certain period can be estimated through two MF samples, by simple difference between the value verified in the following sample in relation to the previous one.

In areas under grazing, however, AF can be established using exclusion cages (AGUIAR, s.d.; PEDREIRA, 2002; BARIONI et al., 2003; PEDREIRA et al., 2005; ZANINE et al., 2006; CARVALHO et al., 2008; SILVEIRA FILHO, 2011; MACIEL et al., 2014; SILVA et al., 2016). There are several methods that involve the use of exclusion cages. The simplest is sampling using the "non-pairing" (MNE) method. It consists of "cutting the area covered by the cage, discarding the cut forage, placing the cage, allowing the pasture to grow and cutting again to determine the production at the end of the grazing period or a certain period of time" (AGUIAR, s.d, p.2). Another technique involves a "simple pairing" procedure, that is, a pairing between sampling points (BARIONI et al., 2003). Two points (A and B) are chosen, representative of the pasture and similar to each other in terms of the amount of forage present; one of them is cut (point A), weighing the forage harvested, and the exclusion cage is placed at the other point (B), keeping the vegetation intact. After the evaluation period, the forage that is under the cage (point B) is cut and the material is weighed. The AF is given by the difference between the MF of point B in relation to that collected previously at point A.

Gardner (1986, p.115) compares these two methods:

> An improved, but not perfect estimate of growth can be obtained by using cages placed in the pasture, which protect the pasture from animal grazing. Of the various existing methods of using cages, the simplest is to cut the area to be covered by the cage, discard the cut forage, place the cage, allow the pasture to grow, and cut again, to determine the yield at the end of the grazing period. or at a predetermined interval.
>
> A second method requires two identical areas, one of which will have the forage cut and weighed while the cage is placed on top of the other. When the forage inside the cage is cut, growth is estimated by the difference between the yields of the two areas. None of these techniques will give an accurate estimate of pasture growth under grazing. The second method has the disadvantage of having two sources of error: one associated with cutting without the cage, and the other with cutting the area inside the cage.

Moraes et al. (1990) developed a third method for assessing AF with exclusion cages, which they called "triple matching" (MTE). In this, in addition to the two points mentioned in the previous method, a third point of the pasture is allocated, similar to the others. This third point will be the reference for the next sampling, when it will then constitute point A, looking for two other points that are equivalent to it. In this case, the FA is calculated by the difference between the MF observed inside the cage (point B) in one sample, in relation to the forage quantified at point A (outside the cage) in the immediately previous sample, representing what grew under the cage in the previous sample. period in question (PEDREIRA, 2002; PEDREIRA et al., 2005; ZANINE et al., 2006).The evaluation of AF is valid and necessary in any pasture used in animal feed, but it stands out when it comes to forages that are widely adopted in the productive environment. The Tifton 85 (*Cynodon dactylon* x *Cynodon nlemfuensis* cv. Tifton 68) is a perennial summer grass with high nutritional value and widely used in western Santa Catarina, having been the material most mentioned by rural extension workers when asked about the species used in the region (JOCHIMS et al., 2017). In view of this large regional adoption, the dimensioning of its production capacity can collaborate in achieving better results in a considerable number of properties.

In this context, the work aimed to (i) measure the monthly accumulation rate of forage in the Tifton 85 pasture, projecting the production curve of the species throughout the year; and (ii) compare the use of the "non-matching" and "triple-matching" sampling methods for the measurement indicated in item (i).

MATERIAL AND METHODS

LOCATION, CHARACTERIZATION AND MANAGEMENT OF THE EXPERIMENTAL AREA

The field stage was conducted during 2019 at Fazenda Primavera, premises of the Campo Erê Vocational Education Center (CEDUP), located at Rodovia SC 160, km 7, Municipality of Campo Erê, West Mesoregion of Santa Catarina. The area is located at coordinates 26º26'49" south latitude and 53º04'33" west longitude, at an average altitude of 884 m a.n.m.

The experimental area consisted of a seven-year-old Tifton 85 pasture, measuring 94 m by 102 m (0.9588 ha), used to feed lactating dairy cows using a rotational grazing method. Soil analysis carried out in October 2018 showed the following result for layer 0 (zero) at 10 cm: clay content = 44%; pH in water=5.8; SMP index= 6.0; phosphorus=5.4

mg/dm3; potassium=348.0 mg/dm3; organic matter=4.9%; aluminum=0 cmolc/dm3; calcium=10.3 cmolc/dm3; magnesium=4.1 cmolc/dm3; hydrogen plus aluminum = 4.36 cmolc/dm3; cation exchange capacity (CTC) at pH 7.0= 19.64 cmolc/dm3; base saturation in CTC at pH 7.0=77.78%. The area was fertilized with 180 kg of monoammonium phosphate (MAP) and 200 kg of potassium chloride (about 17 kg N, 90 kg P2O5 and 125 kg K2O/ha).

EXPERIMENTAL DESIGN AND TREATMENTS

The experiment was carried out in a completely randomized design, with four replications. Each repetition involved three "collection stations" (ECs), randomly chosen for each sampling. Each EC consisted of three points (A, B and C), as recommended by the MTE, as described by Vidart et al. (2010), here modified to contemplate, simultaneously, the analysis of the MNE.

The work was divided into two fronts of analysis. The first consisted of evaluating the rate of monthly accumulation of dry matter (DM) of the Tifton 85 pasture throughout the year (which resulted in the elaboration of the growth curve – or production – of the pasture), using the technique of "non-pairing" and taking the months as treatments. The second evaluation was the comparison between different forage accumulation estimation methods, contrasting the MNE and MTE treatments by quarter, according to the seasons.

SAMPLING AND COLLECTION PROTOCOL

Sampling and collection of available forage were carried out on the last day of each month of 2019, using a square of 0.5 m on a side (0.25 m2) as a sampling unit. In the area corresponding to a given repetition, three ECs were chosen at random, positioning them in locations that were representative of the total area, both in forage availability and in botanical composition. Therefore, the monthly collection involved sampling at 12 points (three ECs in each of the four replicates).

In each EC, three points were chosen, described as A, B and C, similar and equivalent to each other. At point A the forage demarcated by the square was cut at ground level and harvested, and then weighed. At this point, an exclusion cage was allocated. At point B, the forage was not cut but also received an exclusion cage. Point C, in turn, was just marked and signaled, in order to be easily found in the collection of the following month, without any change in vegetation, nor placement of an exclusion cage.

The following month, each EC was returned and the forage that was under the cages was harvested, both at point A and at point B. Point C of the previous sampling became point A of the sampling in question. Next, two other points that are similar to the now point A were sought, in terms of forage availability and botanical composition, designating them as point B and point C. Then, the procedure described above was repeated for each point, both in regarding the cutting of vegetation, regarding the allocation of exclusion cage. Therefore, each EC had two exclusion cages simultaneously, one at point A, for monthly AF assessment by the MNE, and another at point B, corresponding to the MTE.

The forage samples were packed in plastic bags and immediately weighed to determine the production of green matter. Then, they were dried in an oven at 55oC until constant weight, to verify the dry matter content at this temperature.

PARAMETERS COLLECTED, CALCULATED AND EVALUATED

The instantaneous availability of forage was determined in two ways: (a) through the amount of mass harvested at point "A" of a given EC, part of a given repetition "r", in a given month "m", before placing the exclusion cage at this point; and (b) through the amount of mass collected at point "B" of a given EC, part of a given repetition "r", in a given month "m", when removing the exclusion cage from this point, reflecting the estimate availability in the previous month plus the accumulation of forage in the period. The instantaneous availability of forage was not, properly speaking, a variable of analysis, having only the function of allowing the calculation of the monthly AF.

Monthly PA was evaluated using the MNE's and MTE's own methodologies. In the MNE, the AF was estimated by the instantaneous availability of forage harvested at point A of a given EC in month "m", when the exclusion cage was removed (placed in month "m-1", that is, in the month before the month "m"), which represents the forage growth in the time interval between the collections of months "m-1" and "m", that is, what grew in month "m". In the MTE, the monthly AF consisted of the difference between the instantaneous availability of forage harvested at point B of a given EC in month "m" and the mass of forage harvested at point A of this same EC in month "m-1". Some data calculated by the MTE proved to be incongruent, notably with regard to the AF for the months of April and July. For this reason, it was decided to compare the methods by quarter, in compliance with the seasons.

In both methods, the monthly PA in a given repetition "r", in a given month "m", was the arithmetic mean between the monthly accumulation of forage observed in the three ECs that constitute the repetition "r". Daily PA was calculated by dividing the monthly PA by the number of days in the respective month.

STATISTICAL ANALYSIS

The data referring to the daily PA rate, according to the month, were submitted to analysis of variance, with means compared by Tukey's test at 5% probability.

With regard to the effect of the sampling method, the daily PA values were contrasted, by quarter, using Student's t test, at a 5% significance level. In this case, we worked with an unequal number of repetitions, since some data related to the MTE were discarded due to their inconsistency.

RESULTS AND DISCUSSION

Monthly production and daily accumulation of DM in Tifton 85, according to month, are shown in Table 1 and figure 1. Annual production reached 25.4 t/ha, a value close to that observed by Gomes et al. (2015), in Xambrê, PR, and superior to that of Alvim et al. (1999), in Coronel Pacheco, MG, and Soares Filho et al. (2002), in Piacatu, SP. As expected for a tropical forage, forage production was concentrated in the summer period and the five months of highest productivity accounted for 71% of the annual total.

The month of January registered the maximum daily AF, differing significantly ($P<0.05$) from the value verified in the months of February, March, November and December, and the daily productions of these months exceeded those indicated in any of the remaining months ($P< 0.05$). Between the minimum (August) and maximum (January) PA, there was a variation of the order of ten times. The productions of the first three months of the year largely surpassed those obtained by Carvalho et al. (2000), in Piracicaba, SP, at

Month	Monthly dry matter production (kg/ha)	Daily accumulation of dry matter (kg/ha)	
January	5.451	175,84 ± 9,63	**a**
February	3.359	119,95 ± 15,74	**b**
March	2.893	93,33 ± 10,84	**b**
April	1.030	34,33 ± 12,15	**cd**
May	1.178	38,02 ± 5,82	**cd**
June	1.097	36,58 ± 3,62	**cd**
July	749	24,16 ± 3,91	**cd**
August	525	16,94 ± 5,50	**d**
Septembeer	1.153	38,42 ± 9,21	**cd**
October	1.637	52,80 ± 10,87	**c**
November	3.059	101,96 ± 19,74	**b**
December	3.279	105,76 ± 29,55	**b**
Total/Average	***25.410***	***69,84 ± 48,77***	

Means followed by unequal letters differ significantly by Tukey's test at 5%.

Table 1. Monthly production and daily accumulation of dry matter (kg/ha) in Tifton 85 pasture, according to the month of the year 2019, as determined by the "non-pairing" method. Municipality of Campo Erê, West Mesoregion of Santa Catarina, SC.

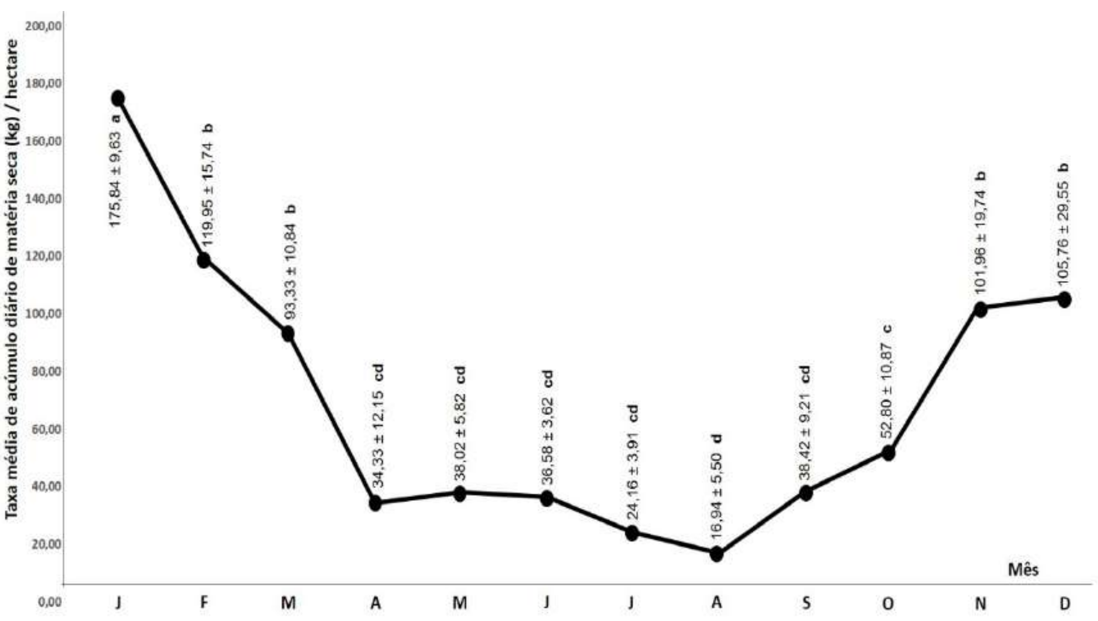

Figure 1. Average rate of daily dry matter accumulation (kg/ha) in Tifton 85 pasture, according to the month of the year 2019, as determined by the "non-pairing" method. Municipality of Campo Erê, West Mesoregion of Santa Catarina, SC.

a cutting height of 5 cm, and by Fagundes et al. (2012) and Moreira et al. (2015), both in Adamantina, SP. Likewise, the results for the months of September and November were higher than those of Carvalho et al. (2000) and Fagundes et al. (2001), both in Piracicaba, SP, but, on the other hand, in the months of August and October these authors recorded PA rates higher than those presented here. The production in December was similar to that described in these works.

Assuming that the pasture is used with a forage supply of around 6% (6 kg of DM per day for every 100 kg of animal live weight), considered adequate for Tifton 85 (AGUIAR et al., 2004; SAUTER, 2019), in the month of August, the pasture could be occupied with a continuous animal load of only 282 kg of PV/ha, while, in January, the pasture could contain no less than 2,930 kg of PV/ha, while throughout the month.

The data attest to the occurrence of strong seasonality in forage production. Seasonality occurs in all locations, to a greater or lesser extent (BARIONI et al., 2011), being evidenced through changes in forage availability and quality due to climatic conditions (REIS; ROSA, 2001), with effects on performance. animal (GONÇALVES et al., 2020). 40 years ago, Pedreira and Mattos (1981) already signaled this issue. When comparing 25 forage genotypes in Nova Odessa, SP, during three years, they found that, on average, the production from November to January was more than fourteen times higher than that observed in the period from June to August. Normally, herd productivity follows that of forage, alternating periods of high and low performance, with notorious economic repercussions. In view of this, the adequacy or balance between the availability and demand of food is one of the most relevant aspects in pastoral systems (PEDREIRA et al., 2005). In the case of Tifton 85 in southern Brazil, the marked seasonality encourages the use of practices that mitigate this imbalance, such as the introduction of forage species with a winter cycle through overseeding.

Table 2 presents the comparison between the sampling methods (MNE and MTE) regarding the determination of the average values of AF, grouped by quarter. It appears

Year season (Months)	**Sampling Method**		**Significance**
	No Pairing	**Triple Pairing**	
Summer (January to march)	129,71 ± 39,43	120,33 ± 59,20	NS
Autumn (April to june)	36,31 ± 15,01	33,95 ± 23,45	NS
Winter (July to september)	26,51 ± 13,69	21,22 ± 19,55	NS
Spring (October to december)	86,84 ± 38,02	49,52 ± 29,58	P<0.000075
Average	***69,84 ± 47,87***	***56,26 ± 44,26***	---

NS: Contrast between means not significant.

Table 2. Average rate of daily dry matter accumulation (kg/ha) in Tifton 85 pasture, according to sampling method ("non-pairing" and "triple-pairing"). Municipality of Campo Erê, West Mesoregion of Santa Catarina, SC.

that there was no significant difference (P>0.05) between the methods in estimating DM production in three of the four periods, referring to the summer, autumn and winter seasons. However, in the collections for the months from October to December (spring), the values verified by the MNE were higher (P<0.05) than those indicated by the MTE, which obviously indicates that both are not equivalent in terms of effectiveness.

Among the two methods under analysis, the MTE has been used more frequently for quantitative PA measurement, citing, for example, the works by Paula et al. (2012) and Dias et al. (2015). This method reflects with greater reliability what happens in the pasture, as it starts from a LAI that reflects the agrostological condition in which it actually finds itself, and not from a very low LAI due to forage cutting at the beginning of the evaluation period, as in the MNE. In view of this, the MTE provides, in theory, a more real estimate of the AF. However, the method proves to be more laborious and contains a large source of error, namely the visual estimate of forage availability between the points in duplicate that will be sampled. The difficulty and subjectivity inherent to this assessment justify the higher coefficients of variation found in this work, compared to the MNE (Table 2). On the other hand, the MNE – adopted, for example, in the work by Dufloth and Vieira (2012) – introduces a source of error by starting from a completely defoliated sample, a situation different from that normally seen in pastures under proper management.

In measuring pasture growth capacity, repetition over time is essential, given the variability of climatic factors between different years, a factor that greatly affects forage production and its distribution over the months. Silva and Nascimento Júnior (2007, p.122) emphasize:

> "Until recently, despite the emphasis given to the knowledge of the forage accumulation curve of pastures after cutting or grazing, their seasonality of production, morphological composition and nutritional value of the forage produced, few studies reported data collected for periods that exceeded a growing season.

Thus, the data presented in this work refer to the first year of evaluation of the Tifton 85 pasture and are, therefore, preliminary and partial. The evaluation is being repeated over time (two more years of collections), in order to reduce the erratic effect determined by the specific climatic characteristics of a year.

CONCLUSIONS

Under the conditions of Western Santa Catarina and based on the year 2019, the Tifton 85 grass presented a forage production curve with high seasonality, with 71% of the annual total distributed in five months. Forage accumulation varied about tenfold between extreme yield months. These data demonstrate the importance of an adequate adjustment of animal load in the pasture, balancing the availability of forage and the demands of the herd, as well as referring to the need for other practices, such as the introduction of wintering species in the area.

The difference in the estimate of forage accumulation verified between the "non-pairing" and "triple-pairing" methods in one of the four analysis periods is sufficient to attest that they cannot be considered equivalent or interchangeable. Although the "triple pairing" seems to more faithfully reflect the real situation of the pasture, each method has its advantages and limitations and its choice must be based on specific local conditions, including the ease of execution and the desired degree of precision.

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