Acta Scientiarum. Animal Sciences
ISSN: 1807-8672
Editora da Universidade Estadual de Maringá - EDUEM

Carvalho, Vinícius Emanoel; do Carmo Araújo, Saulo Alberto; de Oliveira Alves, Danilo; dos Santos, Carlos César; Silva Rocha, Norberto

Dry matter intake and milk yield of cows grazing Xaraés palisadegrass under different management strategies

Acta Scientiarum. Animal Sciences, vol. 41, e46843, 2019
Editora da Universidade Estadual de Maringá - EDUEM

DOI: https://doi.org/10.4025/actascianimsci.v41i1.46843

Acta Scientiarum

http://periodicos.uem.br/ojs/acta
ISSN on-line: 1807-8672
Doi: 10.4025/actascianimsci.v41i1.46843

Dry matter intake and milk yield of cows grazing Xaraés palisadegrass under different management strategies

Vinícius Emanoel Carvalho[1], Saulo Alberto do Carmo Araújo[2*], Danilo de Oliveira Alves[1], Carlos César dos Santos[1] and Norberto Silva Rocha[3]

[1]Universidade Federal dos Vales do Jequitinhonha e Mucuri, Campus JK, Alto da Jacuba, Diamantina, Minas Gerais, Brasil. [2]Departamento de Zootecnia, Universidade Federal dos Vales do Jequitinhonha e Mucuri, Campus Unaí, Rodovia BR-25, Sentido Unaí-Paracatu, 38610-000, Unaí, Minas Gerais, Brasil. [3]Faculdade de Ciências da Saúde, Unaí, Minas Gerais, Brasil. *Author for correspondence. E-mail: sauloaraujo.ufvjm@gmail.com

ABSTRACT. This study aimed to evaluate the intake and milk yield of crossbred cows (Holstein x Zebu), under two management strategies, based on 95% light interception and fixed days. Eight lactating cows with body weight of 466 kg (± 35 kg) and lactation stage of 137 days (± 107 days) were used, four animals were assigned to each treatment. Dry matter intake was estimated indirectly, using neutral detergent insoluble fiber as internal indicator and chromium oxide as external indicator. This was a completely randomized design, with four replications, two grazing strategies and three days of occupation. The animals under light management showed dry matter intake on the first day (11.42 kg) similar to the second day (9.57 kg), and this was similar to the third day (7.06 kg), but the intake on the first day was greater than on the third day. On the fixed days, intake did not differ between the first and second day (12.05 and 11.47 kg, respectively), and intake of the third day (6.70 kg) was lower than in the first two days. The dry matter intake in relation to the body weight of the animals presented similar results to the dry matter intake of forage in kilos, which can be explained by the small difference in weight between the mean of the groups. The individual milk yield showed a similar behavior among the grazing strategies for the days of occupation, which increased from the first to the second day (12.49 to 13.88 kg) and decreased from the second to the third day (12.20 kg). Grazing management strategies did not promote differences in the performance traits of lactating cows. The day of grazing during the period of occupation can be decisive for intake and production.

Keywords: animal production; dairy cattle; grazing strategies; light interception; milk production; occupation period.

Received on March 4, 2019.
Accepted on March 27, 2019.

Introduction

The intensification of pasture use has been widely used in farms destined for dairy production, in order to directly increase the profitability of the livestock system. Pasture is the most efficient feed from the economic point of view for cattle feeding, which justifies efforts to optimize the resources that compose the pasture ecosystem. In this sense, the adoption of pasture management strategies that aim to combine a greater supply of forage and adequate nutritional value can contribute in an effective way to increase the productivity of the zootechnical exploitation.

Studies on tropical forage management in pastures based on ecophysiological characteristics have provided results similar to those obtained with temperate forages, which have been evaluated for a longer time, with higher volume of work (Voltolini et al., 2010).

The management of grazing with intermittent stocking has periods of occupation that can vary from one to seven days, which results in a diet that varies throughout the stay of the animals in the paddock, so that the longer the period of occupation, the greater the quantitative and qualitative losses in the pasture (Cóser et al., 1999).

Dry matter intake is one of the most important elements for animal performance, since it is the primary factor for the ingestion of nutrients, especially energy and protein, necessary to meet the maintenance and production requirements of the animal (Brâncio et al. 2003).

In this context, the relationship between the characteristics of forage, the estimation of consumption and milk yield in each day of occupation of the paddock can elucidate existing doubts about this theme, and, thus, help in the determination of better management practices.

The goal of this study was to evaluate the intake and milk yield of Holstein x Zebu cows, under two strategies of intermittent grazing management in relation to the rest period of the pasture (24 fixed rest days and 95% light interception) along three days of occupation of the paddocks.

Material and methods

The experiment was conducted at the Moura Experimental Farm, belonging to the Federal University of the Jequitinhonha and Mucuri Valleys (UFVJM), located in the municipality of Curvelo, State of Minas Gerais (18°44'52,03" South latitude and 44°26'53,56" West longitude). According to the Köppen classification (1948), the climate in the region is Aw, tropical savanna type, with annual mean temperature of 22ºC, annual rainfall of 1,300 mm and well-defined seasons, rainy summers and dry winters.

Xaraés palisadegrass (*Brachiaria brizantha cv. Xaraés*) pasture was planted in January 2012, using the conventional method of soil tillage and broadcast seeding with 3 kg viable pure seeds and 250 kg single superphosphate/ha. In June 2012, initial grazing was carried out to take advantage of the available forage and to avoid the forage bedding.

The experiment was conducted between November 2012 and April 2013. Pasture management was conducted under two strategies, with 24 days of fixed rest period (DF) and 95% light interception (IL), in four grazing cycles. Both grazing strategies were composed of 9 paddocks of approximately 3000 m^2, in which the animals were managed by means of the intermittent stocking grazing method. The rest time of 24 days was determined based on pre-experimental observations.

Measurements of IL of the pasture were carried out weekly at 10 random points of the paddocks until measurements close to 95%, when the frequency of monitoring was performed daily. It was used a canopy analyzer - AccuPAR Linear PAR / PAI captometer, Model - 80 (DECAGON Devices®) to evaluate the light interception in the paddocks. These readings were performed between 10:00h and 14:00h. Whenever possible, we avoided reading from 12:00h to 1:00h, as it was found that leaf curling during this period increased the amount of light that reached the ground and could thus underestimate the value of the light interception. The canopy height was measured simultaneously to the IL evaluations, and 10 measurements were taken at the same points.

The criterion adopted for the removal of the animals from the paddocks was different between the treatments. In the DF management, after calculating the stocking rate based on the forage supply and pasture dry matter, the animals remained the three days of occupation without any change in the lot, whereas, in the IL management, the regulating animals were eventually relocated so that the post-grazing residue presented 20% residual leaf area, which was measured by continuous visual monitoring of two previously trained observers, who followed the lowering of the pasture during the entire period of occupation.

Eight Holstein x Zebu lactating cows were used, with body weight of 466 kg (± 35 kg) and lactation stage of 137 days (± 107 days). During this period, the animals received 4.0 kg/day of commercial concentrate, divided into two meals during milking, respectively. The commercial concentrate had the following composition: 24% crude protein, 2% ether extract, 15% crude fiber, 12% mineral matter, 2% calcium, 0.6% phosphorus and 87% total digestible nutrients. The mineral supplement was supplied ad libitum in the paddocks for all animals used in the present study.

The individual milk production was determined in the two daily milks by means of automated meters, coupled to the milking sets to obtain the average yield at the end of each grazing cycle. The milk yield corrected to 3.5% fat (PLc) was calculated from the equation proposed by Sklan, Ashkenazi, Braun, Devorin and Tabori (1992):

$$PLc = (0.432 + 0.1625xG)xPL$$

in which, G = % fat in milk; PL = milk yield in kg day^{-1}.

For the evaluation of the forage dry matter intake, the animals were subjected to an adaptation period of 18 days to the treatment (grazing management strategies) and six days of collection. These six days were related to the use of two paddocks for each treatment, in each day of occupation.

DM intake was indirectly estimated using neutral detergent insoluble fiber (NDFi) as an internal indicator, according to the equation (Cochran, Adams, Wallace, & Galyean, 1986):

$$CMSF = [(PF * CIFZ) - (CMSS * CISu)/CIFR$$

where: CMSF = forage dry matter intake (kg day^{-1}); PF = fecal output (kg/day); CIFZ = concentration of fecal indicator (kg kg^{-1}); CMSS = CMS of the supplement (kg day^{-1}); CISu = concentration of the indicator in the supplement (kg kg^{-1}); CIFR = concentration of the indicator in the forage (kg kg^{-1}).

Fecal output was estimated using chromium oxide as an external indicator using the following formula (Kimura & Miller, 1957):

$$PF = OCF/COFPF$$

where: PF= fecal output (g day^{-1}); OCF= chromium oxide supplied (g day^{-1}); COF= concentration of chromium oxide in feces (g g^{-1} DM).

The period for adaptation of the animals to the external indicator (chromium oxide) was 7 days, with oral delivery, with two daily doses of 5g each, followed by another 6 days of indicator supply and collection of feces twice a day, at 6h and 2h, on each day of occupation of the animals in the paddock. The samples were frozen for further processing and analysis. Composite samples of faces of each animal per day of occupation in the paddock were used. Chromium analysis was performed at the Laboratory of Food Analysis of Embrapa Dairy Cattle.

To obtain the NDFi, we collected samples of newly ingested pasture and feces of each animal per day of occupation in the paddock in two rumen fistulated castrated male cattle, to obtain extruded samples. These animals had their rumen emptied and were allowed to graze for 40 minutes without access to water. Soon after grazing, the extruded samples were collected and the ruminal contents removed previously were returned.

After pre-drying in an oven at 55ºC for 72 hours, extruded samples and feces samples were incubated in the rumen of the same animals used for ruminal extrusion collection, for 144 hours. For this, TNT 100 bags were used, with a ratio of 16.67 mg/cm^2. After the incubation period, they were removed, washed and pre-dried (55ºC for 72 hours), for later calculation of NDF by the method of Van Soest (1994).

To obtain the whole plant, samples were collected with the aid of a square-shaped frame (1 m^2) at two points representing the condition of the paddocks, cutting the forage close to the ground. The contents of neutral (NDF) and acid (ADF) detergent insoluble fiber were determined by the method proposed by Van Soest, Robertson, and Lewis (1991) and crude protein (CP) was determined by the Kjedhal method (Association of Official Analytical Chemists [AOAC], 1995).

The content of total digestible nutrients (TDN) of the pasture was estimated according to the equation proposed by Cappelle, Valadares Filho, Silva and Cecon (2001), based on the NDF content of the forage. The animal requirement estimates were based on the mean weight and milk yield of all animals, according to National Research Council (NRC, 2001).

The design was completely randomized (DIC), with two grazing strategies and three days of occupation, with four replications (animals). Data were tested by analysis of variance in the software SISVAR 5.3 (Ferreira, 2011), using the Tukey's test at 5% probability for comparison of means.

Results and discussion

There was a significant interaction between grazing strategies and days of occupation for pasture dry matter intake (Table 1).

The animals managed according to IL showed intake on the first day similar to the second day, but intake on the first day was higher than in the third day. In relation to DF, intae did not differ between the first and second day, and the intake of the third day was lower than in the first two days.

Table 1. Pasture dry matter intake (CMSP) in kilograms (kg) and in percentage of body weight (% BW) according to days of paddock occupation, of cows under different grazing management strategies.

Grazing days	1º day		2º day		3º day		CV[1]	P-value
Management	IL	DF	IL	DF	IL	DF	(%)	
CMSP (kg)	11.42	12.05	9.57	11.47	7.06*	6.70*	16.15	0.0015
CMSP (%BW)	2.7	2.75	2.28	2.63	1.68*	1.53*	16.20	0.0016

IL = defoliation based on 95% light interception; DF = fixed rest period of 24 days; [1]coefficient of variation; *Significant at 5% probability by Tukey's test.

On average, there was a 41.4% reduction in dry matter intake from the first to the third day of occupation, which may suggest that the animals underwent food restriction on the last day of grazing. This possible restriction may have caused higher intake on the first day, which is superior to the requirement of these animals, according to NRC (2001), in intake of dry matter, crude protein and total digestible nutrients intake.

The intake in relation to the body weight of the animals presented similar results to the intake of dry matter of forage in kilograms, which can be explained by the small difference in weight between the average of the lots.

The results regarding the intake of dry matter, crude protein and total digestible nutrients estimated in the present study, for the three days of occupation (Table 2), were compared with the predicted values, according to NRC recommendations (2001).

On the third day, the difference between the estimated and predicted values were negative for the parameters evaluated (CMS, PB and NDT). This indicated that, on this day, the diet ingested by the animal was not sufficient to meet the necessary requirements for the observed production. The day that promoted results closer to the predicted requirement was the second day, which presented intermediate values of nutrient intake compared to the other days in question.

It is important to note that, despite being the best reference of nutritional requirements for dairy cattle, NRC equations (2001) were formulated based on data from animals and diets very different from those used in the present study.

The reduction in consumption during the three days of occupation was concomitant with the reduction in forage quality (Table 3).

The reduction in content of CP and increase in fiber constituents (NDF and ADF) were more evident in the results of whole plant compared to the extrusa, showing that the animals selected portions of the forage supplied with higher nutritional value. Results similar to the present study were found by Clipes, Silva, Detmann, and Vásquez (2006), who evaluated Mombasa guinea grass under intermittent stocking grazing with occupation of three days and found increases in the fiber constituents of this forage.

For efficient animal production, using intermittent stocking grazing, it is essential to consider the total production and the quality of the forages, because, due to the selectivity of the animals, the high-quality material is ingested first, producing a cyclic profile of nutrients as a function of transfer of animals between paddocks. In this context, when the animals occupy a paddock for several days, the nutritive value of the forage consumed, greater on the first day of grazing, is reduced with the advancement of the occupation period (Van Soest, 1994).

Table 2. Predicted and estimated intake of dry matter (CMS), crude protein (CPB) and total digestible nutrients (CNDT), expressed in kilograms per day, of dairy cows according to the days of paddock occupation.

			Grazing days			
Nutrients	Requirement*	Concentrate	1	2	3	Mean
CMS	12.35	3.76	11.74	10.52	6.88	9.71
CPB	1.71	0.84	1.14	0.87	0.54	0.85
CNDT	7.87	3.08	6.84	6.05	3.84	5.42
	CMS	- 8.59	3.15	1.93	- 1.71	1.12
Difference (diet - requirement)	PB	- 0.87	0.28	0.01	- 0.33	- 0.02
	NDT	- 4.79	2.26	1.00	- 1.35	0.64

*calculated according to NRC (2001); the values presented are in kg DM day^{-1}.

Table 3. Content of crude protein, neutral detergent fiber and acid detergent fiber of the extrusa and the whole plant, on a dry matter basis, referring to the three days of occupation of the Xaraés palisadegrass paddock, managed under different intermittent grazing strategies.

Grazing days	1º day		2º day		3º day	
Management	IL	DF	IL	DF	IL	DF
			Crude protein (%DM)			
Extrusa	9.84	6.64	8.36	8.23	8.11	7.51
Whole plant *	5.52	5.41	3.95	3.98	3.88	4.09
			Neutral detergent fiber (%DM)			
Extrusa	61.57	60.79	62.17	64.05	67.16	67.32
Whole plant *	65.9	68.33	69.12	66.43	70.31	70.12
			Acid detergent fiber (%DM)			
Extrusa	30.62	30.56	33.33	33.64	32.01	34.17
Whole plant *	33.69	35.65	34.37	33.89	36.33	37.07

IL = defoliation based on 95% light interception; DF = fixed rest period of 24 days; *cutting close to the ground.

The reduction in forage quality during the period of occupation of the paddocks was accompanied by the reduction of leaves and percentage increase of stem and dead material (Table 4). The reduction in pasture DM availability also occurred gradually over the days of occupation.

The increases observed between the days of occupation for the NDF and ADF contents and the proportions of stem and dead material indicated an increase in the constituents of the cell wall, which led to a decrease in forage quality after the first day under grazing.

Individual milk yield and milk yield corrected to 3.5% fat (Table 5) showed no differences between management strategies.

These results corroborate Blaser et al. (1986) who evaluated intermittent stocking grazing with three days of occupation and reported an increase in milk yield from the first to the second day and a decrease on the third day, whereas, with five days of occupation, increases were found in yield from the first to the third day and from this decrease until the fifth day of grazing. The authors associated such variations with the mass of forage and selectivity in grazing, where, on the first day, the forage consumed presented higher nutritive value that was reduced during the period of occupation.

The reduction in forage intake and quality from the first to the third day of grazing did not result in a significant difference in milk yield between the days of paddock occupation. Theoretically, the daily milk yield, in part, corresponds to the nutrient intake of the previous day. Thus, milk yield on the second day of occupation would be expected to be higher than the other days, due to the greater amount of available mass and the better nutritional quality presented on the first day of occupation. Likewise, the quantitative and qualitative reduction of forage on the last day of occupation would result in a lower dry matter intake and, consequently, lower milk yield on the first day of occupation of the next paddock.

Nevertheless, Bezerra, Queiroz, Bezerra, Pereira, and Paulino (2004) reported that the digesta can remain in the gastrointestinal tract on average 63 hours for diets with particle size close to 14 mm. Thus, in a given moment, there could be, in ruminal content, material resulting from grazing carried out in previous days. Probably, this may explain the similar milk yield in the three days of grazing, even with reductions in pasture supply and quality on the last day of occupation. Similarly, Cóser et al. (1999) observed no differences between the individual milk yields of cows on elephantgrass pasture, with periods of occupation of 1, 3 or 5 days. In addition, it is possible that metabolic mechanisms are also acting to prevent the drastic reduction in milk yield in a short period of time, since milk synthesis is a complex and dynamic process. Therefore, studies with periods of three days of occupation may not detect differences in milk production between days, due to the ruminal dynamic process (characteristics of the digesta and the time of its permanence in the rumen).

The close relationship between the studied variables and the sharp reduction in the intake observed between the first two days and the third day of occupation may indicate a management option that aims to reduce these variations. In this sense, an alternative that could be adopted to reduce this effect, consists in the use of a less demanding lote de repasse, which consumes the pasture until the residual height on the third day of occupation.

Table 4. Morphological composition and pasture mass (kg ha^{-1}), on a dry matter basis, of the whole plant during the three days of occupation of the Xaraés palisadegrass paddock, managed under different intermittent grazing strategies.

Grazing days	1º day		2º day		3º day	
Management	IL	DF	IL	DF	IL	DF
% leaf	30.1	35.0	14.5	18.4	8.9	11.2
% stem	46.2	51.8	55.5	57.6	55.5	57.2
% dead material	23.7	13.2	30.0	24.1	35.6	31.6
DM*	550.7	605.1	506.0	424.3	499.9	377.2

IL = defoliation based on 95% light interception; DF = fixed rest period of 24 days; *in kilograms per hectare.

Table 5. Milk yield (kg) of crossbred Holstein x Zebu cows during the period of occupation of the Xaraés palisadegrass paddock, managed with two grazing strategies.

Grazing days	1º day		2° day		3º day		CV[1]	P-value
Management	IL	DF	IL	DF	IL	DF	(%)	
PL [ns]	12.30	12.68	13.98	13.78	12.20	12.20	20.49	0.7575
PLc [ns]	11.52	12.87	13.90	14.97	12.05	12.80	20.48	0.7645

IL = defoliation based on 95% light interception; DF = fixed rest period of 24 days; PL = milk yield; PLc = milk yield corrected to 3.5% fat (Sklan et al., 1992); [1]coefficient of variation; [ns] non-significant.

Conclusion

Grazing management strategies did not promote differences in the performance traits of lactating cows. The day of grazing, during the period of occupation, can be determinant for consumption of the forage.

References

Association of Official Analytical Chemists [AOAC]. (1995). *Official methods of analysis* (16th ed.). Arlington, VA: AOAC International.

Bezerra, E. S., Queiroz, A. C., Bezerra, A. R. G. F., Pereira, J. C., & Paulino, M. F. (2004). Perfil granulométrico da fibra dietética sobre o tempo médio de retenção e a digestibilidade aparente de dietas de vacas leiteiras. *Revista Brasileira de Zootecnia*, 33(6), 2378-2386. doi: 10.1590/S1516-35982004000900026

Blaser, R. E., Hammes Júnior, R. C., Fontenot, J. P., Bryant, H. T., Polan, C. E., Wolf, D. D., ... Moore, J. S. (1986). *Forage-animal management systems*. Blacksburg, VA: Virginia Polytechnic Institute and State University.

Brâncio, P. A., Nascimento Junior, D., Euclides, V. P. B., Fonseca, D. M., Almeida, R. G., Macedo, M. C. M., & Barbosa, R. A. (2003). Avaliação de três cultivares de *Panicum maximum* Jacq. sob pastejo: Composição da dieta, consumo de matéria seca e ganho de peso animal. *Revista Brasileira de Zootecnia*, 32(5), .1037-1044. doi: 10.1590/S1516-35982003000500002

Cappelle, E. R., Valadares Filho, S. C., Silva, J. F. C., & Cecon, P. R. (2001). Estimativas do Valor Energético a partir de Características Químicas e Bromatológicas dos Alimentos. *Revista Brasileira de Zootecnia*, *30*(6),1837-1856. doi: 10.1590/S1516-35982001000700022

Clipes, R. C., Silva, J. F., Detmann, E., & Vásquez, H. M. (2006). Composição químico-bromatológica da forragem durante o período de ocupação em pastagens de capim-elefante (*Pennisetum purpureum*, Schum) e capim-mombaça (*Panicum maximum*, Jacq) sob manejo rotacionado. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*, *58*(5), 868-876. doi: 10.1590/S0102-09352006000500024

Cochran, R. C., Adams, D. C., Wallace, J D., & Galyean, M. L. (1986). Predicting digestibility of different diets with internal markers: Evaluation of four potential markers. *Journal of Animal Science, 63*(5),1476-1483. doi: 10.2527/jas1986.6351476x

Cóser, A. C., Martins, C. E., Fonseca, D. M. D., Salgado, L. T., Alvim, M. J., & Teixeira, F. V. (1999). Effect of different grazing periods in elephant grass pasture upon milk production. *Pesquisa Agropecuária Brasileira, 34*(5), 861-866. doi: 10.1590/S0100-204X1999000500018

Ferreira, D. F. (2011). Sisvar: a computer statistical analysis system. *Ciência e Agrotecnologia, 35*(6), 1039-1042. doi: 10.1590/S1413-70542011000600001

Kimura, F.T.; & Miller, V.L. (1957). Chromic oxide measurement. Improved determination of chromic oxide in cow feed and feces. *Journal Agriculture Food Chemistry, 5*, 216-232. doi: 10.1021/jf60073a008.

Köppen, W. (1948). *Climatologia: con un estudio de los climas de la tierra*. Mexico, MX: Fondo de Cultura Econômica.

National Research Council [NRC]. (2001). *Nutrient requeriments of dairy cattle* (7th ed.). Washinton, DC: National Academy Press.

Sklan, D., Ashkenazi, R., Braun, A., Devorin, A., & Tabori, K. (1992). Fatty acids, calcium soaps of fatty acids, and cottonseeds fed to high yielding cows. *Journal of Dairy Science,* 75, 2463-2472. doi: 10.3168/jds.S0022-0302(92)78008-4

Van Soest, P. J. (1994). *Nutritional ecology of the ruminant*. New York, NY: Cornell University Press.

Van Soest, P. J., Robertson, J. B., & Lewis, B. A. (1991). Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. *Journal of Dairy Science, 74*(10), 3583-3597. doi: 10.3168/jds.S0022-0302(91)78551-2

VoltolinI, T. V., Santos, F. A. P., Martinez, J. C., Clarindo, R. L., Penati, M. A., & Imaizumi, H. (2010). Características produtivas e qualitativas do capim-elefante pastejado em intervalo fixo ou variável de acordo com a interceptação da radiação fotossinteticamente ativa. *Revista Brasileira de Zootecnia, 39*(5), 1002-1010. doi: 10.1590/S1516-35982010000500009