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Performance of crossbred lactating cows at grazing in response to nitrogen supplementation and different levels of concentrate feed

[*Desempenho de vacas mestiças leiteiras a pasto em resposta à suplementação nitrogenada e a diferentes níveis de concentrado*]

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ABSTRACT

The performance of crossbred (1/2 Holstein x Zebu) cows supplemented on *Brachiaria decumbens* pasture during the wet-dry transition period was evaluated. Eight cows with 497±50kg, during third and fourth lactations and after the lactation peak were distributed in two 4 x 4 Latin squares. The treatments consisted of a factorial with two types of mineral supplements (nitrogenous and mineral salt) and two levels of concentrate (0.3 and 0.6% body weight (BW)/cow/day), based on corn and soybean meal (60:40), and supplied during the morning and afternoon milking. The experiment lasted 56 days, divided into four periods of 14 days, with seven days for adaptation and seven for data collection. No interaction (P> 0.05) was observed between the supplements and the concentrate levels. The nitrogenous salt and the highest concentrate level increased (P< 0.05) the intake of crude protein, and the highest concentrate level increased (P< 0.05) the intake of non-fibrous carbohydrates and the digestibility of crude protein. No effect (P> 0.05) of supplement and concentrate level was observed on the milk constituents and feed efficiency. Grazing crossbred after the lactation peak during the wet-dry transition period achieve the productive potential with 0.3% BW of concentrate per day and mineral salt.

Keywords: dairy cow, feed evaluation, milk, supplementation, tropical pasture

RESUMO

Foi avaliado o desempenho de vacas mestiças (1/2 Holandês x Zebu) suplementadas em pastagens de Brachiaria decumbens *durante o período de transição águas-seca. Oito vacas com 497±50kg, durante a terceira e a quarta lactação e após o pico de produção, foram distribuídas em dois quadrados latinos 4 x 4. Os tratamentos consistiram de um fatorial com dois tipos de suplementos (sal nitrogenado e sal mineral) e dois níveis de concentrado (0,3 e 0,6% do peso corporal (PC)/vaca/dia), baseado em milho e farelo de soja (60:40) e suprido durante as ordenhas da manhã e da tarde. O experimento durou 56 dias, divididos em quatro períodos de 14 dias, sendo sete dias para adaptação e sete para coletas. Não foi encontrada interação (P>0,05) entre os suplementos e os níveis de concentrado. O sal nitrogenado e o maior nível de concentrado aumentaram (P<0,05) o consumo de proteína bruta, e o maior nível de concentrado aumentou (P<0,05) o consumo de carboidratos não fibrosos e a digestibilidade da proteína bruta. Não foi observado efeito (P>0,05) de suplemento e de nível de concentrado sobre os componentes do leite e a eficiência alimentar. Vacas mestiças após o pico de lactação durante o período de transição águas-seca alcançam seu potencial produtivo com 0,3% do PC/dia de concentrado e sal mineral.*

Palavras-chave: vacas, avaliação de alimentos, leite, pastagem tropical, suplementação

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INTRODUCTION

The use of pasture is traditionally the most widely used production system in Brazilian livestock, mainly because it represents the most inexpensive system of ruminant production (Dias-Filho, 2011).

Pastures present some restrictions associated with the rapid vegetative growth in the summer (wet season), insufficient availability of dry matter in the winter (dry season) and low protein content, low digestibility and high cell wall content for most of the year. Consequently, the activity of rumen microorganisms is limiting, which can prejudice the use of available energy from forage, resulting in a decrease in dry matter intake and animal performance (Ramírez *et al*., 2009; Baroni *et al*., 2010).

Initially, pasture supplementation programmes aimed to overcome the difficulties of the forage shortage period. However, with the incessant and necessary quest for greater efficiency in activity, supplementation was recently also suggested in the wet season, when there is a greater supply of forage, to potentiate the performance of the animals by increasing the total dry matter, protein and energy intake (Porto *et al*., 2009).

The objective of this experiment was to evaluate the effect of nitrogen supplementation and two levels of concentrate on the intake and digestibility of dry matter and its constituents, milk production and composition, and dietary efficiency of crossbred (½ Holstein vs. Zebu) cows in lactation, in a tropical pasture of *Brachiaria decumbens* during the wet-dry transition period.

MATERIALS AND METHODS

The experiment was conducted at Boa Vista farm, Cachoeirinha district, which belonged to the Universidade Federal de Viçosa (UFV), Viçosa-MG, Brazil, during the transition of the wet-dry period, following the rules of The Ethic Commission in Use of Production Animals of Universidade Federal de Viçosa, number 01/2013.

The city of Viçosa is located in the region of Zona da Mata, in the State of Minas Gerais, at 649m altitude. It is geographically defined by the coordinates 20° 45' 20" south latitude and 42° 52' 40" west longitude. The climate is of type Cwa, according to the classification proposed by Köppen, and the average rainfall is 1,341.2mm/year.

Eight ½ Holstein-Zebu cows, with initial average body weights of 497±50kg (mean ± SD), between the third and fourth lactation, after peak production (100 days postpartum) and with average milk yield of 10kg/day, were used. The cows were kept in a managed area with *B. decumbens* pasture during the wet-dry transition period. The experiment was evaluated according to a 4 x 4 Latin square design (four cows, four treatments and four periods) using two simultaneous squares to guarantee the adequate degrees of freedom for the error.

The experiment lasted 56 days. It was divided into four experimental periods of 14 days. The first seven days were for adaptation, and the last seven were for data collection and sampling.

The treatments consisted of a 2 x 2 factorial arrangement of treatments, with two forms of supplement use (mineral salt versus nitrogenous salt) provided *ad libitum* in a covered feed bunk in the pasture, and two levels of concentrate (0.3 and 0.6% body weight of concentrate/animal/day). Concentrates had approximately 0.26kg/kg of crude protein, based on 0.60 and 0.40kg/kg of corn meal and soybean meal, respectively, divided into two portions and supplied during morning and afternoon milking. The animal was expected to eat all the concentrate during milking. The nitrogenous salt contained 0.50, 0.25 and 0.25kg/kg of corn meal, urea:ammonium sulphate 9:1 and mineral salt, respectively, to achieve an intake of 150g of urea/cow/day or 1.2% of urea in the total dry matter. In addition to pasture, supplements and concentrate, water was provided *ad libitum*. The chemical composition of the food and the supplements are listed in Table 1.

Table 1. Chemical composition of the concentrate, nitrogenous salt and *B. decumbens*

Item[1]	Concentrate[2]	Nitrogenous salt[3]	*B. decumbens*[4]
DM[5]	85.90	86.12	32.26
OM[5]	96.92	75.29	91.50
CP[5]	26.10	66.52	7.61
NDIN[6]	26.98	4.40	35.02
EE[5]	2.66	1.29	1.16
NDFap[5]	19.02	10.15	63.21
NDFi[5]	2.03	1.42	23.10
NFC[5]	49.14	11.57	9.82

[1]Values in percentage of dry matter, except DM, which is expressed in percentage of natural matter. [2]Concentrate: 0.60 and 0.40kg/kg of corn meal and soybean meal, respectively. [3]Nitrogenous salt: 0.50, 0.25 and 0.25kg/kg of corn meal, urea:ammonium sulphate 9:1 and mineral salt, respectively.[4] Average of samples obtained by manual grazing simulation during the entire experimental period. [5]DM – dry matter; OM – organic matter; CP – crude protein; EE – ethereal extract; NDFap – neutral detergent fibre corrected for ashes and protein; NDFi – indigestible neutral detergent fibre; and NFC – non-fibrous carbohydrates, all in g/kg of DM. [6]NDIN – Neutral detergent insoluble nitrogen, in g/kg of total nitrogen.

The supplied mineral salt was a commercial mineral supplement containing: Calcium (15.6%); Phosphorus (5.1%); Sulphur (2.0%); Magnesium (3.3%); Sodium (9.3%); Potassium (2.82%); Cobalt (0.003%); Copper (0.040%); Chromium (0.001%); Iron (0.2%); Iodine (0.004%); Manganese (0.135%); Selenium (0.002%); Fluorine (0.051%); Zinc (0.170%); Vitamin A (135,000.00I.U.); Vitamin D3 (68,000.00I.U.); and Vitamin E (450.00I.U.). Phosphorus solubility was 95%.

A pasture area of four hectares was divided into two paddocks. Each of the two paddocks was divided into seven sub-paddocks: 1-7 for the supply of nitrogenous salt and 8-14 for the mineral salt. The animals were rotated and supplemented in the sub-paddocks every two days for better pasture utilization and the elimination of possible paddock effects on the treatments. At the end of each experimental period, the cows returned to the first sub-paddock.

The evaluation of intake and digestibility of the components of the diets, milk production and composition, daily body weight variation and food efficiency were measured from the 7th to the 14th day.

Sampling for the qualitative evaluation of the pasture consumed by the animals was performed through manual grazing simulation. During the collection data and sampling periods of each experimental sub-period, the grazing was quantified every two days by simulated grazing. It was then used to estimate the intake and digestibility coefficients. The sample was weighed and immediately taken to the oven with forced air circulation at 55°C and milled with a knife mill (1mm and 2mm).

On the 13th day of each experimental period, a pasture sample was collected to quantify the availability of dry matter (DM) and potentially digestible dry matter (DMpd), with a cut close to the soil of four areas delimited by a metal square of 0.5 x 0.5m that was randomly selected in each experimental paddock. After the collection, each sample was weighed and homogenized, and a composite sample was elaborated from the samples of each paddock. The DMpd was estimated according to the following equation, described by Porto *et al*. (2009): $DMpd = 0.98 \times (100 - NDF) + (NDF - NDFi)$, where: DMpd = potentially digestible dry matter (g/100 g); 0.98= true digestibility of the cell contents; NDF = neutral detergent fibre (g/100g); and NDFi = indigestible neutral detergent fibre (g/100g).

On the 14th day of the experimental period, after milking in the morning, individual weighing of the animals was performed to evaluate the weight variation, as well as the body condition score (BCS). A score scale of one to five points was used, as recommended by the National Research Council (Nutrient..., 2001). Scoring was obtained by three suitably trained assessors.

Intake and digestibility estimates were made during each subperiod, from the 5th to the 13th day, and the first days were used to adapt the animals to the indicators. To estimate faecal excretion, 20g of chromic oxide/animal/day (Cr_2O_3), packed in paper cartridges and introduced by an oesophageal probe, were used as an external indicator in a daily portion at 8:00 a.m. To estimate the individual intake of the mineral salt and nitrogenous salt supplement, titanium dioxide (TiO_2) was added, mixed in the supplement in the proportion of 10g of indicator for each kg of supplement. The NDFi was used as an internal indicator to estimate the digestibility, together with faecal excretion, making it possible to estimate the dry matter intake of pasture.

For the estimation of the digestibility coefficients, faecal samples were collected directly in the rectal ampulla in the amount of 300g on the last three consecutive days (12th to 14th day of each experimental period) according to the following distribution: 12th day at 4:00 p.m., 13th day at 12:00 p.m. and 14th day at 8:00 a.m. This distribution aimed at the preparation of a daily composite sample for a better representation of faecal excretion. The samples were placed in plastic bags and stored at -20°C for further drying, milling and chemical analysis.

The analyses for the determination of dry mass and chemical composition of food, faeces and leftovers were conducted at the Animal Nutrition Laboratory of the Department of Animal Science of the UFV.

For laboratory analyses, the composite samples of feed, pasture and faeces, per animal and per experimental period, were thawed and dried in a forced ventilation oven (55°C/72 hours). Subsequently, the samples were homogenized. A composite sample of faeces based on the dry weight in air, per animal, of the three days of collection was elaborated. All samples were processed in a Willey-type mill with a 1mm mesh sieve (laboratory chemical analysis) and a 2mm mesh sieve (ruminal incubation for NDFi determination). Samples composed by animal and experimental period were then prepared and stored in plastic containers. Analyses of dry matter, mineral matter, ethereal extract, and crude protein were performed according to procedures described by Detmann *et al*. (2012).

For the NDF analysis, samples of forage, concentrates and faeces were treated with thermostable alpha amylase, without the use of sodium sulphite, according to the recommendations in Mertens (2002). Corrections of the ash and protein contents contained in the NDF were conducted according to Detmann *et al*. (2012).

The non-fibrous carbohydrate (NFC) content of diets was calculated as follow: NFC = 100 – MM – EE – NDFap – (CP – CP of urea + Urea), where MM = mineral matter, EE – ethereal extract, NDFap – neutral detergent fibre corrected for ashes and protein, CP – crude protein and urea, all in g/100g (Detmann; Valadares Filho, 2010).

The total digestible nutrient values (TDN) were calculated for the different diets, as adopted by NRC (Nutrient..., 2001): TDN (g/100 g) = CPd + NDFapd + NFCd + (2.25 x EEd), where CPd, NDFapd, NFCd and EEd represent the total digestible nutrients, and TDN is based on the dry matter of the diets.

For the determination of NDFd, the food and faecal samples were dried and ground in a 2mm mesh sieve and sequentially packed in previously prepared non-woven fabrics bags (100g/m^2, dimension 4cm x 5cm) in duplicate. The bags were incubated via cannula in the rumen of a crossbred cow receiving a mixed diet for 264 hours (Casali *et al*., 2008). After the incubation period, the bags were washed in running water until completely clear and subjected to neutral detergent extraction for one hour, to evaluate the indigestible neutral detergent fibre (NDFi) as an internal indicator (Mertens, 2002).

The chromium contents were analysed in the faecal samples using nitroperchloric digestion and atomic absorption spectrophotometry (Souza *et al*., 2013), and titanium dioxide was analysed by colorimetry (Titgemeyer *et al*., 2001).

The excretion of faecal DM was estimated using the chromic oxide indicator, and it was estimated based on the ratio between the amount of indicator supplied and its faecal concentration: Faecal dry matter (g/day) = ((amount of indicator supplied, g) x 100)/Faecal indicator concentration (g/100g).

The estimate of individual intake of the supplement was obtained with TiO_2 as follow: IIS = ((FE x ICF)/ISGG) x SGG, where: IIS = individual intake of supplement (kg/d); FE = faecal excretion (kg/day); ICF = indicator concentration in animal faeces (kg/kg); ISGG = amount of indicator in the supplement given to the group of animals (kg/d); and SGG = amount of supplement given to the group of animals (kg/d).

The estimation of the voluntary dry matter intake (DMI) was performed using NDFi as the internal indicator, according to the following equation: DMI (kg/d) = {[(FExICF) – IIFS]/ICFO} + SDMI + CDMI, where: FE = faecal excretion (kg/d); ICF = indicator concentration in animal faeces (kg/kg); IIFS = intake of indicator from supplement (kg); ICFO = indicator concentration in the forage (kg/kg); SDMI = supplementary dry matter intake (kg/d); and CDMI = concentrate DMI (kg/d).

The cows were milked twice a day at 7:00 a.m. and 3:00 p.m., with the presence of calves. Milk was weighed in the morning and afternoon, on days 12 to 14 of each experimental period. Two samples of milk per cow were obtained, in the afternoon of the 13^{th} day and in the morning of the 14^{th} day of each experimental period, in the division of 1/3 and 2/3, being composed of animal and period. The samples were stored in bottles containing Bronopol®, kept at 2-6°C and sent to the Laboratory of Animal Nutrition of the UFV for analysis of protein, fat, lactose and total dry matter, according to the methodology described by the International Dairy Federation (Whole..., 1996).

The production of corrected milk (PCM) to 35g/kg fat was estimated according to Sklan *et al*. (1992) by the following equation: PCM = (0.432 + 0.1625 x percentage milk fat) x milk production in kg/day.

The feed efficiency was calculated for each cow by dividing the average milk yield by the average DM intake of each experimental period. The results were submitted to an analysis of variance using the Statistical and Genetic Analysis System (Sistema..., 2000). The effect of concentrate, supplement and interaction levels was considered significant at the 0.05 probability level. In the case of a non-significant interaction, the variables were analysed independently.

RESULTS AND DISCUSSION

Estimates of total DM availability and dry matter potential digestibility (DMpd) of forage during the experiment decreased from the first to the fourth experimental period (6628kg/ha, 5244kg/ha, 5830kg/ha and 5922kg/ha of DM, and 4611kg/ha, 3606kg/ha, 3498kg/ha and 2992kg/ha of DMpd), probably in response to the change in seasonality from the wet to the dry season. According to Bodine and Purvis (2003), forage mass between 3800 and 4500kg/ha is not a limiting factor for animal performance.

The average values of DM and DMpd were 5922kg/ha and 3677kg/ha, respectively, giving a potential forage digestibility of 61.9%. Not all DM consumed by the animal was used, and it should be based on the availability of DMpd. The content of DMpd decreased in each experimental period, causing a lower forage intake.

No significant effect ($P > 0.05$) was observed for the interaction between mineral supplements and concentrate levels for any of the evaluated variables, and only the main effects (supplements and concentrate levels) on the studied variables were presented.

The characteristics of body weight, daily weight variation and body condition score were neither affected ($P > 0.05$) by mineral supplements (mineral salt or nitrogenous salt) nor by concentrate levels (Table 2). Body weight was expected to increase with an increase in the concentrate level, due to the greater offering of nutrients, such as energy and protein, as observed by Pimentel *et al*. (2013), who verified average daily gains of 259g/day. The body condition score was not affected by the different treatments, probably due to the better grazing quality at the beginning of the experiment.

Table 2. Body weight (BW), daily weight variation (DWV) and final body condition score (BCSf) as a function of different treatments

Item	Supplement*		Concentrate (%BW/day)*		SEM
	MS	NS	0.3	0.6	
BW (kg)	496.5	494.1	496.5	494.1	15.200
DWV (kg)	-0.80	-0.26	-0.31	-0.75	0.481
BCSf	3.01	3.16	3.02	3.15	0.142

BW= body weight; SEM= standard error of mean; MS= mineral salt; NS= nitrogenous salt.
*Non-significant (P> 0.05) for all variables.

The daily intake of DM, DM from pasture, OM, EE, NDFap, NFC, NDFi, digestible OM, digestible NDF and TDN was not affected by supplementation (P> 0.05; Table 3). Mineral supplements affected (P< 0.05) the intake of CP, where the cows that consumed the nitrogenous salt had higher CP intake due to higher urea intake.

An increase in the concentrate level did not affect the daily intake of dietary components by dairy cows grazing (P> 0.05), except for the intake of crude protein and non-fibrous carbohydrates (P< 0.05), which increased with increasing levels of concentrate in the diet (Table 3). This attribution was due to the greater contribution of these constituents in the highest concentrate level.

Table 3. Intake of feed constituents as a function of different treatments

Item	Supplement		Concentrate (%BW/day)		SEM
	MS	NS	0.3	0.6	
			kg/day		
DM	11.31	11.00	10.83	11.48	0.837
DMp	9.38	8.54	9.27	8.65	0.837
OM	10.35	10.02	9.85	10.52	0.751
CP	1.22[a]	1.41[b]	1.17[a]	1.46[b]	0.067
EE	0.17	0.17	0.16	0.18	0.013
NDFap	6.10	5.99	6.12	5.97	0.529
NFC	2.85	2.64	2.49[a]	3.00[b]	0.157
NDFi	1.95	2.08	2.06	1.97	0.126
OMd	5.49	5.14	5.04	5.59	0.596
NDFd	2.99	2.83	3.01	2.81	0.400
TDN	5.47	5.34	5.12	5.69	0.541
			g/kg body weight		
DM	22.88	22.44	21.95	23.37	1.420
DMp	18.96	17.42	18.81	17.52	1.379
OM	20.93	20.43	19.96	21.40	1.268
NDFap	12.34	12.22	12.41	12.15	0.869
NDFi	3.94	4.26	4.19	4.01	0.253

BW = body weight; SEM = standard error of mean; MS = mineral salt; NS = nitrogenous salt; DM = dry matter; DMp = dry matter from pasture; OM = organic matter; CP = crude protein; EE = ethereal extract; NDFap = neutral detergent fibre corrected for ashes and protein; NFC = non-fibrous carbohydrates; NDFi = indigestible neutral detergent fibre; OMd = digestible organic matter; NDFd = digestible NDF; TDN = total digestible nutrients.
[a, b] Treatments with different letters differ statistically for supplement or concentrate (P< 0.05).

A decrease in pasture dry matter intake with increased supplementation is known as the substitution rate, which is one of the main factors related to the variation observed in the milk production response using different types of supplementation (Bargo *et al*., 2002). However, concentrate level had no significant effect (P> 0.05) on pasture intake.

Bwire and Wiktorsson (2003) and Pérez-De La Ossa *et al*. (2013) reported an increase in dry matter intake according to the higher inclusion of concentrate in the diet of cows with additive effect, which was different from the present study. The fibre content decreased with the greater inclusion of concentrate in the diets, causing a reduction of rumination and, consequently, increasing the passage rate.

There was no effect of mineral supplementation (P> 0.05) on the digestibility of DM, OM, EE, NDFap, NFC and TDN (Table 4). In the case of the concentrate level, there was only an effect for the digestibility of CP (P< 0.05), in which the greater inclusion of concentrate in the diet generated a high intake of nitrogenous compounds, supporting a greater development of ruminal microorganisms (Uddin *et al*., 2015), as well as the lower participation of endogenous nitrogen in digestibility estimation.

Table 4. Total apparent digestibility of feed constituents and total digestible nutrients as a function of different treatments

Item	Supplement		Concentrate (%BW/day)		SEM (%)
	MS	NS	0.3	0.6	
			g/kg		
DM	484	468	465	490	32
OM	523	503	502	524	28
CP	588	641	589[a]	640[b]	16
EE	-633	-542	-246	-929	51
NDFap	476	455	478	453	37
NFC	622	593	571	644	34
			g/kg of dry matter		
TDN	477	477	465	489	24.7

BW = body weight; SEM = standard error of mean; MS = mineral salt; NS = nitrogenous salt; DM = dry matter; OM = organic matter; CP = crude protein; EE = ethereal extract; NDFap = neutral detergent fibre corrected for ashes and protein; NFC = non-fibrous carbohydrates; TDN = total digestible nutrients.
[a, b] Treatments with different letters differ statistically (P< 0.05).

The digestibility of EE observed in this study presented negative values in all treatments due to the low EE levels in the diets consumed by the animals, causing intake below the faecal metabolic contribution.

No effects (P> 0.05) of mineral supplementation and concentrate level on milk yield and feed efficiency were observed (Table 5). Increased milk production was expected with the highest level of concentrate due to a possible increase in DM intake and digestibility, which would provide more energy intake, which increases the concentration of propionate in the rumen, leading to a greater amount of substrate for glucose production in the liver. This available glucose is used in the synthesis of lactose, promoting the osmotic potential increase and favouring the transport of water to the interior of the alveolar lumen of the mammary gland (Griinari *et al*., 1997).

Table 5. Milk yield, feed efficiency and milk composition as a function of different treatments

Item	Supplement*		Concentrate (%BW/day)*		SEM
	MS	NS	0.3	0.6	
MY, kg/day	9.75	9.79	9.41	10.12	0.440
MYc, kg/day	9.56	9.62	9.26	9.92	0.557
FEf[3]	0.89	0.91	0.92	0.90	0.077
Milk composition, g/kg					
Fat	34.1	34.4	34.0	34.3	3.378
Protein	29.0	29.3	28.4	29.9	0.843
Lactose	41.6	42.4	41.5	42.4	1.120
TDE	115	117	115	118	3.047
DDE	81.5	82.7	80.8	83.3	1.327

BW = body weight; SEM = standard error of mean; MS = mineral salt; NS = nitrogenous salt; MY = milk yield; MYc = milk yield corrected to 3.5% fat; FEf = feed efficiency (kg of milk/kg of DMI); TDE = total dry extract; DDE = defatted dry extract.
*Non-significant (P> 0.05) for all variables.

The lack of effect obtained for milk yield and feed efficiency by nitrogenous supplementation and the highest concentrate level may be related to the reduction of nutrient utilization with their increased supply in the diet (Sinclair *et al*., 2013). This effect occurs as a curvilinear (Bargo *et al*., 2003) or hyperbolic response due, among other factors, to the existence of a biological limit of nutrient utilization by the animals (Lana *et al*., 2005).

There was no effect (P> 0.05) of mineral supplementation and level of concentrate on milk composition (Table 5). Fat is the milk component with the greatest variation caused by the diet, with changes in the rumen fermentation processes (Sutton, 1989). Silva *et al*. (2001) reported that fat production decreased linearly with increase in urea. According to Teixeira *et al*. (2015), crossbred Holstein-zebu cows increased fat and protein contents, as the fraction of Holstein breed decreased, due to the reduction of milk yield. However, in the current analysis, no significant variation in milk fat was observed.

The milk production verified in this experiment (Table 5) was within the range of 9.3 to 17.3kg of milk/day in crossbred cows, according to Oliveira (2015). Some authors obtained yields ranging from 10.5 to 12.1kg of milk/day in similar conditions (Silva *et al*., 2009, Pimentel *et al*., 2013).

The intake of DM, TDN and CP were not satisfied in the different treatments in comparison with the NRC 2001 (Table 6), for cows after three weeks of lactation, with 500kg of weight and 10kg of milk/day. Pasture utilization and the lowest level of concentrate provided better efficiency for milk production.

Table 6. Observed and estimated intakes of feed constituents by crossbred lactating cows as a function of supplement and diet concentrate level

Item	Requirement[1] (kg/d)	Treatment							
		MS	NS	0.3	0.6	MS	NS	0.3	0.6
		kg/d				Difference[2] (kg/d)			
DM	13.7	11.31	11.00	10.83	11.48	-2.40	-2.7	-2.87	-2.22
TDN	8.45	5.47	5.34	5.12	5.69	-2.98	-3.11	-3.33	-2.76
CP	1.88	1.22	1.41	1.17	1.46	-0.66	-0.47	-0.71	-0.42
NDF	3.84	6.10	5.99	6.12	5.97	2.26	2.15	2.28	2.13

[1]Requirements estimated according to NRC 2001, for cows after three weeks of lactation, with 500kg of weight and production of 10kg of milk/day. [2]Differences between the amount eaten and established requirements.
MS = mineral salt; NS = nitrogenous salt; DM = dry matter; TDN = total digestible nutrients; CP = crude protein; NDF = neutral detergent fibre.

CONCLUSIONS

Crossbred cows after the lactation peak, in tropical pasture during the wet-dry transition period, reach their productive potential with 0.3% BW/day of concentrate. It was not efficient to use nitrogenous salt, since pastures had adequate levels of protein.

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