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Behavior of beef cattle and the microclimate with and without shade

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ABSTRACT. It was evaluated the intake behavior of Nellore steers in system without shade (WS), and silvopastoral system (SP) maintained in star grass (*Cynodon plectostachyus*) in summer and winter. Twenty-four Nellore steers were used (12 in each system), mean age 18 months and weight of 294.5 kg. The design was completely randomized with two seasons, two treatments, 24 hours and 12 repetitions. The observations were conducted in three days, for 24 hours, with an interval of 15 minutes, with effect of the hour on the grazing behavior (GRAZ) with a maximum of 52.1% and lying ruminating (LYRUM) with a minimum of 12.3%, both at 14h. The lying idle (LYIDL) was influenced by hour with a minimum of 11,6%at 14h, and by season, with 23.9% in summer, and 13.9%, in winter. However, the standing ruminating (STRUM), without effect of hour, was affected by the interaction of season x system in summer (9.43%) and (6.19%), and winter (4.36%) and (8.27%), respectively, for SP and WS. Standing idle (OCEMP) was influenced by hour, with maximum 15.8% at 14h, and an interaction of system x season, in summer (20.10%) and (8.82%); and winter (9.05%) and (8.44%), respectively, for SP and WS. The SP system has changed the environment that affected the animal intake behavior.

Keywords: welfare, season, Nelore, shadow.

Comportamento de bovinos de corte e o microclima em sistema com e sem sombra

RESUMO. Avaliou-se o comportamento ingestivo de novilhos anelorados, em sistema sem sombra (SS), e em sistema silvipastoril (SP) mantidos em grama estrela (*Cynodon plectostachyus*) no verão e inverno. Foram utilizados 24 novilhos anelorados (12 em cada sistema), com média de 18 meses e peso de 294,5 kg. O delineamento foi inteiramente casualizado com duas estações, dois tratamentos, 24h e 12 repetições. As observações foram realizadas em três dias, durante 24h, com intervalo de 15 min., com efeito da hora para os comportamentos pastando (PAST) com máxima de 52,1% e ruminando deitado (RUDEIT) com mínima de 12,3%, ambos às 14h. O ócio deitado (OCDEIT) foi influenciado pela hora e estação, em que nas horas com mínima de 11,6% às 14h enquanto no verão (23,9%) e inverno (13,9%). Ruminando em pé (RUEMP), sem efeito da hora, porém sofreu interação estação x sistema, no verão (9,43%) e (6,19%); e inverno (4,36%) e (8,27%), respectivamente, para SP e SS. O ócio em pé (OCEMP) sofreu efeito da hora, com máxima de 15,8% às 14h, e interação estação x sistema, no verão (20,10%) e (8,82%); e inverno (9,05%) e (8,44%), respectivamente, para SP e SS. O sistema SP alterou o ambiente afetando o comportamento ingestivo animal.

Palavras-chave: bem-estar, estação do ano, Nelore, sombra.

Introduction

Studies on intake behavior of ruminants are used to establish the relationship between behavior and nutrient intake, and to verify the potential use of knowledge about the feeding behavior to improve animal performance (MENDES et al., 2010).

According to Zanine et al. (2007), the study on the ingestive behavior is an important tool for the elaboration of management protocols, which may facilitate and increase the productivity when properly designed and executed. Therefore, knowledge of the patterns of choice behavior, location, and ingestion of pasture by animal are essential to establish management practices.

Pastures are the main source of food for cattle and the use of inappropriate management practices has caused degradation, and reduction of its quality (CARLOTTO et al., 2010), and thus the animals seektoadjust their behavior in order to meet their needs.

The climatic factors must be considered in animal production since they may change the physiological behavior of animals, causing a decline in production, mainly under low food availability (MARQUES et al., 2005). According to Hodgson (1990), this can be considered an adaptation of animals to environmental conditions and management, once the ruminants modify their intake behavior to achieve and maintain certain level of consumption, consistent with their nutritional requirements.

Silvopastoral systems have been widely studied and applied in agriculture and livestock of tropical and subtropical regions. However, the ideal is to plan the spacing between trees, allowing a balanced growth between trees and pasture (SOARES et al., 2009).

According to Leme et al. (2005), given the high levels of solar radiation in tropical regions, the shade of trees can favor significantly the performance of the animals, once Souza et al. (2010) stated that the intake behavior is influenced by the presence of trees in grazing environments.

In this way, this study evaluated the effect of the presence or not of trees on the intake behavior of Nellore steers and the microclimate in summer and winter.

Material and methods

The experiment was conducted in February (summer) and July (winter) 2010 in the northwest region of Paraná State, in the municipality of Paranavaí (22º 44' South and 52º 28' West), 453 m altitude, characterized by Cfa mesothermal humid subtropical climate, according to the classification of Köeppen (CAVIGLIONE et al., 2000).

It was evaluated the behavior of beef cattle in silvopastoral system (SP), consisting of star grass (*Cynodon plectostachyus*) intercropped with eucalyptus with two years of implementation and trees with average height of 8 m and in a system without shade (WS) in summer and winter. In order to observe the behavior, paddocks were used with an area of 6.05 ha in each system.

In the silvopastoral system (SP), the trees were arranged in double rows, at the ground level, with an average density of 290 trees per hectare, with spacing of rows, with 2.5 x 2.5 m between trees and 25 m between rows. The trees were not pruned during their development.

Twenty-four Nellore steers were used, with average live weight of 280 ± 50 kg (summer) and 309 ± 40 kg (winter) individually identified with non-toxic paint at wither height and fourth hindquarter. The animals were distributed into the systems (12 each) and adapted to each environment and the presence of people mounted on horses, with no escape behavior in the presence of observers. For night observation was used artificial lighting.

The behavior of animals was observed by using the focal sampling route method and instant collection route (MARTIN; BATESON, 1994).

For each season, the observations of behavior were conducted during three days for 24 hours, with sampling interval of 15 min., totaling 13,824 observations. The observations were performed by trained pairs, mounted on horses, taking turns with each 6h period, according to Souza et al. (2010).

The choice of days for observation was scheduled to occur on days with minimal cloud cover and with no rainfall, and during the observation period the animals received only mineral supplementation as regular management.

The observed activities were: grazing (GRAZ); standing ruminating (STRUM) and lying (LYRUM), standing idle (STIDL) and lying (LYIDL).

The behavioral activities were considered as mutually exclusive, that is, at each record, each animal was classified performing only one activity.

For the SP system, in the seasons, wind speed (Ws), air temperature (Ta), relative humidity (RH) and black globe temperature (Tg) were recorded at the geometric center of the shadow (mobile) and between rows (fixed). For the WS system the same variables were registered, with a fixed location.

The environmental variables (Ws, Ta and RH) were collected by using a pocket weather station Kestrel® 3000. The Tg was obtained with the use of a globe with black plastic ball (15 cm diameter) and alcohol column thermometer.

In data collection, the gears were placed at 1.60 m above the ground simulating the height of the dorsum of animal. For the evaluation of the shade, the gears were placed in the center of the shade, and moved with the movement of the shade. It had been performed a prior study of this displacement for each station.

The climate data collection was carried out simultaneously with the collection of behavioral data, every hour during the 24 hours.

For the evaluation of environments, the black globe-humidity index (BGHI) (BUFFINGTON et al., 1981) was used:

$$BGHI = Tg + 0.36\, Dpt + 41.5$$

where:

Tg = black globe temperature (ºC);

Dtp = dew-point temperature (°C).

where:

$Dtp = 273.15[0.971452–0.057904 \log_e P_p\{Ta\}]^{-1} – 273.15$; $P_p\{_{Ta}\}$ = Vapor partial pressure of air at Ta, where:

$P_p\{_{Ta}\} = (P_s\{ Ta \} \times RH) / 100$; RH =Relative humidity;

$P_s Ta\} = 0.61078 \times 10^{(7.5 \times Ta)/(Ta+237.5)}$;

Ta = Air temperature.

and determined the radiant thermal load index (RTL), proposed by Esmay (1979):

$$RTL = \sigma T_{rm}^4, W m^{-2}$$

where:

σ = Stefan-Boltzmann constant, 5.67×10^{-8} $Wm^{-2}K$-4;

T_{mr} = mean radiant temperature (°K);

$T_{mr} = \{100 \{2.51 WS^{0,5} (Tg - Ta) + ((Tg + 273.15) / 100)^4\}^{0.25}$.

where:

Ta = air temperature (°C);

Tg = black globe temperature (°C);

Ws = wind speed (m s^{-1}).

The forage availability evaluation was made before the start of grazing by double sampling methodology from Wilm et al. (1944), and forage offer (FO) was determined as the fraction between the available forage and animal average load on each date of behavior evaluation and expressed as kg ha^{-1} of dry matter DM leaf day^{-1} for live weight (LW) (SOLLENBERG et al., 2005). The bromatological analysis, the fractions leaf and stem + green sheath were ground in a Willey mill with a sieve of 1 mm and, posteriorly, the levels of dry matter (DM) at 105°C, crude protein (CP) by the method of AOAC (1990) and neutral detergent fiber (NDF) according to Van Soest et al. (1991).

The experimental design was completely randomized, with two seasons, two treatments (systems), 24h and 12 repetitions, and the data were submitted to analysis of variance, according to the GLM procedure of SAS (2008), and the mean values compared by Tukey's test at 5% probability.

The percentage of records of each behavior in each hour was arcsine of square root transformed into a normal distribution.

Results and discussion

In the summer, the availability of dry matter (DM) of leaves in the SP was 1,757 kg ha^{-1}, and in the WS was 1,376 kg ha^{-1}; in winter, the SP had 223 kg ha^{-1}, and WS, 357 kg ha^{-1}. For the stem, in the summer, we registered for the SP 4,876 kg ha^{-1} and for the WS, 3.793 kg ha^{-1}, and the SP in the winter had 1,006 kg ha^{-1} and WS, 1,383 kg ha^{-1} (Table 1). These results indicate, in the summer, due to the average live weight of steers (LW) with 208 kg, an adequate offer of leaves (FO) with 17.43% (SP) and 13.65% (WS), but in the winter this offer was limiting with LW of 309 kg and offer of 2.00% (SP) and 3.20% (WS), since according to Hodgson (1990), the offer from two to three times the daily requirement of the animal (10 to 12% live weight) would provide the maximum performance of grazing animals. The leaf:stem ratio in the summer was 0.36:1 for both SP and WS, and in the winter was 0.22:1 and 0.26:1, considered to be low with an accumulation of dead matter in the winter 4,282 and 2,321 kg ha^{-1}, respectively, for the SP and WS systems. Rodrigues et al. (2006), studying five varieties of *Cynodon* grass, found good results in the leaf:stem ratio, ranging from 0.52:1 to 1.23:1.

During the summer, the levels of crude protein (CP) in the leaf were 13.28 in SP and 13.72% in WS in the winter, 15.76 in SP and 14.52% in WS. For the stems, in summer, it was verified the value 5.32 in SP and 4.97% in WS, while in winter, 4.27 in SP and 3.83% in WS. The levels of neutral detergent fiber (NDF), in the leaf during the summer was 72.65 in SP and 71.84% in WS, and in the winter, 68.32 in SP and 68.85% in WS. In summer, the stem presented 74.29 in SP and 79.13% in WS, while in the winter, 82.69 in SP and 80.62% in WS, being appropriate for the plant development. These values are similar to those found by Rodrigues et al. (2006) that examined the chemical composition of *Cynodon* and have verified values of CP from 14.5 to 26.1% in the leaves, and between 5.7 and 17.3% in stems. As for the NDF, the same authors found levels from 53.0 to 82.2% in the leaves, and between 65.3 to 85.6% in stems, evidencing that the plant age had affected ($p < 0.01$) the NDF values of stem.

Table 1. Availability of dry matter (DM), crude protein (CP) and neutral detergent fiber (NDF) in leaf and stem, leaf:stem ratio (L:S) DM of dead material (DeM), forage offer (FO) in the different treatments.

Treatments		Leaf			Stem			L:S	DeM	FO
		DM (kg ha^{-1})	CP (%)	NDF (%)	DM (kg ha^{-1})	CP (%)	NDF (%)		DM (kg ha^{-1})	(%)
Summer	SP	1757	13.28	72.65	4876	5.32	74.29	0.36:1	1408	17.43
	WS	1376	13.72	71.84	3793	4.97	79.13	0.36:1	2434	13.65
Winter	SP	223	15.76	68.32	1006	4.27	82.69	0.22:1	4282	2.00
	WS	357	14.52	68.85	1383	3.83	80.62	0.26:1	2321	3.20

SP = silvopastoral system; WS = system without shadow.

These results were also supported by Hodgson (1990) affirming that over time, the plants under go significant changes in composition and structure.

In summer, the minimum air temperatures (Ta) observed were 24.4 in the SP and 24.3°C in the WS, and maximum 34.6 in the SP and 36.4°C in the WS (Table 2). These maximum temperatures recorded are close to the upper critical temperature (UCT) found by Silva (2008) for zebu cattle (35°C). Similar results were observed by Souza et al. (2010), with minimum and maximum values of 25.5 and 37.0 and 25.5 and 37.7°C, respectively, for the systems SP and WS, for the same season and region. In the winter, the minimum and maximum air temperatures (Ta) were, respectively, 15.5 and 29.1°C for the SP system and 15.8 and 28.6°C for the WS system, not limit for the animals used in the experiment.

Table 2. Mean values, minimum (min.) and maximum (max) of the black globe (Tg) and air temperature (Ta), relative humidity (RH), wind speed (W), the black globe-humidity index (BGHI) and the radiant thermal load (RTL), in the seasons and systems.

Environmental variables		Systems					
		SP			WS		
		average	min.	max.	average	min.	max.
Tg (°C)	Summer	30.7	21.7	40.7	32.9	22.3	47.3
	Winter	23.2	13.8	36.3	23.7	13.0	34.5
Ta (°C)	Summer	29.2	24.4	34.6	29.3	24.3	36.4
	Winter	22.2	15.5	29.1	22.3	15.8	28.6
RH (%)	Summer	71.9	47.7	89.8	71.6	47.0	89.0
	Winter	65.2	40.7	86.0	64.5	40.7	86.3
Ws (m s^{-1})	Summer	1.9	0.5	4.7	3.1	1.2	6.4
	Winter	3.8	2.4	6.6	5.7	1.8	9.5
BGHI	Summer	81.9	72.4	91.8	84.8	73.2	98.6
	Winter	71.7	62.5	82.1	71.3	60.0	83.8
RTL (W m^{-2})	Summer	521.0	365.9	920.3	626.8	371.3	947.4
	Winter	476.0	345.7	695.0	513.1	302.4	872.6

SP = silvopastoral system; SW = system without shadow.

In summer, the relative humidity (RH), with average, minimum and maximum of 71.9, 47.7 and 89.8% in the SP and 71.6, 47.0 and 89.0% in the WS, and in winter, with 65.2, 40.7 and 86.0% in the SP and 64.5, 40.7 and 86.3% in the WS were lower than the maximum found by Amaral et al. (2009) who observed 99% in summer and winter, but greater than the minimum, with 43.33 and 31.50% in summer and winter, respectively.

The average values, minimum and maximum, of wind speed (Ws) in the summer were 1.9, 0.5, 4.7 m s^{-1} for the SP system, and 3.1, 1.2, 6.4 m s^{-1} for the system WS, and in the winter were 3.8, 2.4, 6.6 m s^{-1} for the SP system, and 5.7, 1.8 and 9.5 m s^{-1} for the WS system, evidenced a drop in the values for the SP system. This result corroborates Soares et al. (2009), which obtained a 51% decrease in wind speed within a forested area.

In summer, the values found to BGHI in the SP system ranged from 72.4 to 91.8 with an average of 81.9, and in the WS system, from 73.2 to 98.6 with an average of 84.8. According to Hahn (1985) for dairy cattle, animals more sensitive than those used in this experiment, the values would be in a range between critical stress and emergency situation. Nevertheless Silva (2008) pointed out that the observations were conducted under the conditions of the United States, with animal fully adapted, but possibly, for animals adapted to tropical conditions, the values may be different.

During the winter, the BGHI in SP system varied between 62.5 and 82.1 with an average of 71.7, and in the WS system, between 60.0 and 83.8 with an average of 71.3 indicating a situation of thermal comfort for most of the time.

The grazing, lying ruminating, lying idle, and standing idle behaviors showed a quadratic effect ($p < 0.05$) from the day hour, without effect ($p > 0.05$) for lying ruminating (Figure 1). The maximum value was 52.1% (GRAZ) and 15.8% (STIDL) and minimum values of 12.3% (LYRUM), and 11.6% (LYIDL), respectively, all occurring at 14h. These results are in accordance with Van Soest (1994) who high lighted the diurnal habit of grazing of the ruminants, with little grazing at night.

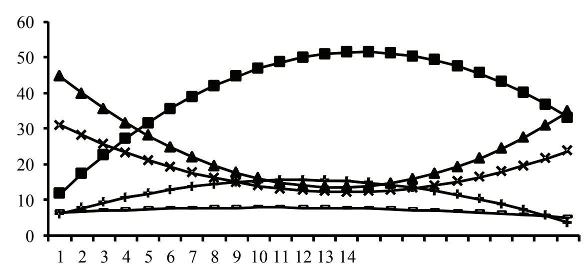

Figure 1. Percentage of time in the different behaviors of the animals - ((–■–) GRAZ = 5.75 + 6.24H – 0.2H^2 (r^2 = 0.14) (–▬–) STRUM = 6.16 + 0.32H – 0.015H^2 (r^2 = 0.013) (–▲–) LYRUM = 49.81 – 5.34H + 0.19H^2 (r^2 = 0.21); (–×–) LYIDL= 34.03 – 3.14 H + 0.11 H^2 (r^2 = 0.11); (–+–) STIDL = 4.24 + 1.92 H – 0.08 H^2 (r^2 = 0.14)), depending on the hour of day.

The effect of the time on the GRAZ behavior is consistent with Zanine et al. (2007), which reported a similar result in the preference of the animals to alternate periods of grazing, ruminating and idle. Likewise, Souza et al. (2010) reported similar behavior for animals with access to shade, but for those without access to shade, verified an increased grazing during more favorable times.

The results of the standing idle behavior (STIDL) indicated that the animals tend to adjust to the thermal environment by changing their posture, standing up to increase the losses by convection (MARQUES et al., 2005).

For the behavior of standing ruminating (STRUM) the time of day had no effect on this behavior, showing that the animals prefer to perform this activity lying.

For the time of lying ruminating (LYRUM) and lying idle (LYIDL) follows the same pattern of behavior. These behaviors are interrelated and occur preferably lying and are used as the best indicators that the animal is in good welfare (LEME et al., 2005).

The GRAZ and LYRUM behaviors were not influenced by the seasons (Table 3) ($p > 0.05$), but there was a tendency to be higher in winter. This can be explained by changes in the leaf:stem ratio, which in summer was 0.36:1 for SP and WS systems and in winter was 0.22:1 and 0.26:1 for the systems SP and WS, respectively, causing an increase trend of grazing time. For Schio et al. (2011), the leaf:stem ratio and distribution of leaves in the sward profile strongly influence the selection process, but, according to Zanine et al. (2007), the selective behavior promotes a longer grazing time.

Table 3. Mean values and standard errors of the percentage of grazing (GRAZ), lying ruminating (LYRUM) and lying idle (LYIDL) of the animals according to the seasons.

Behavior	Seasons		CV
	Summer	Winter	(%)
Grazing (GRAZ)	37.1 ± 23.6 a	43.6 ± 27.4 a	44.28
Lying ruminating (LYRUM)	18.8 ± 10.6 a	27.3 ± 20.1 a	45.23
Lying idle (LYIDL)	21.9 ± 14.9 a	13.9 ± 9.9 b	47.37

Means followed by same letter in the same row are not different by the Tukey's test at 5%.CV = coefficient of variation.

By multiplying the percentage of time the animals remained in the activities by the daily time, the average grazing time was 534 min. in the summer and 627 min. in the winter. Hodgson (1990) showed that grazing time above 480-540 min. per day indicate a limiting supply to the forage intake.

The animals spent long time on grazing, both in summer and winter, especially due to the low leaf:stem ratio, which, in the summer was equal for the systems SP and WS (0.36:1), but different during the winter, 0.22:1 in SP and 0.26:1 in WS. It may also explain the lack of difference ($p > 0.5$) between seasons, in summer the value was 37.1%, while in winter, 43.6%, once according to Zanine et al. (2007), the animal increase the grazing time to compensate the selectivity, also corroborated by Ortêncio Filho et al. (2001) that reported animals consume, on average, values between 2 and 5% of body weight per day on grazing, and the grazing time varies depending on the availability and type of food.

Likewise, the behavior lying ruminating (LYRUM) was not influenced ($p > 0.05$) by the season. According to Van Soest (1994), rumination is proportional to the amount of neutral detergent fiber (NDF) of diets. This lack of difference can be related to the selective grazing, due to a trend for a longer grazing time in winter, and according to Zanine et al. (2007), the selective grazing allows compensating the low quality forage, ingesting the most nutritious part of the plants.

Missio et al. (2010), studying the intake behavior of feedlot young bulls with different concentrate levels, found out that the time spent to ruminate decreased linearly ($p < 0.0001$) with increasing concentrate in the diet, mainly by decreased intake of neutral detergent fiber over time of STRUM of 8.75, 8.65, 6.76 and 5.73h, indicating preference for lying ruminating.

Freitas et al. (2010), evaluating the behavior of feedlot steers with several levels (0,33 and 66%) of replacement of corn silage by sunflower silage, verified no difference ($p > 0.05$) for the behavior LYRUM, with 7.85, 8.03, and 8.21 h day^{-1}.

The LYIDL behavior was affected ($p < 0.05$) by the seasons, with 21.9% in the summer and 13.9% in the winter, a response associated with the air temperature which was 29.2ºC in summer, and 23.2ºC in winter, a result consistent with Ortêncio Filho et al. (2001) that also observed an increase in idle time in the hottest period of the year to decrease the surplus of the metabolic heat production. Silva (2008) explained that the ruminants when in a lying position are displaying a welfare state and also increase the contact surface area for heat loss by conduction. Faria et al. (2011) observed that the animals spend more time lying when the land had lower temperatures indicating that the animals find greatest comfort when environmental conditions are favorable.

In summer, the STRUM behavior (Table 4) presented a difference between systems ($p < 0.05$), being higher in SP (9.43%) than WS (6.19%), while in winter, although lower in SP (4.36%) than WS (8.27%), no difference was detected ($p > 0.05$) between systems.

Table 4. Mean values and standard errors of the percentage of standing ruminating behavior (STRUM) of the animals according to season and type of system used.

Season	System		
	SP	WS	CV (%)
Summer	9.43 ± 3.8 aA	6.19 ± 4.2 bA	52.07
Winter	4.36 ± 3.9 aB	8.27 ± 6.7 aA	

Means followed by the same uppercase in the columns and lowercase in the rows are not different by Tukey's test at 5%; CV = coefficient of variation, SP = silvopastoral system; WS = system without shadow.

In the summer, the difference between the systems may be because the standing posture eases heat loss by convection, aided by the lower average wind speed in SP (1.9 m s^{-1}) compared to WS (3.1 m s^{-1}) (Table 2), with mean air temperature of 29.2 and 29.3°C and maximum of 34°C and 36.4°C, for SP and WS, respectively, values considered below the threshold by Silva (2008) for zebu cattle (35°C). However, a maximum close and above this value indicate thermal discomfort, and to maintain homeostasis, the animals need to stay longer in this position in this system. In winter, the Ta was not limiting and had no influence on the time STRUM between the systems.

According to Leme et al. (2005), an indicator of welfare for rumination and idle is the lying position, when these activities are performed in a standing position, indicate discomfort, which maybe an indicative an environment with greater thermal stress.

Silva (2008) affirmed that for cattle in tropical environments, the most effective physiological mechanism of thermolysis is the evaporative, under stress, with respiratory evaporation accounting for 30% of the total, and the remaining 70%, to cutaneous evaporation.

Missio et al. (2010), studying 16 feedlot young bulls, aiming to assess the feeding behavior with different levels (22, 40, 59 or 79%) of concentrate in the diet found no difference ($p > 0.05$) for STRUM with values of 0.21, 0.26, 0.51 and 0.44 h day^{-1}.

The animals spent longer time ($p < 0.05$) in STIDL behavior in summer (Table 5) in the SP system (20.10%) compared to winter (9.05%), while those of the WS system showed no difference ($p > 0.05$) between summer (8.82%) and winter (8.44%).

Table 5. Mean values and standard errors of the percentage of behavior standing idle (STIDL) of the animals according to season and type of system used.

Season	System		
	SP	WS	CV (%)
Summer	20.10 ± 10.4 aA	8.82 ± 5.8 bA	43.51
Winter	9.05 ± 7.3 aB	8.44 ± 6.4 aA	

Means followed by the same uppercase in the columns and lowercase in the rows are not different by Tukey's test at 5%; CV = coefficient of variation, SP = silvopastoral system; WS = system without shadow.

The highest percentage of time spent on STIDL in the SP system during the summer can be explained by the preference of the animals to stay in this position to improve the heat loss by convection. The maximum air temperature (Table 2) in the summer of 34.6°C for SP and 36.4°C, for WS system, reached values close and above the upper critical temperature for zebu cattle (> 35°C) (SILVA, 2008), and with wind speed lower in the SP system (1.9 m s^{-1}) in relation to the WS system (3.1 m s^{-1}), the animals sought to spend longer time standing in the SP system.

In the winter, as the maximum temperature was 29.1 and 28.6°C, not considered limiting to the thermal comfort of animals, no difference was observed for the STIDL behavior. According to Leme et al. (2005), the animals tend to adjust to thermal environment by changing their posture, and the environmental conditions during the winter do not promote heat stress.

Missio et al. (2010), investigating feedlot young bulls receiving various levels of concentrate (22, 40, 59 and 79%), verified no difference ($p > 0.05$) for the STIDL (2.21, 3.20, 4.17 and 3.74 h day^{-1}), indicating that the activities of the animals standing were less related to levels of concentrate in the diet than other causes. However, Freitas et al. (2010) detected differences ($p < 0.05$) for STIDL, considering animals that received 0, 33 and 66% of sunflower silage replacing corn silage, respectively, with times of 2.69, 3.48 , 3.93 h day^{-1}, analyzing the effect of diet on this behavior.

Conclusion

The silvopastoral system has changed the environment by reducing the temperature of the globe, and the wind speed by reducing the BGHI and RTL, altering the behavior of animals that spent longer time lying idle during the summer. The availability of adequate shade provides an alternative site with better conditions for the animal welfare, compared to a system without shade.

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