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PASTURE SHADOWING REDUCES SEARCHES FOR WATER TROUGHS BY DAIRY COWS

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ABSTRACT
Shading pastures alters the animals' routine and may have an influence on their relationship with water. The objective was to assess the behavior of crossbred cows related to shade and the search for water in three systems: Full sun; Moderate shading and Intense shading. The experiment was conducted at Embrapa Agrossilvipastoril (Sinop/MT/Brazil) from summer 2017 to summer 2018. Behavior of dairy cows' observations were carried out in three typical days in each season, from 6 am to 6 pm. Univariate analyzes were performed by SAS® On Demand and multivariate (principal component analysis) by Excel. The full sun system stimulated a higher frequency of animals looking for the water trough and a longer stay around it, as well as a shorter stay in the shade combined with a lower frequency of animals in this location, being more associated with incident radiation than temperature and temperature and humidity index. When there was shade available in the shaded treatments, the observed relationships were just the opposite. Therefore, shading, even if moderate, contributes to lessen the discomfort of dairy cows caused by radiation; this radiation, which encourages animals to frequent and remain around water troughs.
Key words: radiation; shade time; silvopastoral

INTRODUCTION

The adverse climatic conditions of tropical regions may contribute to reduce milk production. In these regions prevail high air temperatures due to the high incident solar radiation associated with other elements like humidity and wind, that can cause heat stress in the animals, affecting their growth, milk production and quality, and reproduction. To relieve the excess of heat, animals make use of available possibilities in their environment, such as increasing water intake and searching for shadow. Therefore, the presence of these components is of paramount importance for soothing the thermal stress of the animal. Agrosilvopastoral systems have a great potential to provide a friendly environment for the cattle in the topics, improving thermal comfort through shading and consequently an ambience with mild temperature; bettering the nutritional value of the pasture; supplying food for animals through grazing or in troughs; reducing the seasonality in forage production and, consequently, increasing milk production. The objective of this study was to know the behavior of crossbred cows, regarding the search and permanence in places with shade and drinking troughs, submitted to two different shade regimes in agrosilvopastoral systems and in full sun pasture, managed under intermittent stocking in Mato Grosso, Northern Brazil.

MATERIAL AND METHODS

The experiment was carried out at Embrapa Agrossilvipastoril in Sinop, Mato Grosso state, Brazil. The experimental period was from December 2017 to March 2019 and the evaluations were conducted in the following seasons: Summer 2017, Autumn 2018, Winter 2018, Spring 2018, and Summer 2018. According to the Köppen-Geiger classification, the climatic type in the region is Aw – Tropical savanna, with presence of two well-defined seasons: rainy (from October to April) and dry (from May to September), and due to the small annual thermal amplitude, with monthly averages varying between 23.5º C and 25.5º C and maximum below 36 ° C, with annual water deficiencies ranging from 243.72 to 307.43 mm and water surpluses of 954.61 and 890.90 mm (MOTA et al., 2013 - Figure 1). The soil is classified as Latossolo Vermelho-Amarelo (SiBCS) or Ferralsol (WRB/FAO) and a flat relief (VIANA et al., 2015).

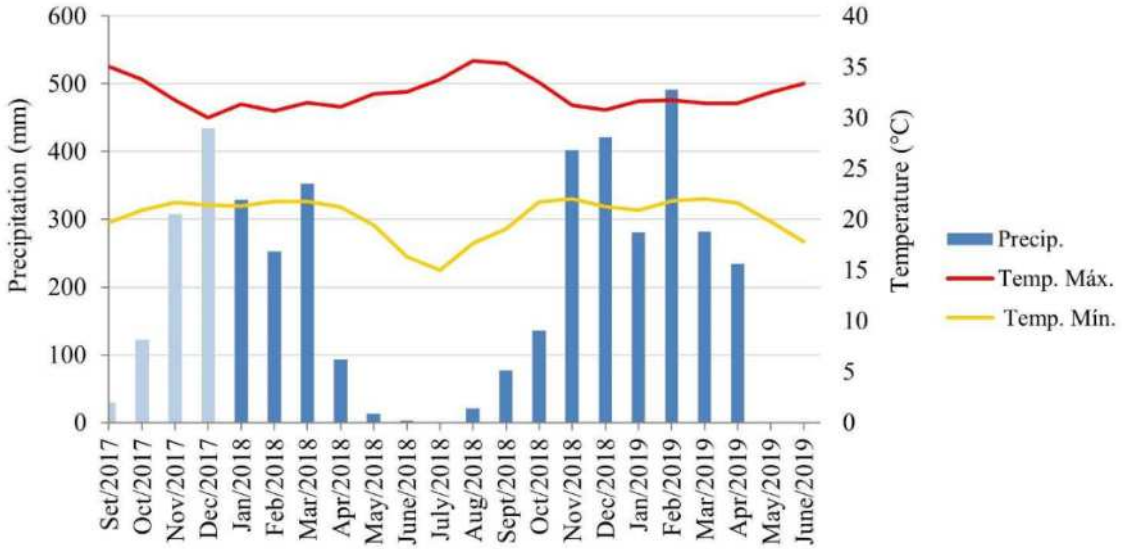

Figure 1. Microclimatic variables at the experiment site from September 2017 to June 2019. Accumulated monthly precipitation (mm), average maximum temperature (ºC) and average minimum temperature (ºC).

The experimental area of 10 ha was implemented with massai grass (*Megathyrsus maximus* cv. Massai) in three systems: full sun with restricted access to the shade (without trees - FSS), moderate shading (rows of trees spaced 52 m - MSS) and intense shading (tree rows spaced 15 m apart - ISS), with a useful pasture area of 2.4 ha. Eucalyptus (*E. urophilla* x *E. grandis* clone H13) were planted in 2010 (East-West Direction), with densities of 338 and 714 trees ha^{-1} in the moderate and intense shading systems, respectively. To evaluate animal behavior, six lactating crossbred Gir x Holstein cows were used in Summer 2017, Autumn 2018, Spring 2018, and Summer 2018, and eight in winter 2018 in each system. There were 25 observation times in three typical days of each season, from 6 am to 6 pm, every 30 minutes (MELLO et al., 2017). Due to the physiological responses presented by the cows in the full sun system, concomitant with the low relative humidity of the air and cloudiness, these cows were allowed access to the gate with partial shade, during the hottest times of the day (Access to shade: Summer 2017, between 1:00 pm and 2:00 pm; Autumn 2018, between 2:00 pm and 4:00 pm; Winter 2018, between 8:00 am and 9:00 am, and between 11:30 am and 2:00 pm; Spring, between 2:00 pm and 4:00 pm; Summer 2018, between 2:30 pm and 5:00 pm). In this context, it was necessary to consider that the animals of the full sun system had restricted access to the shade during the entire experimental. To assess the environmental conditions, temperature and humidity index (THI) was used and estimated by the equation of Thom (1959): THI = Tb + (0.36 x DPT) + 41.2; where Tb = dry bulb temperature in degrees Celsius; DPT = Dew point temperature (° C). For data analysis of animal behavior, the values of the hourly averages calculated for the season, the mean temperature and photosynthetically active radiation were used, on the days of the evaluation of the

animal behavior in the range from 6 am to 6 pm. Microclimate variables were obtained from the averages of the meteorological stations of each system, that is, for the full sun system it was only the information of a station located in the center of the plot, whereas for the moderate shading system the averages of four stations, distributed perpendicularly between the rows were used, while for the intense shading system it was the average information from three meteorological stations, similarly distributed. The statistical analysis of the data was performed using the PROC MIXED procedure of the statistical package SAS® On Demand (SAS INSTITUTE INC, 2020). The data were subjected to analysis of variance using a model of repeated measures over time. In choosing the variance and covariance matrix, the Akaike Information Criterion (WOLFINGER, 1993) was used. The experimental design was in Randomized Complete Blocks with split-plot with the evaluation times being allocated to the subplots and the three sequential days of analysis, considered as replications in time. To assess the relationships between the studied behavior variables (frequency of cows in the shade, length of stay in the shade, frequency of visits to the water trough and time spent in the water trough), and of these with the systems in different seasons of the year in which they were measured, a principal component analysis (PCA) was performed on the data set.

RESULTS AND DISCUSSIONS

The time spent and frequency of cows in the shade were greater in the shaded systems (541 minutes day^{-1} and 63%, respectively, on average) compared to the full sun system (187 minutes day^{-1} and 19%, respectively) ($P < 0.10$). Meanwhile, the time spent at the water trough and the frequency of visits to the water trough were higher in the full sun system (27 minutes day^{-1} and 9.2%, respectively) compared to shaded systems (9.2 minutes day^{-1} and 1.2%, respectively, on average) ($P < 0.10$). Photosynthetically active radiation was higher in the full sun system (6.7 MJ m^{-2} day^{-1}) and intermediate in the moderate shading system (5.4 MJ m^{-2} day^{-1}) than in the intense shading system (3.0 MJ m^{-2} day^{-1}) ($P < 0.0001$). Higher values for average temperature and temperature and humidity index were obtained in winter 2018 (30.9 ° C and 78.7, respectively) ($P_{\text{temp and THI}} < 0.0001$).

From the principal component analysis, the first two components had eigenvalues above the unit and allowed to explain 82.78% of the variability between the observations, whose pattern could be associated with PC1. In turn, it was not possible to identify any pattern, neither for the systems studied nor for the seasons that could be associated with PC2. Considering that the variables associated with PC1 explain 53.82% of the variability, the influence of the shading level on animal behavior was more important than on the microclimate, since PC1 are more strongly associated with the time in the shadow, frequency to water troughs, time in water troughs and photosynthetically active radiation (PAR) and, although the square cosine of the frequency in the shadow was higher for PC2 (0.4821), the value is very close to the 0.4187 obtained for PC1, which indicates that this variable also contributes substantially to this component. The biplot in Figure 2 shows the correlations circle and the observations cloud in the plane of the first two principal components. The variables that showed the greatest contrast between the shading systems with the greatest association with PC1 were time spent in the shade (Shade time), frequency of visits of animals to the water trough (Water Freq), time spent in the water trough (Water time) and PAR. According to the correlation matrix (Pearson), it was found that the higher the frequency of animals in the shade, the greater the number of animals that remained in this location (+0.8732) and the less they frequented water trough (-0.6356), the less time they spent at this location (-0.6129). On the other hand, the more animals sought water trough, the longer they stayed there (+0.9464). Although slightly lower, the correlation between radiation and behavioral variables related to time spent in the water trough (-0.3830) and shade (+0.5069) were still significant, pointing to a tendency for there to be a greater influence of radiation with these animal behaviors than with temperature and THI (less than 0.1500).

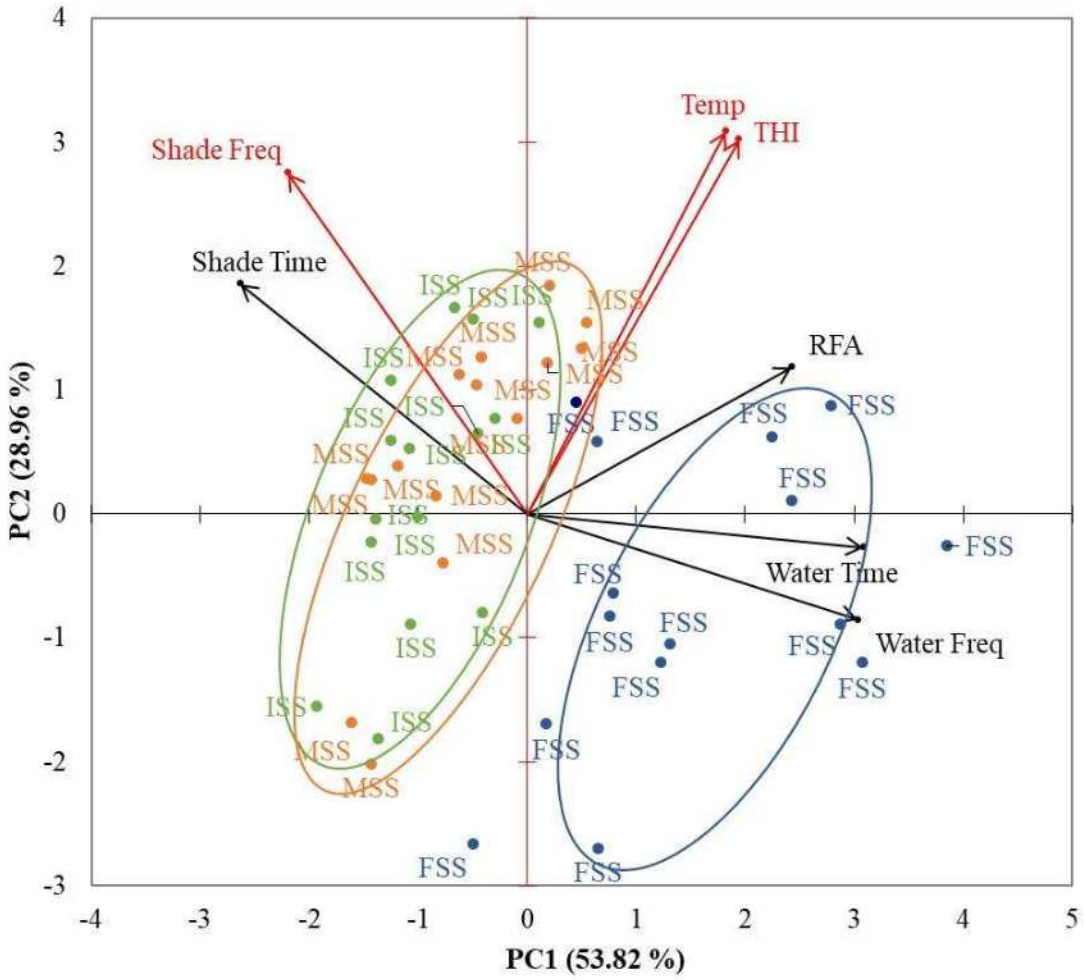

Figure 2. Biplot representation of the Principal Component Analysis (PCA) showing the correlation circle and observations cloud in the plane of the first two principal components. Full sun (FSS-Blue), moderate shading (MSS-orange) and intense shading (ISS-Green).

In the full sun system, animals spent less time in the shade due to restricted access, and having high incident radiation in this environment, more animals sought water troughs and stayed there longer. As the cows that were in the two shaded systems had available shadowing in abundant areas, even in the system with moderate shading, they looked for the places in the system where the shade was more intense and spent more time there. Consequently, the frequency of searching for the water trough was lower and they remained in this place for a short time, only presumably to quench their thirst. The opportunity of animals to search for areas where there was greater shading even in the system with moderate shading may explain the similar results observed in the behavior of animals that were subjected to systems of moderate and intense shading and their distinction with those that were placed in full sun. While, in shaded systems (MSS and ISS) the animals' behavior was similar to each other but opposite along the PC1 axis to the full sun system (FSS) (Figure 2).

The cows that were in the shaded systems showed a reduction of 66.7% in the time (minutes) spent in the water trough and 75% less visits to the water trough compared to full sun (27 minutes and 4%, respectively, on average). From the point of view of behavior, animals in shaded environments may seek more for other activities, being more active than animals in the system in full sun. Mello et al. (2017), also observed, in an experiment in the same place, that heifers in an environment with available shade visited less times the water trough, they stated that heifers visit the water trough more frequently to reduce body temperature, especially during peak hours, due to thermal discomfort,

between 10 am and 3 pm. Therefore, shading, even if laterally to the paddock, contributes to alleviate the animals' thermal discomfort and allow an improved ambience for dairy cows.

CONCLUSIONS

Agrosilvopastoral systems by providing shade for animals, mitigate their needs for frequent search for water trough. Solar radiation on animals is a climatic variable that must always be considered in pasture-based dairy farming systems.

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