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The effects of providing portable shade at pasture on dairy cow behavior and physiology

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ABSTRACT

Access to pasture has advantages for cows such as reduced lameness and improved udder health, but also may expose cows to stressors such as extreme heat. The objective of this study was to understand how portable shade affected physiological and behavioral responses of pastured dairy cows in a Canadian summer. Over 8 wk, a total of 24 lactating Holstein cows were separated into 2 treatments, one with access to shade and a control without access to shade. The cows were pastured in groups of 4, with 3 field sections per treatment. Instantaneous scan sampling of behaviors (drinking, lying, grazing, other) performed in the shade or not were recorded every 5 min for 3 h/d during the hottest part of the day (peak hours: 1130–1530 h) 3 d/wk. Ambient temperature, humidity, and vaginal temperature were recorded at 10-min intervals. Daily milk production was also recorded. Differences between treatments by week were analyzed using the generalized linear mixed model with group as random effect and treatment as fixed effect. Cows with shade access were observed at the water trough up to 6.42 times less and lying down up to 1.75 times more. Cows with shade access grazed up to 1.5 times more but only when the temperature-humidity index was above their comfort threshold ($\geq$72) during the hottest part of the day (wk 2). Cows sought shade when it was made available, but spent less than half of their time observed (%) in the shade (40.8 $\pm$ 4.67) with the exception of wk 2 when most of the time was spent under the shade (74.3 $\pm$ 4.77). Daily lying time was highest during peak hours for cows with shade access. However, no overall difference in total lying time between the 2 treatments was observed. No differences were found in vaginal temperature or milk production between treatments with the exception of wk 1 for daily milk production, which was higher for cows in the control treatment. In conclusion, cows sought shade when it was provided at pasture, whereas cows without access to shade seemed to alter their behavior to cope with heat stress, as seen from the lack of physiological differences between treatments. The results indicate that providing cows with access to pasture under a temperate climate does not seem to have any detrimental physiological or production effects and providing them with shade can potentially decrease production costs and help with water conservation strategies as fewer cows were observed at the water when shade was provided.

Key words: dairy cow, portable shade, behavior, heat stress

INTRODUCTION

Access to pasture has been shown to have several advantages for dairy cow welfare, such as reduced lameness and improved udder health (Washburn et al., 2002; Hernandez-Mendo et al., 2007), as well the ability to perform a wider range of natural behaviors. However, under certain conditions, pastured cows may be exposed to undue stress, such as extreme heat that can increase water consumption, decrease feed intake, increase body temperature, and lower milk production (Kadzere et al., 2002). Pastured cows may also be exposed to fly attacks, which may be exacerbated by increased heat.

Dairy cows have been reported to spend less time at pasture as the temperature-humidity index (**THI**) increases when given the choice between pasture or freestall barn (Legrand et al., 2009), and to seek shade when air temperature and solar radiation increase (Kendall et al., 2006). The comfort threshold for Holstein dairy cattle has been established at a THI of $\geq$72 (Ravagnolo et al., 2000). In Canadian temperate regions, THI can exceed the comfort threshold for short periods (i.e., 1 d to 1 wk at a time), and such a short-term moderate heat stress has been shown to increase vaginal temperature and decrease milk production in dairy cows (Ominski et al., 2002). Beede and Collier (1986) speculated that thermal stress can seriously affect animals in temperate regions because they are not adapted to deal with heat stress conditions.

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Providing access to shade at pasture can help alleviate some of the effects of heat stress such as increased time at the waterer (Schütz et al., 2010) and increased body temperature (Valtorta et al., 1997), and it can also increase production (Kendall et al., 2006). Cows have been reported to be highly motivated to use shade in warm weather (Schütz et al., 2008) and prefer shade over sprinklers at pasture even though sprinklers are a more effective cooling method (Schütz et al., 2011).

Although access to shade can help diminish several negative effects brought on by an increased heat load while at pasture, Kendall et al. (2006) found that cows with access to shade grazed less during the hottest part of the day compared with cows without access to shade. In intensive grazing rotational systems required by high-yielding pastured cows, fresh strips of pasture are provided to the cows twice a day. When temperatures are above the comfort threshold, a portable shade might help diminish the potential lower grazing time by providing fresh forage near or under the shade on a daily basis instead of forcing the cows to remain under a permanent shade structure located further from fresh pasture. The objective of this study was to understand how portable shade systems affect physiological and behavioral responses of dairy cattle during an Eastern Canadian summer.

MATERIALS AND METHODS

Animals and Treatments

The study was conducted at the Organic Dairy Research Centre of the University of Guelph (Alfred, Ontario, Canada) located in the Saint Lawrence Lowlands climatic region. The study lasted a total of 8 wk, from July 8 to August 30, 2013. Twenty-four Holstein lactating dairy cows were used. At the start of the study, cows were on average (±standard deviation) 212 ± 95 DIM with a lactation number of 2.33 ± 1.20 and an annual milk production of 9,795 ± 1,199 kg.

Cows were assigned to 12 experimental pairs (n = 2 cows). Treatment groups were balanced for days in milk, lactation number, annual milk production, and coat color. Coat color was determined through visual observation by 2 observers on all 24 cows, and an average for each cow was determined. Cows were classified into 3 different color groups: mostly white (4 cows), mostly black (12 cows), or in between (8 cows).

All cows had previous experience with pasture as they are kept on pasture all day except during the 2 daily milkings and follow organic management practices. Each pair was assigned to 1 of 2 treatments, access to shade, and no access to shade for the first 4 wk of the study, and was switched to the other treatment on wk 5 for the remaining 4 wk. Each week, one pair was combined with a new pair from the same treatment. The combined pair groups (n = 4) were randomly assigned to a new field section (3 field sections for each treatment) measuring an average of 280 m^2 (SD = 87 m^2), with detailed group organization provided in Table 1. Animals in the shade treatment were given access to a rectangular portable shade structure (3.05 × 6.1 m; METEC Metal Technology Inc., Vankleek Hill, Ontario, Canada) giving each cow 4.65 m^2 of available shade and possible grazing area underneath the structure. This is in accordance with the recommended space of 3.72 to 5.57 m^2 of shade per cow (Higgins et al., 2011) with one structure per field section (3 structures in total). Solar protection was provided by a black shade cloth placed flat as the roof of the structure (80% of solar radiation protection; GGS Structures Inc., Lincoln, Ontario, Canada). Shade structures were always placed with the short side facing north to provide as much shade as possible throughout the day. All cows were given a habituation period of one wk to the shade structures before the beginning of the study as well as to the presence of the observers. Shade structures were moved daily with a tractor to follow the cows and fresh pasture. Cows were kept in the field section from 1000 to 1630 h for 5 d a week. From evening to morning milking, cows were all kept together in a separate pasture. Water was provided ad libitum with a trough (1.30 × 0.80 m) provided in each of the field sections, from which all 4 cows per section could drink simultaneously. Cows were milked twice a day (around 0700 h and at 1700 h). After the morning milking, cows were provided with concentrate and minerals to supplement their pasture-based diet.

Climatic Variables

Air temperature and relative humidity were recorded automatically at 10-min intervals with environmental loggers (Hobo Pro Data loggers, Onset Computer Corp., Bourne, MA) for 4 d per week (Monday to Thursday). Two data loggers were placed near the experimental pastures, ensuring they were always under the sun. Two data loggers were placed under one of the shade structures directly under the shade cloth on the northeast corner of the structure. Data from the data loggers were downloaded at the end of each experimental week. The THI was calculated using the air temperature and relative humidity following Schütz et al. (2011):

$$\text{THI} = (1.8 \times \text{T} + 32) - [(0.55 - 0.0055 \times \text{RH}) \times (1.8 \times \text{T} - 26)],$$