IMPACT OF FREQUENCY OF FEEDLINE SOAKING COMBINED WITH EVAPORATIVE AIR COOLING IN A HUMID ENVIRONMENT

M. J. Brouk, J. F. Smith, D. V. Armstrong, M. J. VanBaale, D. R. Bray, and J. P. Harner[1]

Summary

Heat stress in hot and humid environments reduces milk production, decreases reproduction, and increases health-related problems. The summertime environment in north-central Florida is especially difficult because the combination of high relative humidity and high temperature results in a temperature-humidity index (THI) above the critical value of 72 for significant portions of the day. Previous work at Kansas State University had shown that the combination of soaking and evaporative air cooling could effectively cool heat-stressed cattle. Effectiveness of this feedline soaking, either in the afternoon and at night, or only at night, in combination with evaporative cooling was evaluated on a commercial dairy located in north-central Florida. A high-pressure fogging system and feedline soakers were installed in a typical 4-row freestall barn equipped with tunnel ventilation creating a north to south airflow of 6 to 8 mph at the cow level. Eight lactating Holstein cows in each of two, 292-stall pens were selected and fitted with vaginal temperature probes. Data on vaginal temperature and respiration rate were used to evaluate two cooling treatments. Barn temperature averaged 74.8 ± 5.4ºF, relative humidity was 84.6 ± 15.4 %, and THI was 74.7 ± 5.3 during the study. The evaporative cooling system reduced average barn temperature by 0.9ºF and reduced afternoon temperatures by a maximum of 9.2ºF. Average respiration rates were less (58.5 vs. 66.9 breaths/min) in the afternoon and night soaking treatment, compared with the respiration rate of cattle in the night soaking treatment. Differences were greatest at the 10:00 p.m. observation (55.0 vs. 73.3 breaths/min). Average vaginal temperature was also less (102.0 vs. 102.6°F) in the afternoon and night soaking treatment. Our results indicate that the combination of cooling the air via a high-pressure fogging system and feedline soaking reduced heat stress experienced by dairy cattle. Using feedline soaking during the afternoon and night was more effective than soaking only at night.

(Key Words: Cow Comfort, Cow Cooling, Heat Abatement.)

Introduction

Heat stress causes a significant loss of milk production and income each summer in Kansas. Effects of heat stress continue to impact milk production, reproduction, and health into the fall and early winter. Impacts on reproduction and health also may negatively impact future lactations. Many Kansas State University studies have shown the positive benefits of heat abatement on milk production and dairy farm income. Other studies have shown that increasing the frequency of soaking and using supplemental airflow increases

[1]Department of Biological and Agricultural Engineering.

heat loss from cattle and reduces body temperature and respiration rates. Amount of heat stress experienced by cattle is a function of air temperature, relative humidity, exposure to solar radiation, and airflow or wind speed. Relative stress levels are often described by the temperature-humidity index (THI), which combines the effects of temperature and relative humidity. It is generally accepted that dairy cattle begin to be stressed when THI exceeds 72.

The environment of north-central Florida is challenging. High temperature and relative humidity stress cattle and limit the effects of heat-abatement systems. High relative humidity reduces evaporation and, therefore, the degree to which water evaporation can be used to reduce air temperature in evaporative cooling systems or to reduce body surface temperature in soaking systems. Afternoon relative humidity, however, is generally reduced enough to gain some benefit from evaporative cooling of the air, and additional cooling may be possible from soaking. The purpose of this study was to evaluate the combination of evaporative cooling of the air with feedline soaking in the afternoon and at night or only at night.

Procedures

A 700-ft-long 4-row, head-to-head freestall dairy barn equipped with tunnel ventilation (north to south airflow) and a high-pressure fogging system was used to evaluate a combination cow-cooling system in north-central Florida. The fogging system operated when the temperature exceeded 80ºF from 11:00 a.m. to 10:00 p.m. and when above 83ºF from 10:00 p.m. to 11:00 a.m. the next day. Sidewall height was 12 ft, and the peak height of the roof was 13.2 ft with a 1/12 pitch. Curtain sidewalls were closed during the cooling study. A feedline soaking system also was installed in each of the two pens.

Eight lactating Holstein cows were selected from each of two pens and were fitted with a vaginal temperature recorder. In a replicated, switchback design, two soaking treatments were applied to the pens. Treatments were: 1) soaking in the afternoon and at night (10:00 p.m. to 6:00 a.m. the following morning; - A&N) and 2) soaking just at night (10:00 p.m. to 6:00 a.m. the following morning; - N). Feedline soakers were activated when the barn temperature exceeded 72ºF, and the system soaked for 1.6 minutes (followed by 4.8 minutes off). Approximately 0.3 gal of water was applied to each cow-standing area per soaking. The 24-hour study day began at 10:00 a.m. and ended at 09:59 a.m. the next day. Respiration rates of the cattle fitted with the vaginal probes were observed and recorded at 6:00 a.m., 4:00 p.m., and 10:00 p.m. of each study day. Respiration rates were then averaged by day, treatment, pen, and time of observation before analysis. Vaginal temperature was recorded every minute and averaged into 15-minute periods. Barn and ambient temperature and relative humidity were recorded every 15 minutes with data loggers, and the data were averaged by hour of the day. A mixed-model procedure was used to analyze the data. Fixed effects included treatment and time of observation. Replicate was considered a random effect, and time of observation within pen was analyzed as a repeated measure.

Results and Discussion

Barn temperature averaged 74.8 ± 5.4ºF, relative humidity was 84.6 ± 15.4 %, and THI was 74.7 ± 5.3 during the study. The evaporative cooling system reduced average barn temperature by 0.9ºF and reduced afternoon temperatures by a maximum of 9.2ºF. Average hourly variations in temperature, relative humidity, and THI are shown in Figures 1 through 3. Temperature differences were greatest between the barn and ambient conditions in the afternoon hours when ambient relative humidity was least. Reduced afternoon ambient relative humidity increased water evaporation from the evaporative cooling system, and reduced barn temperature below that of ambient conditions. Evaporative cooling increased barn humidity, compared with ambient conditions, but barn THI was reduced.

Average respiration rates were less (*P*=0.05; 58.5 vs. 66.9 breaths/minute) for cattle in the A&N treatment than for those in the N treatment. Differences (Figure 4) were greatest at the 10:00 p.m. observation (55.0 vs. 73.3 breaths/minute). Average vaginal temperature also was less (102.0 vs. 102.6°F) in the A&N treatment than in the N treatment. A significant drop in vaginal temperature was detected in the N treatment after the start of soaking at 10:00 p.m. (Figure 5). Our results indicate that the combination of cooling the air via a high-pressure fogging system and using feedline soaking reduced heat stress experienced by dairy cattle in a high-humidity environment. Using feedline soaking during the afternoon and night was more effective than soaking only at night. Soaking during the afternoon resulted in less body heat accumulation during the late afternoon and early nighttime, reducing heat stress experienced by cattle.

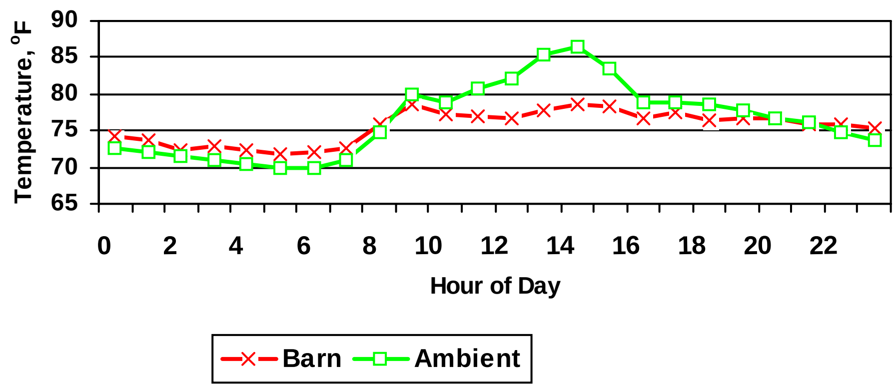

Figure 1. Average Ambient and Barn Temperature by Hour of Day.

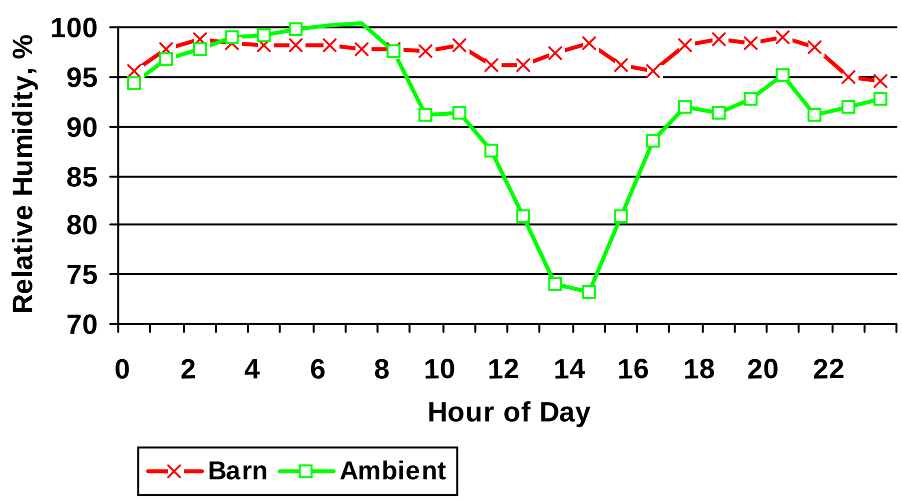

Figure 2. Average Ambient and Barn Relative Humidity by Hour of Day.

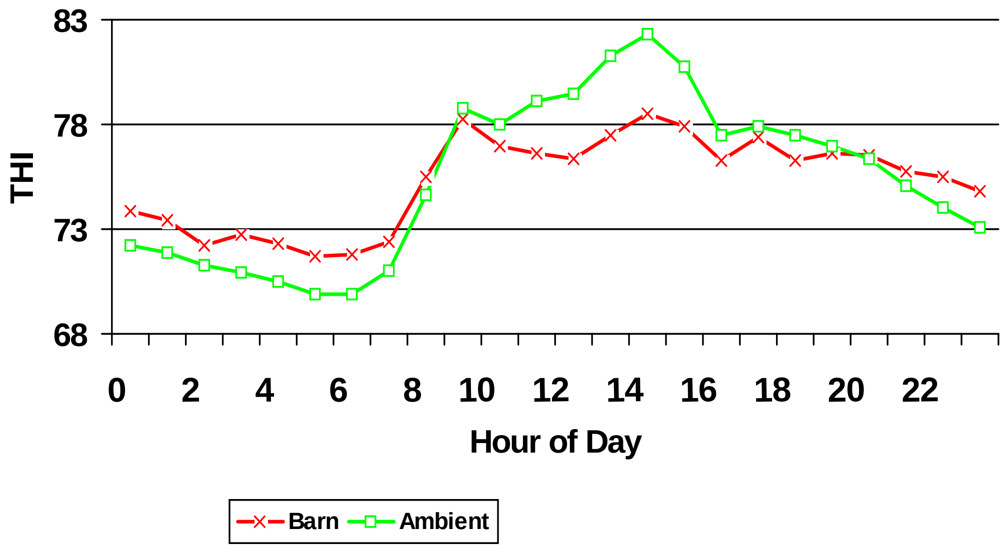

Figure 3. Average Ambient and Barn THI by Hour of Day.

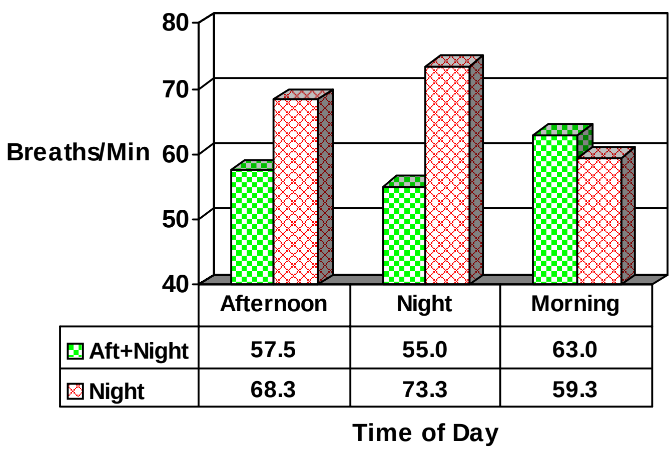

Figure 4. Average Respiration Rates of Cattle Exposed to Two Soaking Systems.

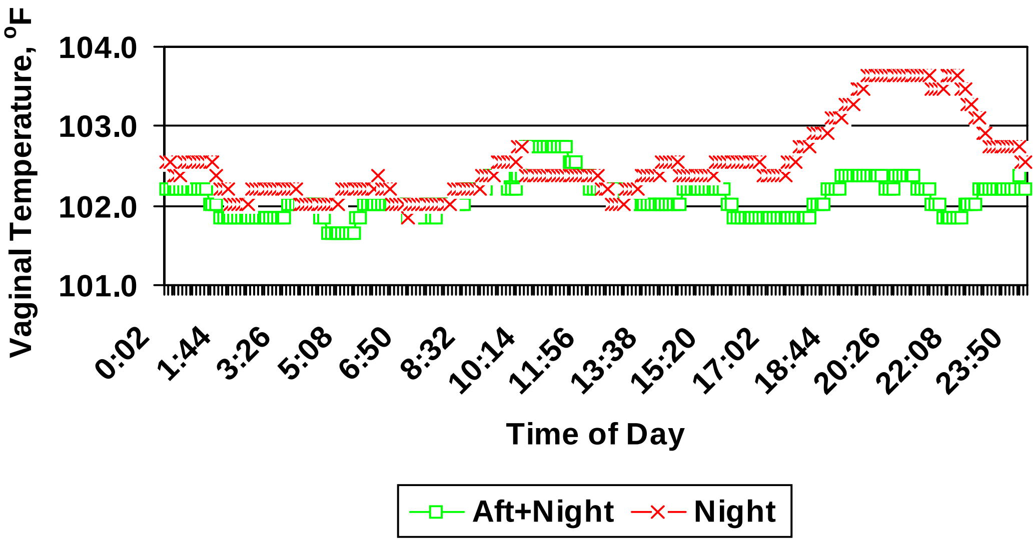

Figure 5. Average Vaginal Temperature of Cattle Soaked by Two Soaking Systems.