Effect of Sprinkling on Heat Stressed Heifers

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Sprinkling of heat stressed heifers reduces body temperature, respiration rate and pulse rate while maintaining dry matter intake.

Summary

Six heifers were housed in controlled environmental stalls. All heifers were sprinkled with water between 1300 - 1500 hours for three days followed by a two-day period in which three were sprinkled between 1200 - 1600 hours and three were not. This was followed by a one day hot period during which all heifers were sprinkled (1300 - 1500 hours). Rectal temperature and respiration rate were reduced in all animals during the first three days of heat stress. On days four and five, heifers sprinkled four hours had lower rectal temperature, respiration rate and pulse rate than heifers which were not sprinkled. Comparison of rectal temperature on days one - three vs day six of heat stress revealed heifers not sprinkled on days four - five were higher on day six vs days one - three. Sprinkling cattle effectively alters physiological responses to heat stress and improves dry matter intake.

Introduction

Using sprinklers to improve animal performance and well-being during episodes of elevated environmental temperature has been reported previously (*2001 Nebraska Beef Report*, pp. 79-81). However, the experimental conditions when the sprinklers were tested allowed all animals adequate access to the sprinklers. Ideal situations such as this may not always exist in commercial feedyard settings. Inconsistent sprinkling may predispose animals to increased levels of stress.

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The objectives of this study were to determine individual animal responses to sprinkling when ambient conditions exceed the animal's thermoneutral zone. Additionally, effects of a missed or doubled sprinkling time were evaluated to determine if inconsistent water application alters the animal's physiological response to heat stress.

Procedure

Six Shorthorn heifers (avg. BW = 813 $\pm$ 88 lbs) were used in a 22 - day crossover experimental design. Heifers were housed in 9.8 x 3.3 ft stalls inside a semi-controlled environment facility at the University of Queensland - Gatton, Australia. Temperature within the facility can be maintained at any temperature between 60 - 104°F for extended periods. Relative humidity could not be controlled. Treatments (sprinkled or not sprinkled on days four - five of elevated temperature) were applied in two replications such that all animals were subjected to each treatment. Each replication consisted of a three-day thermoneutral period (TNL) and six-day period with elevated ambient temperature (HOT). During the first three days of HOT all animals were sprinkled for two hours (1300 - 1500 hours) using overhead sprinklers (.75 gal/hd/min). On days four - five of HOT, three animals were cooled (double wet) for four hours (1200 - 1600 hours), while the remainder were not sprinkled (no wet). On day six of HOT, all animals were sprinkled two hours (1300 - 1500 hours). The following day, all animals were subjected to a one-day rest period of thermoneutral conditions after which treatments were reversed. A time line for the trial is shown in Table 1.

Each stall was equipped with an individual feeder and waterer and animals were allowed ad libitum access to a finishing diet (12% CP, 155 Mcal ME/cwt) consisting of: barley, cottonseed meal, and sunflower hulls. Rectal temperature was recorded every 5.4 min and averaged over hourly intervals by a data logger attached to a thermistor. Respiration rate and pulse rate were recorded at bi-hourly intervals on day two of TNL and days one, four, five and six of HOT. Respiration rate was measured by visual observation of flank movement, while pulse rate was measured using an infrared pulse monitor attached to a shaved area on the ear of each animal. Dry matter intake was recorded by load cells under each feed bunk at 15 min intervals and averaged hourly. Ambient conditions (temperature and relative humidity) within the room at a height of 3 ft above the floor were recorded at 5.4 min intervals and averaged hourly. Temperature-humidity index (THI) was calculated using the following equation:

$$THI = Temp - (.55 - (.55 \times (RH/100))) \times (Temp - 58)$$

Data were analyzed using repeated measures in Proc GLM of SAS. Results were analyzed by environmental period with the model for all parameters including animal, treatment, and replication.

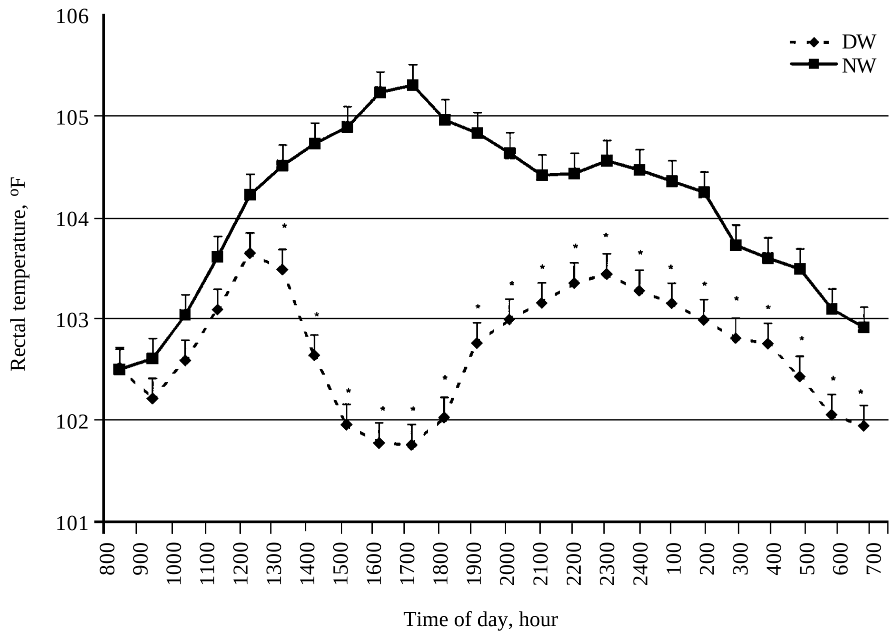

Figure 1. Effect of double (DW) vs. missed (NW) sprinkling on rectal temperature of heifers under hot environmental conditions. Treatment x time interaction (P<0.001). *Values within a time differ (P<.05).

Results

Rooms were heated between 800 - 1500 h each day, after which, rooms were allowed to cool. Mean temperature during the thermoneutral period was 68°F (range 67 - 74°F), and mean relative humidity was 65% (range 55 - 75%). These conditions, as well as the THI (range 65 - 70), were well within the thermoneutral zone for feedlot cattle.

During HOT, temperature averaged 88°F (range 79 - 100°F) and relative

Table 1. Time line of treatment application. Each Group contained three heifers.

Day	1	2	3	1	2	3	4	5	6
	TNL, no sprinkling			HOT, all cattle sprinkled (1300 - 1500 hours)			HOT, Group 1 Sprinkled (1200 - 1600 hours), 2 not sprinkled		HOT, all Sprinkled
Day	1	2	3	1	2	3	4	5	6
	TNL, no sprinkling			HOT, all cattle sprinkled (1300 - 1500 hours)			HOT, Group 2 Sprinkled (1200 - 1600 hours), 1 not sprinkled		HOT, all Sprinkled

Table 2. Main effect means of physiological measurements of heifers by period .

Item[a]	Treatments		SEM	P-value
	Double Wet	No Wet		
Thermoneutral				
Rectal temperature, °F	102.4	102.0	.2	.54
Respiration, breaths/min	41.0	41.0	3.5	.32
Pulse, beats/min	66.9	64.5	4.1	.49
HOT, days 1 - 3				
Rectal temperature, °F	103.2	103.4	.05	.56
Respiration, breaths/min	95.9	114.0	2.8	.18
Pulse, beats/min	74.6	80.8	1.7	.24
HOT, days 4 - 5				
Rectal temperature, °F	102.7	104.1	.04	.001
Respiration, breaths/min	92.6	117.9	1.8	.001
Pulse, beats/min	75.2	78.4	.9	.03
HOT, day 6				
Rectal temperature, °F	103.3	103.8	.05	.22
Respiration, breaths/min	109.8	99.4	2.6	.07
Pulse, beats/min	75.8	75.4	1.2	.77

[a]No sprinkling occurred during thermoneutral. Sprinkling was done on all heifers between 1300 - 1500 h during HOT, days one - three and six. During HOT days four - five, sprinkling was done on half the heifers (Double Wet) between 1200 - 1600 h, the balance were not sprinkled.

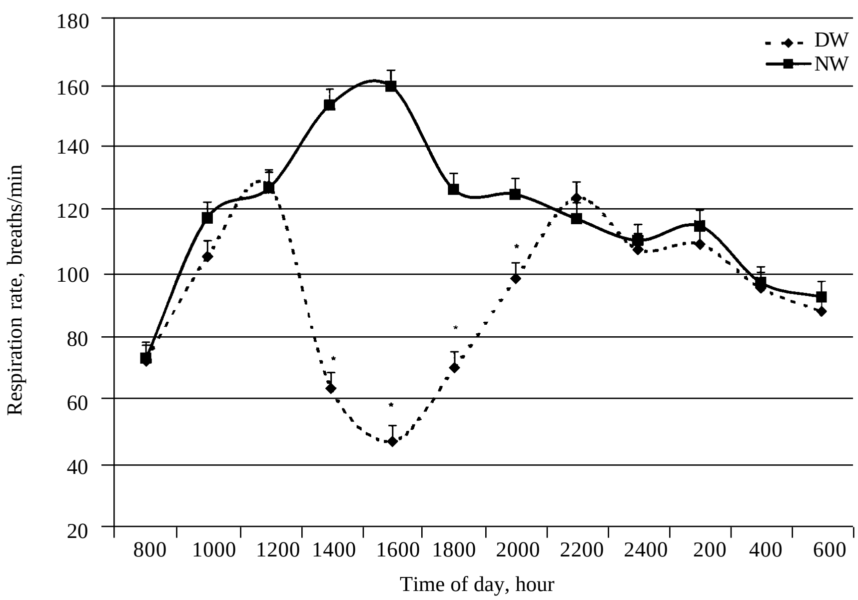

Figure 2. Effect of double (DW) vs. missed (NW) sprinkling on respiration rate of heifers under hot environmental conditions. Treatment x time interaction (P<.001). *Values within a time differ (P<.05).

humidity averaged 70% (range 50 - 96%). These conditions resulted in THI ranging from 76 - 88, and was above 80 for approximately 20 hours/ day. According to currently accepted values, THI values > 79 are considered dangerous for feedlot cattle.

Dry matter intakes of heifers for TNL, HOT days one - three, HOT days four - five, and HOT day six are presented in Table 1. Intakes during TNL and HOT days one - three were not different between treatments (P > .2) and averaged 13.1 and 10.8 lb/d, respectively. Reductions in DMI during heat stress are an adaptative mechanism by the animal to reduce metabolic heat load. The 18% decrease in DMI between TNL and HOT days one - three confirm the animals were subjected to discomfort when ambient temperature was elevated. Intakes during HOT day four - five were affected by treatment such that No Wet heifers had 19% lower DMI than Double Wet heifers. Dry matter intakes for the subsequent HOT day six remained lower (P = 0.08) for No Wet heifers even though sprinkling times during this period were similar between treatments. Intakes of No Wet heifers were 33% lower than Double Wet heifers during this period.

Physiological measurements of the heifers are presented in Table 2. During the TNL period, no treatment differences were observed for any parameter and are considered within the normal range for beef cattle. Likewise, during HOT days one - three, rectal temperature, respiration rate and pulse rate of all heifers responded similarly to hot conditions accompanied by sprinkling. Treatment and treatment x time interaction were not significant. However, rectal temperature and respiration rate changed with respect to time (P < 0.01), while pulse rate was only minimally affected (P = 0.08). Rectal temperature was lowest at 900 hours (101.3 ± .10°F) then gradually increased (P < 0.05) until the initiation of sprinkling (103.6 ± .10°F; 1300 hours) at which time it began to decline to 102.7 ± .10°F at 1600 hours. Rectal temperature increased to a high of 104.2 ± .10°F at 2300 hours, then began to decline again. Respiration rate followed a similar trend by being lowest at 800 hours (72.3 ± 6.8 breaths/min), then increased (P < 0.05) until the initiation of sprinkling (127.7 ± 6.8 breaths/ min at 1200 hours). Respiration rate declined 36% by 1600 hours, then increased to a maximum of 136.0 ± 6.8 breaths/min at 2000 hours, after which it slowly declined.

Figure 1 shows rectal temperature of heifers with respect to time (treatment x time, P < 0.001) during HOT days four - five. All heifers had similar increases in rectal temperature through 1200 hours. At 1300 hours, rectal temperature of Double Wet heifers began to decline (P < 0.05), while No Wet heifers increased (P < 0.05). The difference in rectal temperature was maximized 5 hours after

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the initiation of sprinkling (1700 hours) with Double Wet heifers having 3.5°F lower rectal temperature (101.8 vs 105.3 ± .09 °F). Differences in rectal temperature were continued through 700 hours. Figure 2 shows respiration rate of heifers during HOT days four - five with respect to time (treatment x time, $P < 0.001$). Like rectal temperature, heifers had similar respiration rate at the initiation of sprinkling. However, Double Wet heifers declined 50% ($P < 0.01$) by 1400 hours, while No Wet heifers increased 20% ($P < 0.05$). Differences in respiration rate were maximized at 1600 hours at which time Double Wet heifers had a 3-fold lower respiration rate than No Wet (47.3 vs 159.2 ± 4.8 breaths/min). Differences remained between the treatments until 2200 hours, at which time all heifers had returned to pre-sprinkling respiration rates. Pulse rate of heifers was variable with time (Figure 3), however Double Wet heifers were lower ($P < 0.05$) than No Wet at 1200 and 1600 hours.

Measurements of rectal temperature, respiration rate, and pulse rate during HOT day six were minimally affected by previous cooling strategy (Table 2). Figure 4 shows rectal temperature of heifers which tended to be affected by the interaction of treatment x time ($P = 0.14$). Double wet heifers tended to be lower than NW heifers until 1600 hours. Data were also analyzed for alterations in rectal temperature before and after HOT days four - five. Heifers which had been subjected to 2 x water application had no change in rectal temperature response either overall ($P > 0.10$) or with respect to time ($P > 0.10$). However, rectal temperature of animals which had missed a cooling application did differ with respect to time ($P < 0.01$; Figure 5). Rectal temperature of No Wet heifers between 1000 - 1600 hours was higher after missing a cooling period than prior to. This elevation of rectal temperature of rectal temperature is likely a carryover effect of not being cooled the previous two days. However, the profound differences in rectal temperature, respiration rate and pulse rate of between No Wet and Double Wet heifers during HOT days four - five illustrate their risk of heat stress related losses during such times.

Table 3. Dry matter intakes of heifers by period (lb/d).

	Treatments			
Period[a]	Double Wet	No Wet	SEM	P-value
Thermoneutral	12.08	14.08	1.41	.37
HOT, days 1 - 3	10.23	11.44	1.01	.45
HOT, days 4 - 5	12.10	9.32	.68	.03
HOT, day 6	10.29	6.88	1.04	.08

[a]No sprinkling occurred during thermoneutral. Sprinkling was done on all heifers between 1300-1500 h during HOT, days one - three and six. During HOT days four- five, sprinkling was done on half the heifers (Double Wet) between 1200 - 1600 h, the balance were not sprinkled.

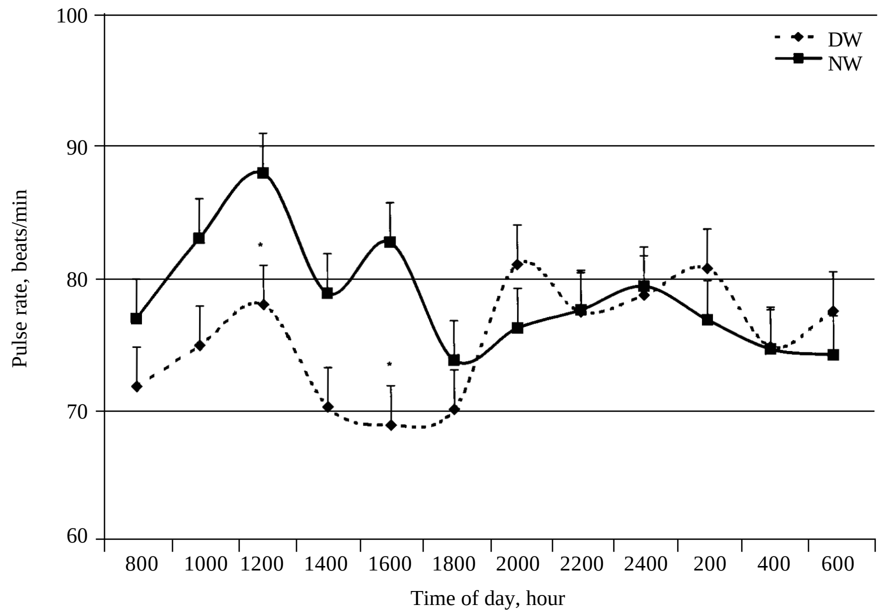

Figure 3. Effect of double (DW) vs. missed (NW) sprinkling on pulse rate of heifers under hot environmental conditions. Treatment xtime interaction (P<.05). *Value within a time differ (P<.05).

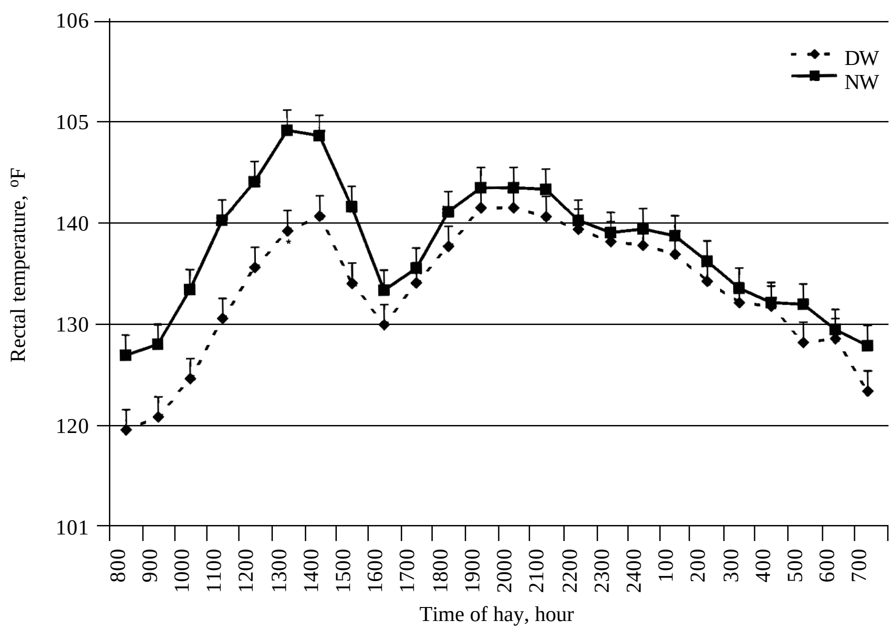

Figure 4. Effect of double (DW) vs. missed (NW) sprinkling on subsequent day (SS2) rectal temperature of heifers under hot environmental conditions accompanied by single sprinkling (1200-1400 h). Treatment x time interaction (P=.14).

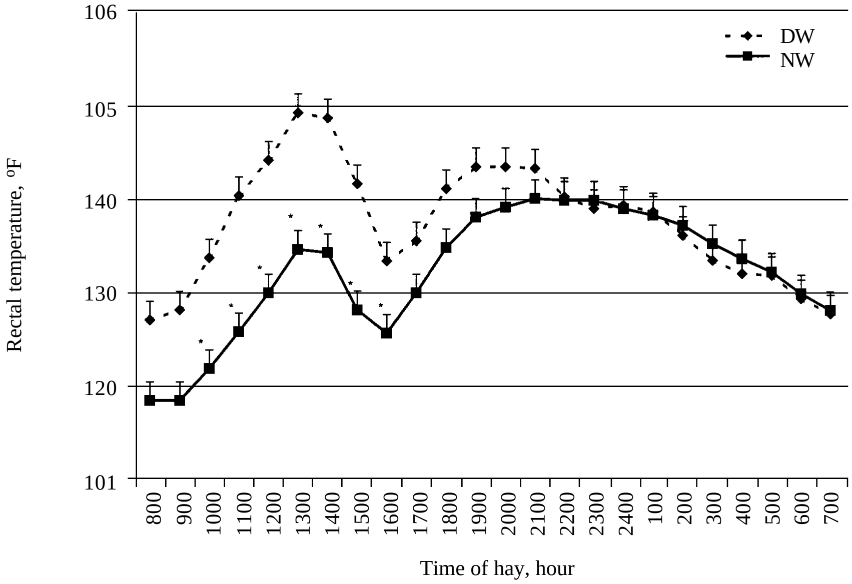

Figure 5. Comparison of rectal temperature of heifers prior to and after missing a sprinkling period. Before vs afer x time interaction (P<.01). *Values within a time differ (P<.05).

Sprinkling cattle is an effective method of altering animal response under conditions conducive to heat stress. Cooling cattle by use of sprinklers maintains dry matter intake under hot environmental conditions and effectively buffers a rise in body temperature which can lead to death. When cooling strategies are employed, they should be consistent and remain uninterrupted until weather conditions no longer pose any danger.

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