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Bedding Material in Dirt-Floor Pens Reduces Heat

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Introduction

Weather-related stressors are a well-recognized opponent to animal welfare and can have important ramifications for animal performance. Sound animal husbandry practices historically have attempted to diminish the effects of deleterious environmental factors. Providing aid to animals when temperatures are above or below their thermal neutral zone (TNZ) can improve animal welfare and/or performance. Because most breeds of cattle are not well equipped to deal with heat, the temperatures at which heat stress can begin to affect cattle can be surprisingly low. The onset of mild heat stress can occur at a temperature humidity index (THI[1]) value of 75, which can correspond to an ambient temperature as low as 78°F.

Aside from food, water, and shelter, arguably the most widely used intervention to counteract the elements is the provision of bedding material during times of cold weather or during events for which the stress of cold may prove too difficult for animals to compensate (i.e., calving, illness, etc.). By providing a layer of insulation as bedding for animals, heat exchange via conduction from their body to the earth is decreased, allowing them to maintain body temperature at a much lower cost to their metabolism. This basic principle of insulation also may be applied in times of heat stress.

In an attempt to decrease the effects of heat stress in feedlot cattle, some producers apply wheat straw or grass hay as bedding material, hypothesizing that bedding acts as an insulator from the pen floor, which otherwise serves as a reservoir and conductor of heat. Bedding materials normally are lighter in color than the pen surface, and therefore have less solar heat gain. To the best of our knowledge, no studies have been conducted to examine the effects of these bedding materials on the temperature of the pen surface. Additionally, determining the effects of varying thicknesses of manure on pen surface temperatures may provide useful information for management decisions regarding pen cleaning and maintenance.

Experimental Procedures

Plots (each approximately 21.5 ft^2) within a dirt-surfaced feeding pen near Manhattan, KS, were assigned randomly to 1 of 4 treatments, with 4 separate plots per treatment. Treatments consisted of a bare pen surface, wheat straw applied at a depth of 6 inches, and manure applied to the bare pen surface to depths of 6 and 12 inches. Surface temperatures of treatment plots were measured by a handheld infrared thermometer (Fluke, Inc., Everett, WA) with an accuracy of ±1.5% and a pre-set emissivity of 0.95. Measurements were collected every 30 minutes for 5 hours from 11:00 a.m. through 4:00 p.m. on June 30, 2011. Temperature measurement was conducted at a similar height and angle at each measurement time point. Environmental weather data were

[1] THI = Dry bulb temperature F° − (0.55−(0.55 × (relative humidity/100))) × (dry bulb temperature F° − 58).

measured using a multi-sensor onsite weather station (Campbell Scientific, Logan, UT) operated by the Kansas State University Turfgrass team. Data were analyzed using the MIXED procedure of SAS (SAS Institute, Cary, NC) with repeated measures over time. Significance was declared at $P < 0.05$ and tendencies at $P < 0.10$.

Results and Discussion

During the period of time when surface temperature measurements were collected, the dry bulb air temperature averaged 97°F (Table 1) with a corresponding relative humidity value of 31%. Although the relative humidity was not considered extreme, the air temperature was high enough to result in a THI that would be considered a time of severe risk for heat stress in cattle.

Application of wheat straw at a depth of 6 inches significantly decreased the surface temperature of the test plot versus all treatments ($P < 0.05$, Table 2). Face temperature was 25°F greater for the bare pen surface and with 6 inches of manures compared with wheat straw bedding ($P < 0.001$); however, surface temperature of the wheat straw plots was only 6°F cooler than the plots with 12 inches of manure ($P = 0.03$). The decreased surface temperature associated with wheat straw likely occurred as a result of a decreased absorbance of radiated solar energy due to the light color of the wheat straw. Pen surfaces absorb and accumulate heat from solar radiation, and the insulative properties of wheat straw likely played a role in diminishing solar heat gain. Materials with properties similar to those of wheat straw (corn stalks, poor-quality grass hay, etc.) could have comparable effects on surface temperatures of cattle feeding pens.

It is plausible that 12 inches of manure provided more insulation from the pen floor than 6 inches of the same material, which resulted in a decreased face temperature ($P < 0.001$), but further investigation is needed, and allowing excessive accumulation of manure is not advised.

Implications

These observations indicate that the use of wheat straw as a bedding material in dry dirt-floor cattle feeding pens can decrease the surface temperature of the bedded area, which may offer cattle a cooler place to rest in times of high heat load.

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Table 1. Environmental conditions during the experimental period

Item	Dry bulb temperature, °F	Relative humidity, %	Wind speed, MPH	Solar radiation, Langley
Mean value	97.9	31	3.6	780

Table 2. Surface temperature of different materials in a cattle feeding pen

	Pen surface treatment					
Item	Bare surface	6 in. wheat straw	6 in. manure	12 in. manure	*P*-value	SEM
Surface temperature, °F	136.6[a]	111.6[b]	136.7[a]	117.8[c]	<0.0001	2.04

[abc] Means with different superscripts differ significantly ($P < 0.05$).