2010

Tympanic Temperature Profiles of Confined Beef Cattle

Terry L. Mader
University of Nebraska-Lincoln, tmader1@unl.edu

Leslie J. Johnson
University of Nebraska-Lincoln, ljohnson13@Unl.edu

Tympanic Temperature Profiles of Confined Beef Cattle

Terry L. Mader
Leslie J. Johnson[1]

Summary

Angus crossbred yearling steers were used to evaluate tympanic temperature (TT) profile of cattle displaying high, moderate, or low levels of heat stress. Data indicate cattle that do not adequately cool down at night are prone to greater body temperatures during a subsequent hot day. Cattle that are prone to displaying moderate levels of heat stress but can cool at night will maintain average tympanic temperatures at or near those of cattle that tend to consistently maintain lower peak tympanic temperatures. In addition, during cooler and moderately hot periods, cattle change TT in a stair-step or incremental pattern, while under hot conditions, average TT of group-fed cattle moves in conjunction with ambient conditions, indicating that thermoregulatory mechanisms are at or near maximum physiological capacity.

Introduction

Previous studies (*2006 Nebraska Beef Report*, pp. 79-82) suggest that the range of daily TT may vary with the extent cattle are challenged by the heat event and that cattle may compensate (cool more at night if opportunities exist) by lowering TT to below normal TT levels after an excessive heat load event. The objectives of this study were to compare tympanic temperature profiles of feedlot steers that differ in heat stress susceptibility under varying summer environmental conditions.

Procedures

Tympanic temperature (TT) profiles from previously published research (*2007 Nebraska Beef Report,* pp. 77-79) were compared based on the magnitude of the TT displayed. Profiles were compared among animals that displayed high (> 107°F), moderate (106 to 107°F), and low (106 <°F) peak TT during the hottest day of the study, based on the temperature humidity index [THI; THI = ambient temperature - (0.55 - (0.55 * (relative humidity/100))) * (ambient temperature - 58)].

Details of the cattle utilized, management protocol, and study procedures are outlined in the *2007 Nebraska Beef Report* (pp. 77-79). An equal number of animals were utilized in the high, moderate, and low profile groups (8 head/group). Tympanic temperatures (TT) were recorded using Stowaway XTI® data loggers and thermistors (Onset Corporation, Pocasset, Mass.). Dataloggers recorded temperatures at 1-hour intervals in 24 animals from 8 pens (3 animals/pen) during a six-day period in which a severe heat event occurred. The event included a cool day (day 41), moderately hot (MHOT B-days 42 to 43) days, and hot (HOT B-days 44 to 46) days. The hot period was defined as successive days with maximum temperatures above a threshold of 90°F.

Performance data were analyzed using the MIXED procedure of SAS (Statistical Analysis Service, Cary, N.C.). Tympanic temperatures among groups of animals displaying low, moderate, and high TT were analyzed using a repeated measures model that included TT group, day, time of day,

(Continued on next page)

Table 1. Daily tympanic temperature (TT) of cattle exhibiting high, moderate, and low TT during day 41 through day 46 of study.

		Cattle, TT,°C[1]				
		High	Moderate	Low	SE	*P*-value
Cool Day						
	Minimum	—	—	—	—	
	Noon	102.3[a]	101.6[b]	101.8[b]	0.2	0.04
	Maximum (1700)	103.2[a]	102.2[b]	102.6[b]	0.2	0.01
	Midnight	102.6	102.2	102.1	0.2	0.25
Day -2						
	Minimum (0800)	101.1	100.9	100.9	0.1	0.67
	Noon	102.5[a]	101.9[b]	102.1[ab]	0.1	0.04
	Maximum (1800)	104.5[e]	103.9[d]	103.9[d]	0.2	0.06
	Midnight	102.4	102.0	102.2	0.1	0.15
Day -1						
	Minimum (0800)	101.0	100.6	100.8	0.1	0.16
	Noon	102.7[a]	101.8[b]	102.2[ab]	0.2	0.02
	Maximum (1700)	104.5[a]	103.7[b]	103.6[b]	0.2	0.03
	Midnight	102.3	101.9	102.2	1.7	0.21
Day 0 (start of hottest day)						
	Minimum (0700)	101.6[a]	100.9[b]	101.2 [b]	0.1	0.02
	Noon	103.8[a]	102.7[b]	102.9[b]	0.1	0.01
	Maximum (1800)	107.6[a]	106.7[b]	105.7[c]	0.2	0.01
	Midnight	103.4	102.9	103.3	0.3	0.32
Day 1						
	Minimum (0700)	101.1[a]	100.5[b]	101.3[a]	0.2	0.01
	Noon	104.5[a]	103.6[b]	103.8[b]	0.3	0.06
	Maximum (1700)	106.4[e]	105.6[d]	105.4[d]	0.2	0.02
	Midnight	103.0[a]	102.2[b]	102.3[b]	0.2	0.02
Day 2						
	Minimum (0700)	101.7[a]	100.7[b]	101.3[a]	0.2	0.01
	Noon	105.2[a]	103.8[b]	104.2[b]	0.3	0.01
	Maximum (1500)	106.7[a]	105.4[b]	105.6[b]	0.3	0.01
	Midnight	103.0[a]	102.2[b]	102.8[ab]	0.2	0.01

[1]Classification based on peak TT observed on day 0 (7/22/2005).
[a,b,c]Means within a day and time with unlike superscripts differ ($P < 0.05$).
[d,e]Means within a day and time with unlike superscripts differ ($P < 0.10$).

(Continued on next page)

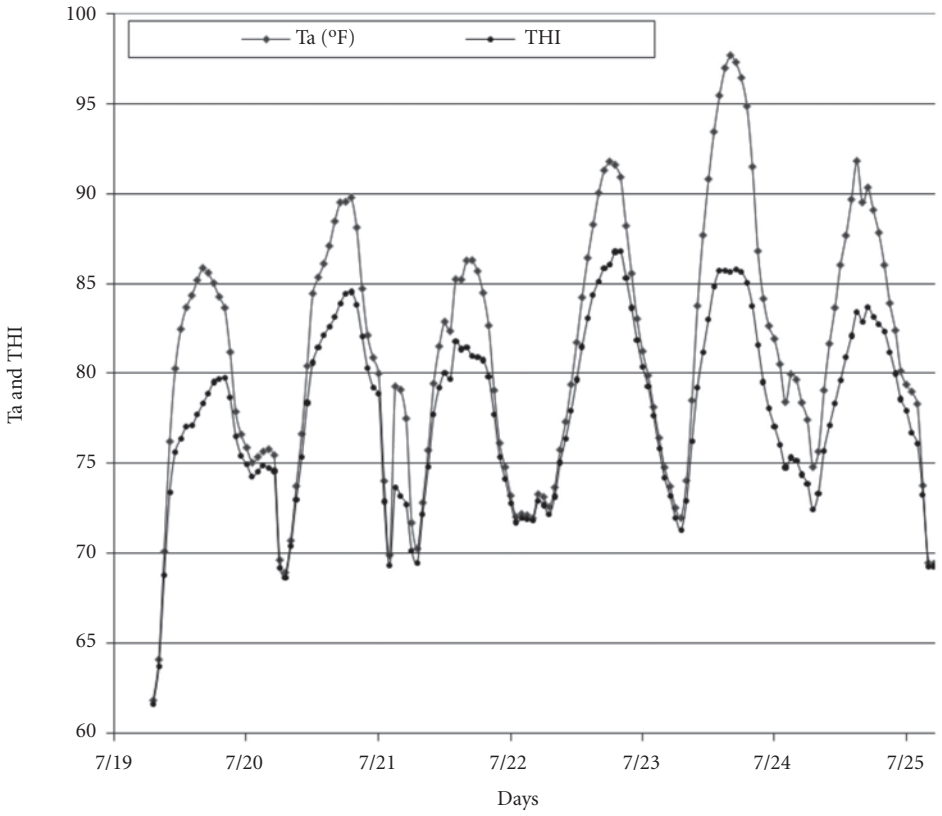

Figure 1. Ambient temperature (Ta) and temperature-humidity index (THI) for days 41 to 46 of study.

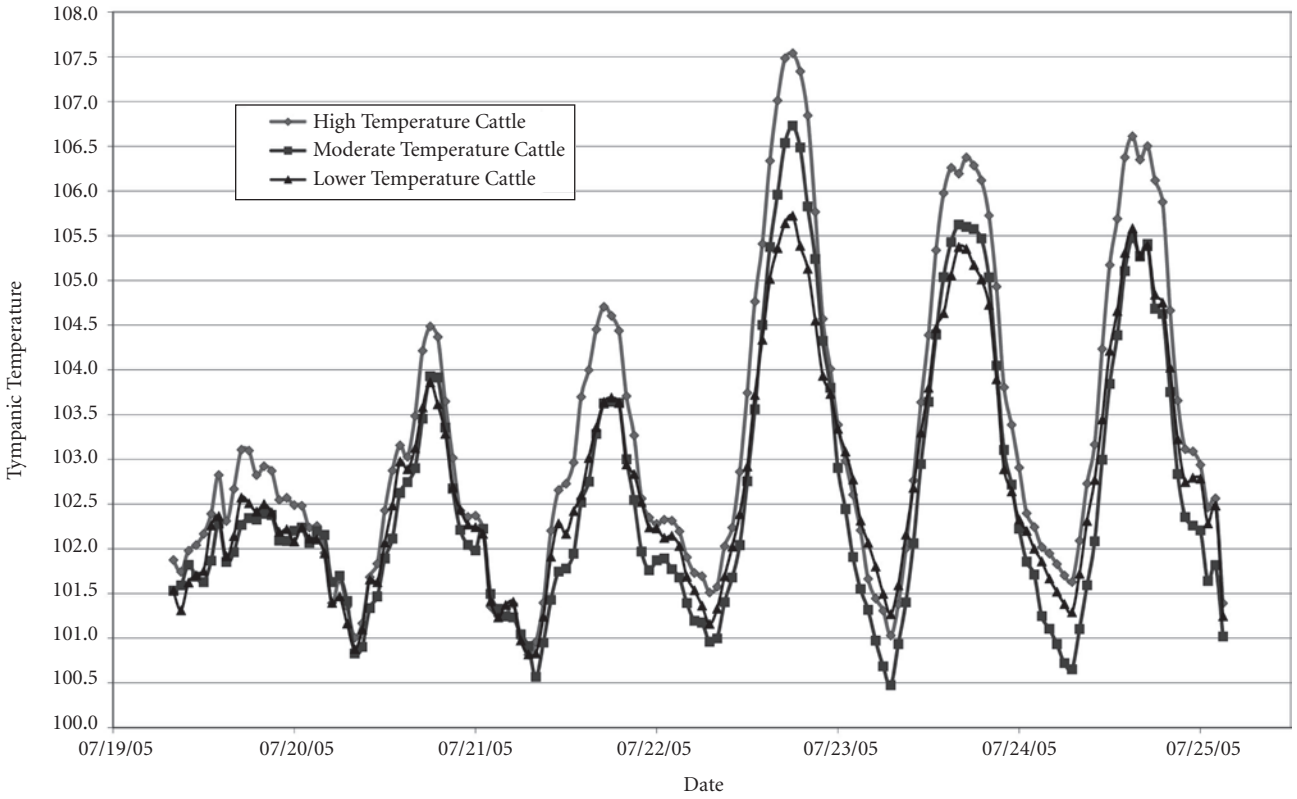

Figure 2. Diurnal tympanic temperature (TT) pattern for cattle exhibiting high (peak TT > 107°F), moderate (107°F > peak TT > 106°F), or low (peak TT < 106°F) heat stress levels on 7/22/2005.

(Continued on next page)

and all possible interactions. The specified term for the repeated statement was animal within day.

Results

A heat wave occurred during this study (Figure 1) in which the THI averaged or exceeded 84 for 3 days in a row (days 44 to 46). A THI of 84 or greater is considered to be in an emergency category, in which cattle are experiencing extreme heat stress. Cattle deaths in surrounding feedlots were documented during this period, although no cattle in this study died.

TT profiles of cattle exhibiting high, moderate, or low levels of heat stress are shown in Table 1 and Figure 2. From these data, it is evident that cattle with high TT had elevated TT even during the first day (cool day) at 1200 hr and 1700 hr. However, cattle with a moderate TT appeared to have the most elasticity in TT than either the high or low group, reaching moderately high TT during the hot days, but able to reach a lower ($P < 0.05$) TT by morning than either the high (days 0, 1, and 2) or the low (days 1 and 2) group. This could be related to feed intake and possibly performance; however, over the entire study, the ADGs of the low, moderate, and high TT groups were 3.40, 3.31, and 3.57 lb/day, respectively.

Based on TT profiles, these data suggest cattle that fail to cool down at night are prone to achieving greater body temperatures during hot days. Cattle that are prone to get hot but can cool at night can keep peak body temperatures at or near those of cattle that tend to consistently maintain lower body temperatures. Thus, cattle that have the ability and /or opportunity to dissipate body heat at night tend to have lower peak TT during the day. In the current study, TT profile of the moderate group displayed some TT compensation with lower morning TT during the three hot days than the high and low profile groups. However, the average magnitude of difference (day 0 high minus day 1 low) was similar for the high (107.55 – 101.05 = 6.50°F) and moderate (106.74 – 100.47 = 6.27°F) profile groups vs. the low (105.73 – 101.26 = 4.47°F) TT profile group. The magnitude of TT change, as calculated from day 1 maximum minus day 2 minimum values, were 4.71, 4.95, and 4.07, respectively for the high, moderate, and low groups. In addition, during cooler and moderately hot periods, TT of cattle changes in a cyclical or stair-step (up and down) pattern. However, under hot conditions, TT moves in conjunction with ambient conditions, indicating that thermoregulatory mechanisms are near maximum physiological capacity for preventing TT from rising. It should be noted that these data are based on the average of a group of animals, which tends to smooth the body temperature curve. Individual animals may display a more erratic TT profile pattern.

Conclusion

There may be considerable variation in heat stress tolerance among cattle. Some cattle are more susceptible to heat stress than others, but this tolerance is not necessarily performance related. Nevertheless, cattle are remarkable in their ability to mobilize coping mechanisms when challenged by environmental stressors. Under three-day heat events, such as the one found in this study, thermoregulatory processes are unable to maintain a constant TT, and TT therefore tends to mirror changes in environmental conditions as defined by ambient temperature and THI.

---

[1]Terry L. Mader, professor, Leslie J. Johnson, research technician, Animal Science, Haskell Agricultural Laboratory/Northeast Research and Extension Center, Concord, Neb.