Impact of Brahman genetics on body temperature of heifers on pasture under heat stress.

Raluca Mateescu, Department of Animal Sciences, University of Florida

Bos indicus and *Bos indicus* influenced cattle, like Brangus, are better able to regulate body temperature in response to heat stress due to a number of physiological and cellular level adaptive traits. The multibreed herd at the University of Florida (UF) Beef Research Unit allowed us to quantify the change in body temperature in heifers with various proportions of Brahman genes per unit increase in heat stress as measured by temperature-humidity index (THI) and to assess how different breed groups responded to varying intensity and duration of heat stress. A total of 299 two-year old heifers from six breed groups ranging from 100% Angus to 100% Brahman were evaluated under hot and humid conditions during 2017 and 2018 summer days.

The variation in environmental heat stress conditions ranging from days with moderate heat stress conditions to days with severe heat stress conditions provided us with the opportunity to compare the response of different breed groups under a range of heat stress environments. There are two important observations illustrated by our data. As shown in **Figure 1**, the heat load in 2017 was severe for three consecutive days and the body temperature of all heifers, regardless of breed group, was elevated. Under these extreme heat stress conditions, even the purebred Brahman heifers are not able to maintain body temperature below 39˚C. When heat load was moderate or high during 2018, Brahman heifers had a significantly lower body temperature compared with all other breed groups (**Figure 2**). During these days of medium to high heat stress, Brahman heifers were able to maintain body temperature below 39˚C for most of the time. This is important because it was estimated that uterine temperature exceeding 39˚C was associated with a reduction in conception rate. Same temperature was shown to reduce blastocyst production in *Bos taurus indicus* cows as a result of compromise oocyte developmental capacity. Based on our data, considering the 39˚C body temperature as a threshold to indicate inability to cope with heat stress, we can infer that days with a heat load greater than 34 present a challenge for all heifers, regardless of breed, to maintain body temperature bellow 39˚C.

It is important to note that during 2017 when heifers were exposed to severe heat load for three days, the body temperature of Angus heifers was significantly higher than for Brahman heifers only for day 3. This could be an indication of a superior ability of Brahman heifers to adapt to several days of severe heat stress in a row. On the other hand, during 2018 when heifers were exposed to moderate and high heat load (first and second day in 2018, Figure 3), the body temperature in Angus heifers was significantly higher than in Brahman heifers for most of the day, approximately between 0900h and 2000h. Data presented in **Figure 2** would also suggest that the critical factor in the ability to maintain a lower body temperature might not be the number of hours with high or extreme THI but rather the lack of opportunity to cool down during the night hours. During the 3 nights in 2017 which preceded the days with extreme heat stress conditions, the THI was not lower than 71.

The body temperature for Angus heifers when environmental THI is low, was 0.06°C greater than the population average body temperature under low THI. The body temperature of all other breed groups under low THI was not different than the population average. The body temperature for the 100% Angus breed group increased by 0.417°C for every 5 units of THI. The body temperature of the 25%, 32.5%, 50%, and 75% Brahman breed groups showed a numerical decrease with the increase in percentage of Brahman genes, but they were not significantly different from the population. These results suggest that cattle with 100% Brahman genetics have a superior tolerance to heat stress, reflected in a smaller increase in body temperature in response to an increase of 5 THI units in environment. Angus cattle have a significantly lower thermotolerance reflected in a larger increase in body temperature.

A heterosis effect, defined as the deviation of the crossbreds (50% Brahman) from the average of the two parental breeds (0% Brahman and 100% Brahman, respectively) was estimated for the tolerance to heat stress. This moderate heterosis of -8.35% indicates that the resilience to heat stress of an Angus X Brahman crossbred is 8.35% better than the average of the parental breeds due to heterosis.

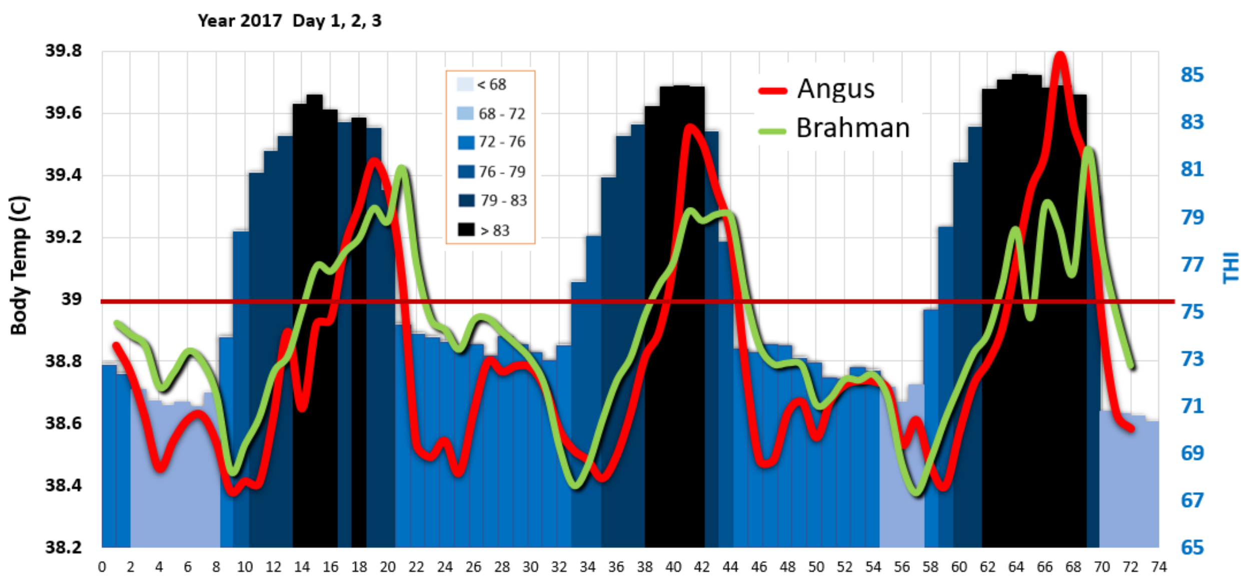

Figure 1. Hourly body temperature (˚C, left axis) for purebred Angus (red line) and purebred Brahman (green line) for three consecutive days during 2017 when the heat load was severe for three consecutive days. The hourly temperature humidity index (THI, right index) is depicted as blue shaded bars following the scale in the graph. When exposed to severe heat stress, even Brahman heifers are not able to maintain body temperature below 39˚C.

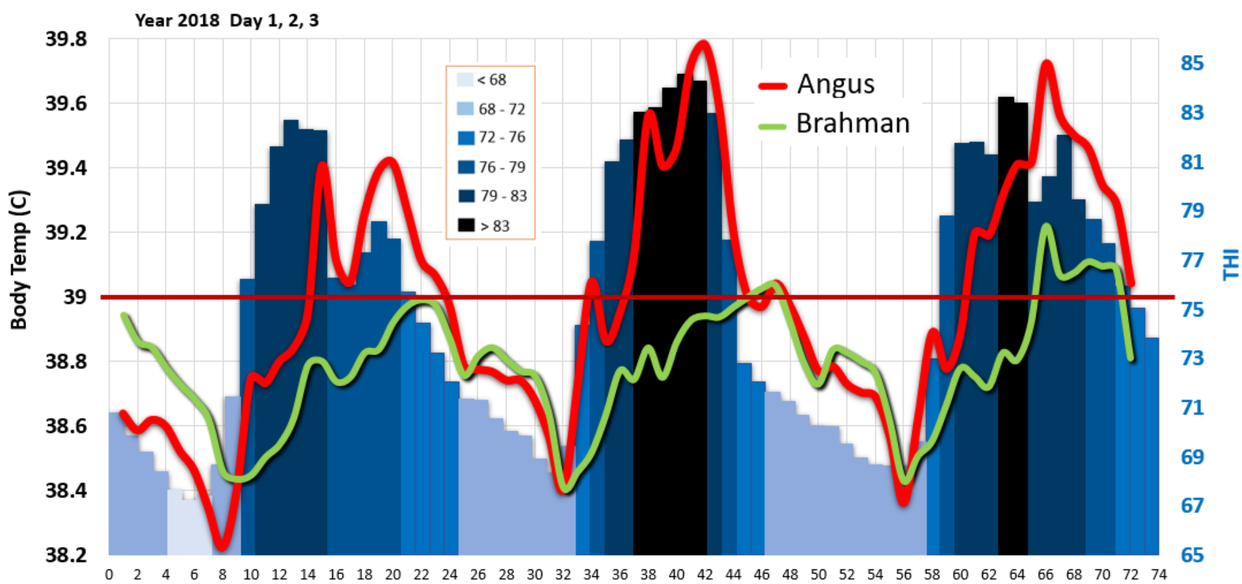

Figure 2. Hourly body temperature (˚C, left axis) for purebred Angus (red line) and purebred Brahman (green line) for three consecutive days during 2018. Heat load over the first, second and third day was moderate, high, and high, respectively. The hourly temperature humidity index (THI, right index) is depicted as blue shaded bars following the scale in the graph. When heat load was moderate or high during 2018, Brahman heifers had a significantly lower body temperature compared with all other breed groups and were able to maintain body temperature below 39˚C for most of the time.

Conclusion. The beneficial effect of Brahman genetics is dependent on the magnitude of environmental heat stress. When breed groups were exposed to moderate or high heat stress, the Brahman group had a significantly superior resilience to heat stress, but when exposed to severe heat stress even Brahman group could not adequately cope. Along with the number of hours under high heat stress THI during the day, the opportunity to cool down during the night seems to be the critical factor. Climate change predictions with heat stress conditions intensifying and expanding into currently temperate zones indicate the imperative need to develop effective strategies to ensure sustainable beef production systems. Effective strategies will require the identification of the genes conferring the superior thermotolerance in Brahman cattle. This will allow genomic selection within breeds for superior productivity under hot and humid conditions or introduction of thermotolerance variants in thermo-sensitive breeds through targeted introgression or gene editing technology.

Raluca Mateescu is a Professor of Quantitative Genetics & Genomics in the Department of Animal Sciences at University of Florida. For more information visit https://www.ralucamateescu.com/