Genetic evaluation for heat tolerance in Angus cattle

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Introduction

Because beef cattle are raised in extensive conditions, growth can vary across production environments. Within-breed genotype x environment interactions have been reported for weaning weight and yearling weight (Butts et al., 1971; Bertrand et al., 1987). When Hereford cattle were adapted to the Florida or the Montana climate, calves had 20 lb heavier weaning weights when grown in the environment they were adapted to (Butts et al., 1971). Genetic lines within a breed differ in their adaptability to specific regions. Thus, selection would be more accurate when using genetic predictions specific to a given environment.

Part of this genotype x environment interaction could be attributed to differences in heat tolerance, an economically important trait for livestock producers in certain environments. In the beef industry, total economic losses from heat stress are estimated to be greater than $360 million annually (St.-Pierre et al., 2003). Heat stress reduces feed intake, growth, milk production, and pregnancy percentage. Angus experience greater physiological effects of heat stress than *Bos indicus* and tropically adapted *Bos Taurus* breeds (Hammond et al., 1996). With Angus dominating the United States (US) beef industry, improving heat tolerance can have a large economic impact nationally and can increase the use of Angus genetics in regions with greater heat stress.

Livestock populations can be selected for improved heat tolerance if genetic variation exists for the phenotype associated with greater temperatures. Genetic evaluations have been developed to identify those animals that are more robust to changes in temperature-humidity index (**THI**; Ravagnolo and Misztal, 2000; Zumbach et al., 2008b). As weather patterns become more erratic and global warming continues, the more robust animals will be more productive and profitable for farmers. Temperature data can be incorporated into genetic evaluations using reaction norms, which yield EPD based on different THI values. These methods have been applied to dairy, swine, and beef cattle to create selection tools for heat tolerance.

Modeling heat stress

Heat stress was characterized using THI (Zumbach et al., 2008a). These THI data were obtained from public weather station databases, because previous research demonstrated that off-farm weather data was just as useful as on-farm data for assessing heat load (Freitas et al., 2006). Heat stress was based on weather conditions for 30 days before the weaning weigh date. The average THI for this period was used for the analysis. If the average THI was less than 75 °F, then the THI was set to 75 °F, and these animals were not expected to be heat stressed. All animals in a weaning contemporary group were exposed to the same environmental conditions and had the same amount of heat stress.

Weaning weights from the South region were used to develop a heat tolerance genetic evaluation. Heat stress was incorporated into a reaction norm model resulting in environment-specific EPD for weaning weight and maternal milk. Additionally, weight was evaluated using a univariate model similar to a traditional growth evaluation for comparison.

Results

Heritabilities for weaning weight were greatest for large THI indicating that genetic variation exists to select for heat tolerance. Genetic correlations between THI values of ≤ 75 and ≥ 82 °F were less than 0.50 and were indicative of weaning weights being different traits depending on the environmental temperature. Sire rankings were assessed for bulls with at least 25 progeny with weaning weights. The rank correlation for proven sires was 0.32 between THI of ≤ 75 and 85 °F. Producers would select different bulls depending on the THI for their location for the 30 days prior to weaning. Greater response to selection could be achieved by selecting bulls that were best adapted to the climatic conditions.

Conversely, heritabilities for maternal milk were consistent across heat loads indicating no change in genetic variability across environmental temperatures. Genetic correlations were strong between different heat load values with little re-ranking of proven sires. Possibly, heat stress affects cows by decreasing fertility and body condition but not milk production as measured by calf growth. Thus, milk can be selected across environmental temperatures with similar response to selection.

Reaction norms for the 10 greatest (black) and least (grey) weaning weight proven sires from the univariate model are presented in Fig. 1. This figure presents the EPD for each bull based on THI from ≤ 75 to 85 °F. Bulls with straight lines would be expected to produce progeny with similar growth across THI environments. If the line decreases from left to right, that bull's progeny are expected to grow less as THI increases and have poor heat tolerance. If the line increases from left to right, the bull's progeny are expected to grow more as THI increases and have good heat tolerance. Because the lines for some of the greatest (black) and least (grey) growth sires cross, those sires would be expected to have similar progeny growth in environments with large THI even though the greatest growth sires were clearly superior for lesser environmental temperatures.

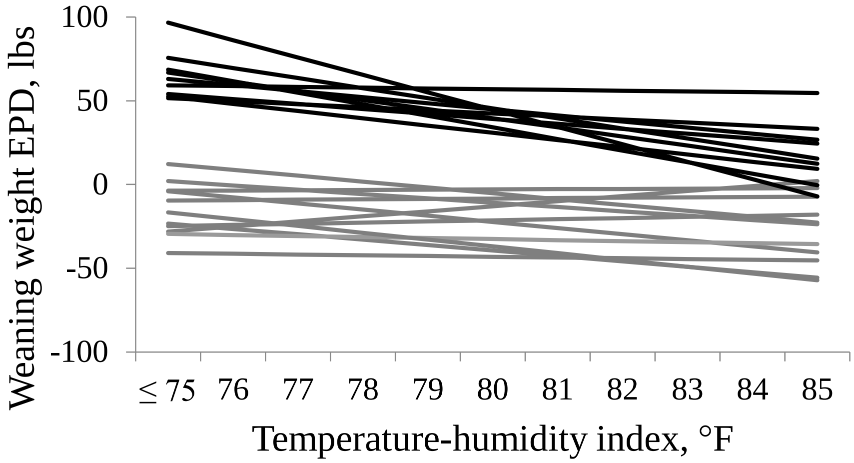

Fig. 1. Reaction norms for the 10 proven bulls with the greatest (black) or least (grey) weaning weight direct EBV from the univariate analysis for Angus in the South region

The genetic trends for weaning weight based on 3 THI values are illustrated in Fig. 2. Weaning weight was less for greater THI indicating growth genetic potential was less in hot environments. Genetic merit has been increasing for THI of ≤ 75 and 80 °F but has started decreasing for THI of 85 °F. Thus, current selection practices in the Angus breed may be qreducing heat tolerance in the South. Angus breeders would benefit from selection tools to improve or maintain heat tolerance in areas affected by heat stress.

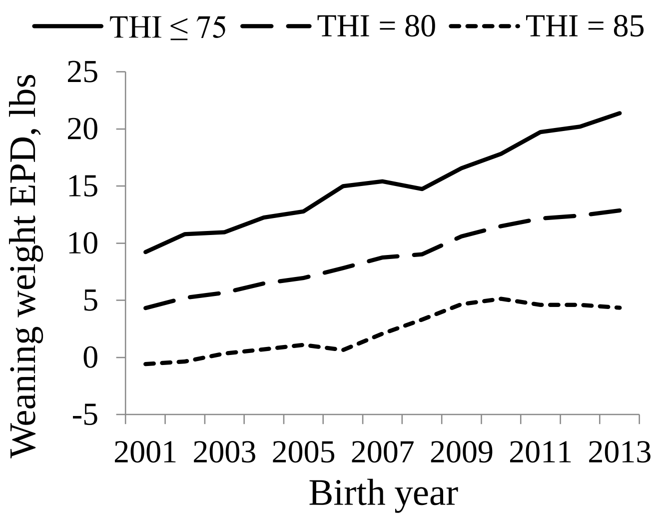

Fig. 2. Genetic trend for weaning weight direct from the reaction norm based on 3 temperature-humidity index (THI) values for Angus in the South region

Conclusions

Genetic variation exists for heat tolerance in Angus, and these cattle can be selected to improve weaning heat tolerance. Proven sires rank differently depending on THI, which has consequences for selection and mating decisions. Producers in the South region would benefit from environment-specific selection tools to identify the best growth sires for the specific climatic conditions. Additionally, Angus breeders should be concerned about weaning heat tolerance because of the decreasing genetic trend for weaning weight in extreme heat stress.

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