Genetic parameters for body temperature under hot and humid conditions in an Angus–Brahman population

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Climatic stress and beef cattle

- Major limiting factor of production efficiency
  - In beef cattle in tropical and subtropical environments.
  - In dairy cattle throughout most of the world.
- > **50%** cattle in the world – maintained in hot and humid environments
  - including ~ 40% of beef cows in US.
- Substantial differences in thermal tolerance
  - Among breeds
  - Among animals within breeds
- Indication of opportunities for **selective improvement.**

In response to heat stress cattle will:

- Regulate internal **heat production**
  - Modulating basal metabolic rate
  - Changing: feed intake, growth, lactation, activity
- Regulate **heat exchange**
  - Increasing blood flow to the skin
  - Increasing evaporative heat loss through sweating & panting

Genetics of thermotolerance

- **Heritability** of rectal temperature
  - 0.19, Brahman x Angus crossbred pop. (Riley et al. 2012)
  - 0.17, dairy cattle in FL (Dikmen et al. 2012)
- Selection for improved thermal tolerance is possible
  - If we can identify animals with genetically superior core body temperature regulation when exposed to environmental thermal stress.
  - Need phenotypes and tools to make selection decisions

Reveal the **genetic architecture** of traits defining **thermal tolerance** in *Bos Indicus* influenced cattle.

UF - Multibreed Angus x Brahman Herd

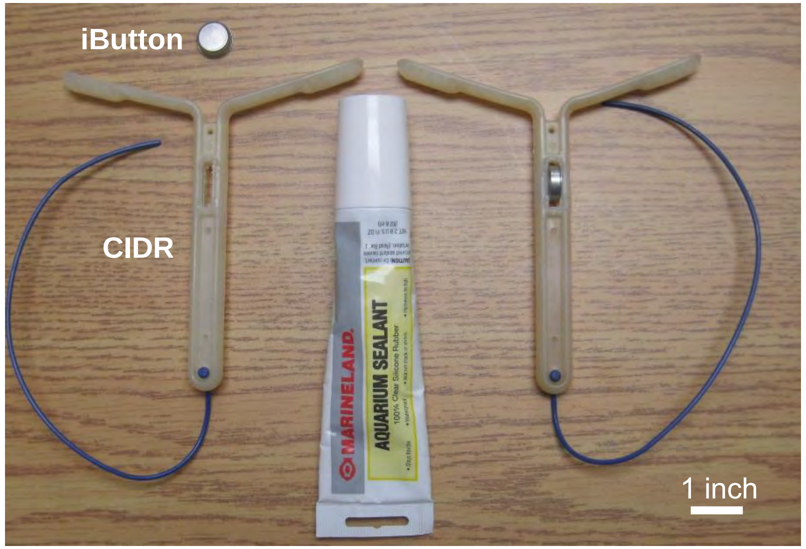
- Summer 2015, 2017
  - **286 cows**: from 100% Brahman to 100% Angus

Breed Group	Angus %	Brahman %	Angus %	Brahman %
1	100	0	100-80	0-20
2	75	25	79-60	21-40
3	62.5	37.5	62.5	37.5
4	50	50	59-40	41-60
5	25	75	39-20	61-80
6	0	100	19-0	81-100

Internal Body Temperature

- Summer 2015, 2017
  - **286 cows**: from 100% Brahman to 100% Angus
  - Vaginal **temperature** at 5-min intervals for 5 days
  - Air temperature and relative humidity – recorded continuously in the pastures

DS1922L iButton Temperature Logger, Range: -40°C to +85°C, Resolution: 0.0625°C (11 bit) or 0.5°C (8 bit)



Environmental Measurements

- HOBO data loggers recorded **every 15 minutes:**
  - **dry bulb temperature** (**T_{db}**)
  - **relative humidity** (**RH**)
  - **dew point temperature** (**T_{dp}**)
  - **black globe temperature** (**T_{bg}**)

- The temperature-humidity index (**THI**) was used to quantify heat stress and it was calculated as in Dikmen et al., 2008:

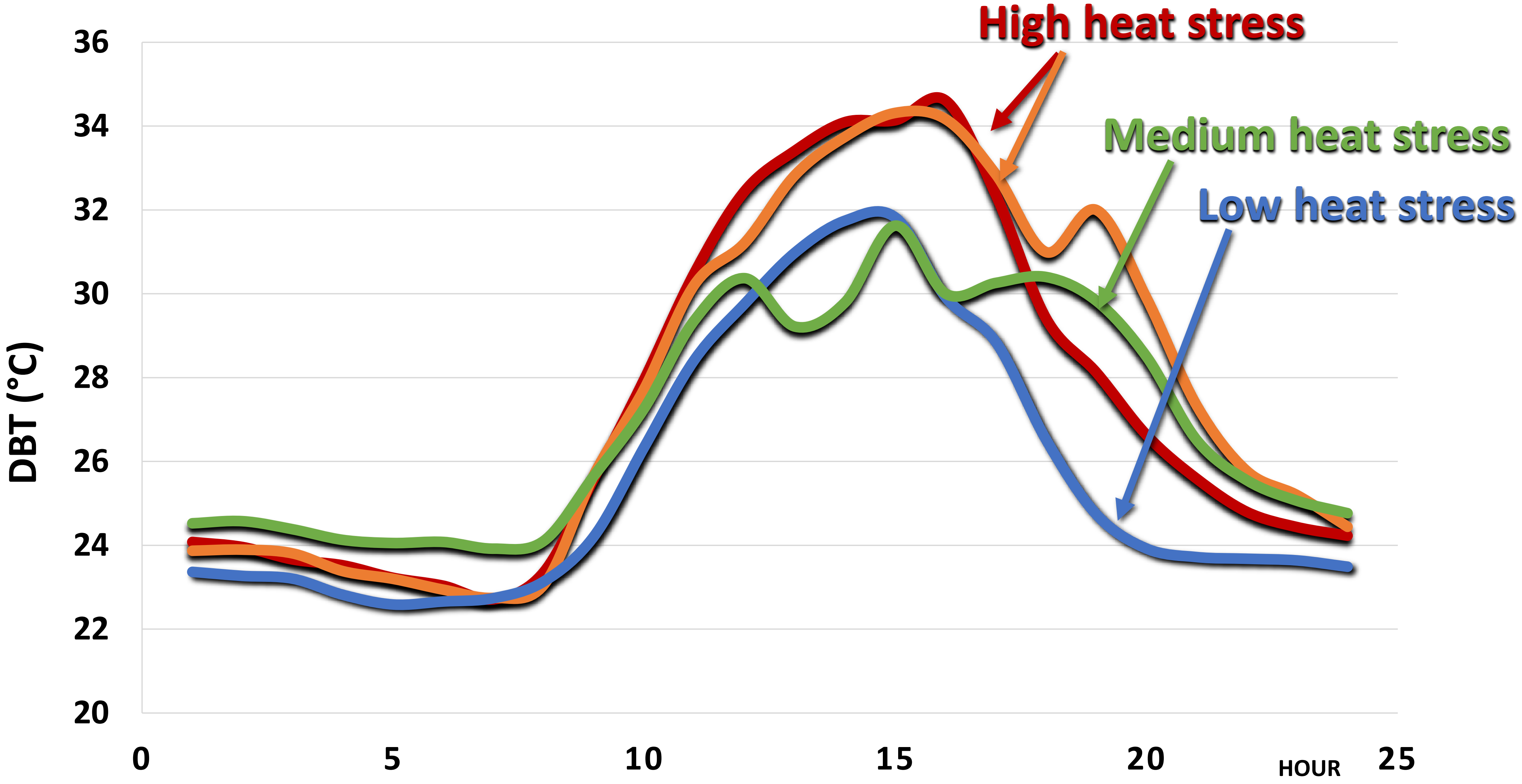
$$THI = (1.8 \times T_{db} + 32) - [(0.55 - 0.0055 \times RH) \times (1.8 \times T_{db} - 26)]$$

UF

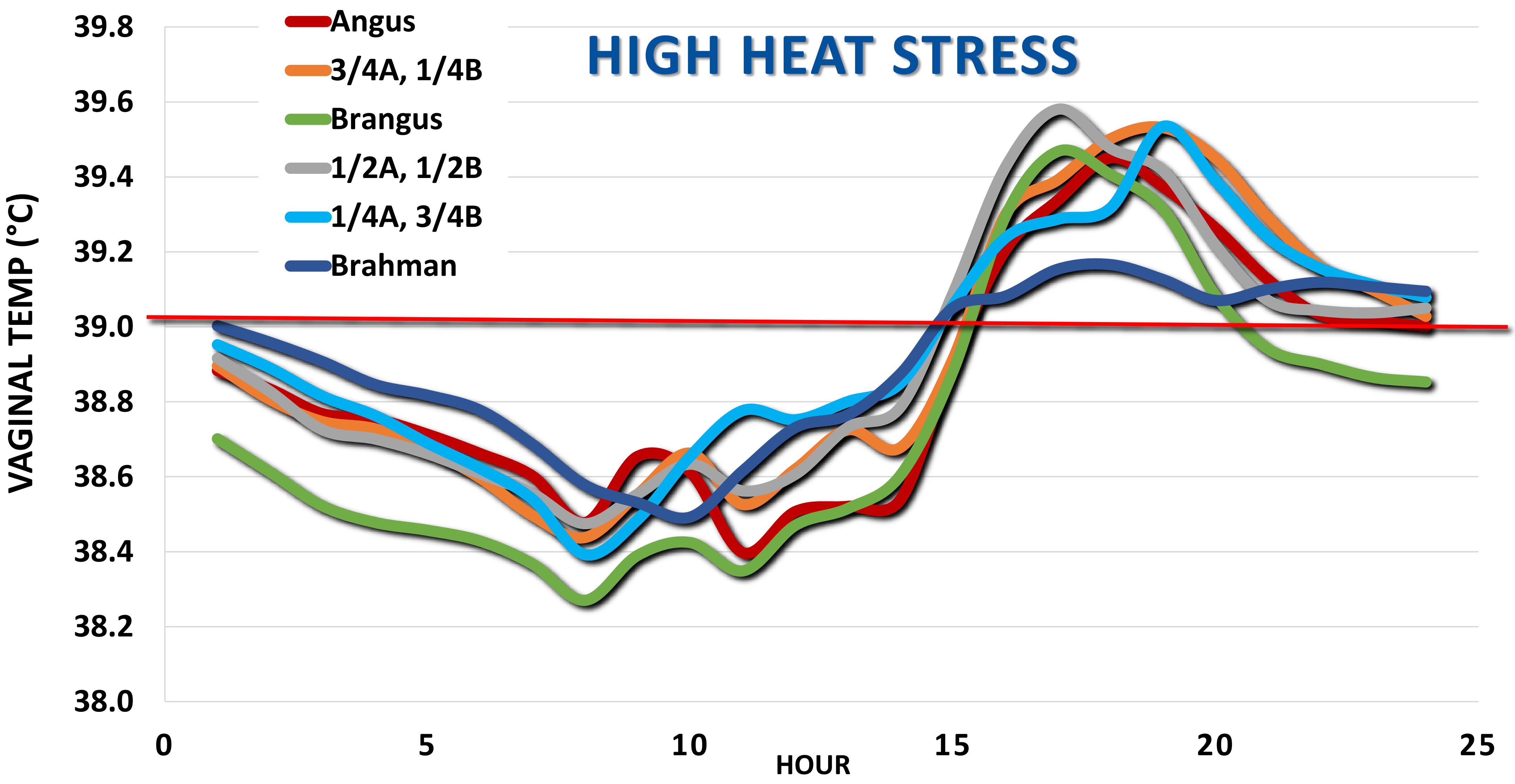
Genetic Parameters - variables

- **Low** THI: **74** and **74.5**
- **High** THI: **84** – **84.5**
- **Average** THI: **77** – **77.5**
- Vaginal temperature for each cow Low, High, Avg. = **average temp of all the 5-min** measurements when the cow was exposed to that respective THI.
- Diff THI: High-Low THI
- **WOMBAT**: univariate animal models - genetic and residual variances, heritability.

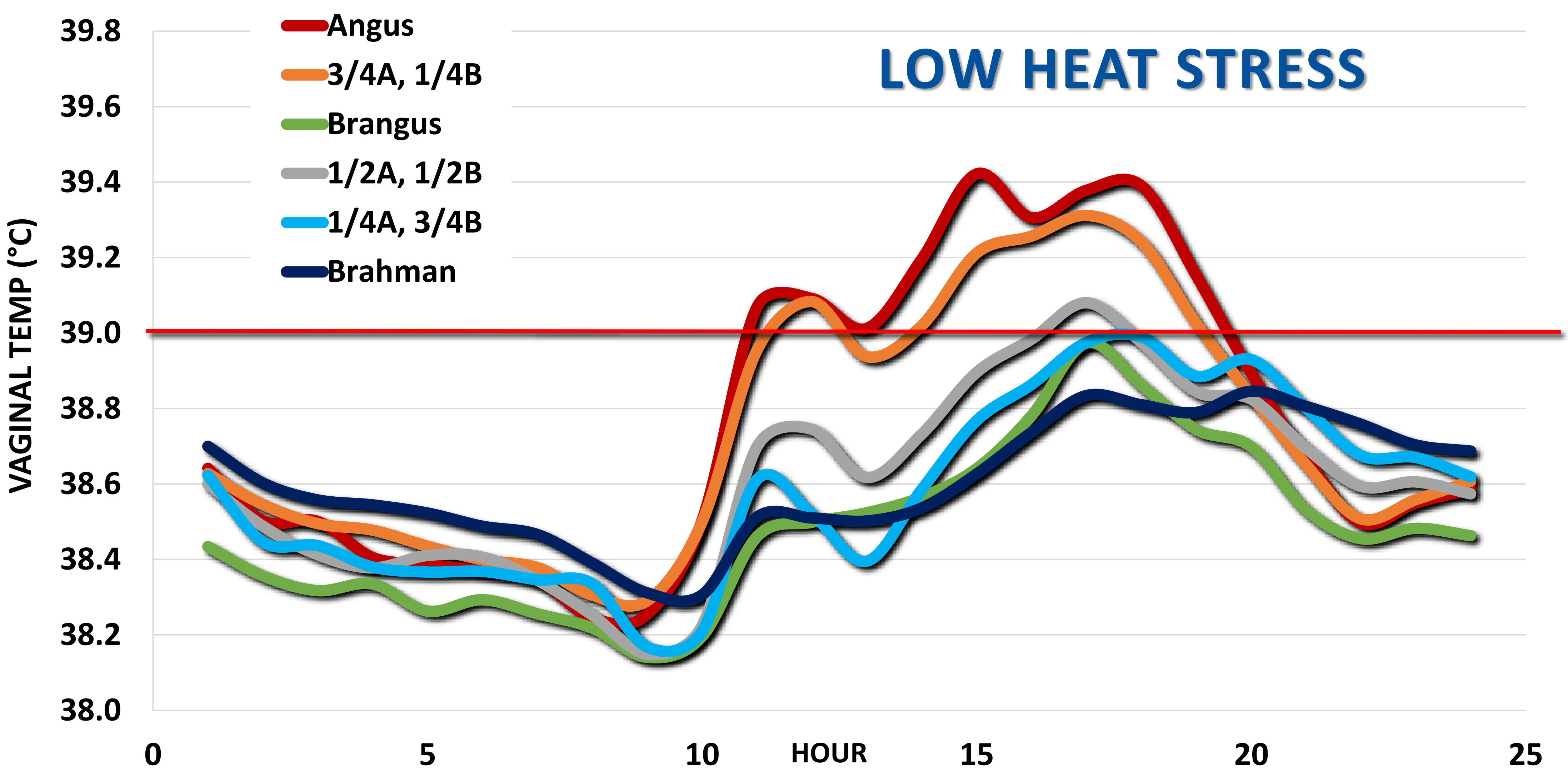
Outside temperature – by replicate



Vaginal Temp. under high heat stress



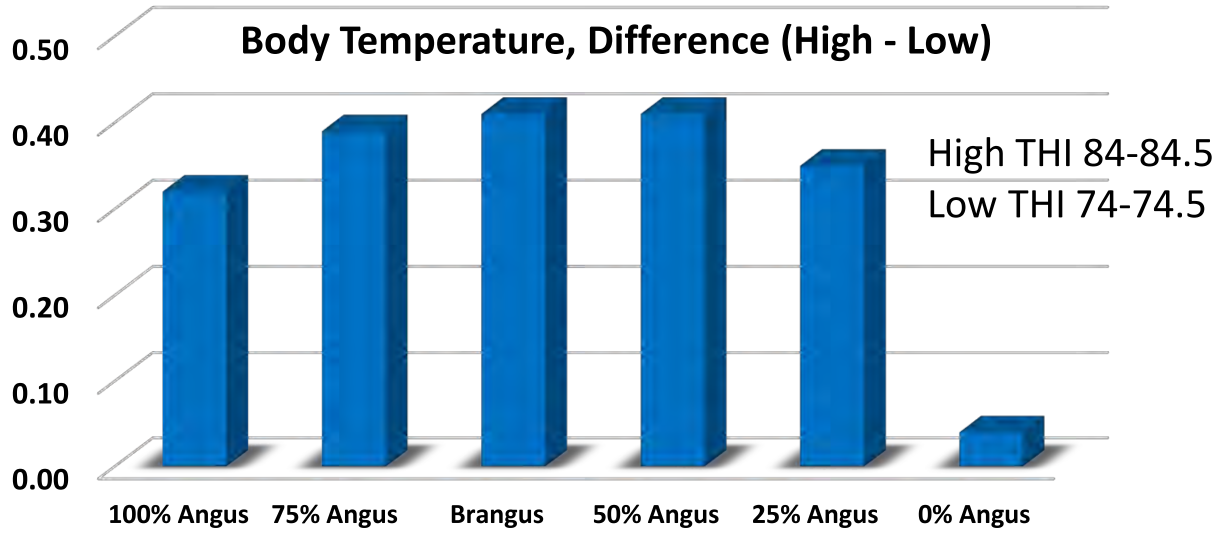
Vaginal Temp. under low heat stress

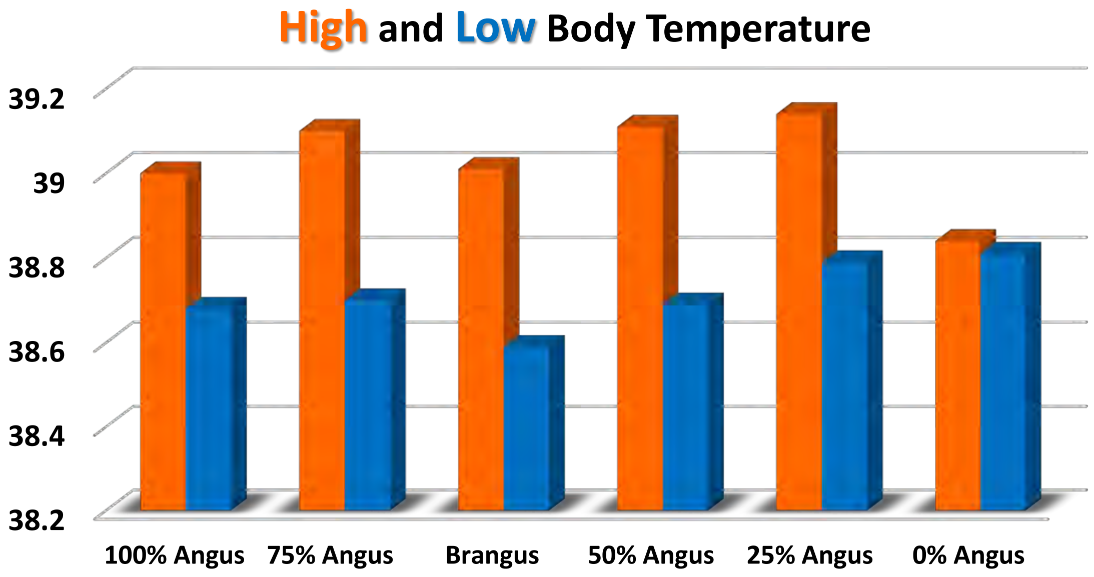


LSMeans - 6 different breed groups

Trait	h^2
Temp Diff Hi-Low	**0.27**
Temp High	**0.11**
Temp Low	**0.25**
Temp Average	**0.20**

Trait	σ^2_a	σ^2_e
Temp Diff Hi-Low	0.17	0.45
Temp High	0.07	0.56
Temp Low	0.14	0.42
Temp Average	0.09	0.35





Conclusions

- **Climatic stress** - major limiting factor of production efficiency in beef cattle in tropical and subtropical environments.
  - Expected to increase due to climate change.
- Differences in **thermal tolerance** exist:
  - Opportunities for selective improvement.
- **Genomic tools** are needed to select replacement heifers or bulls with increased thermotolerance.
- Development of the "**cow of the future**" with high productivity and resistant to heat stress will be realized through use of **genomic selection.**

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Comments/ Questions