Impact of heat stress on weights, weight gain and fertility in the local breed ‘Rotes Hoehenvieh’

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The breed ‚Rotes Hoehenvieh‘ (RHV)

- Endangered breed (2018: **2,157** cows and **166** bulls in Germany), originally distributed in Central Europe
- **Characteristics of the breed:**
  - medium sized, well muscled, single-coloured red brown, end of tail white coloured, bright horns with dark horn tips, bright mouth, dark and hard claws
  - robust, modest, calving ease, good maternal qualities, excellent pasture conversion, good meat quality
  - **height:** bulls: 142 cm cows: 138 cm **weight:** bulls: 900 kg cows: 650 kg
  - **milk yield:** 4,000 kg/year 4.5 % fat 3.5 % protein
- **original use:** milk- and meat production, draft animal for field work

Heat stress effects in cattle

- heat stress will occur more frequently in Europe in the future (German Meteorological Service, 2018)
- current focus in cattle heat stress studies: dairy cows
- **last two months** of gestation have high influence on bovine fetus growth (Baumann and Currie, 1980)
- heat stress during the **last 6 weeks of gestation** ⇒ reduced birth weight and 365d-weights in calves of dairy cows (Monteiro et al., 2016)
- **direct** heat stress ⇒ reduced daily weight gains in growing crossbred calves (Habeeb et al., 2011) and in feedlot heifers (Mitlöhner et al., 2001)
- **direct** heat stress ⇒ prolonged calving intervals in cows (Moore et al., 1992)

Impact on beef and dual-purpose cattle in outdoor production systems?

Aim of the study

- to analyze the impact of **heat stress** (HS) and **number of heat stress days** (nHS) on
  - ➡ production traits (birth weight, 200d-weight gain, 365d-weight gain) and
  - ➡ the female fertility trait ‘calving interval’

  of RHV cattle

- to focus on **different time periods** (7d, 42d and 56d) before (a.p.) and after calving (p.p.)

- to find indications for **time-lagged effects** in calves due to heat stress during the stage of fetus growth

Materials and Methods

Data set (2000 – 2018, provided by VIT Verden):

- birth weights (n = 3,610)
- 200d-weight gains (n = 2,634)
- 365d-weight gains (n = 2,078)
- calving intervals (n = 2,298)

- climate data from public weather stations
- identification of closest weather station to each herd by use of Geosphere package in R (Hijmans et al., 2016)
    - maximal distance: 53.7 km, minimal distance: 523.4 m, mean distance: 22.2 km

Materials and Methods

Climatic indicator:

$$THI = (1.8 \times T\,°C + 32) - (0.55 - 0.0055 \times RH\,\%) \times (1.8 \times T\,°C - 26)$$ (NRC, 1971)

- **mean THI (mTHI)** for all periods a.p. and p.p.
- classes: mTHI ≤ 39, mTHI = 40 – 49, mTHI = 50 – 59, mTHI ≥ 60

- **number of heat stress days (nHS)** for all periods a.p. and p.p. with **mTHI ≥ 60**
- classes: 7 d-period: 0 - 2 d, 3 - 5 d, 6 – 7 d
  42 d-period: 0 – 10 d, 11 – 20 d, 21 – 30 d, 31 – 42 d
  56 d-period: 0 – 10 d, 11 – 20 d, 21 – 30 d, 31 – 40 d, 41 – 56 d

Materials and Methods

Statistical model: $y_{ijklmn} = \mu + c_i + p_j + f_k + s_l + g_m + s(c)_{li} + e_{ijklmn}$

where

y = observations for production traits (birth weight, 200 d- and 365 d-weight gain) or for calving interval

μ = overall mean effect

$\mathbf{c_i}$ = fixed effect of mTHI (< 39, 40 – 49, 50 – 59, ≥ 60) or nHS classes (1, 2, 3, 4, 5) at 7 d, 42 d or 56 d a.p. or p.p.

$\mathbf{p_j}$ = fixed effect of parity (1, 2, 3, 4, 5, 6, 7 and ≥8)

$\mathbf{f_k}$ = fixed effect of farm of birth (1 – 130)

$\mathbf{s_l}$ = fixed effect of season (winter, spring, summer and autumn)

$\mathbf{g_m}$ = fixed effect of sex (male or female)

$\mathbf{s(c)_{li}}$ = fixed effect of nested mTHI or nHS class during the time periods before or after calving within season

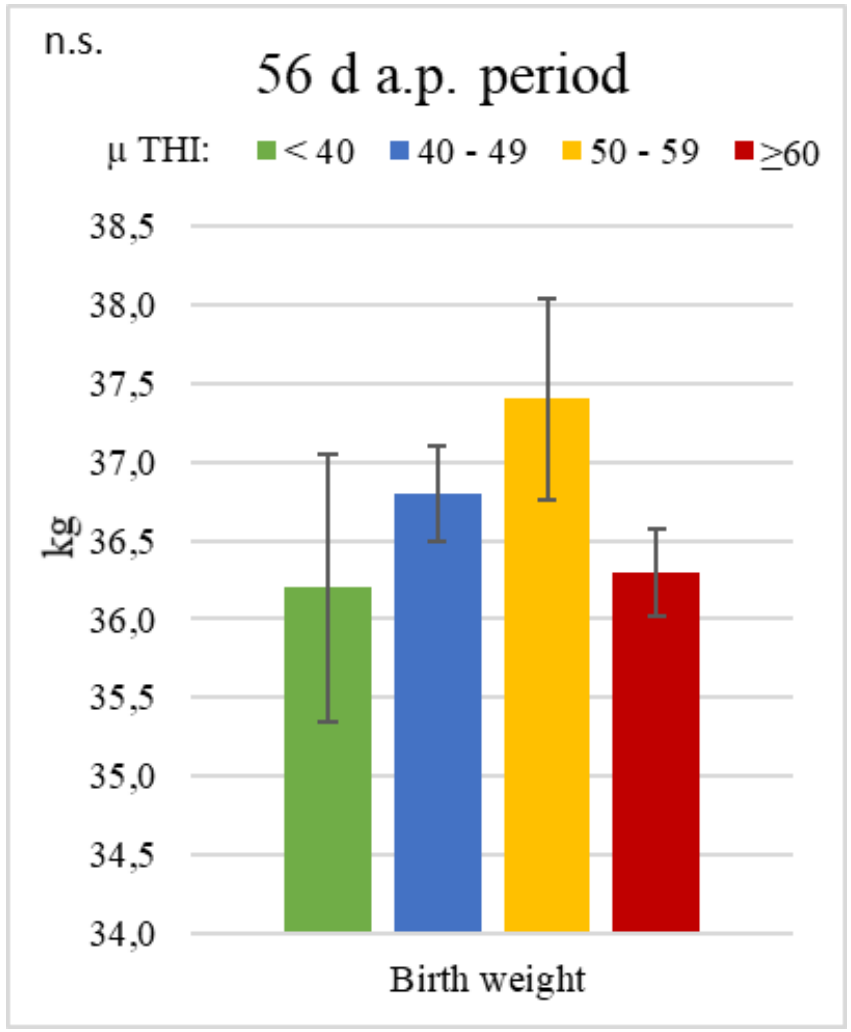
and $\mathbf{e_{ijklmn}}$ = random residual effect

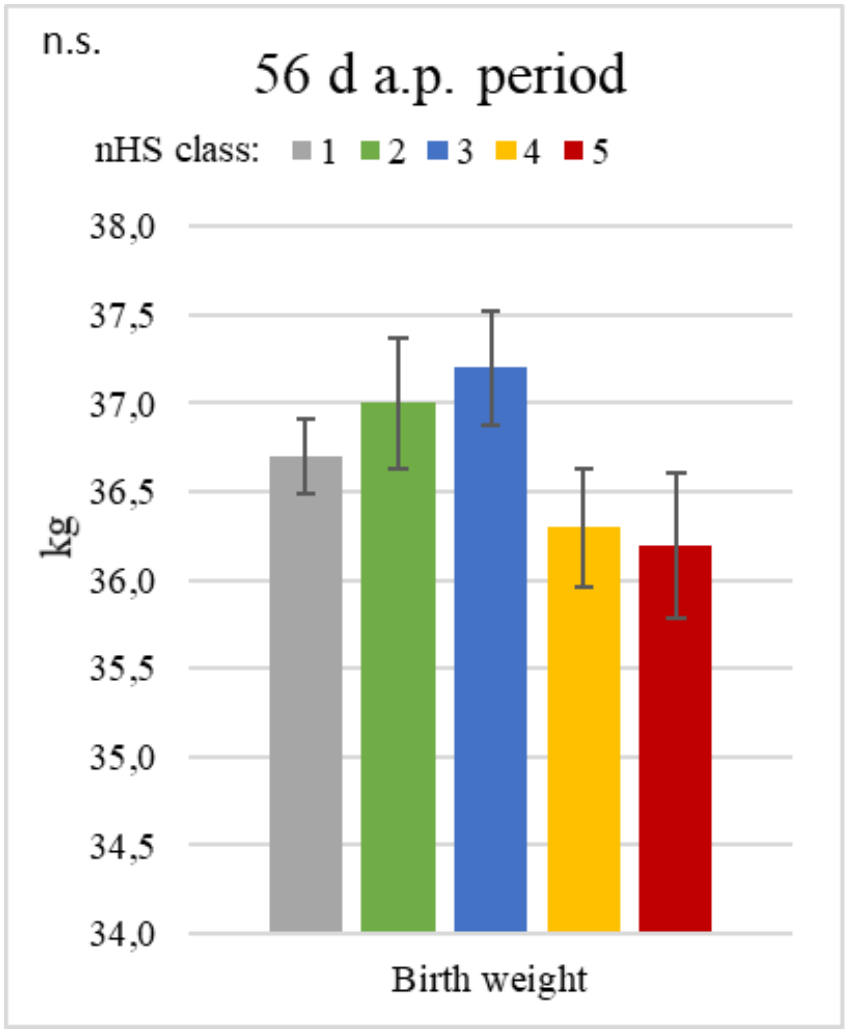
(SAS University Edition; SAS Institute, Cary, NC, USA)

Table of significances

	birth weight	200 d-weight gain		365 d-weight gain		calving interval	
n	3611	2634		2078		2298	
	a.p.	**a.p.**	**p.p.**	**a.p.**	**p.p.**	**a.p.**	**p.p.**
mTHI							
7 d	ns	≤ 0.05	ns	ns	ns	≤ 0.05	ns
42 d	ns	ns	ns	≤ 0.05	≤ 0.001	ns	ns
56 d	ns	ns	≤ 0.05	≤ 0.05	≤ 0.001	≤ 0.05	≤ 0.001
nHS							
7 d	≤ 0.05	≤ 0.01	ns	ns	≤ 0.05	ns	ns
42 d	ns	≤ 0.05	≤ 0.01	≤ 0.001	≤ 0.001	ns	≤ 0.01
56 d	ns	ns	≤ 0.01	≤ 0.01	≤ 0.001	≤ 0.01	ns

Impact of heat stress during the 56 d a.p. period on birth weights in calves





nHS class: 1: 0 – 10 d;
2: 11 – 20 d;
3: 21 – 30 d;
4: 31 – 40 d;
5: 41 – 56 d

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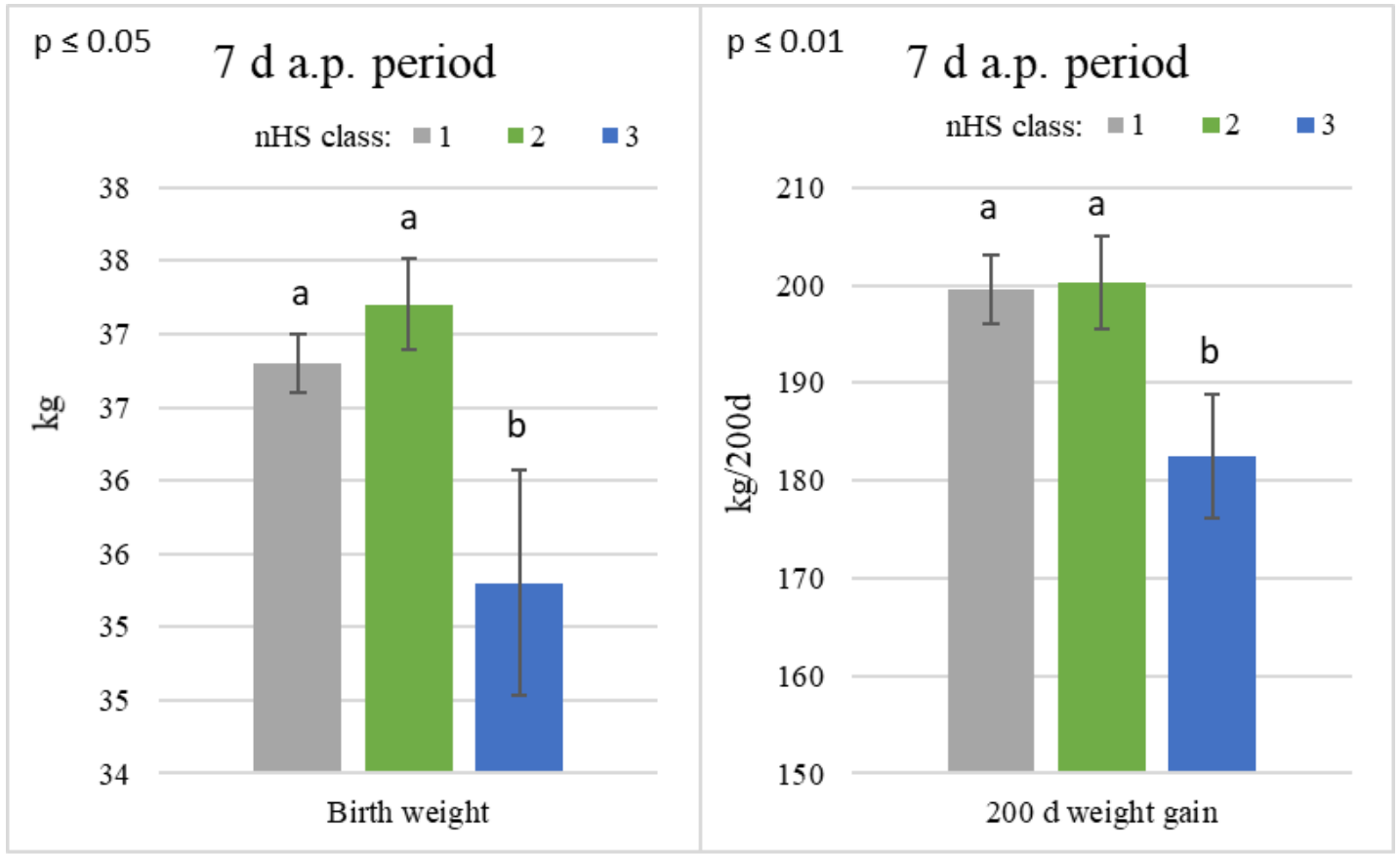
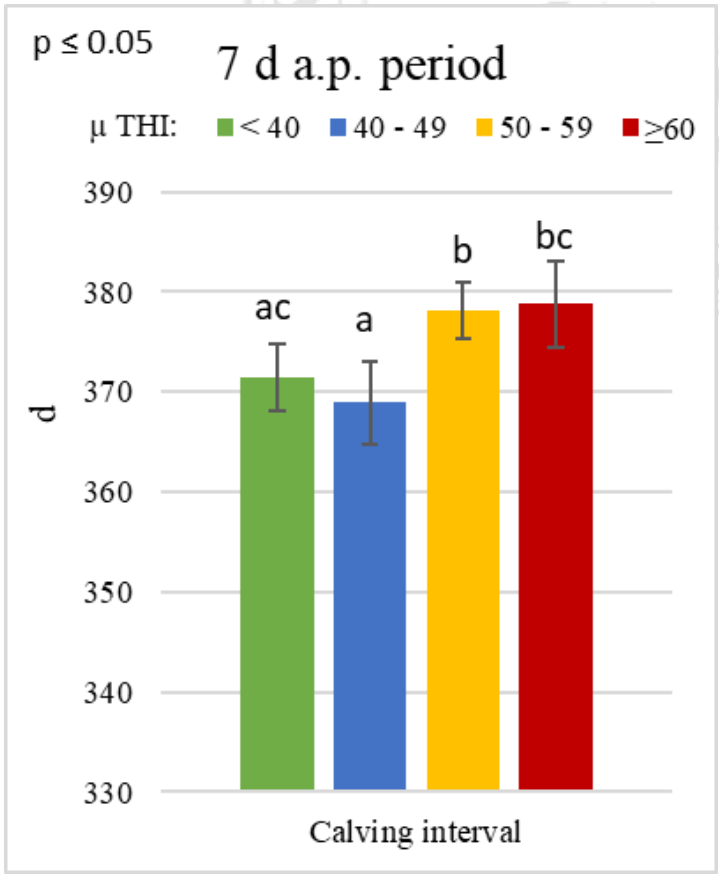
Impact of heat stress during the 7 d a.p. period on calves and dams





nHS class: 1: 0 – 2 d, 2: 3 - 5 d, 3: 6 - 7 d

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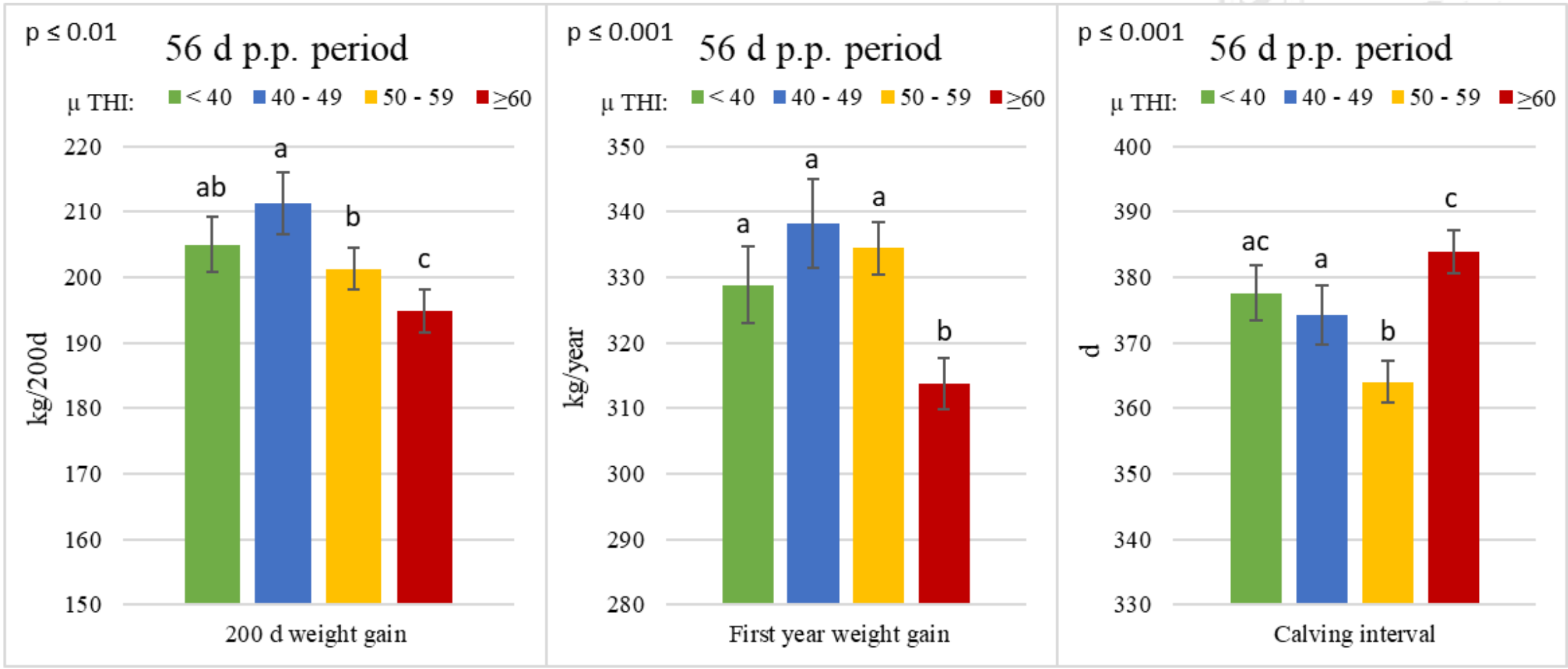
Impact of mTHI class during the 56 d p.p. period on calves and dams



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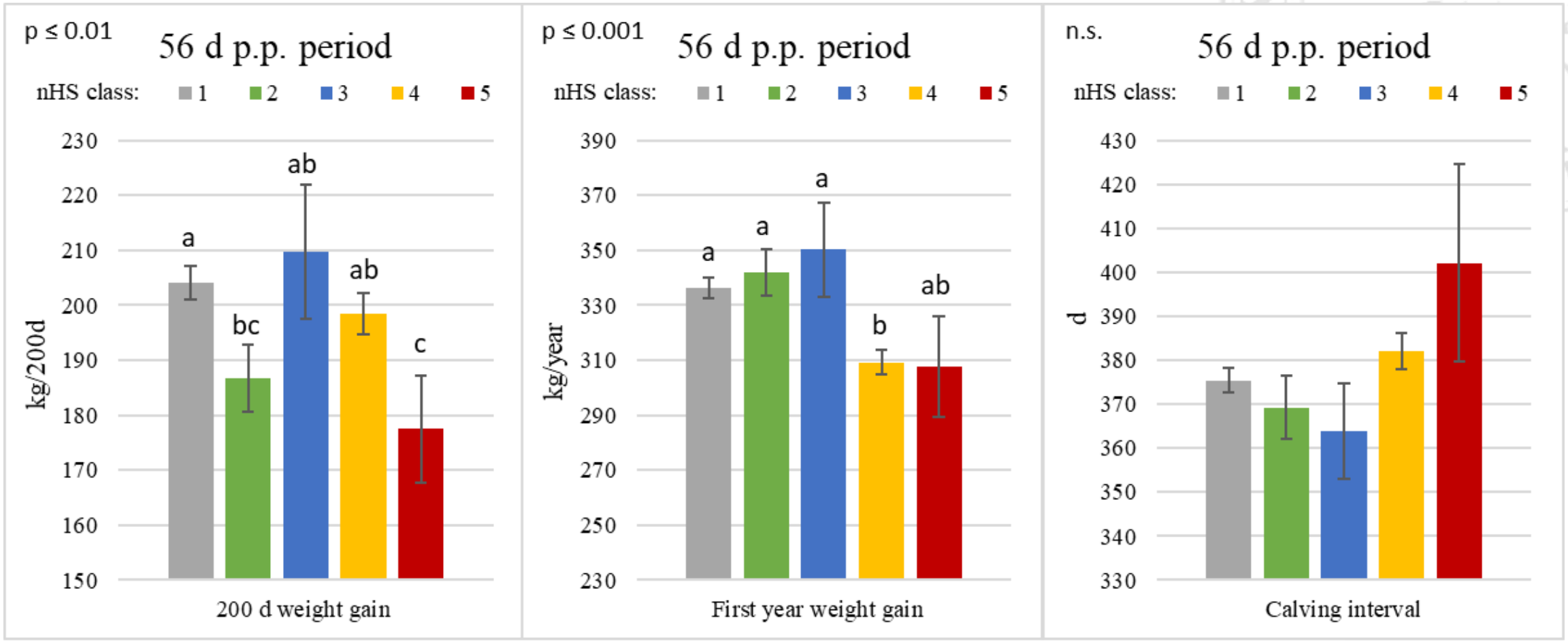
Impact of nHS class during the 56 d p.p. period on calves and dams



nHS class: 1: 0 – 10 d; 2: 11 – 20 d; 3: 21 – 30 d; 4: 31 – 40 d; 5: 41 – 56 d

Conclusions

- detrimental effect of mTHI and nHS on weight development traits of RHV calves and on CI of their dams in many observation periods
- regarding heat stress ➡ **the 7 days a.p. and the 56 days p.p.** period = most affecting
- heat stress is an actual and highly important topic

!!! also for ‚robust' cattle breeds kept in outdoor production systems

We **recommend** to improve grazing conditions!

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Shade and water misting effects on behavior, physiology, performance, and carcass traits of heat-stressed feedlot cattle
F. M. Mitlohner, J. L. Morrow, J. W. Dailey, S. C. Wilson, M. L. Galyean, M. F. Miller and J. J. McGlone

J ANIM SCI 2001, 79:2327-2335.

Outlook

- now starting HS-study:
  - impact of intra uterine heat stress during late pregnancy on performance traits, health and metabolism of dairy cows (dams and offspring)
  - several generations

Aim: proof of epigenetic imprinting-effects

→ Use for optimization of breeding strategies to enhance robustness!

Thank you for your attention!

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