Genetics Of Days Open Under Heat Stress In Thai Crossbred Holsteins

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Introduction

Heat stress has large negative effects on production, reproduction, and survival in dairy cattle (Fuquay (1981); St-Pierre (2003); Jordan (2003)). Thus, in areas subjected to short- or long-term heat stress, managing such stress is economically important. In developed countries, heat stress is usually handled by management. Cow body temperature can be reduced by cooling devices such as shades, fans and sprinklers. Poor fertility during hot weather can be managed by avoiding breeding during the hot period, estrus synchronization or timed artificial insemination. Despite such measures, sensitivity to heat stress (especially for fertility) seems to have increased (Pszczola et al. (2009); Aguilar et al. (2009)), which indicates selection against heat tolerance.

Days open (**DO**) is an economically important trait for fertility. Because of recording ease, it is popular for genetic selection (VanRaden *et al.* (2004); González-Recio *et al.* (2006)). For purebred dairy cattle, DO variability based on region and across calving months can be used to construct a heat-stress index for fertility (Oseni *et al.* (2004a)). Using that index, Oseni *et al.* (2004b) found substantial genetic variation in DO related to heat stress. Pszczola *et al.* (2009) used the index for a national evaluation of US Holsteins and found a detrimental trend for DO under heat stress.

Few studies on genetics of heat stress have been done in tropical countries. In Thailand, most dairy cattle are crossbreds of *Bos taurus* (Holsteins) and *B. indicus* (Sahiwal, Red Sindhi, Brahman and Native). Compared to the United States and European countries, heat stress in Thailand lasts longer, and humidity is high all year. Because economics restricts cooling devices to few or none, production is usually low. Decreased cow fertility in Thailand because of heat stress may be compensated somewhat by less environmental stress from production.

The purpose of this study was to 1) determine DO seasonality for Thai cows with a large percentage of Holstein genetics and 2) compute genetic components of fertility with and without heat stress by breed group and parity using a reaction norm model.

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Material and methods

Data. Data were 18,413 first- and second-parity DO records of 12,162 Thai crossbred Holstein cows. Records were obtained from the Department of Livestock Development and private farms for 94 Thai herds with calvings between 1990 and 2006. Records with DO of <21 or >365 days were excluded from analysis. Records with DO from 21 to 49 days were set to have DO of 50 days, and records with DO from 251 to 365 days were set to 250 days as suggested by VanRaden *et al.* (2004). Mean calving age (and standard deviation) was 31.6 (5.7) and 46.0 (7.0) months for first and second parities, respectively. Records were grouped by percentage of Holstein genetics (breed group (**BG**)): <75.0, 75.0 to 87.4, 87.5 to 93.6, 93.7 to 97.9 and ≥98.0%. Calving seasons were summer (March to June), rainy (July to October) and winter (November to February). Mean 305-day milk yield for BG was 3674, 3846, 4231, 4605 and 4701 kg, respectively.

Statistical analyses. A fixed model was used to estimate solutions for calving month:

$$y_{ijk\ell m} = HY_i + CM_{jk} + P_\ell + \overline{CA}_\ell + b(MY_{305}) + e_{ijk\ell m},$$

where $y_{ijk\ell m}$ is DO for cow m that calved in herd-year (HY) i and calving month (CM) j (1 to 12) nested in breed group k (1 to 5) for parity (P) ℓ (1 or 2) with mean calving age ($\overline{CA}$), b is a fixed regression coefficient, MY_{305} is 305-day cumulative milk yield and $e_{ijk\ell m}$ is residual, as well as to calculate a heat stress index (HI; the reaction norm model) by breed group and parity:

$$HI_{jk} = (LS_{jk} – min_k)/(max – min_k),$$

where LS_{jk} is the least squares solution for CM j within breed group k, min_k is the minimum solution within breed group k and max is overall maximum solution.

A random regression animal model was used to estimate variance components by parity:

$$y_{ijk\ell m} = HY_i + CM_j + BG_k + \overline{CA}_\ell + b(MY_{305}) + a_m + b_{HI}(HI_m) + e_{ijk\ell m},$$

where BG is breed group, a_m is random additive genetic effect of cow m, b_{HI} is the linear random regression coefficient for heat stress in cow m and $HI_m = (LS_j – min)/(max – min)$, where the solutions are separated by parity.

The DO data were analyzed with the GLM procedure of SAS to determine DO patterns across calendar months by breed group and parity. Next AIREMLF90 (Misztal *et al.* (2002)) was used to estimate solutions for calendar month with the fixed model as well as genetic components.

Results and discussion

Least squares means of DO were longest for March (162.5 days for first parity and 165.5 days for second parity), which is associated with the summer season in Thailand, and shortest for October (129.1 and 129.6 days), which is associated with the late rainy season. When DO was analyzed by breed group (Figure 1), least squares means also were longest in March and shortest in October for all breed groups. In addition, DO increased with percentage of Holstein genetics for both parities. The phenotypic effect of heat stress is stronger in the second parity for all breed types.

Estimates of genetic components and correlation are shown in Table 1. Total heritability estimates for DO ranged from 6.9 to 8.8% for first parity and from 4.7 to 7.4% for second parity. Heritability estimates were highest for summer calvings (8.8 and 7.4%) and lowest for late rainy season calvings (6.7 and 4.7%) for both parities. Genetic correlations between regular and heat stress effects were 0.40 for first parity and 0.54 for second parity. These results indicate that heat stress has a large effect on Thai crossbred Holsteins with large percentage of Holstein breed but a smaller one when that percentage is smaller. A possible explanation is that most dairy cattle in Thailand are crossbred between *B. taurus* and *B. indicus*, which allows better adaptation to hot environments.

Conclusion

Calving month or season greatly affected phenotypic and genotypic variation in DO in Thai crossbred cows. The season effect was greater in second than first parity and was particularly large for cows with $\geq$98.0% Holstein composition. Lower DO can be achieved by genetic selection. Selective breeding so that the breed composition is less than 88% Holstein would ensure lower DO..

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Table 1: Estimates of genetic components and correlation for DO by parity for Thai crossbred cows

Parameter	Parity 1	Parity 2
$Var(a_m)$	271	190
$Var(b_{HI})$	40	45
$Var(e)$	3938	4039
$r_{g(a_m),(b_{HI})}$	0.40	0.54

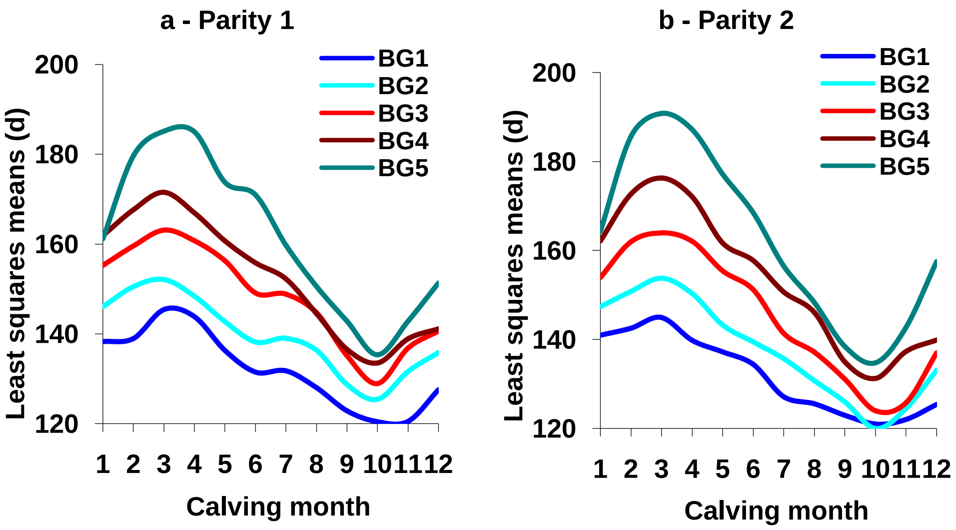

Figure 1: Least squares means for DO across calving months by breed group (percentage of Holstein genetics: BG1 = <75.0%, BG 2 = 75.0 to 87.4%, BG 3 = 87.5 to 93.6%, BG 4 = 93.7 to 97.9% and BG 5 = ≥98.0%) and parity

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