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Short communication. Effects of some environmental factors and extended calving interval on milk yield of Red Holstein cows

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Abstract

The effects of extended calving interval (CI), calving month, calving year and parity on lactation length (LL), lactation milk yield (LMY), the first 305 days milk production of the lactation (305-dMY) and daily milk yield (DMY) of Red-Holstein cows were investigated. A total of 286 CI and lactation records were collected from 116 cows in a dairy farm located in Aegean Region of Turkey between 2001 and 2010. The CI data were divided into three classes: CI12 (12 months), CI15 (15 months) and CI18 (18 months). The CI class affected LL ($p < 0.01$), LMY ($p < 0.01$), 305-dMY ($p < 0.05$) and DMY ($p < 0.01$). Compared to CI12, LMY increased by 18.9% and 30.9%, and 305-dMY increased by 8.8% and 8.1% in CI15 and CI18, respectively. However, DMY was numerically decreased by 2.4% in CI15 ($p > 0.05$) and by 15.9% in CI18 ($p < 0.01$). Because of the higher temperature and relative humidity in summer months, it is advised that some extra precautions need to be taken to compensate the adverse effects of heat stress in cows in the region. In addition, extending CI from 12 to 15 months did not cause any significant production losses; however extending CI to 18 months resulted in a significant decrease in DMY.

Additional key words: 305-days milk yield; daily milk yield; heat stress; lactation milk yield; reproductive management.

Resumen

Comunicación corta. Efectos de algunos factores ambientales y del intervalo entre partos sobre la producción de leche de vacas Red Holstein

Se estudiaron en vacas Red Holstein los efectos del intervalo entre partos (CI), mes del parto, año de parto y número de partos sobre la duración de la lactación (LL), producción de leche por lactación (LMY), los primeros 305 días de producción de leche en la lactación (305-dMY) y producción diaria de leche (DMY). Para el estudio se utilizaron un total de 286 registros de CI y producción de leche obtenidos a partir de 116 vacas de una granja ubicada en la región del mar Egeo en Turquía entre los años 2001 y 2010. Los datos de CI se agruparon en tres clases: CI12 (12 meses), CI15 (15 meses) y CI18 (18 meses). El CI afectó a la LL ($p < 0,01$), LMY ($p < 0,01$), 305-dMY ($p < 0,05$) y DMY ($p < 0,01$). En comparación con CI12, la LMY aumentó 18,9% y 30,9% y la 305-dMY aumentó 8,8% y 8,1% en CI15 y CI18, respectivamente. Sin embargo, la DMY disminuyó un 2,4% en el grupo CI15 ($p > 0,05$) y un 15,9% en el grupo CI18 ($p < 0,01$). Debido a la elevada temperatura y humedad en los meses de verano, se aconseja tomar precauciones adicionales para compensar los efectos adversos del estrés térmico en vacas lecheras en climas similares. El aumento del CI de 12 a 15 meses no causó pérdidas de producción significativas; sin embargo, la extensión del CI hasta 18 meses resultó en una disminución significativa en la DMY.

Palabras clave adicionales: 305 días de producción de leche; estrés por calor; manejo de la reproducción; producción de leche por lactación; producción diaria de leche.

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Abbreviations used: 305-dMY (305-days milk yield); CI (calving interval); DMY (daily milk yield); LL (lactation length); LMY (lactation milk yield); THI (temperature humidity index).

Milk production per dairy cow increased rapidly in the last few decades due to the intensive breeding programs and improvements in nutritional and management factors. However, this increase in the production accelerated the production related diseases, reduced the fertility, longevity and welfare of dairy cows (Sorensen *et al*., 2008; Dobson, 2009).

In dairy herds, the present production level of 12-13 months of calving interval (CI) is no longer optimal (Österman & Bertilsson, 2003; Oltenacu, 2009). Extending CI up to 24 months may improve reproductive performance and provide an opportunity to exploit the superior lactation persistency of high yielding cows (Kolver *et al*., 2007). Rehn *et al*. (2000) reported that extending CI from 12 months to 15 months increased the milk yield by 15-16% in Swedish Red and White, and Swedish Holstein cows, but the production per day decreased about 2-5%. In contrast, Krzyzewski *et al*. (2004) reported that extending CI did not have any effect on milk production and composition in Holstein Friesian cows, but decreased the percentage of mastitis and metabolic diseases.

Extending CI might be economically suited to high producing and primiparous dairy cows (Arbel *et al*., 2001; Oltenacu, 2009; Butler *et al*., 2010); however, the suitability of extending CI depends on cow milk production potential, economical feed supplements, management expertise, environmental constrains, herd size and labor availability (Borman *et al*., 2004).

The objectives of this study were to determine the effects of extended CI and some environmental factors such as calving months, calving year and parity on lactation length (LL), lactation milk yield (LMY), 305-days milk yield (305-dMY) and daily milk yield (DMY) of a high producing Red Holstein herd in the conditions of Mediterranean climate in Turkey.

The data were collected from a Red Holstein rearing farm located in Aydin Province, Turkey. CI, LL, LMY and 305-dMY data from 116 Red Holstein cows collected between 2001 and 2010 were obtained from the Cattle Breeders' Association of Turkey and the farmer's records. Before the statistical analyses, CI data were divided into three classes: the CI data below 400 days were included into CI12 (12 months), CI data between 400 days and 499 days were included into CI15 (15 months) and CI data more than 499 days were included into CI18 (18 months). In addition, twelve calving months, eight calving years (from 2001 to 2008) and five parity classes (1, 2, 3, 4, and 5 or more) were assumed.

DMY was calculated by dividing LMY by CI. Data were analyzed using GLM procedure of SAS (SAS, 1999). The differences between the least square means of fixed factor levels were considered to be statistically significant at $p < 0.05$ (2-tailed) based on Tukey's adjustment type-I error rate. The statistical model used for the analysis is as follows:

$$Y_{ijklm} = \mu + a_i + b_j + c_k + d_l + (bd)_{jl} + (cd)_{kl} + e_{ijklm}$$

where, Y_{ijklm}: LL, LMY, 305-dMY and DMY, μ: overall mean, a_i: calving month effects (i = 1, 2, 3, …,12), b_j: calving year effects (j = 2001, 2002, …, 2008), c_k: parity effects (k = 1, 2, 3, 4 and 5+), d_l: CI class effects (l = CI12, CI15 and CI18), $(bd)_{jl}$: calving year × CI class interaction effects, $(cd)_{kl}$: parity × CI class interaction effects, and e_{ijklm}: random error.

In order to evaluate the climate in the region and monitor the heat stress in cows, temperature humidity index (THI) was calculated from the formula of Kibler (1964). For this purpose, the long term monthly averages of temperature (°C) and relative humidity (%) of Aydin province (Turkish State Meteorological Service, 2012) were used (Fig. 1).

The overall mean of CI was 443 ± 4.9 days, and the averages of CI12, CI15 and CI18 were 361 ± 2.1, 443 ± 2.7 and 558 ± 4.5 days, respectively. Least square means of LL, LMY, 305-dMY and DMY were 349 ± 4.0 days, 8,509 ± 120.1 kg, 7,679 ± 87.5 kg and 19.4 ± 0.25 kg, respectively (Table 1).

There were effects of parity ($p < 0.01$), CI class ($p < 0.01$), calving year × CI class interaction ($p < 0.05$)

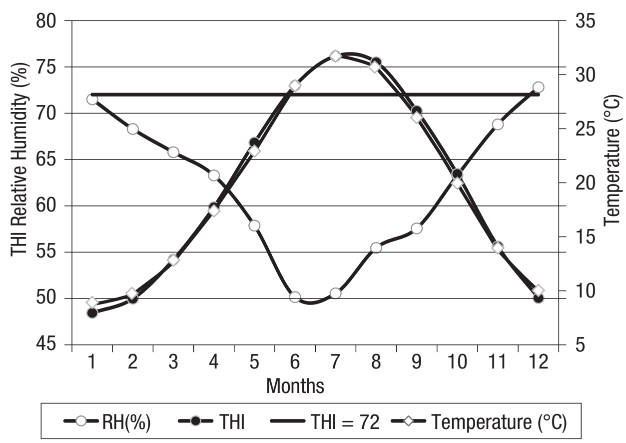

Figure 1. Long term monthly averages of temperature (°C) and relative humidity (RH, %) and temperature humidity index (THI) of Aydin province, Turkey. Heat stress starts at THI = 72 in dairy cows.

Table 1. Least square means ($\bar{X} \pm S_{\bar{X}}$) of lactation length (LL), lactation milk yield (LMY), 305-days milk yield (305-dMY) and daily milk yield (DMY) of Red Holstein cows

Factor	n	LL (days)	LMY (kg)	305-dMY (kg)	DMY (kg)
Calving month		$p < 0.52$	$p < 0.07$	$p < 0.02$	$p < 0.09$
Calving year		$p < 0.10$	$p < 0.01$	$p < 0.01$	$p < 0.01$
2001	63	350 ± 8.5	7,936 ± 338.9^{Aa}	7,001.2 ± 262^{Aa}	17.8 ± 0.75^{Aa}
2002	30	363 ± 11.1	8,717 ± 444.0^{ABab}	7,606.0 ± 343.2^{ABab}	19.2 ± 0.98^{ABCab}
2003	38	325 ± 8.6	7,813 ± 344.5^{Aa}	7,520.4 ± 266.3^{ACab}	17.8 ± 0.76^{ABa}
2004	31	361 ± 8.3	8,818 ± 333.0^{ABab}	7,909.7 ± 257.4^{ABabc}	19.6 ± 0.73^{ABCab}
2005	44	351 ± 7.6	9,405 ± 305.2^{ABb}	8,431.0 ± 235.9^{BCbc}	21.0 ± 0.67^{BCb}
2006	39	357 ± 7.3	9,997 ± 291.9^{Bb}	8,855.6 ± 225.7^{Bc}	22.0 ± 0.64^{Cb}
2007	24	361 ± 9.9	9,110 ± 397.1^{ABab}	7,974.5 ± 307.0^{ABabc}	19.6 ± 0.87^{ABCab}
2008	17	359 ± 11.4	8,694 ± 455.7^{ABab}	7,729.7 ± 352.2^{ABabc}	19.5 ± 1.00^{ABCab}
Parity		$p < 0.01$	$p < 0.04$	$p < 0.04$	$p < 0.10$
1	106	373 ± 5.8^{Aa}	8,693 ± 231.6^{ab}	7,467 ± 179.0^{a}	19.4 ± 0.51
2	76	350 ± 5.8^{ABab}	8,626. ± 231.8^{ab}	7,924 ± 179.2^{ab}	19.5 ± 0.51
3	43	365 ± 8.6^{ABab}	9,720 ± 343.2^{a}	8,406 ± 265.3^{b}	21.3 ± 0.76
4	29	344 ± 9.2^{ABb}	8,697 ± 365.4^{ab}	7,829 ± 282.4^{ab}	18.8 ± 0.80
5+	32	335 ± 8.5^{Bb}	8,321 ± 337.3^{b}	7,764 ± 260.8^{ab}	18.8 ± 0.74
CI class		$p < 0.01$	$p < 0.01$	$p < 0.02$	$p < 0.01$
CI12	106	292 ± 6.0^{Aa}	7,557 ± 239.5^{Aa}	7,458 ± 185.1^{a}	20.8 ± 0.53^{Aa}
CI15	99	356 ± 5.2^{Bb}	8,987 ± 207.4^{Bb}	8,116 ± 160.3^{b}	20.3 ± 0.46^{Aa}
CI18	81	413 ± 6.3^{Cc}	9,890 ± 253.0^{Bc}	8,059 ± 195.6^{b}	17.5 ± 0.56^{Bb}
Calving year × CI class	–	$p < 0.03$	$p < 0.78$	$p < 0.74$	$p < 0.74$
Parity × CI class	–	$p < 0.03$	$p < 0.30$	$p < 0.35$	$p < 0.32$
Overall mean	286	349 ± 4.0	8,509 ± 120.1	7,679 ± 87.5	19.4 ± 0.25

CI: calving interval.

Within each parameter and effect, means with different superscript differ significantly. $^{A, B, C}$: significance at $p < 0.01$; $^{a, b, c}$: significance at $p < 0.05$.

and parity × CI class interaction ($p < 0.05$) on LL, but calving month and calving year did not affect ($p > 0.05$) LL.

As expected, LL mean increased gradually as the CI class increased (Table 1). LL mean of the CI12 was 292 ± 6.0 days and increased by 64 days in CI15 and 121 days in CI18, respectively. LMY was affected by calving year ($p < 0.01$), parity ($p < 0.05$) and CI class ($p < 0.01$). As shown in Fig. 2, the highest LMY mean found for April (9,948 ± 435.3 kg) was 1840 kg higher ($p < 0.01$) than that of June. Similarly to LL, LMY was increased gradually with increasing CI (Table 1). The lowest LMY for CI12 was 7,557 (± 239.5) kg, which was 1430 kg and 2333 kg lower ($p < 0.01$) than those of CI15 and CI18, respectively. Moreover, the difference of 903 kg found between LMY means of CI15 and CI18 was also significant ($p < 0.05$).

There were effects of calving month ($p < 0.05$), calving year ($p < 0.01$), parity ($p < 0.05$) and CI class ($p < 0.05$) on 305-dMY. The lowest and highest 305-dMY means were observed in June (7,185 ± 324.7 kg) and in December (8,604 ± 267.7 kg), respectively (Fig. 2), and the difference between these two months was statistically significant ($p < 0.05$).

The observed calving month effects on LMY and 305-dMY indicate that the higher temperature and relative humidity seen in summer months could cause heat stress in the cows, and as a result of that LMY and 305-dMY decreased. As can be seen in Fig. 1, the THI was over 72 in June, July and August in the region. Bouraoui *et al.* (2002) highlighted the importance of the heat stress in cows, and reported that feed intake began to decrease when THI reached 72 and continued to decrease dramatically over 76. Additionally, some other traits of Red Holstein cows such as reproductive, milk constituents and somatic cell count were also significantly affected by hot summer months in this herd (Koç *et al.*, 2011).

There were effects of calving year ($p < 0.01$) and CI class ($p < 0.01$) on DMY. For DMY means of CI classes, a different pattern from LL, LMY and 305-dMY was observed. DMY decreased as the CI

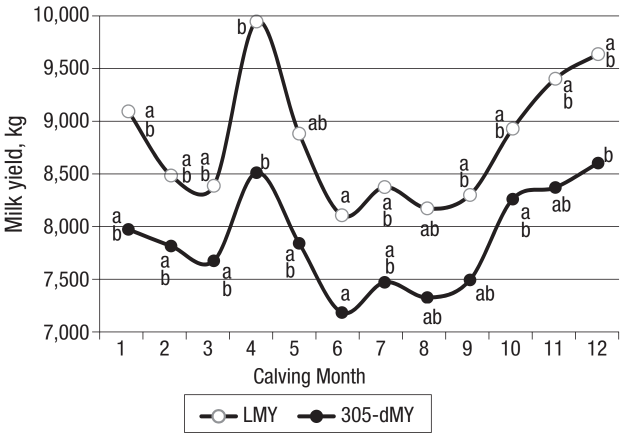

Figure 2. Monthly changes of lactation milk yield (LMY) and 305-days milk yield (305-dMY) of Red Holstein cows. Different letters indicate significant differences ($p < 0.05$).

class advanced, and the mean for CI18 was the lowest and different ($p < 0.01$) from those of CI12 and CI15. On the other hand, the difference between CI12 and CI15 means was statistically insignificant ($p > 0.05$). DMY in CI12 and CI15 was 3.3 kg and 2.8 kg higher ($p < 0.01$), respectively, than that of CI18.

A gradual increase in LL and LMY was observed as CI increased. However, when the 305-dMY and DMY were considered, the pattern was reversed, especially for DMY. The LMY increased by 18.9% (1430 kg) in CI15 and 30.9% (2,333 kg) in CI18. For 305-dMY, the increase was 8.8% (658 kg) and 8.1% (601 kg) for CI15 and CI18, respectively. However, DMY decreased ($p < 0.01$) by 2.4% in CI15 (0.5 kg day^{-1}) and by 15.9% in CI18 (3.3 kg day^{-1}). It was reported that delaying the beginning of insemination provides some economic advantages to the farmers, in terms of maintaining the high peak yield for a longer period (Rehn *et al.*, 2000) and prevents the negative effects of the calving to conception interval on milk yield for cows (Vargas *et al.*, 2000). In addition, cows with 12 months of CI were reported to have higher fertility problems than those of cows with longer CI (Larsson & Berglund, 2000).

In conclusion, in the conditions of Mediterranean climate some extra precautions need to be taken to compensate the adverse effects of heat stress in cows in summer months. In addition, extending CI from 12 to 15 months did not cause any significant production losses; however, if CI was extended to 18 months, a significant decrease occurred in DMY. Therefore, CI could be extended to 15 months for this herd, and probably for other high producing herds under similar productive conditions. However, it has to be stressed that the suitability of extended CI will depend on several factors such as cow production level, management expertise, environmental constrains, herd size, labor availability, milk prices, feed costs, calf and replacement heifer prices.

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