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THE EFFECT OF HEAT STRESS ON SOME REPRODUCTIVE TRAITS IN JERSEY COWS UNDER SEMI-HUMID CONDITIONS IN TURKEY

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Abstract

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This study was aimed to evaluate reproductive losses of Jersey cattle attributed to heat stress. Reproductive traits such as first calving age, days open, gestation length, and first calving interval of 253 Jersey cows raised in The Karakoy State Farm of Samsun province in Turkey, from 1995 to 2005, were used as retrospective data. In addition, heat stress terms were calculated with temperature humidity index (THI) for successive seasons and data were arranged appropriately to THI values of seasons. The mean values for temperature, humidity and THI were 25.30^{o}C, % 73.83 and 74.67 in summer, respectively. Regarding to weather parameters, signs and symptoms of heat exhaustion was only observed during summer season. The overall means for first calving age, days open, gestation length, and first calving interval were 525.37; 813.34; 69.73; 283.55; and 365.98 days, respectively. From these traits, only first breeding age was significantly affected ($P < 0.05$) from heat stress. In addition, it was detected that summer calves reached first breeding age later than those born in other seasons did. As a result, maintenance cost increased at least $ 123-164 per cow because of the delay of first breeding age.

Key words: first breeding age, first calving age, heat stress, jersey, temperature and humidity index

Introduction

The most comfortable environmental temperature range for dairy cattle is between 5^{o}C and 25^{o}C, also is called as the thermal comfort zone (McDowell, 1972). Minimal physiological cost and maximum productivity are normally achieved in thermal comfort zone (Folk, 1974). Above the upper critical temperature (25^{o}C) dairy cattle have an increased respiratory rate and rectal temperature cohesive with a diminishing of milk production and reproductive performance (Bitman et al., 1984). Although milk and reproductive yields are affected by many factors, environmental factors, especially the temperature and humidity affect negatively reproductive traits in dairy cows. Heat stress is a most familiar factor to responsible for the low fertility of dairy cows inseminated in the summer due to the influencing conception rate. Furthermore first calving age and first breeding age get higher (Fox and Tylutki, 1998) while conception rate of cattle decreases 20-30 % in summer than in winter (Alnimer et al., 2002).

Recently, heat stress has been become most popular due to influence whole productivity in dairy cattle. Although, changes in rectal temperature are the most accurate indicator of heat stress in cattle, there are no available convenient tools to simply observe of it. Temperature and humidity index (THI) has been adopted one of the alternative method for the decision of the heat stress levels (Amstrong, 1994; Silanikove, 2000).

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Heat stress interval levels regarding of THI were graded as follows: thermo neutral when average THI < 70, mild heat stress when 70 ≤ THI < 74, heat stress 74 ≤ THI < 77, and severe heat stress when THI ≥ 77 (Davis et al., 2003).

Economic losses attributing to heat stress in livestock is very huge. For instance, generally, St-Pierre et al. (2003) estimated that economic losses caused by heat stress were $ 2.4 billion dollars per year in US, with the dairy industry contributing $ 1.5 billion dollars. Similarly, for cattle production, $ 28 in Nebraska and $ 40 million dollars in Iowa (Smiley, 1996) is including estimates for the long-term impact on other traits such as feed intake, growth and mortality. Furthermore, Tucker et al. (2001) indicated that maintenance cost delaying breeding age attributed to heat stress is $ 3 – 4 cow/day. Older first breeding age causes older the first calving age in a herd. When the first calving age delays, lifetime milk production will be decreased (Haworth et al., 2008). Moreover, 7-25% more maintenance cost is needed as the respiratory rate or panting increases due to the increase of environmental temperature (NRC, 1981). There are genotypic differences in reproductive performance traits within the breeds. Jersey cows are more resistant than Brown Swiss and Holstein against heat stress (Garcia-Peniche et al., 2005). First breeding age is 450-500 days and first calving age is 730-780 days in Jersey cows (Powell, 1985; Heinrichs and Vazquez-Anon, 1993; Garcia-Peniche et al., 2005; Hare et al., 2006). Jersey is raised intensively in Karadeniz region in Turkey. The Karakoy State Farm is a solely gene pool for Jerseys in Turkey originated from American Jersey and they provide the need of semen and stud animal. In the state farm has been stick to ordinary pure breed schemes with artificial insemination provided from US since 1958 (Alpan and Arpacik, 1996). The objective of this study was to explicate the effect of heat stress on some reproductive traits such as the first breeding age, first calving age, days open, gestation length and first calving interval.

Materials and Methods

253 Jersey cows, having very similar body weight and having first breeding age, were raised in The Karakoy State Farm of Samsun province from 1995 to 2005. Retrospective data were included in all information about reproductive traits such as first breeding age, first calving age, days open, gestation length, and first calving interval of Jersey cows. It is located in the eastern part of Bafra District Latitude 41°34’ N, Longitude 35° 55’ E and at 20 meters above sea level in the central Black Sea Region in northern of Turkey. Regarding of tools climatic data classification described by Daget (1977), the area can be considered as semi-humid Mediterranean climate (Table 1) and the precipitation regime is characteristic for Mediterranean region.

Table 1
Climatic data of the study area between 1995–2005

Variable	Value
Mean annual precipitation (mm)	809.1
Mean precipitation values successive seasons (A, W, Sp, Su) (mm)	262.6, 245.5, 183.7, 117.3
Mean annual temperature (°C)	13.9
Maximum temperature for the warmest month (°C)	38.4 (July)
Minimum temperature for the coldest month (°C)	- 6.8 (January)
Mean annual relative humidity (%)	76.0

A: Autumn, W: Winter, Sp: Spring, Su: Summer

Data were analyzed to investigate of outlier values with post-hoc test and diagnosing as to be outliers values, were discarded off data set. Therefore, in this study, 253 performance data were used. THI were calculated by using the mean temperature and mean humidity values of Turkish State Meteorological Service between 1995 and 2005 belonging to Bafra district of Samsun (DOM, 2010). THI was calculated with following equation described by (Thom, 1959):

THI = (0.8 x ambient temperature) + (% relative humidity / 100) x (ambient temperature 14.4) + 46.4

Statistical analysis: One-way classification were used to investigation of effect of heat stress on reproductive traits variable such as first breeding age (day), first calving age (day), days open (day), gestation length (day) and first calving interval (day). These model also were applied in order to compare the mean temperature, mean humidity and THI values in seasons of artificial insemination (winter: December, January, February, spring: March, April, May, summer: June, July, August, autumn: September, October, November). One-way model were executed by SAS (2008) using with ANOVA. Duncan test was applied to the data for comparing the significant sub-groups.

Results

The least square means of reproductive traits were summarized in Table 2. Reproductive traits for first breeding age, first calving age, and days open, gestation length and first calving interval were 525.37; 813.34; 69.73; 283.55; 365.98 days, respectively. In this study, there were found that only the effect of heat stress on the first breeding age was significant ($P < 0.05$) while it was not significant on the other reproductive traits ($P > 0.05$). The means of temperature, humidity and THI values by seasons of artificial insemination between 1995 and 2005 were in Table 3. In present study, it was determined that the effect of season on temperature, humidity and THI was significant ($P < 0.05$). The mean temperature was 25.30°C, mean humidity was 73.83 % and THI was 74.67 in summer.

Discussion

In present study, first breeding age of the inseminated cows in summer was determined as 541.63 days.

Table 3
The average temperature, humidity and THI values by season of artificial insemination between 1995–2005 in the study area

Season	Temperature, °C	Humidity, %	THI
Winter	8.40 ± 0.57^{a}	72.30 ± 0.70^{a}	48.77 ± 0.88^{a}
Spring	14.27 ± 2.37^{ac}	77.77 ± 0.64^{c}	57.73 ± 3.75^{ab}
Summer	25.30 ± 1.00^{b}	73.83 ± 0.63^{ab}	74.67 ± 1.49^{c}
Autumn	18.30 ± 2.60^{c}	75.50 ± 1.50^{bc}	64.03 ± 4.04^{b}
F value	14.74***	6.20*	14.20***

Values are expressed as mean ± SE.
* $P < 0.05$ *** $P < 0.001$
a, b, c : Means in column with different superscripts are significantly different ($P < 0.05$)

It was accepted that optimal first breeding age should be between 450-500 days for a productive cattle breeding. Inseminated cows in summer caused a delay of 41 days at first breeding age. According to the results of Tucker et al. (2001), it means that the maintenance cost at least $ 123-164 per a cow because of the delay of first breeding age (except the 7-25 % extra maintenance cost). First breeding age of the inseminated cows in summer delayed because energy need of cow increases to continue thermo neutrality during the summer. This situation causes decrease in appetite and dry matter consumption (Kamiya et al., 2005). As a result, reproductive balance is affected negatively (Fox and Tylutki, 1998; Rensis and Scaramuzzi, 2003; Soydan et al., 2009). This adversely effect of heat stress may cause delaying of first breeding and first calving age (Badinga et al., 1985; Drew, 1985; Wolfenson et al.,

Table 2
The least squares means of some reproductive traits

Season of artificial insemination	First breeding age		First calving age		Days open		Gestation length		First calving interval	
	N	*	N	NS	N	NS	N	NS	N	NS
Spring	86	522.31 ± 4.87^{a}	86	806.06±5.93	86	70.47±3.18	86	284.82±1.15	86	369.16±3.29
Summer	49	541.63 ± 6.64^{b}	49	827.15±8.11	49	72.92±4.18	49	286.56±1.47	49	362.92±3.74
Autumn	51	523.76 ± 6.49^{a}	51	809.69±7.71	51	73.59±3.89	51	285.89±1.50	51	366.48±3.64
Winter	67	513.77 ± 5.57^{a}	67	810.47±6.99	67	61.94±3.54	67	286.92±1.44	67	365.35±3.15
Overall	253	525.37±2.97	253	813.34±3.62	253	69.73±1.86	253	283.55±0.70	253	365.98±1.73

Values are expressed as mean ± SE.
* $P < 0.05$; NS: $P > 0.05$
a, b : Means in column with different superscripts are significantly different ($P < 0.05$).

1997; Roth et al., 2001; Rensis and Scaramuzzi, 2003). In addition, the reason of getting older first calving and first breeding age might be the high THI value. Furthermore, in the present study, it was determined that THI value was 74.67 in summer and it is indicated that there was a heat stress. This result was very similar with finding of Davis et al. (2003). They determined that occurs when THI value was between 70 and 77, a middle and high-leveled heat stress. Moreover, they indicated that normal and high-leveled heat stress might cause first breeding and first calving age to delay. In present study tendency to reach, first breeding age older in summer than in others seasons of artificial insemination confirm their results.

In this study it was found out that first calving age was 827.15 days and was higher than 720 days old age which was determined by Hare et al. (2006), 760 days old age which was determined Heinrichs and Vazquez-Anon (1993), 785 days old age which was determined Powell (1985), 804 days old age which was by Nieuwhof et al. (1989). It was known that interval of optimal first calving age should be between 730-780 days for a productive cattle rising. First calving age determined in present study is 47 days higher than the optimal value and this means milk production will be delay and profitability of the farm will be affected from this discrepancies (Haworth et al., 2008).

First calving interval value determined in present study is similar to the optimal value reported for a dairy cattle (Stott and Delorenzo, 1988; Nieuwhof et al., 1989; Silva et al., 1992; Hare et al., 2006).

Days open was 69.73 days. This value is less than 110 days that was results of Bonczek et al. (1992), 116 days that was suggested by Silva et al. (1992) and 117.6 days that was suggested by Moya et al. (1989) but is between within the thermal comfort zone for productive cattle rising.

Conclusion

In present study, it was determined that the effect of heat stress on first breeding age was significant. Moreover, the first calving age have been tending to increase in summer according to heat stress. In present study, inseminated cows in summer caused a delay of 41 days at first breeding age. It delays caused a maintenance cost $123-164 per a cow. The delay of first breeding age also retards the first calving age 47 days. Lifetime milk production of the cow may decrease when the first calving age delays. Many applications like shade, fans, air conditioning and sprinkler can be used to avoid to adversely effects of heat stress on reproductive traits.

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