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Effects of Calving Years, Times and Seasons on Milk Yield Traits in Turkish Brown Swiss Cows in a Steppe Climate

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This study was conducted to investigate the environmental factors affecting milk yield traits of Turkish Brown cows raised at the Ulaş state farm under a sub–tropical climate.

First the effect of calving years on actual milk yield, daily milk yield, 305–day milk yield, 305–day mature age milk yield, lactation duration and dry period days were investigated. In 2000 to 2006, the actual milk yield, daily milk yield, 305–day milk yield, 305–day mature age milk yield, lactation duration and dry period days were significantly related to calving years. Second the effect of calving times on actual milk yield, daily milk yield, 305–day milk yield, 305–day mature age milk yield, lactation duration and dry period days were detected. These data indicate that the peak milk yield is at the 5th–7th calving times with maturity in Brown Swiss cows reared in the Central Anatolia region in Turkey. We carried out the effect of calving season on the identical items. The seasons of calving affect actual milk yield, days of lactation duration and days of dry period. Cows that calve in winter have the highest actual milk yield. This could be due to stable nutrition during the important first lactation period to avoid cold stress. However, better management is required for cows calved in autumn that are under high temperature stress during an important lactation period.

Keywords: dry period, environmental factors, lactation duration, milk yield, subtropical climate, Turkish Brown cattle

INTRODUCTION

The Brown Swiss breed was originally brought to Turkey from the slopes of the Alps in Switzerland for pure–breeding of Brown Swiss and improvement of native cow breeds with low milk yield. The breed of Turkish Brown was obtained from Brown swiss bulls with primitive cows of Turkey (Native Gray and Red cattle of Eastern, and Native Black and South Anatolian Red cattle) in a backcross breeding method. Brown cattle were mostly reared in the Central and East Anatolia regions with the steppe climate of Turkey. We have previously reported reproduction characteristics in Brown Swiss cows reared under steppe climate conditions in Turkey. We found that birth and insemination season affected the first insemination and first calving ages; cows born in autumn and winter showed an earlier first insemination and first calving age than those in spring and summer, and the same trend was observed for the insemination season (Çilek and Gotoh, 2011).

Milk yield is the result of the combined effects of genotype and environmental conditions. Despite attempting to control environmental conditions, the upper limit of milk yield is determined by genetics (Alpan and Aksoy, 2009). Milk yield shows differences among breeds or individuals of the same breed (Alpan and Aksoy, 2009; Çilek and Tekin, 2007a; Bakır *et al*., 2009; Çilek, 2009a; Çilek and Bakır, 2010). If a dry period and calving interval are longer than the ideal time, total milk production of the cows during their lifetime decreases (Çilek and Tekin, 2007b; Bakır and Çilek, 2009; Çilek, 2009b).

Calving season affects milk yield because of seasonal differences in feeding at different stages of lactation. Cows calving in winter have high milk yields, probably due to good feeding levels in the first 3 or 4 months of lactation. Milk yield increases because of feed containing alfalfa being given during the period when milk yield begins to decrease (Çilek and Tekin, 2005). On the other hand, cows calving in summer have low milk yields due to their being subjected to high environmental temperatures in the first 3 or 4 months of lactation (Çilek, 2002). In general, there is a positive correlation between body weight and milk yield. It is thought that milk yield increases with increasing body weight (Alpan and Aksoy, 2009). Cows with a large body weight eat more food and have a larger amount of breast tissue. Milk yield increases with age up to maturity (6–8 years old) and decreases thereafter (Çilek and Tekin, 2006b). In regions with a high temperature, such as tropical regions and in very cold regions, milk yield is low (Çilek and Tekin, 2006a). In particular, negative effects start in an environmental temperature lower than 5 degrees and higher than 25 degrees Celsius (Şekerden and Özkütük; 2000). Low environmental humidity, feeding, disease, and oestrus have a negative effect on milk yield (Kumlu, 1991). Cows with a high milk yield can be milked more times than 2 times in a day. As the milking frequency increases, milk yield increases. While pregnancy progresses and calving approaches, milk yield decreases due to an increase in progesterone levels and decreasing feed consumption as a result of the demands of the fetus (Bohmanov *et al*.,

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2008). Loker *et al.* (2009) showed that milk and fat yields begin to decline after approximately 4 months of pregnancy for all breeds and protein yield begins to decline after approximately 2 months of pregnancy for all breeds.

This study was conducted to investigate the environmental factors affecting milk yield traits of Turkish Brown cows raised at the Ulaş state farm under a sub–tropical climate.

MATERIALS AND METHODS

In the central Anatolia region, the climate is a typical steppe. There are great temperature differences between day and night. Rainfall is low; however, in winter there is snow. A continental climate prevails in central Anatolia. Summers are hot and dry, and winters are cold and rainy. The mean annual rainfall is 411 mm. The number of days above 30˚C per year during the investigation was less than 30 and the mean number of days below 0˚C per year was 120. There were 30 mean snow days, and 70 days per year during the investigation had snow–covered soil. The temperature during the year ranged between –30.4˚C and +38˚C. Sivas highland plateaus are lush green in spring and autumn, and in the summer, they show the appearance of a steppe. The ratio of forest and shrub lands, pastures, and cultivated areas is 11%, 43%, and 42% in Sivas province, respectively.

The cattle were fed in the barn throughout the year. The amount of feed for cattle was set according to the level of milk yield by using rations. There were no differences in feeding among seasons. To avoid cold stress, we increased the amount of feed energy during the winter months. Cows were fed during the cool hours in summer to avoid hot stress, and dry grass, sainfoin, vetch, and clover were produced on this farm. Concentrated feed was also used in the rations. Corn silage was performed and used during the year. For cows that produced the highest milk yield (more than 25 kg), 4 kg dry grass (sainfoin, vetch, and alfalfa), 15 kg forage, 9 kg concentrated feed and 6 kg barley pulp were given (total digestible nutrients [TDN]: 13 kg; total crude protein [CP]: 2,884 kg). There were no feeding differences among seasons, and cattle were fed with standard rations.

In this study, monthly test day milk yield records of Brown cows reared in Ulaş State Farm were used. A total of 1695 records for lactation duration, lactation milk yield, daily milk yield, 305–day milk yield, 305–day mature age milk yield and 1384 records for the dry period were used in calculations. Normally, the duration of lactation is between 200 and 500 days and the ages of cows are 2 years to 12 years of age. The phrase "305–day mature age milk yield" means that milk yield for all cows was adjusted according to the mature age (aproximately 8 years of age) and the duration of 305 days of lactation. The lactation duration and lactation milk yield were estimated from test milk yields collected once a month using the Holland method (Çilek, 2008; Çilek and Tekin, 2006b; Keskin *et al*., 2009). The 305–day milk yield and 305–day mature age milk yield were estimated by using adjustment factors estimated for this herd (Çilek and Tekin, 2006a). In this study, 9 calving groups were formed at 2 to 10 years of age and older. Four season groups were formed for calving season as winter, spring, summer and autumn. Seven groups for calving years were formed between 2000 and 2006. Lactation less than 200 days was not used in the calculations of this study.

To determine the effects of age of cows, calving years and calving season on milk yield traits, a general linear model was performed by using the minitab program (Minitab, 1995). Duncan's multiple range tests were used for multiple comparisons in important subgroups. The model of Yijkl = μ+ai+bj+ck+eijkl was used to analyze effective factors on milk yield. In the model above: μ= mean milk yield of brown cow population; ai =calving years (i= 2000…..2006); bj = calving season (j = winter, spring, summer, autumn); ck = effect of calving age (k= 2, 3, 4, …10>); and eijkl = the error term (0, σ^2).

RESULTS

The least square means for the effect of calving years on actual milk yield, daily milk yield, 305–day milk yield, 305–day mature age milk yield, lactation duration and dry period days are presented in Table 1. The total mean of the least squares means for actual milk yield, daily milk yield, 305–day milk yield, 305–day mature age milk yield, lactation duration and dry period days were 5377 kg, 16 kg, 4963 kg, 5161 kg, 334 days and 132 days, respectively. The calving year had a significant effect on the actual milk yield (P<0.01), daily milk yield (P<0.001), 305–day milk yield (P<0.001), 305–day mature age milk yield (P<0.001), lactation duration (P<0.001) and dry

Table 1. Change in least square means for milk traits in calving years in Brown Swiss cows reared in the Central Anatolia region in Turkey

year	2000	2001	2002	2003	2004	2005	2006	Total mean	p value
Traits for all cattle									
(number)	(262)	(243)	(279)	(249)	(235)	(227)	(200)	(1695)	
Actual Milk yield, kg	6436^{a}	5831^{b}	5354^{c}	4831^{e}	5162^{cd}	4879de	5144^{cde}	5377±77	0.01
Daily Milk yield, kg	18.1^{a}	17.4^{b}	15.6^{d}	14.2^{e}	15.9^{cd}	16.0^{cd}	16.3^{c}	16.2±0.16	0.001
305 day milk yield,. kg	5589^{a}	5349^{b}	4820^{c}	4387^{d}	4856^{c}	4783^{c}	4958^{c}	4963±50	0.001
305 –Mature age –milk yield,. kg	5809^{a}	5554^{a}	5013^{bc}	4567^{d}	5051^{bc}	4971^{c}	5159^{b}	5161±52	0.001
Lactation duration, Days	356^{a}	336^{bc}	347^{ab}	340^{bc}	329^{cd}	310^{e}	317^{d}	334±4	0.001
(number)	(203)	(214)	(236)	(186)	(190)	(195)	(160)	(1384)	
Dry period, days	155^{a}	143^{b}	114^{c}	107^{c}	107^{c}	133^{b}	144^{b}	132±4	0.001

period days (P<0.001). The actual milk yield, daily milk yield, 305–day milk yield, 305–day mature age milk yield, lactation duration and dry period days were largest in 2000. The actual milk yield, daily milk yield, 305–day milk yield, and 305–day mature age milk yield were lowest in 2003. The lactation duration showed the lowest value in 2005. The days of the dry period were lowest in 2002, 2003 and 2004 (Table 1).

The least square means for the effect of calving times on actual milk yield, daily milk yield, 305–day milk yield, 305–day mature age milk yield, lactation duration and dry period days are presented in Table 2. Calving times significantly affected the actual milk yield (P<0.001), daily milk yield (P<0.001), 305–day milk yield (P<0.001), 305–day mature age milk yield (P<0.05), lactation duration (P<0.001) and dry period days (P<0.01). The actual milk yield was highest at the 3rd calving time and lowest in the 10th calving time (P<0.001). The daily milk yield and 305–day mature age milk yield were highest at the 7th calving time and lowest at the 2nd and 10th, and 2nd calving times, respectively (P<0.001, P<0.05, respectively; Table 2). The 305–day milk yield was highest at the 5th and 7th calving times and lowest at the 2nd and 10th calving days (P<0.001). The 305–day mature age milk yield was highest at the 7th calving time and lowest at the 2nd calving time (P<0.05). Additionally, the days of duration of lactation were significantly higher at the 2nd and 3rd calving times and lower at the 7th and 8th calving times compared with the other times (P<0.001, Table 2). The days of the dry period were longest at the 6th calving time and shortest at the 2nd calving time (P<0.01).

The least square means for the effect of calving season on actual milk yield, daily milk yield, 305–day milk yield, 305–day mature age milk yield, lactation duration and dry period days are shown in Table 3. Calving season significantly affected actual milk yield, lactation duration days and days of the dry period (P<0.001, P<0.001 and P<0.01, respectively; Table 3).

For calving season analysis, the actual milk yield and days of lactation duration were highest in winter and lowest in autumn (P<0.001). However, the days of the dry period were significantly longer in autumn than in the other seasons (P<0.01). There were no significant differences in daily milk yield, 305–day milk yield and 305–day mature age–milk yield among seasons.

DISCUSSION

Based on records over time (2000–2006) used for Brown Swiss cows reared in the Central Anatolia region in Turkey, the current study showed that the actual milk yield, daily milk yield, 305–day milk yield, 305–day mature age milk yield, days of lactation duration and days of dry period were 5377 kg, 16 kg, 4936 kg, 5161 kg, 334 days and 132 days, respectively. The milk yield traits showed the lowest values in 2003. A drought occurred in this area in 2003. Therefore, the amount of forage production was very low.

Table 2. Change in least square means for milk yield traits in calving times in Brown Swiss cows reared in the Central Anatolia region in Turkey

calving times	2	3	4	5	6	7	8	9	10	p value
Traits for all cattle										
(number)	(264)	(386)	(325)	(267)	(209)	(110)	(67)	(36)	(31)	
Actual Milk yield, kg	5387^{bc}	5793^{a}	5656^{ab}	5636^{ab}	5311^{bc}	5374^{bc}	5321^{bc}	5220^{c}	4698^{d}	0.001
Daily Milk yield , kg	14.3^{d}	15.8^{c}	16.8^{ab}	17.0^{ab}	16.7^{ab}	17.4^{a}	16.9^{ab}	16.2^{bc}	14.8^{d}	0.001
305 day milk yield, kg	4491^{c}	4932^{b}	5147^{ab}	5216^{a}	5059^{ab}	5261^{a}	5100^{ab}	4944^{b}	4520^{c}	0.001
305 –Mature age –milk yield, kg	4951^{c}	5178^{abc}	5276^{ab}	5268^{ab}	5057^{bc}	5311^{a}	5148^{abc}	5094^{abc}	5162^{abc}	0.05
Lactation duration, days	376^{a}	369^{a}	340^{b}	333^{bc}	320^{cd}	313^{d}	310^{d}	322^{bcd}	318^{cd}	0.001
(number)	(239)	(339)	(276)	(218)	(150)	(85)	(44)	(17)	(16)	
Dry period, days	114^{d}	116^{cd}	127^{bcd}	134^{abcd}	150^{a}	130^{abcd}	132^{abcd}	148^{ab}	137^{abc}	0.01

Data show mean. * NS: non–significant. $^{a.b.c}$ significant difference between years (P<0.01).

Table 3. Change in least square means for milk yield traits in seasons of calving in Brown Swiss cows reared in the Central Anatolia region in Turkey

year	Winter	Spring	Summer	Autumn	P value
Traits. calving season					
(number)	(382)	(525)	(459)	(329)	
Actual Milk yield, kg	5597^{a}	5554^{ab}	5321^{c}	5035^{d}	0.001
Daily Milk yield.,kg	16.3	16.1	16.2	16.2	NS
305 day milk yield,. kg	5033	4989	4973	4858	NS
305 –Mature age –milk yield, kg	5233	5192	5172	5046	NS
Lactation duration, Days	344^{a}	344^{ab}	331^{c}	314^{d}	0.001
(number)	(306)	(429)	(376)	(273)	
Dry period, days	125^{b}	126^{b}	127^{b}	150^{a}	0.01

Data show mean. * NS: non–significant. $^{a.b.c.d}$ significant difference between years (P<0.01).

In the present study, the mean lactation duration was 334 days and it was higher than the ideal time (305 days). This duration of lactation is longer than values reported between 275 and 319 days in previous studies (Yanar *et al*., 1998; Kopuzlu, 2003; Tilki *et al*., 2003; Çilek and Tekin, 2007a; Çakıllı and Güneş, 2007; İnci *et al*., 2007; Bakır *et al*., 2009; Çilek and Bakır, 2010). Lactation duration should be planned as 305 days by the manager and vet of the farm. It is important for vets to regulate the duration of lactation and dry period for a better milk production cycle for cows. In the farm in the current study, lactation duration slowly decreased until 2006, which was nearly at the ideal time. This decreasing in lactation duration could be due to better regulation of artificial insemination by operators.

The mean dry period (132 days) in the present study was longer than previously reported values (122 days) (Kopuzlu, 2003. Tilki *et al*., 2003. Çilek and Tekin, 2007a; Çakıllı and Güneş, 2007; İnci *et al*., 2007; Bakır *et al*., 2009; Çilek and Bakır, 2010). This longer dry period could be one of the critical problems in this farm. A longer dry period could be due to a shorter lactation duration and longer calving intervals. Better fertility control by vets could affect the balance among lactation duration, dry period and calving interval. To make animals more profitable, it is essential to control the reproductive cycle; cows should be pregnant as soon as possible during the service period to shorten the dry period.

Effect of calving times on milk yield traits

The lowest daily and 305–day milk yield were obtained from cows at the 2nd calving time and the highest was obtained from cows at the 7th calving time (Table 2). As expected, daily milk yield decreased slowly after 7 years of age. The 305–day milk yield is higher than values reported in some previous studies (Aydın *et al*., 1998; Kopuzlu, 2003; Tilki *et al*., 2003; Çilek and Tekin, 2007a; Bakır *et al*., 2009) and lower than values in other studies (Çakıllı and Güneş, 2007; İnci *et al*., 2007; Çilek and Bakır, 2010). The 305–day milk yield and 305–day mature age milk yield showed the highest values in cows at the 7th calving time, and after the 7th calving time, these values gradually decreased. This finding confirmed that the peak milk yield was at the 5th–7th calving times with maturity in Brown Swiss cows reared in the Central Anatolia region in Turkey. After the 6th calving time, dry period days were maintained at a higher level. These findings may indicate a decline in reproductive ability.

We found that the duration of lactation gradually decreased with calving times. This may be reason for the highest level of all milk yields traits and a shorter service period at a mature age. However; a longer lactation duration for old cows could be the reason for reproductive problems.

Effect of calving season on milk yield traits

In the current study, seasons of calving affected actual milk yield, days of lactation duration and days of dry period ($P<0.001$, $P<0.001$ and $P<0.01$, respectively). Çilek and Tekin (2005) previously reported that the effect of calving season on milk yield was significant and milk yield was high in cows calved in winter. Cows calved in winter have high milk yields, probably due to good feeding levels in the first 3 or 4 months of lactation. In winter, to avoid cold stress, we increased the amount of feed energy. They also increased milk yield due to feed containing alfalfa being given during the period until milk yield begins to decrease. However, cows calved in autumn have low milk yields and a short lactation duration because of being subjected to high environmental temperatures in the last months of lactation. The current study showed that the dry period of cows calved in autumn was longer than that in other seasons because of drying of milk yield in summer with high environmental temperatures in the last months of lactation.

The present study found that the calving season did not affect daily milk yield, 305–day milk yield and 305–day mature age milk yield. Fadlelmoula *et al.* (2007) reported that parity had a significant effect on milk yield per lactation, average daily milk yield and dry period. There was a significant effect of calving year and calving age on daily milk yield in this previous study. Although Koç and Kızılkaya (2009) reported that effects of herd, lactation month, lactation number, and milking time were statistically significant ($P<0.01$), Parra–Bracamonte *et al*. (2005) reported that the effect of calving season on daily milk yield in Mexico was significant. This difference between studies could be related to environmental differences and feeding systems.

Milk yield is affected by nutrition and management. Cows calved in winter have a longer lactation duration and shorter dry period than those calved in autumn. There were no differences among calving seasons in daily milk yield in the current study. Cows that calved in winter could be given concentrate feeds in the barn during the first lactation period because of the cold season. After this time, they could be given feed containing alfalfa and green grass until the milk yield began to go dry. On the other hand, cows calved in summer and autumn were exposed to high environmental temperatures during most of the important time for lactation.

In the farm of the current study, to more improve milk yield traits, there needs to be an improvement in feeding, prevention of mastitis and other diseases, and use of sperm of bulls with a high genetic capacity. Simultaneously, management to regulate the balance between lactation duration and dry period based on the cow's health may be effective in increasing milk yield. Increasing the lactation duration and dry period to longer than the optimal time is undesirable. To control these variables, the most important factor would be to control reproduction in this herd. Measures should be taken in terms of fertility; for example, veterinary services, fertility control, and herd management actions, such as oestrus monitoring, and they must be carefully performed.

CONCLUSION

In conclusion, our study demonstrated the milk yield

traits of Brown Swiss cows reared in the Central Anatolia region with a steppe climate. In 2000 to 2006, the actual milk yield, daily milk yield, 305–day milk yield, 305–day mature age milk yield, lactation duration and dry period days were significantly related to calving years. These data indicate that the peak milk yield is at the 5th–7th calving times with maturity in Brown Swiss cows reared in the Central Anatolia region in Turkey. The seasons of calving affect actual milk yield, days of lactation duration and days of dry period. Cows that calve in winter have the highest actual milk yield. This could be due to stable nutrition during the important first lactation period to avoid cold stress. However, better management is required for cows calved in autumn that are under high temperature stress during an important lactation period.

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