Turk J Vet Anim Sci
29 (2005) 821-828
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Research Article

Effect of Season on Some Fertility Parameters of Dairy and Beef Cows in Elazığ Province

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Received: 26.02.2004

Abstract: This study was conducted to investigate the effects of seasons on some fertility parameters of dairy and beef cows in Elazığ province.

A total of 511 multiparous dairy and beef cows in four commercial herds were used as material in the study. Climatic data were obtained from reports prepared at the Department of Meteorology in Elazığ. Daily maximum, minimum and average ambient temperatures and relative humidity were recorded throughout the year. Estruses were detected by observation twice a day. The expression of overt estrus was evaluated observing the degrees of signs of estrus. Cows were inseminated artificially after about 12 h from beginning estrus. First-service conception rates were determined by rectal palpation on the 75th day after insemination.

Intensity of estrus signs were significantly affected by the seasons, especially in dairy cows. While the expression of overt estrus decreased in the cows inseminated during the hot months of the year, it increased in spring compared to the other seasons. The cows inseminated in summer had significantly lower conception rates than cows inseminated in other seasons. Moreover, this decrease in conception rate in dairy cows appeared to be carried into autumn.

In conclusion, heat stress during summer resulted in a decrease in the exhibition of estrus behavior and conception rates of dairy and beef cows. Therefore, additional reproductive strategies are needed to counteract the adverse effect of heat stress on fertility during summer.

Key Words: Cow, heat stress, season, conception rate, fertility.

Elazığ Yöresindeki Etçi ve Sütçü İneklerin Bazı Fertilite Parametreleri Üzerine Mevsimin Etkisi

Özet: Bu çalışma Elazığ yöresinde yetiştirilen etçi ve sütçü ineklerin bazı fertilite parametreleri üzerine mevsimin etkilerini araştırmak amacıyla yapılmıştır.

Araştırmada, dört ticari sürüden elde edilen birden fazla doğum yapmış toplam 511 baş etçi ve sütçü inekler materyal olarak kullanıldı. İklimsel bulgular, Elazığ'daki meteoroloji müdürlüğünden temin edildi. Günlük maksimum, minimum ve ortalama çevre sıcaklığı ve nispî nem oranı yıl boyunca kaydedildi. Östruslar günde iki defa gözlemle belirlendi. Östrus davranışlarının şiddeti, östrus belirtilerinin görülme derecesine göre değerlendirildi. İnekler östrusun başlangıcından yaklaşık 12 saat sonra tohumlandı. İlk tohumlama gebelik oranları tohumlama sonrası 75. günde rektal palpasyonla belirlendi.

Özellikle sütçü ineklerde, östrus davranışlarının şiddeti üzerine mevsimin önemli bir etkisi vardı. Yılın sıcak aylarında tohumlanan ineklerde östrus davranışlarında bir azalma görülürken, ilkbaharda diğer mevsimlere göre östrus davranışlarının daha belirgin olduğu tespit edildi. Yaz mevsiminde tohumlanan ineklerde diğer mevsimlere göre gebelik oranında önemli derecede bir azalma görüldü. Buna ilaveten sütçü sığırlarda bu azalmanın sonbahar mevsiminde de devam ettiği gözlendi.

Sonuç olarak, yaz ayları boyunca görülen sıcaklık stresi, etçi ve sütçü ineklerde östrus davranışlarının sergilenmesinde ve elde edilen gebelik oranlarında bir azalmaya sebep olmuştur. Bu yüzden yaz mevsimi boyunca fertilite üzerine sıcaklık stresinin kötü etkilerinin giderilmesi için ilave önlemlerin alınması gerekmektedir.

Anahtar Sözcükler: İnek, sıcaklık stresi, mevsim, gebelik oranı, fertilite

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Introduction

The changing seasons are an important factor that affects reproductive performance. Seasonal influences on fertility of beef and dairy cows are associated with climatological changes such as air temperature, relative humidity, air movement and solar radiation (1,2).

Heat stress occurs as combinations of air temperature and relative humidity and it is the major environmental factor responsible for lower fertility in cattle (3). There is evidence that efficiency of reproduction is not uniform through the year. Fertility in dairy and beef cows is depressed during the summer months in many warm areas of the world by heat stress. This is a worldwide problem that inflicts heavy economic losses and affects about 60% of the world cattle population (4-6).

Armstrong (7) reported that several situations such as reduced feed intake, increased water intake, increased body temperature and changed blood hormone concentration can occur in cattle exposed to heat stress. Moreover, multiparous cows producing more milk are especially susceptible to heat stress (8).

Heat stress decreases the intensity and duration of estrus and increases the incidence of anestrus and silent ovulation. The consequence of these changes is an increase in the total number of inseminations and a reduction in the proportion of inseminations resulting in pregnancy (1,9,10).

One way of measuring the severity of heat stress in cattle is the temperature – humidity index (THI), which is calculated as a function of ambient temperature and relative humidity (7,11). A THI value above 72 is generally considered stressful to dairy cows (12). When the temperature exceeds 27 °C, even with low humidity, the effective temperature is above the comfort (animal's thermo-neutral) zone for cattle (5).

Elazığ, located in Middle Eastern Anatolia region of Turkey, has a steppe climate. Summers are hot and dry with temperatures above 30 °C. Springs and autumns are generally mild. However, there is a great temperature difference between day and night. The temperatures can drop below zero. The winters are long and snow remains on the ground from December to March.

The objective of the present study was to evaluate the effects of seasons on some fertility parameters of dairy and beef cows in Elazığ province.

Materials and Methods

The study was conducted in an area around Elazığ province in Turkey, located at latitude 38°40'N, between January and December 2002. A total of 511 lactating multiparous dairy and beef cows at the age of 2-5 were provided from four commercial herds that sheltered in half-open barns in the province. In this study, Holstein (n=335; average yielding 25±2.5 kg milk per day) and Simmental (n=176; average yielding 16±3.1 kg milk per day) cows were used. The cows were grouped as beef and dairy. They were milked twice a day and were under similar conditions of care and nutrition throughout the year.

All the animals were subject to a gynecological examination once on the 35th day postpartum. The ovaries of cows were examined by rectal palpation to observe corpus luteum regression and identify the ovulatory follicle. The cows with ovarian cysts or uterine infections and the ones that had retained placenta were excluded from the study.

Climatic data were obtained from reports prepared at the Meteorological Service in Elazığ (5 km from the research location). A daily maximum, minimum and average ambient temperature and relative humidity were recorded at location. Based on this information, four seasons were established: winter (December, January, and February), spring (March, April, and May), summer (June, July and August) and autumn (September, October and November). An average daily THI was calculated using the following formula (11).

$$HIA = 16.92 + 0.1852 \times TF + 5.379 \times RH - 0.1003 \times TF \times RH$$

$$HIB = (9.417 \times TF^2 + 7.289 \times RH^2 + 0.3454 \times TF^2 \times RH) \times 0.001$$

$$HIC = (0.1021 \times TF^2 \times RH^2 - 8.15 \times TF \times RH^2) \times 0.0001$$

$$HID = (2.916 \times RH^3 - 3.865 \times TF^3 + 0.1427 \times TF^3 \times RH) \times 0.00001$$

$$HIE = (1.975 \times TF \times RH^3 - 0.2184 \times TF^3 \times RH^2) \times 0.0000001$$

$$HIF = (8.433 \times TF^2 \times RH^3 - 0.482 \times TF^3 \times RH^3) \times 0.00000000001$$

$$THI = HIA + HIB + HIC + HID + HIE + HIF$$

TF= temperature in degrees Fahrenheit RH = relative humidity

A chart was used to estimate the severity of heat stress of cows developed by Wiersma (Figure 1).

Temperature (Degrees)																							
F	C	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	
64	17.8																						
66	18.9																						1
68	20.0																						
70	21.1																					72	
72	22.2																				72	72	
74	23.3																72	72	73	73	74	74	2
76	24.4												72	72	73	73	74	74	75	75	76	76	
78	25.6										72	73	73	74	74	75	75	76	76	77	77	77	
80	26.7							72	72	73	73	74	74	75	76	76	77	78	78	79	79	80	
82	27.8						72	73	73	74	75	75	76	77	77	78	79	79	80	81	81	82	3
84	28.9				72	73	73	74	75	75	76	77	78	78	79	80	80	81	82	83	83	84	
86	30.0			72	73	74	74	75	76	77	78	78	79	80	81	81	82	83	84	84	85	86	
88	31.1	72	72	73	74	75	76	77	78	79	79	80	81	81	82	83	84	85	86	86	87	88	
90	32.2	72	73	74	75	76	77	78	79	79	80	81	82	83	84	85	86	86	87	88	89	90	
92	33.3	73	74	75	76	77	78	79	80	81	82	83	84	85	85	86	87	88	89	90	91	92	
94	34.4	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	4
96	35.5	75	76	77	78	79	80	81	82	83	85	86	87	88	89	90	91	92	93	94	95	96	
98	36.6	76	77	78	79	80	82	83	84	85	86	87	88	89	90	91	93	94	95	96	97	98	
100	37.7	77	78	79	80	82	83	84	85	86	87	89	90	91	92	93	94	95	97	98			
102	38.8	78	79	80	81	83	85	85	86	87	89	90	91	92	94	95	96	97	98				
104	39.9	79	80	81	82	85	85	86	88	89	90	91	93	95	95	96	97						
106	41.0	80	81	82	84	85	86	88	89	90	91	93	94	95	97	98							
108	42.1	81	82	83	85	86	87	89	90	92	93	94	96	97									
110	43.2	81	83	85	86	87	89	90	91	92	94	96	97										5
112	44.3	82	85	85	87	88	90	91	94	94	96	97											
114	45.4	83	85	86	88	89	91	92	94	96	97												
116	46.5	85	86	87	89	90	92	94	95	97													
118	47.6	85	87	88	90	92	93	95	97														
120	48.7	86	88	89	91	93	94	96	98														

Figure 1. Temperature Humidity Index (THI) table for estimation of heat stress for dairy cows. (1-No stress, 2-Mild Stress, 3- Medium Stress, 4-Severe Stress, 5- Deadly Stress). Modified from Frank Wiersma (1990). Department of Agricultural Engineering, University of Arizona, Tucson.

Estrus was detected by observation for 30 min twice a day. The cows showed primary or secondary physiological and psychological signs of estrus such as standing, mounting other cows, restlessness, nervousness, red and swollen vulva, cervical mucus and decreasing feed intake and reducing milk production. Intensity of estrus expression was scored on a scale of 0 to 5 [5 = excellent (standing, mounting other cows, restlessness, nervousness, red and swollen vulva, cervical mucus and decreasing feed intake and reducing milk production), 4 = good (standing, mounting other cows, red and swollen vulva, cervical mucus), 3 = normal (red and swollen vulva, cervical mucus and decreasing feed intake and reducing milk production), 2 = fair (red and swollen vulva, decreasing feed intake and reducing milk production), 1 = poor (decreasing feed intake and reducing milk production), 0 = no estrus] by taking estrus behaviors as the criterion.

Cows were artificially inseminated with frozen-thawed semen from bulls with good fertility approximately 12 h after the onset of natural estrus. Cows were inseminated at observed first estrus period between 50 and 120 d postpartum.

Cows were observed for estrus between 19 and 21 d after insemination. First-service conception rates were determined on the 75th day after insemination by rectal palpation of the uterus.

Statistical Analyses

All values were calculated as means ± standard errors of the means (± SEM) and P values < 0.05 were considered significant. The data on the number of days from calving to first insemination and the degree of intensity of estrus signs were analyzed statistically using the General Linear Model procedure of SPSS (SPSS for Windows version 10.0). The conception rate was defined as the number of cows that became pregnant divided by the total number of cows inseminated at first estrus. The differences in conception rates were analyzed statistically using the chi-squared test procedure of MINITAB (MINITAB for Windows version 14.0).

Results

Meteorological data are summarized in Table 1. There was substantial variation in seasonal ambient temperature and humidity at location. Monthly average environmental temperatures ranged from –2.1 to 27.1 °C, and average relative humidity ranged from 40.6% to 73.5%. A daily maximum temperature exceeded 27 °C during summer (from June to August). Relative humidity was lowest in July (40.6%) and increased to 73.5% in January.

During January, the maximum THI was 62 and cows maintained normothermia. However, during July and August, the maximum THI values were 82 and 83, respectively. These data indicate that heat stress occurred during summer (June, July and August) when upper critical temperatures (24 to 27 °C) were exceeded.

The intervals from calving to first insemination, the intensity of estrus signs and the conception rate of beef and dairy cows are shown in Table 2.

Intensity of estrus signs was significantly affected by the season, especially in dairy cows ($P < 0.05$). While the expression of overt estrus decreased in the cows inseminated during the hot months of the year, it increased in spring compared to the other seasons.

The number of days from calving to first insemination in dairy and beef cows did not differ between seasons. However, an increase was observed in the length of the postpartum period in beef cows during autumn compared to that of the other seasonal groups, but this increase was not statistically significant.

The relationship between the increase in THI and the decrease in pregnancy rate is illustrated in Figure 2. The differences were determined in conception rate of beef and dairy cows during summer compared to those of the other seasons. The cows inseminated in summer had a significantly lower conception rate than cows inseminated in the other seasons. Moreover, this decrease in conception rate in dairy cows appeared to be carried into autumn.

Discussion

Heat stress is a causative factor that reduces reproductive performance of cattle when the THI is high

Table 1. Meteorological data for Elazığ.

Seasons and Months		Ambient Temperature (°C)			Relative Humidity (%)			THI Index		
		Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Winter	December	13.8	-16.4	-2.1	97	38	70.3	65	44	55
	January	9.2	-5.5	2.6	97	37	73.5	62	54	57
	February	11.8	-4.0	3.1	95	28	66.3	64	48	58
Spring	March	19.3	-2.6	7.8	97	28	63.7	68	54	63
	April	20.8	2.4	10.8	98	31	62.6	69	62	66
	May	28.8	8.6	16.6	95	27	53.3	76	68	71
Summer	June	34.5	13.0	22.6	74	24	45.3	79	67	73
	July	37.4	19.4	27.1	60	20	40.6	82	71	76
	August	35.6	17.4	25.8	67	28	41.9	83	72	76
Autumn	September	32.0	12.6	21.7	84	31	47.8	78	66	71
	October	30.5	2.0	15.3	96	27	58.5	77	57	65
	November	9.5	-1.2	8.4	95	35	65.2	70	46	57

Table 2. Effect of season on the intervals from calving to first insemination, the intensity of estrus signs and the conception rate of beef and dairy cows.

Season	Cows	The intensity of estrus signs	The intervals from calving to first insemination	Conception rate
Winter	Beef	3.54 ± 0.12[ad]	79.4 ± 2.3	71.4a (30/42)
	Dairy	3.62 ± 0.10[a]	83.0 ± 1.8	73.3a (44/60)
Spring	Beef	4.00 ± 0.08[b]	76.7 ± 1.7	80.0a (44/55)
	Dairy	4.02 ± 0.06[b]	76.6 ± 1.3	78.9a (101/128)
Summer	Beef	3.21 ± 0.11[cd]	77.6 ± 2.6	48.7b (19/39)
	Dairy	3.18 ± 0.08[c]	78.1 ± 1.7	47.9b (35/73)
Autumn	Beef	3.85 ± 0.12[ab]	88.1 ± 2.3	65.0ab (26/40)
	Dairy	3.78 ± 0.09[ab]	83.5 ± 2.1	68.9a (51/74)

a,b,c,d: Values with different letters in same column are significantly different ($P < 0.05$).

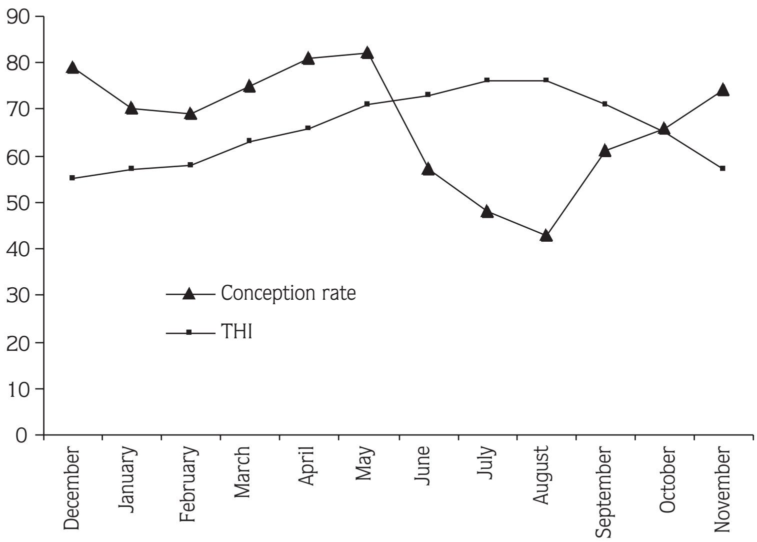

Figure 2. The relationship between THI and conception rate.

than 72 (3). In the present study, average THI was observed as 78 during summer. The magnitude of heat stress experienced in Elazığ during summer classified as medium heat stress.

The variations were observed in the expression of overt estrus between seasons. Especially in summer, the behavioral estrus signs significantly decreased compared to the other seasons. These data are in agreement with other research (13,14) showing that the intensity of estrus significantly decreased during hot months and it is more difficult to detect estrus in heat stressed cows. Nebel et al. (15) reported that motor activity and other behaviors of estrus decreased and the incidence of anestrus and silent ovulation increased during summer. White et al. (10) found that beef cows were mounted more frequently during estrus in winter compared to in summer. Similarly, Pennington et al. (16) reported that there was a reduction in the number of mounts in hot weather compared to cold weather, leading to poor detection of estrus. However, Walker et al. (17) reported that season did not alter estrus behavior, and the increase in temperature did not influence the duration and intensity of estrus in dairy cows. Seasonal effects on estrus behavior may differ among studies due to breed of cows, climatological variations, or managemental factors such as frequency of milking, feeding, movement of cows (10).

The mechanism by which heat stress reduces the intensity of estrus signs may be hormonal changes such as the decrease in circulating estradiol concentration. Some recent studies (18,19) indicated that plasma estradiol concentration was reduced during summer by heat stress. Wilson et al. (20) suggested that heat stress inhibited follicular growth during the preovulatory period, and abnormal ovarian function in heat stressed cows was manifested as a decrease in the proestrus rise in estradiol. The decrease in estradiol secretion from the dominant follicle may cause poor expression of estrus (12).

Rensis and Scaramuzzi (6) reported that LH level was decreased by heat stress and the dominant follicle that developed in a low LH environment lead to reduced estradiol secretion, which resulted in poor expression of estrus, and a decrease in the conception rate. However, the mechanisms by which heat stress alters the plasma LH concentrations are not known.

The postpartum period of dairy cows did not differ among seasons. However, the number of days from calving to first insemination in beef cows was longer in autumn compared to the other seasons, but this difference was not statistically significant. Ray et al. (21) reported that first lactation cows were more sensitive than other lactation groups to the thermal stress of summer, and had a significantly longer postpartum period, but the interval from calving to first insemination was similar to that in multiparous cows calving in spring, summer and autumn. Similarly, Lewis et al. (9) reported that heat stress did not alter days from calving to first estrus. However, these results differ from those of Jonsson et al. (22), which suggested that the reduction in dry matter intake by heat stress resulted in a negative energy balance, which prolonged the postpartum period and decreased fertility in dairy cows. Negative energy balance leads to decreased plasma concentrations of insulin and glucose, which are essential for normal folliculogenesis. Lower plasma concentrations of insulin and glucose lead to impaired follicular development and delayed ovulation. In contrast, we observed that heat stress did not alter dry matter intake throughout the year. The possible reason for the difference in the results of these two studies could be variation of location, severity of heat stress, and physiology of cows (milk production, body temperature etc.)

We found that there was a reduction in conception rate during summer in dairy and beef cows. The decrease in conception rate during summer ranged between 18% and 33% compared to the other seasons. These data are in agreement with earlier studies (23,24). Cavestany et al. (1) found that the decrease in conception rate could range between 20% and 30% during the hot season, depending on the severity of heat stress, compared to the cold season. Similarly, Monty and Wolff (25) reported that heat stress has been shown to reduce reproductive efficiency both by reducing estrus expression/detection and by decreasing conception rate.

Some studies (26,27) reported that heat stress was associated with the decline in conception rate owing to the damage in the oocyte. Al-Katanani et al. (27) reported that the population of small follicles is particularly sensitive to physiological changes that occur during heat stress, and developing small follicles that are damaged by heat stress during summer may ovulate an infertile oocyte, leading to a reduced conception rate.

Roman-Ponce et al. (28) reported that there was an increase in uterine and ovarian temperature, depending on the increase in environmental temperature. The effect of heat stress on fertility might be the result of a direct effect of high ovarian and uterine temperature. The formation of gametes and the development of oocytes are temperature sensitive. These changes can inhibit embryonic development and may increase early embryonic loss (26).

In the present study the negative effects of heat stress on conception rate appeared to be carried into the autumn in dairy cows even though the cows were no longer exposed to heat stress. This observation is similar to the results of Roth et al. (29), who suggested that this could be a lasting effect of heat stress during the hot months on the antral follicles that will develop into large dominant follicles 40-50 days later.

In conclusion, this research indicated that there was a reduction in the reproductive performance of dairy and beef cows during summer by heat stress. Heat stress caused a decrease in the expression of overt estrus and conception rate. It has been demonstrated that the low conception rate was associated with the decrease in the intensity of estrus. Therefore, additional reproductive strategies are needed to counteract the adverse effect of heat stress in summer on fertility.

Acknowledgment

The authors wish to express their gratitude to Oğuz DEMIRCI, Electrical and Computer Engineering Department, University of New Mexico, NM, USA, for revising the language of the manuscript.

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