Turk J Vet Anim Sci
30 (2006) 257-263

Research Article

Calving and Preweaning Growth Performance Traits of Calves Sired by Charolais, Simmental and Eastern Anatolian Red Bulls

Abdülkadir ÖZLÜTÜRK[1], Mete YANAR[2,*], Naci TÜZEMEN[2], Sinan KOPUZLU[1]

[1]Eastern Anatolian Agricultural Research Institute, Ilıca, Erzurum-TURKEY

[2]Department of Animal Science, Faculty of Agriculture, Atatürk University, Erzurum- TURKEY

Received: 15.07.2005

Abstract: Charolais (C)-, Simmental (S)-, and Eastern Anatolian Red (EAR)-sired calves born in 2 locations in Eastern Anatolia were compared in terms of calving traits and preweaning growth characteristics. Breed of sire effects were significant ($P < 0.01$) for birth weight, 205-day weaning weight, average daily weight gain from birth to weaning, and some body measurements at birth. S- and C-sired calves were heavier at birth and larger for most body measurements at birth than EAR-sired calves. The C- and S-sired calves also had higher 205-day weight than the EAR-sired calves. Although the level of calving difficulty was higher in the S and C crosses, the differences were not statistically significant. Male calves had significantly ($P < 0.01$) heavier birth and 205-day weights, higher preweaning average daily gain and greater body measurements (e.g., height at withers, heart girth and cannon bone girth) than females. Location differences were also significant ($P < 0.01$) for survival rate from birth to weaning, preweaning growth rate and 205-day weight. In conclusion, although C- and S-sired calves performed similarly for most traits, all parameters of the preweaning growth were higher in calves sired by S and C bulls than in calves sired by EAR bulls. Therefore, both C and S could be considered as sire breeds for crossbreeding programs to be implemented in Eastern Anatolia, since these breeds did not cause an adverse influence on the calving and growth traits of the crossbred calves.

Key Words: Calf, breeds of sire, growth traits, beef cattle, calving traits

Şarole, Simental ve Doğu Anadolu Kırmızısı Boğalardan Elde Edilen Buzağıların Buzağılama ve Sütten Kesim Öncesi Büyüme Performans Özellikleri

Özet: Doğu Anadolu Bölgesinde iki ayrı lokasyonda, Şarole (Ş), Simmental (S) ve Doğu Anadolu Kırmızısı (DAK) ırkı boğalardan olan buzağıların, buzağılama ve sütten kesim öncesi büyüme özellikleri karşılaştırılmıştır. Boğa ırkının doğum ağırlığı, 205 günlük sütten kesim ağırlığı, doğum ile sütten kesim arası günlük canlı ağırlık artışı ve doğumda alınan bazı vücut ölçüleri üzerine etkileri önemli ($P < 0,01$) bulunmuştur. Ş ve S boğalarının buzağıları DAK boğalarının buzağılarına göre doğumda daha ağır ve doğumda alınan bir çok vücut ölçüleri bakımından daha iri olduğu tespit edilmiştir. Ayrıca Ş ve S boğalarının buzağılarının 205 gün ağırlığının DAK boğalarının buzağılarında daha yüksek olduğu belirlenmiştir. S ve Ş melezlerinde buzağılama güçlüğü yüksek olmasına rağmen, bu farklılıklar istatistiksel olarak önemsizdir. Erkek buzağılar, dişilerden önemli ($P < 0,01$) derecede daha yüksek doğum ve 205 gün ağırlıkları ile, sütten kesim öncesi günlük canlı ağırlık ve cidago yüksekliği, göğüs çevresi, ön incik çevresi gibi vücut ölçüleri bakımından üstünlük göstermişlerdir. Sütten kesim öncesi yaşama gücü, büyüme hızı ve 205 gün ağırlığı bakımından da lokasyon farkları önemli ($P < 0,01$) bulunmuştur. Sonuç olarak Ş ve S boğaların buzağıların bir çok özellik bakımından benzer olmasına rağmen, sütten kesim öncesi bütün büyüme parametreleri açısından Ş ve S boğalarının buzağılarının, DAK boğalarının döllerinden daha yüksek olduğu tespit edilmiştir. Bu nedenle, Doğu Anadolu Bölgesinde yürütülecek olan melezleme programlarında, elde edilecek melez buzağıların sütten kesim öncesi büyüme performansları ile buzağılama özellikleri açısından olumsuz etki yapmayacağı için baba ırkı olarak Ş ve S düşünülebilir.

Anahtar Sözcükler: Buzağı, boğanın ırkı, büyüme özellikleri, et sığırı, buzağılama özellikleri

Introduction

The Eastern Anatolian Red (EAR), the dominant indigenous cattle breed of mountainous Eastern Anatolia, is raised for beef and milk production. The breed is well known in this country and has great economic importance in the areas of its origin and the production systems it

*E-mail: myanar@atauni.edu.tr

inhabits. EAR cattle are hardy, disease-resistant, and tolerant to poor care, meager diet and adverse climate conditions. In addition to these advantages, its 6-month weight and daily weight gain between birth and 6 months of age are low, and it is poorly muscled with an unacceptable conformation after fattening. Studies revealed that live weight at 6 months of age and daily weight gain between birth and 6 months of age ranged from 45.6 to 100 kg and from 0.20 to 0.45 kg/day, respectively (1,2). Carcass weight of the breed was also low and varied from 122.3 to 152.5 kg (3,4). The results of these studies indicate that the EAR cattle need to be improved for growth and beef production traits to meet the increasing demand for lean and high-quality beef in Turkey.

Crossbreeding programs have been used in different countries for the benefits of heterosis on both pre- and postweaning growth as well as beef production (5-8). Recently, livestock companies practicing artificial insemination in Turkey started to use generally Simmental (S) and Charolais (C) semen to produce offspring for beef production. However, there is limited scientific information on the performance of C and S in EAR breed as sires. Therefore, there is a need to compare preweaning growth characteristics of the calves sired by these breeds. Results of this comparison will be the first information for the development of a sustainable crossbreeding program and will be helpful for choosing the suitable sire breed for EAR cows in crossbreeding programs that may be implemented in this country.

The main purpose of this study was to compare traits related to calving and preweaning growth of calves obtained from the mating of EAR cows by C, S and EAR sires.

Materials and Methods

The research was carried out under 2 sets of environmental conditions in Eastern Turkey, with the Eastern Anatolian Agricultural Research Institute (EAARI) representing modern cattle management and the village of Aktoprak representing traditional cattle raising in the region. Both research stations are in Erzurum province, Eastern Anatolia. A total of 160 male and female calves produced contemporaneously from EAR, S and C sires. No attempt was made to standardize or change the management practices of these locations including feeding, handling and immunization.

Contemporary groups of calves resulting from estrus-synchronized cows were used for this study. Breeding cows were estrus synchronized by intramuscular injection of $PGF_{2\alpha}$ (Dynolitic, Pharmacia & Upjohn, Puurs, Belgium) twice with an 11-day interval. While 2 groups of EAR cows were inseminated with S and C semen, EAR-sired calves were produced from mating at the same time as the artificial inseminations. The cows calved from late February to late March. After the calves were born, each was individually identified using plastic ear tags and metal ear clips, and birth date was recorded. All dams nursed their calves for about 6-7 months. At the EAARI, cows were fed about 6 kg/head per day of dried alfalfa, hay and 1 kg/head per day of concentrate (12.5% crude protein, 2.5% ether extract, 12.5% crude cellulose, 5.0% crude ash and 88.2% dry matter) during the winter and spring. Before the calves moved into the pasture with their dams in early June, they also received a limited amount of concentrate (17.4% crude protein, 1.8% ether extract, 5.1% crude cellulose, 10.3% crude ash and 94.2% dry matter) at a rate of 300 g/head per day and ad libitum dry hay. In Aktoprak, conventional feeding is performed similar to the practices in most parts of Eastern Turkey. Calves born in the village suckled their dams for 6-7 months, but supplemental feeding was not used. About 6 kg/head per day of wheat or barley straw and dry hay and 0.5 kg/head per day of concentrate (12.0% crude protein, 2.9% ether extract, 12.1% crude cellulose, 5.4% crude ash and 88.0% dry matter) were offered to cows in this location. Housing conditions of cattle in Aktoprak were also poorer than those in EAARI. In particular, ventilation of the closed barns was insufficient, and the inside of these buildings was too dark due to insufficient numbers of windows. There were just 1 or 2 windows of size 50 x 40 cm^2 in the barns, and they could not be opened. Air outlet flues were not also available in these facilities.

Ages of dams ranged from 2 to 5 years old. Breeding, birth and survival records were properly kept for all animals. Calves were weighed by a portable scale (with 100 g sensitivity) and body measurements such as height at withers, body length, height at withers, heart girth, circumference of round and cannon bone girth within 12 h of birth were also determined. Weaning weight was determined and standardized to that of 205 days following the Beef Improvement Federation formula (9).

Calving requiring the use of a calf puller or surgery was classed as 'difficult', while that requiring no more

than hand assistance was classed as 'easy'. Still born calves or those dying within 24 h of birth were classed as 'perinatal mortality', while subsequent preweaning deaths were classed as 'mortality between birth and weaning'.

Data were analyzed using general linear model procedure in SPSS. The model used initially included the effects of breed of sire, sex of calf and locations and all 2- and 3-way interactions. Subsequently, insignificant interaction effects were ignored, and the analyses were performed again according to the reduced model. The 3-way interaction was insignificant for all traits, but there were significant 2-way interactions for some traits. F values for significance testing were based upon error mean square. The significance of the difference among least square means of the main effects was tested by Duncan's multiple-range test. Calving difficulty, calf survival between sire groups, locations and sex of calves were compared by chi-square analysis (10).

Results

The overall percentage of difficult calving was 2.5%, and there was no significant effects of sire breed, location and sex of calves for calving ease trait (Table 1). The incidence of calving difficulty in calves sired by S and C exceeded EAR-sired calves by 5.9% and 3.6% respectively. C- and S-sired calves exhibited about the same percentage of difficult births. Although the frequency of difficult births in male calves was 4.3% greater than that in female calves, the difference was not statistically significant. Location differences were not large, but the incidence of difficult births at Aktoprak exceeded that at EAARI by 1.1%.

The overall percentage of perinatal mortality was 1.25%. The perinatal deaths were observed from the C sire, and both of the calves died were female. The overall incidence of death from birth to weaning was 3.8%, and sire breeds differed significantly ($P < 0.05$) (Table 2). The incidences of death in S- and C-sired calves were 9.1% and 2.9% higher than that in EAR-sired calves. Location difference was also significant. All of the calf mortality between birth and weaning was observed at Aktoprak, where traditional cattle raising is still practiced. However, sex of calves did not significantly affect the percentage of calf deaths.

Table 1. The total numbers and percentages of calves classified by location, breed of sire and sex of calves for easy and difficult calving and mortality.

	Calving Difficulty					Calf Mortality				
	Easy Calving		Difficult Calving		Total	Survival to Weaning		Calf Death Loss to Weaning		Total
	N	%	N	%	N	N	%	N	%	N
Overall	156	97.5	4	2.5	160	154	96.3	6	3.8	160
Locations										
Aktoprak	61	96.8	2	3.2	63	57	90.5	6	9.5	93
EAARI	95	97.9	2	2.1	97	97	100.0	0	0	97
Breed of Sire										
C[1]	53	96.4	2	3.6	55	50	90.9	5	9.1	55
S[2]	32	94.1	2	5.9	34	33	97.1	1	2.9	34
EAR[3]	71	100.0	0	0	71	71	100.0	0	0.0	71
Sex of Calves										
Male	89	95.7	4	4.3	93	90	96.8	3	3.2	93
Female	67	100.0	0	0	67	64	95.5	3	4.5	67

[1]C: Charolais, [2]S: Simmental, [3]EAR: Eastern Anatolian Red

Table 2. Least squares means (± standard error) and significance of mean differences for gestation length, birth weight and some body measurements measured at birth of calves

	N	Gestation Length (days)	Birth Weight (kg)	Height at Withers (cm)	Body Length (cm)	Circumference of Round (cm)	Heart Girth (cm)	Cannon Bone Girth (cm)
Overall	160	283.2 ± 0.6	23.99 ± 0.32	67.4 ± 0.3	59.7 ± 0.4	68.4 ± 0.5	68.2 ± 0.3	10.3 ± 0.1
Locations								*
Aktoprak	63	283.5 ± 1.0	23.69 ± 0.49	67.9 ± 0.4	60.4 ± 0.6	69.2 ± 0.7	67.8 ± 0.5	10.4 ± 0.1
EAARI	97	283.0 ± 0.8	24.30 ± 0.42	67.0 ± 0.4	59.1 ± 0.5	67.7 ± 0.6	68.6 ± 0.4	10.2 ± 0.1
Breed of Sire			**		*	**	**	**
C[1]	55	283.3 ± 0.9	25.80 ± 0.50^{a}	67.9 ± 0.4	60.4 ± 0.6^{a}	70.4 ± 0.7^{a}	69.7 ± 0.5^{a}	10.5 ± 0.1^{b}
S[2]	34	282.6 ± 1.1	25.59 ± 0.63^{a}	67.5 ± 0.6	60.7 ± 0.8^{a}	69.9 ± 0.9^{a}	69.0 ± 0.7^{a}	10.9 ± 0.1^{a}
EAR[3]	71	283.7 ± 1.3	20.60 ± 0.53^{b}	66.8 ± 0.5	58.1 ± 0.6^{b}	64.9 ± 0.7^{b}	65.9 ± 0.6^{b}	9.6 ± 0.1^{c}
Sex of Calves			**	*			**	**
Male	93	284.0 ± 0.8	25.25 ± 0.40	68.1 ± 0.4	59.9 ± 0.5	69.1 ± 0.6	69.4 ± 0.4	10.6 ± 0.1
Female	67	281.4 ± 1.0	22.73 ± 0.48	66.8 ± 0.4	59.5 ± 0.6	67.7 ± 0.7	67.0 ± 0.5	10.0 ± 0.1
Breed of Sire x Locations			**		*	*	*	**
C x Aktoprak	31	285.4 ± 1.19	24.13 ± 0.66^{bc}	67.7 ± 0.6	60.3 ± 0.8^{a}	67.9 ± 0.5	68.6 ± 0.7^{abc}	10.6 ± 0.1^{ab}
C x EAARI	24	281.8 ± 1.31	27.46 ± 0.74^{a}	68.1 ± 0.7	60.4 ± 0.9^{a}	68.7 ± 0.6	70.9 ± 0.8^{a}	10.5 ± 0.1^{ab}
S x Aktoprak	17	281.7 ± 1.57	24.54 ± 0.88^{ab}	67.7 ± 0.8	60.4 ± 1.1^{a}	68.8 ± 0.6	67.8 ± 0.9^{bc}	10.7 ± 0.2^{ab}
S x EAARI	17	283.5 ± 1.53	26.63 ± 0.89^{a}	67.3 ± 0.8	61.0 ± 1.1^{a}	68.7 ± 0.7	69.9 ± 0.9^{ab}	11.0 ± 0.2^{a}
EAR x Aktoprak	15	---	22.38 ± 0.95^{c}	68.2 ± 0.8	60.3 ± 1.2^{a}	67.7 ± 0.7	66.9 ± 1.0^{cd}	10.2 ± 0.2^{b}
EAR x EAARI	56	283.6 ± 1.33	18.81 ± 0.49^{d}	65.5 ± 0.4	55.9 ± 0.6^{b}	68.9 ± 0.4	64.9 ± 0.5^{d}	9.1 ± 0.1^{c}

* $P < 0.05$, ** $P < 0.01$, $^{a-d}$ Means within columns not followed by the same letter differ significantly.
[1]C: Charolais, [2]S: Simmental, [3]EAR: Eastern Anatolian Red

The overall mean gestation length was 283.2 ± 0.6 days. None of the main effects were significant sources of variation and the statistical model accounted for 5.0% of the total variance. Least square means for gestation length, presented in Table 2, demonstrated that calves sired by EAR had numerically longer gestation length than progeny of C and S sires, but the differences were not significant. EAR-sired calves exceeded C- and S-sired calves by 0.4 and 1.1 days.

The average birth weight was 23.99 ± 0.32 kg (Table 2). The breeds of sire, sex of calf were associated with significant ($P < 0.01$) variation and the reduced model accounted for 51.7% of total variation. The interaction between location and breed of sire was highly ($P < 0.01$) significant. Ranking of the breed of sire was C > S > EAR for birth weight. Offspring of C and S sires exceeded ($P < 0.01$) EAR-sired calves by 5.20 and 4.99 kg, respectively. However, calves sired by C and S did not differ significantly. Average birth weight of male calves (25.25 ± 0.40 kg) was greater than that of females (22.73 ± 0.48 kg) regardless of breed of sire and locations. Although calves born at EAARI were 0.61 kg heavier than those at Aktoprak, the location differences in birth weight were not statistically significant.

Some of the body measurements such as body length, heart girth, circumference of round and circumference of cannon bone were significantly affected by breed of sire (Table 2). Progeny of C and S sires were larger than EAR-sired calves in terms of skeletal size at birth. Most of the differences between S- and C-sired calves were not significant.

The overall average daily weight gain from birth to weaning was 0.56 ± 0.01 kg (Table 3). There were significant differences ($P < 0.01$) due to the breed of sire, locations and sex of calves. The only significant interaction was that between sire breed and locations. The reduced model accounted for 64.3% of total variance. The S-sired calves, which had the highest growth rate, gained 230.0 g (53.48%) faster per day than EAR-sired calves, which ranked lowest in growth rate. The C-sired calves exceeded EAR-sired calves by 170.0 g (39.53%). In the preweaning period, average

Table 3. Least squares means (± standard error) and significance of mean differences for 205-day weight, actual weaning weight and weight gain birth to weaning.

	N	205-Day Weight (kg)	Actual Weaning Weight (kg)	Average Daily Weight Gain Birth to Weaning (kg/d)
Overall	148	172.04 ± 2.73	125.29 ± 1.78	0.56 ± 0.01
Locations		**	**	**
Aktoprak	51	146.68 ± 4.23	108.21 ± 2.76	0.47 ± 0.02
EAARI	97	197.40 ± 3.37	142.37 ± 2.20	0.66 ± 0.01
Breed of sire		**	**	**
C[1]	46	184.97 ± 4.34[a]	133.90 ± 2.83[b]	0.60 ± 0.02[b]
S[2]	32	195.68 ± 5.20[a]	143.79 ± 3.40[a]	0.66 ± 0.02[a]
EAR[3]	70	135.48 ± 4.39[b]	98.17 ± 2.87[c]	0.43 ± 0.02[c]
Sex of calves		**	**	**
Male	87	179.77 ± 3.27	130.74 ± 2.13	0.59 ± 0.01
Female	61	164.32 ± 4.04	119.84 ± 2.64	0.54 ± 0.01
Breed of sire x locations	**	**	**	
C x Aktoprak	22	152.92 ± 6.25[b]	110.74 ± 4.08[bc]	0.48 ± 0.02[bc]
C x EAARI	24	217.02 ± 5.97[a]	157.05 ± 3.90[a]	0.72 ± 0.02[a]
S x Aktoprak	15	161.31 ± 7.55[b]	119.71 ± 4.93[b]	0.53 ± 0.03[b]
S x EAARI	17	230.04 ± 7.11[a]	167.87 ± 4.64[a]	0.78 ± 0.03[a]
EAR x Aktoprak	14	125.81 ± 7.86[c]	94.16 ± 5.14[d]	0.40 ± 0.03[c]
EAR x EAARI	56	145.14 ± 3.90[bc]	102.18 ± 2.55[cd]	0.46 ± 0.01[bc]

** $P < 0.01$, [a-d] Means within columns not followed by the same letter differ significantly. [1]C: Charolais, [2]S: Simmental, [3]EAR: Eastern Anatolian Red

daily weight gains of calves reared at EAARI and Aktoprak were also statistically different ($P < 0.01$). The mean values of male and female calves for average preweaning daily gain were significantly influenced by sex of calves.

The actual weaning weight was affected significantly ($P < 0.01$) by all of the main effects, and the reduced model accounted for 67.5% of the total variance. Actual weaning weight of the EAR-sired calves was the lowest, and calves sired by C and S exceeded progeny of EAR by 35.73 and 45.62 kg, respectively.

The average for 205-day weight was 172.04 ± 2.73 kg, and the mathematical model accounted for 67.3% of the total variation. Breed of sire, locations and sex of calf had significant ($P < 0.01$) effects on 205-day weight. The interaction between sire breed and location was also significant. The calves from S and C sires exceeded those from EAR sires by 60.20 and 49.49 kg, respectively (Table 3). The 205-day weight of calves reared in EAARI was higher ($P < 0.01$) than that of calves in Aktoprak.

Discussion

There was no significant difference between the percentage of cows mated to S, C and EAR sires requiring assistance at calving. Similar results were also reported by King et al. (8) and Newman et al. (11), who found insignificant effects of S and C sire breeds on calving difficulty. The finding of this study reveals that mating EAR dams to the S or C sire breeds in the crossbreeding programs may not result in a significant adverse effect with regard to calving difficulty. The percentages of unassisted deliveries of the S and C sire breed groups in this study were higher than the findings published by King et al. (8), who reported 89.0% unassisted deliveries for S and C sire groups. It is expected that male calves would experience a higher incidence of calving difficulty than female calves as already indicated by Freeden et al. (12). In the present study, sex difference was in the expected direction, but not statistically significant.

About one-third of the preweaning mortality took place within 24 h of birth, and the average percentage of perinatal mortality was similar to that reported by Newman et al. (11). The overall incidence of death from birth to weaning was significantly affected by sire breeds, and deaths in C-sired calves were greater than those in S- and EAR-sired calves. All of the calf mortality occurred in Aktoprak. The calf deaths were attributed to bacterial, viral or coccidial infections or mishaps, and might be more dependent on management practices than other factors. Comparable results were obtained by Freeden et al. (5) and King et al. (8), who reported a ranking of postnatal mortality of C > S.

Male calves' average gestation period was 1.6 days longer than females'. This finding compares with 1.4 and 1.9 days sex differences in gestation length reported by Azzam and Nielsen (13), and Herring et al. (14). The influence of sire breeds on the gestation length was not significant, in agreement with Newman et al. (11).

The average birth weights of calves sired by C and S were greater ($P < 0.01$) than that of EAR-sired calves. However, mean birth weights of S- and C-sired calves were similar to each other. The results reported by King et al. (8) and Newman et al. (11) are in agreement with our findings. There was a difference of 2.52 kg between the birth weight of male and female calves, which agreed with other studies (7,12,15).

Significant differences among sire breed groups for daily weight gain from birth to weaning were observed. The sire ranking was S > C > EAR, and preweaning growth rate was in favor of calves sired by S. In the literature, results regarding daily weight gain of S and C-sired calves are inconsistent. King et al. (8) and Southgate et al. (16) did not find any significant differences in the trait for C- and S-sired progeny, while Rahnefeld et al. (6) reported higher gains in C-sired calves than in calves sired by S. Location differences were striking, and the preweaning growth rate of calves reared in EAARI was 39.5% greater than that of calves at Aktoprak. A location x sire breed interaction was evident, and C- and S-sired calves at EAARI grew more rapidly than their contemporary controls (EAR progeny). This result could be attributed to better feeding and management practices at EAARI compared to Aktoprak. The significant location effect on the preweaning daily weight gain is in accordance with the results given by Freeden et al. (12).

S- and C-sired calves did not differ significantly in 205-day weights, but these calves were superior to progeny of EAR (Table 3). This result is consistent with the findings published by King et al. (8) and Newman et al. (11), who reported insignificant differences for adjusted weaning weight between S and C cross calves. Effects of location and location x sire breed interaction were significant. The superiority of calves reared in EAARI over those in Aktoprak could be due to the better feeding, care and housing conditions at the former. In particular, differences between the 2 locations regarding practices of management such as feeding plan, and housing conditions considerably affected 205-day weights of S- and C-sired calves compared with EAR-sired calves. This could be attributed to the higher resistance of EAR calves to the inappropriate raising conditions at Aktoprak compared to the calves of exotic breeds.

In conclusion, this study reveals that, among others, breed of sire had a significant effect on calving and preweaning growth characteristics. Although progeny of C and S sires were better than EAR calves in terms of all preweaning growth parameters, C- and S-sired calves performed similarly for most growth traits. Therefore, both C and S could be taken into consideration as sire breeds for crossbreeding programs to be implemented in Eastern Anatolia, since these breeds did not cause a detrimental effect on the calving and growth characteristics of the crossbred calves.

References

1. İlaslan, M.: Kars Karacaören köyünde yetiştirilen Doğu Anadolu Kırmızısı ile Simental x Doğu Anadolu Kırmızısı F1 ve G1 melezlerinin çeşitli özellikleri. Gazi Osman Paşa Universitesi, Tokat Ziraat Fakültesi (Uygulamalı Araştırma Raporu), Tokat. 1993.
2. Akbulut, Ö., Ulutaş, Z.: Doğu Anadolu Kırmızısı sığırlarda büyüme ve gelişme özellikleri. Hayvan. Araşt. Derg., 1994; 4: 107-109.
3. Bayındır, Ş.: Değişik yaştaki Doğu Anadolu sığırların semirme kabiliyetleri ve bazı kasaplık vasıfları ve bunlar arasındaki ilişkiler. Atatürk Üniversitesi Yayın No: 657, Erzurum. 1988.
4. Özhan, M., Tüzemen, N., Yanar, M.: Büyükbaş Hayvan Yetiştirme. Atatürk Üniversitesi, Ziraat Fakültesi Yayınları No: 134, Erzurum. 2004.

5. Freeden, H.T., Weiss, G.M., Rahnefeld, G.W., Lawson, J.E., Newman, J.A.: Environmental and genetic effects on preweaning performance of calves from first–cross cows. II. Growth traits. Can. J. Anim. Sci., 1982; 62: 51-67.

6. Rahnefeld, G.W., Weiss, G.M., Freeden, H.T., Lawson, J.E., Newman, J.A.: Genetic effects on postweaning growth of three-way cross beef cattle. Can. J. Anim. Sci., 1988; 68: 647-654.

7. Reynolds, W.L., Urick, J.J., Knapp, B.W.: Biological type effects on gestation length, calving traits and calf growth rate. J. Anim. Sci., 1990; 68: 630-639.

8. King, B.D., Petrocek, R.A., Cohen, R.D.H., Guenther, C.L.: The effect of breed of terminal sire on production of beef steers. Can. J. Anim. Sci., 1992; 72: 953-957.

9. Beef Improvement Federation: Guidelines for uniform beef improvement programs. Beef Improvement Federation, Sixth Ed., University of Georgia, Athens, GA. 1990.

10. Devore, J., Peck R.: Statistics, the exploration and analysis data. West Publishing Co., St Paul, MN. 1986.

11. Newman, J.A., Rahnefeld, G.W., Tong, A.K.V., Freeden, H.T.: Calving and preweaning performance of crossbred progeny of some foreign and domestic beef cattle breeds. Can. J. Anim. Sci., 1985; 65: 583-593.

12. Freeden, H.T., Weiss, G.M., Lawson, J.E., Newman, J.A., Rahnefeld, G.W.: Environmental and genetic effects on preweaning performance of calves from first–cross cows. I. Calving ease and preweaning mortality. Can. J. Anim. Sci., 1982; 62: 35-49.

13. Azzam, S.M., Nielsen, M.K.: Genetic parameters for gestation length, birth date and first breeding date in beef cattle. J. Anim. Sci., 1987; 64: 348-356.

14. Herring, A.D., Sanders, J.O., Knutson, R.E., Lunt, D.K.: Evaluation of F1 calves sired by Brahman, Borran and Tuli bulls for birth, growth, size and carcass characteristics. J. Anim. Sci., 1996; 74: 955-964.

15. Bailey, C.M., Moore, J.D.: Reproductive performance and birth characters of divergent breeds and crosses of beef cattle. J. Anim. Sci., 1980; 50: 645.

16. Southgate, J.R., Cook, G.L., Kempster, A.J.: A comparison of different breeds and crosses from the suckler herd. Anim. Prod., 1982; 35: 87-98.