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RESEARCH ARTICLE

The Effect of Non-Genetic Factors on the Linear Type Traits in Brown Swiss Cows Reared in the Eastern Region of Turkey

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ABSTRACT

The study was carried out to investigate the magnitude of non-genetic factors affecting linear type traits in Brown Swiss cattle. For this purpose, 474 observations for the 16 linear type traits on 135 cattle were made. Statistical model used in this research included fixed effects of herd, parity, scorer, stage of lactation, season at classification. Additionally, the age at classification was included to the model as linear and quadratic covariates. Average linear scores for chest width, body depth, angularity, foot angle, rear leg (side view), rear leg (rear view), rump angle, rump width, fore udder attachment, rear udder attachment width, rear udder attachment height, teat placement (rear view), teat placement (side view), teat length, central ligament and udder depth were 5.5±0.1, 6.1±0.1, 5.2±0.1, 4.7±0.1, 4.4±0.1, 4.4±0.1, 5.6±0.1, 5.0±0.1, 5.8±0.1, 5.4±0.1, 6.1±0.1, 5.1±0.1, 4.1±0.1, 5.8±0.1, 5.8±0.1, 6.6±0.1 respectively. Scorers did not have significant effect on all type traits except for the body depth and rear udder attachment width ($P<0.01$). On the other hand, herd, parity, stage of lactation as well as season at classification affected significantly most of the linear type traits. The linear and quadratic effects of age at classification on the most of linear type traits were also significant. Phenotypic correlations among the linear type traits were in low to medium range.

Doğu Anadolu Bölgesinde Yetiştirilen Esmer İneklerde Doğrusal Tip Özellikleri Üzerine Çevresel Faktörlerin Etkileri

ÖZ

Bu çalışma, Esmer sığırlarda linear tip özelliklerini etkileyen çevresel faktörlerin incelenmesi amacıyla yürütülmüştür. Bu amaçla, 135 sığırda 16 adet tip özelliğine ait 474 adet gözlem yapılmıştır. Araştırmada kullanılan istatistiksel modele sürü, laktasyon sırası, hakem, laktasyon dönemi, değerlendirmenin yapıldığı mevsimin etkileri dahil edildi. Ayrıca, değerlendirmenin yapıldığı dönemdeki ineğin yaşı da linear ve kuadratik kovariyet olarak modele ilave edildi. Göğüs genişliği, vücut derinliği, açısallık, arka bacak açısı, arka bacak (yandan görünüm), arka bacak (arkadan görünüm), sağrı eğimi, sağrı genişliği, ön meme bağlantısı, arkadan meme bağlantısı genişliği, arka meme bağlantısı yüksekliği, meme başı yerleşimi (arkadan görünüm), meme başı yerleşimi (yandan görünüm), meme başı uzunluğu, meme merkez bağı ve meme derinliğine ait ortalama doğrusal puanlar sırasıyla 5,5±0,1; 6,1±0,1; 5,.2±0,1; 4,7±0,1; 4,4±0,1; 4,4±0,1; 5,6±0,1; 5,0±0,1; 5,8±0,1; 5,4±0,1; 6,1±0,1; 5,1±0,1; 4,1±0,1; 5,8±0,1; 5,8±0,1; 6,6±0,1 dır. Vücut derinliği ve arkadan meme bağlantısı genişliği dışındaki bütün tip özellikleri üzerine hakemlerin etkisi önemsiz bulunmuştur. Öte yandan, sürü, laktasyon sırası, laktasyon dönemi ve değerlendirmenin yapıldığı mevsim bir çok doğrusal tip özelliklerini önemli derecede etkilemiştir. Değerlendirme sırasındaki yaşın bir çok doğrusal tip özellikleri üzerine linear ve kuadratik etkileri de önemli bulunmuştur. Doğrusal tip özellikleri arasındaki fenotipik korelasyonlar da düşükten orta dereceye kadar değişim göstermiştir.

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Introduction

In recent years, emphasis has changed from subjective grading methods for evaluating cattle to more objective methods such as linear type traits (Essien and Adesope, 2003). The type traits are body components of a cow which is related with milk production. The linear type traits have an influence on milk yield (Khan and Khan, 2016). They are utilized to define the dairyness of a cow and they are the basis of modern-day classification system (Dubey et al., 2014). The linear type traits are considered very important since the superiority in these traits usually helps to maintain a longer production life. They also assist the producer to identify and select phenotype in cows and bulls that would be high in reproduction and carcass yield (Mazza et al., 2013).

Measuring and assessing specific parts of each animal allow the cattle breeders to identify functional and structural weakness which are genetic and potential problems that will occur from inappropriate breeding practices. Additionally, using of the linear appraisal procedure lets the farmer select the correct body type to fit environmental conditions and production system that cattle will be expected to work in. Choosing of cattle with better type traits will also increase the strength of stamina of the animal for dairy production (Khan and Khan, 2015).

Non-genetic factors could be classified as factors with measurable effects such as parity, calving year, herds, the age of cow, calving season, stage of lactation etc., and factors with non-measurable effects, for example, infectious diseases, parasitic infestations etc. The measurable effects can be utilized in formulating the future livestock improvement programs (Javed et al., 2013). In these programs, performance records of animals should be adjusted for the environmental sources of variation in order to decrease known environmental differences between animals as well as to estimate accurately breeding values (Tuzemen et al., 2013).

Several non-genetic factors in linear type classification were reported by Esteves et al. (2004), Mazza et al. (2013), Khan and Khan (2015). Parity, scorer, age of cow at classification and stage of lactation are considered significant environmental factors affecting the linear type traits. On the other hand, the herd is also considered the most significant source of variation in assessment of the linear type traits. The quantification of the non-genetic factors is required for more accurate assessment of the linear type traits (Khan and Khan, 2015). Therefore, the present study was designed to find out the magnitude of non-genetic factors affecting linear type traits Brown Swiss cows reared in the Eastern Anatolian Region.

Material and Method

A total of 474 linear type scores obtained from 158 Brown Swiss cows which were reared in two farms (University farm vs. a private farm) were used for the present study. The linear scoring was made according to the guidelines of the International Committee for Animal Recording (ICAR, 2014). The farms were visited 3 times in a year and the cows were evaluated by 3 scorers. Sixteen traits were scored on a scale of 1-9. The definitions of linear type traits are presented in Table 1. Only lactating cows were scored in the afternoon prior to evening milking. Data regarding parity, age of birth, days in milk were obtained from records kept in these farms. Days in milk were divided into 6 stages of lactation that were 1(<2 months), 2 (2-<4 months), 3 (4-<6 months), 4 (6-<8 months), 5 (8-<10 months), 6 (>10 months). Seasons at classification were grouped into 4 classes (1:Winter, 2:Spring, 3:Summer, 4: Fall).

Table 1. Definition of the Linear Type Traits

Traits	Scores		
	1-3	4-6	7-9
Chest Width	Narrow	Intermediate	Wide
Body Depth	Shallow	Intermediate	Deep
Angularity	Lacks angularity	Intermediate	Very angular
Rump Angle	High pins	Intermediate	Extreme slope
Rump Width	Narrow	Intermediate	Wide
Rear Legs (Side View)	Straight	Intermediate	Sickle
Rear Legs (Rear View)	Extreme toe out	Intermediate	Parallel feet
Foot Angle	Very low angle	Intermediate	Very steep
Fore Udder Attachment	Weak and loose	Intermediate	Extremely strong and tight
Rear Udder Attachment Height	Very low	Intermediate	High
Central Ligament	Outside of quarter	Intermediate	Inside of quarter
Udder Depth	Below hock	Intermediate	Shallow
Teat placement (Rear View)	Outside of quarter	Middle of quarter	Inside of quarter
Teat placement (Side View)	Close	Intermediate	Apart
Teat Length	Short	Intermediate	Long
Rear Udder Attachment Width	Narrow	Intermediate	Wide

The data were analyzed by using the GLM of SPSS statistics program (SPSS, 2004). All data were analyzed by using univariate analysis of variance in the general linear model of SPSS. Different combination of fixed effects and interactions were fitted in the model. Since interaction effects were not significant in the initial analysis, they were excluded from the ultimate mathematical model. The final statistical model was assumed for evaluating the effects of scorer, parity, herds, season at classification and stage of lactation. The linear and quadratic effects of age at classification were also incorporated into the statistical model as covariant. The following statistical model was used;

$Y_{ijklmn}=\mu+a_i+b_j+c_k+d_l+f_m+b_1(g_{ijkl})+b_2(g_{ijkl})^2+e_{ijklmn}$

Where:

μ=Overall Mean

a_i=Effect of i^{th} herd (1-3)

b_j=Effect of j^{th} parity (1-5)

c_k=Effect of k^{th} stage of lactation (1-6)

d_l=Effect of l^{th} scorer (1-3)

f_m=Effect of m^{th} season at classification (1-4)

g_{ijkl}=Age of cows at classification

b_1 and b_2=The linear and quadratic regression coefficients of trait on age of cows at classification

e_{ijklmn}=Random error.

The method of LSD multiple range test was used for comparison among subclass means. Correlations among the linear type traits were also calculated by SPSS program (SPSS, 2004).

Results and Discussion

Least square means along with their standard errors and level of significance of linearly scored type traits for two herds are presented in Table 1, 2 and 3. Herd effects were highly significant (P<0.01) for chest width, body depth, rear leg (side view), rear leg (rear view), teat placement (rear view), udder depth and rear udder attachment width. Teat length and central ligament were also different across herds (P<0.05), but the herd was not a significant source of variation for rear udder attachment height, teat placement (side view), rump angle, rump width, fore udder attachment, angularity and foot angle. The herd difference in type traits indicates differences in feeding, management and housing at two farms. Although climatic conditions at the farms were not very different, housing facilities as well as green fodder and feed availability at the University farm were better for lactating cows. Feed and fodder availability might influence udder development and consequently udder associated linear type traits.

There are several studies indicating herd differences in linear type traits. Khan and Khan (2015) reported significant herd effects on chest width, body depth, angularity, rump angle, rump width, rear legs set, rear legs rear view, foot angle, rear udder height, central ligament, udder depth, fore teat length and rear udder width in Sahiwal cows. Large herd effects for stature and rear udder width in Ayrshire, and for udder depth of Shorthorn and for most linear traits of Jersey cows were in agreement with findings of the present study (Norman et al. 1983). Significant influence of the herds for all type traits with a few exceptions as for this study was noted by Mazza et al. (2013) for Valdostana cattle. Additionally, important herd differences for most of the traits that were revealed the current study were also in accordance with results of Theron and Mostert (2004) who reported a strong effect of herds on linear type traits of Holstein and Jersey cows.

Least square means along with standard deviations and level of significance of linear type traits for different parities are tabulated in Table 1, 2, and 3.

Table 2. Least squares means and standard error of the mean and results of multiple comparison test for linear type traits of Brown Swiss cattle

		Chest Width	Body Depth	Angularity	Foot Angle	Rear Leg (Side View)
	N	Mean±SEM	Mean±SEM	Mean±SEM	Mean±SEM	Mean±SEM
General	474	5.5±0.1	6.1±0.1	5.2±0.1	4.7±0.1	4.4±0.1
Herds		**	**	NS	NS	**
1	117	5.9±0.2	6.4±0.1	5.0±0.2	4.7±0.2	4.1±0.2
2	357	5.2±0.1	5.8±0.1	5.3±0.1	4.6±0.1	4.8±0.1
Scorer		NS	**	NS	NS	NS
1	158	5.7±0.1	6.3±0.1 [a]	5.1±0.1	4.8±0.2	4.5±0.1
2	158	5.5±0.1	6.0±0.1 [b]	5.4±0.1	4.6±0.2	4.3±0.1
3	158	5.5±0.1	5.9±0.1 [b]	5.0±0.1	4.6±0.2	4.5±0.1

Table 2 (continued)

Parity		**	*	*	NS	NS
1	150	5.8±0.2[a]	5.9±0.2[b]	5.0±0.2[b]	4.2±0.3	4.3±0.2
2	60	6.0±0.2[a]	6.2±0.2[a]	5.2±0.2[b]	4.5±0.3	4.2±0.2
3	96	5.8±0.1[a]	6.1±0.1[a]	4.9±0.2[b]	4.7±0.2	4.7±0.2
4	81	5.3±0.1[b]	6.4±0.1[a]	5.1±0.2[b]	5.1±0.2	4.6±0.2
5	87	4.8±0.1[c]	5.9±0.1[b]	5.7±0.2[a]	4.8±0.2	4.4±0.2
Stage of lactation		**	*	*	NS	NS
1	99	5.7±0.1[a]	6.1±0.1[a]	5.3±0.2[a]	4.7±0.2	4.6±0.2
2	63	6.2±0.2[c]	6.1±0.2[a]	4.8±0.2[b]	5.1±0.2	4.4±0.2
3	99	5.4±0.2[a]	6.2±0.2[a]	5.1±0.2[a]	4.6±0.2	4.3±0.2
4	66	4.9±0.2[b]	5.8±0.2[b]	5.2±0.2[a]	4.7±0.3	4.3±0.2
5	24	5.4±0.2[a]	5.9±0.2[a]	5.1±0.3[a]	4.2±0.4	4.4±0.3
6	123	5.7±0.1[a]	6.3±0.1[a]	5.6±0.1[a]	4.7±0.2	4.6±0.1
Season at classification		**	**	NS	NS	**
1	141	5.0±0.1[a]	5.4±0.1[b]	5.3±0.2	4.8±0.2	4.7±0.1[a]
2	114	5.1±0.2[a]	5.9±0.2[a]	5.0±0.2	4.2±0.3	4.0±0.2[c]
3	90	6.3±0.1[b]	6.2±0.1[a]	5.0±0.2	4.9±0.2	4.4±0.2[b]
4	129	5.8±0.1[c]	6.8±0.1[c]	5.4±0.2	4.8±0.2	4.7±0.1[a]
Age at classification						
Linear		**	**	**	*	NS
Quadratic		**	**	**	*	NS

SEM: Standard Error of the Mean, NS: Non-significant, * : (P<0.05), ** : (P<0.01).

Table 3. Least squares means and standard error of the mean and results of multiple comparison test for linear type traits of Brown Swiss cows

		Rear leg (rear view)	**Rump angle**	**Rump width**	**Fore udder attachment,**	**Rear udder attachment width**
	N	Mean±SEM	Mean±SEM	Mean±SEM	Mean±SEM	Mean±SEM
General	474	4.4±0.1	5.6±0.1	5.0±0.1	5.8±0.1	5.4±0.1
Herds		**	NS	NS	NS	**
1	117	4.7±0.2	5.8±0.2	5.2±0.2	6.0±0.3	6.0±0.2
2	357	4.1±0.1	5.4±0.1	4.8±0.1	5.6±0.1	4.7±0.1
Scorer		NS	NS	NS	NS	**
1	158	4.4±0.1	5.6±0.1	5.0±0.1	5.9±0.2	5.5±0.1[b]
2	158	4.4±0.1	5.6±0.1	5.0±0.1	5.7±0.2	5.2±0.1[a]
3	158	4.4±0.1	5.6±0.1	4.9±0.1	5.7±0.2	5.3±0.1[a]
Parity		**	NS	NS	**	**
1	150	4.5±0.2[b]	5.5±0.2	5.1±0.2	6.3±0.3[a]	6.0±0.2[a]
2	60	4.6±0.2[b]	5.9±0.2	5.0±0.2	6.2±0.3[a]	5.4±0.2[b]
3	96	4.9±0.1[a]	5.5±0.1	5.2±0.1	5.4±0.2[b]	5.5±0.2[b]
4	81	4.0±0.1[c]	5.6±0.2	4.8±0.1	5.0±0.2[c]	5.3±0.2[b]
5	87	4.0±0.1[c]	5.6±0.2	4.8±0.1	5.8±0.2[ab]	4.6±0.2[c]
Stage of lactation		**	NS	*	*	**
1	99	4.6±0.1[a]	5.6±0.1	5.1±0.1[ab]	5.4±0.2[b]	6.0±0.2[a]
2	63	4.8±0.2[a]	5.8±0.2	5.4±0.2[a]	5.9±0.3[ab]	5.8±0.2[a]
3	99	4.3±0.2[b]	5.6±0.2	5.0±0.2[ab]	5.3±0.3[b]	5.0±0.2[b]
4	66	3.9±0.2[b]	5.4±0.2	4.8±0.2[b]	5.8±0.3[ab]	4.8±0.2[b]
5	24	4.5±0.2[a]	5.9±0.3	4.8±0.2[b]	6.5±0.4[a]	5.4±0.3[a]
6	123	4.2±0.1[b]	5.4±0.1	4.8±0.1[b]	5.6±0.2[b]	5.2±0.1[b]
Season at classification		NS	*	**	*	**
1	141	4.4±0.1	5.5±0.1[b]	5.1±0.1[a]	5.9±0.2[b]	5.1±0.2[b]
2	114	4.2±0.2	5.6±0.2[b]	4.4±0.2[b]	5.9±0.3[b]	6.3±0.2[a]
3	90	4.6±0.1	5.4±0.2[b]	5.3±0.1[a]	6.0±0.2[b]	5.3±0.2[b]
4	129	4.3±0.1	5.9±0.1[a]	5.2±0.1[a]	5.3±0.2[a]	4.6±0.2[c]
Age at classification						
Linear		NS	NS	**	**	**
Quadratic		NS	NS	**	**	**

SEM: Standard Error of the Mean, NS: Non-significant, * : (P<0.05), ** : (P<0.01).

Table 4. Least squares means and standard error of the mean and results of multiple comparison test for linear type traits of Brown Swiss

		Rear udder attachment height	Teat placement (rear view)	Teat placement (side view)	Teat length	Central Ligament	Udder depth
	N	Mean±SEM	Mean±SEM	Mean±SEM	Mean±SEM	Mean±SEM	Mean±SEM
General	474	6.1±0.1	5.1±0.1	4.1±0.1	5.8±0.1	5.8±0.1	6.6±0.1
Herds		NS	**	NS	*	*	**
1	117	6.0±0.2	4.7±0.2	4.0±0.2	5.6±0.2	6.1±0.2	7.0±0.2
2	357	6.1±0.1	5.4±0.1	4.3±0.1	6.1±0.1	5.5±0.1	6.2±0.1
Scorer		NS	NS	NS	NS	NS	NS
1	158	6.0±0.1	5.1±0.1	4.1±0.1	5.9±0.1	5.8±0.1	6.6±0.1
2	158	6.2±0.1	5.0±0.1	4.1±0.1	5.9±0.1	5.8±0.1	6.7±0.1
3	158	6.1±0.1	5.1±0.1	4.2±0.1	5.7±0.1	5.8±0.1	6.5±0.1
Parity		*	NS	**	**	NS	**
1	150	6.2 ± 0.2^{ab}	4.8±0.2	3.7 ± 0.2^{b}	5.6 ± 0.2^{c}	6.0±0.2	7.2 ± 0.2^{a}
2	60	5.7 ± 0.2^{c}	5.1±0.2	3.8 ± 0.2^{b}	6.0 ± 0.2^{ab}	5.7±0.2	6.8 ± 0.2^{b}
3	96	6.0 ± 0.1^{bc}	5.0±0.1	5.0 ± 0.2^{a}	5.7 ± 0.1^{c}	6.0±0.2	6.4 ± 0.1^{c}
4	81	6.2 ± 0.2^{ab}	5.1±0.1	4.6 ± 0.2^{a}	6.2 ± 0.1^{a}	5.5±0.2	5.8 ± 0.2^{d}
5	87	6.4 ± 0.2^{a}	5.2±0.2	3.6 ± 0.2^{b}	5.7 ± 0.1^{bc}	5.8±0.2	6.9 ± 0.2^{b}
Stage of lactation		**	*	**	**	*	**
1	99	6.5 ± 0.2^{a}	5.2 ± 0.1^{a}	4.8 ± 0.2^{a}	5.9 ± 0.1^{bc}	6.0 ± 0.2^{a}	6.3 ± 0.1^{c}
2	63	6.3 ± 0.2^{ab}	5.0 ± 0.2^{ab}	4.4 ± 0.2^{b}	6.4 ± 0.2^{a}	6.0 ± 0.2^{a}	6.1 ± 0.2^{c}
3	99	6.2 ± 0.2^{ab}	5.0 ± 0.2^{ab}	3.9 ± 0.2^{b}	6.0 ± 0.2^{b}	6.1 ± 0.2^{a}	6.6 ± 0.2^{b}
4	66	5.9 ± 0.2^{bc}	5.4 ± 0.2^{a}	3.4 ± 0.2^{c}	5.6 ± 0.2^{c}	5.5 ± 0.2^{b}	7.1 ± 0.2^{a}
5	24	5.8 ± 0.3^{c}	5.1 ± 0.3^{ab}	4.2 ± 0.3^{b}	5.3 ± 0.2^{d}	5.0 ± 0.3^{c}	7.1 ± 0.3^{a}
6	123	5.8 ± 0.1^{bc}	4.7 ± 0.1^{b}	4.2 ± 0.1^{b}	6.0 ± 0.1^{b}	6.1 ± 0.1^{a}	7.3 ± 0.1^{a}
Season at classification		**	NS	**	NS	NS	**
1	141	5.7 ± 0.1^{a}	5.0±0.1	3.9 ± 0.1^{b}	5.7±0.1	5.8±0.2	6.9 ± 0.1^{a}
2	114	6.7 ± 0.2^{c}	5.0±0.2	3.7 ± 0.2^{b}	5.9±0.2	5.8±0.2	6.0 ± 0.2^{b}
3	90	6.2 ± 0.2^{b}	4.9±0.1	4.5 ± 0.2^{a}	5.8±0.1	5.9±0.2	6.7 ± 0.2^{a}
4	129	5.7 ± 0.1^{a}	5.3±0.1	4.4 ± 0.1^{a}	6.0±0.1	5.7±0.2	6.8 ± 0.1^{a}
Age at classification							
Linear		NS	NS	NS	**	NS	**
Quadratic		NS	NS	NS	**	NS	**

SEM: Standard Error of the Mean. NS: Non-significant. * : (P<0.05). ** : (P<0.01).

Parity effects were highly significant (P<0.01) for chest width, rear leg (rear view), fore udder attachment, rear udder attachment width, teat placement (side view), teat length and udder depth. Body depth, angularity, rear udder attachment height were also significantly (P<0.05) influenced by the parities. Findings of current study for significant effects of parity for chest width, body depth, angularity, rear leg (rear view), fore udder attachment and teat length were in agreement with findings of Khan and Khan (2015). Significant influences of the parity on udder depth, fore udder attachment, rear udder height, rear udder width of Chinese Holstein were in consensus to results of the current study (Liu et al., 2014). In addition, non-significant effect of the parity on rump width reported by Vij et al., (1990) was in accordance with finding of the present study. Findings of the current study for significant effects of parity on rear udder attachment height, udder depth, rear legs (rear view), teat placement (side view) and teat length were also in harmony with results of Yanar (1999).

Least square means along with standard deviations and level of significance of linear type traits for different stage of lactation are presented in Table 1, 2, and 3. Chest width, rear udder attachment height, teat placement (side view), teat length, udder depth, rear leg (rear view) and rear udder attachment width were highly significantly (P<0.01) affected by the stage of lactation while stage of lactation effects was significant (P<0.05) for body depth, angularity, rump width, fore udder attachment, teat placement (rear view) and central ligament. Increase in udder depth score in later stages of lactation was in agreement with findings of Smith et al., (1985) and Khan and Khan (2015). Significant stage of lactation effect on body depth, fore udder attachment, rear udder attachment height, udder depth, teat placement (side view) were in accordance with findings of a study that was carried out on Valdostana cattle by Mazza et al., (2013) in Italy. Stage of lactation effect on chest width, central ligament and udder depth were in agreement with results of Dahiya (2005a) for Hariana cattle. Significant stage of lactation effects for rump width, rear udder attachment height and udder depth in the present study were in consensus to those reported by Dahiya (2005b) for Sahiwal cows. Significant effect of stage of

lactation on udder depth was also in harmony with finding of Vij et al., (1990). As for this study, stage of lactation was also important source of variation for most of type traits of Brazilian Holstein cattle (Esteves et al., 2004).

Least square means along with standard deviations and level of significance of linear type traits for different scorers are given in Table 1, 2, and 3. Non-significant effects of scorers on the all linear type traits except for body depth and rear udder attachment width were in consensus to those reported by Yanar (1999). In other words, the scorers in the present study were not important source of variation for most of linear type traits. The result could be attributed to the employing expert scorers on the linear type traits assessment.

Least square means along with standard deviations and level of significance of linear type traits for different seasons at classification are presented in Table 1, 2, and 3. Highly significant ($P<0.01$) effects of season at classification for body depth, rear leg (side view), rump width, rear udder attachment width, rear udder attachment height, teat placement (side view) and udder depth were determined in this study. Rump angle and fore udder attachment were also significantly ($P<0.05$) affected by season at classification.

Age at classification effect was apparent for all the linear type traits of Brown Swiss cows except for rear leg (side view), rear leg (rear view), rump angle, rear udder attachment height, teat placement (rear view), teat placement (side view) and central ligament. Age of cows at classification had significant ($P<0.01$) linear and quadratic effects on chest width, body depth, teat length, udder depth, angularity, rump width, foot angle, fore udder attachment, rear udder attachment width. As for this study, linear scores of Sahiwal cows increased with advancement in age of cow at classification for chest width, body depth, angularity, rump width and teat length (Khan and Khan, 2015). Highly significant effect of age at classification on growth and size related traits such as chest width, body depth, angularity, rump width could be due to actual biological development of the animals. Growth associated traits change considerably with advancement in age (Vij et al., 1990). Significant effect of age of animal at classification were in agreement with the findings of the current study (Dubey et al., 2014).

Phenotypic correlations among body and feet and leg traits were in low to medium range as reported by (Khan et al., 2008). Correlations ranged from 0.37 between body depth and chest width to -0.46 between udder depth and teat length (Table 4). Correlations among udder traits had negative signs, and the phenotypic correlation was -0.35 between udder depth and rear udder attachment width and -0.38 between teat placement (side view) and fore udder attachment. Correlations of udder depth with fore udder attachment (0.60), rear udder attachment height (-0.10), teat placement (rear view) (0.18), teat placement (side view) (-0.36), teat length (-0.46) were statistically significant. The result was in accordance with the findings of Brotherstone (1994). Teat length possessed negative significant phenotypic correlations with angularity (-0.18), foot angle (-0,10) and fore udder attachment (-0.18). Similar results were already reported by Yanar (1999). Rear udder attachment width was negatively correlated with angularity (-0.18), rear leg (side view) (-0.15), rump angle (-0.18), fore udder attachment (-0.13) (Table 4). As for this study, negative and low correlation values among rear udder attachment width with angularity, rear leg (side view), rump angle, and fore udder attachment was also indicated by Khan et al., (2008) in Sahiwal cows.

Conclusions

The results of this study showed considerable effects of the non-genetic factors on linear type traits of Brown Swiss cows reared Eastern region of Turkey. While herd, parity, stage of lactation as well as season at classification were main environmental factors affected the variation for the type traits, the effects of scorers were limited. Linear and quadratic effects of age of cows at classification were also highly significant for most of the type traits. In livestock improvement programs that will be carried on linear type traits of Brown Swiss cows, the performance records of the animals have to be adjusted for the significant environmental sources of variation in order to decrease known environmental differences between animals as well as to estimate accurately breeding values.

Table 5. Phenotypic correlations among type traits of Brown Swiss cattle

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Chest Width (1)		0.37**	-0.14**	0.02	-0.07	0.18**	0.07	0.19**	-0.12*	0.03	-0.19**	-0.08	0.05	0.02	0.09	-0.11*
Body Depth (2)	0.04		-0.25**	-0.02	-0.06	0.05	0.07	0.21**	-0.26**	0.04	-0.26**	-0.12*	0.15**	0.22**	0.04	-0.29**
Angularity (3)	0.05	0.05		0.01	0.15**	-0.17**	0.06	-0.05	0.11*	-0.18**	-0.02	0.03	-0.07	-0.18**	0.03	0.26**
Foot Angle (4)	0.05	0.05	0.05		-0.02	0.04	-0.05	0.11*	0.11*	-0.05	-0.05	0.02	-0.01	-0.10*	0.12**	0.11*
Rear Leg (Side View) (5)	0.05	0.05	0.05	0.05		-0.17**	0.03	0.08	0.08	-0.15**	-0.11*	0.06	0.08	0.04	0.06	0.06
Rear leg (rear view) (6)	0.05	0.05	0.05	0.05	0.05		0.07	0.08	-0.15**	0.09	0.08	-0.09	0.12**	0.02	0.10*	-0.08
Rump angle (7)	0.05	0.05	0.05	0.05	0.05	0.05		0.00	-0.01	-0.18**	0.01	-0.22**	-0.01	0.02	-0.01	0.03
Rump width (8)	0.05	0.05	0.05	0.05	0.05	0.05	0.05		-0.13**	0.07	-0.14**	-0.15**	0.10*	0.04	0.20**	-0.02
Fore udder attachment (9)	0.05	0.04	0.05	0.05	0.05	0.05	0.05	0.05		-0.13**	-0.02	0.13**	-0.38**	-0.18**	0.08	0.60**
Rear udder attachment width (10)	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.05	0.05		0.23**	-0.08	0.13**	0.029	0.023	-0.351**
Rear udder attachment height (11)	0.05	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05		0.14**	-0.01	-0.02	-0.00	-0.10*
Teat placement (rear view) (12)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05		0	-0.05	0.03	0.18**
Teat placement (side view) (13)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.05	0.05	0.05		0.07	0.067	-0.36**
Teat length (14)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05		0.11*	-0.46**
Suspensory Ligament (15)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05		0.02
Udder depth (16)	0.05	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.05	0.05	0.04	0.04	0.05	

* Correlation is significant at the 0.05 level. ** Correlation is significant at the 0.01 level. Phenotypic correlations (above diagonal) and standard errors below diagonal.

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