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Seasonal and Periodical Rhythmicity of Economic Traits and Various Genetic Parameter Analysis in Sahiwal Cows Under Sub-Tropical Environment

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ABSTRACT

The immediate response of animals to fluctuations in any managemental practices or environmental temperature is an alteration in their physiological responses. For those who failed to deal with, their production performance is affected to a great extent. In the present investigation, seasonal and periodical rhythmicity of economic traits and genetic parameters analysis for growth and first lactation traits of Sahiwal cows were performed. Analysis of variance revealed significant effect of period on all growth traits ($P \leq 0.01$) and first lactation traits under investigation. Effect of season of birth was significant ($P \leq 0.05$) on W6, W12, W18 and W24 whereas BW, W30 and WFC were not significantly affected. Furthermore, season effect was found to be non significant on different first lactation traits except FCI ($P \leq 0.05$). The estimates of heritability for BW, W6, W12, W18, W24, W30, WFC, AFC, FL305DMY, FLL, FCI and FSP were 0.12 ± 0.28, 0.67 ± 0.34, 0.49 ± 0.33, 0.19 ± 0.29, 0.19 ± 0.30, 0.42 ± 0.32, 0.43 ± 0.22, 0.11 ± 0.09, 0.26 ± 0.11, 0.09 ± 0.02, 0.02 ± 0.05 and 0.03 ± 0.03 respectively. The genetic and phenotypic correlations amongst most of the growth and first lactation traits were higher in magnitude. Therefore these results indicated that genetic associations and effect of environmental variations could be effective for formulating selection criteria on the basis of early expressed economic traits in Sahiwal cattle.

HIGHLIGHTS

- Analysis of variance revealed significant effect of period on all growth traits ($P \leq 0.01$) and first lactation traits.
- The genetic and phenotypic correlations amongst most of the body weight and first lactation traits were higher in magnitude.

Keywords: Non genetic factors, Sahiwal cow, first lactation traits, heritability

An alteration in physiological responses is the immediate response of animals to fluctuations in environmental temperature or managemental practices. For those who failed to cope, their production performance is affected greatly (Mohapatra *et al.* 2018). The profitability of a dairy enterprise depends mainly on animal productivity which can be enhanced by selecting the animals as early as possible on the basis of early growth traits, different first lactation traits that can be used as selection criteria for future. The evaluation of animals in terms of growth and production performance traits along with certain seasonal and periodical rhythmicity of favoured traits that is essential to formulate breeding and selection strategies. Various season or period of birth affects growth traits and expression of actual genetic worth which has not easily been understood till date (Rahman *et al.*, 2015). The growth traits of calves under tropical condition are affected by the genotype of the calf, season of birth, age of the dam and feeding and management condition. Environment has an important role not only on the productive performance but also on the reproductive efficiency of the dairy animals. Both production and reproduction traits are low to moderately heritable in dairy animals, which indicates that the major part of variation in these economic traits is

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governed by environmental factors that can be minimized by efficient managerial practices (Savaliya *et al*. 2016).

The weight of the newly born calf is one of the first characteristics of an animal that can be easily measured and is of great importance to breeder and livestock owner in understanding the health status of the new born as well as of its dam. It also gives a good indication of the subsequent development. Birth weight reflects prenatal growth and survivability of the calf. Growth from birth to maturity is of great economic significance and at equal production level smaller and lighter cows become more profitable than larger and heavier cows due to reduced feed and housing costs (Gandhi and Kumar, 2014) and prediction of first lactation traits on the basis of body weights at early ages can enhance the genetic gain by lowering generation interval. The birth weight, weight at different periods, growth rate and other early expressed traits of animal are an expression of its genotype and environmental combination. Knowledge of genetic parameters for economic traits is essential for planning breeding strategies under specific production environment, genetic evaluation of animals and for prediction of response to selection (Rahman *et al.,* 2015). Thus, heritability estimation of growth and first lactation traits is an important parameter to estimate the genetic merit of animals and is required to design the animal breeding programme (Gandhi and Kumar, 2014). Therefore, the present study was initiated to evaluate the effect of different seasons and periods and to estimate various genetic parameters on growth and first lactation traits of Sahiwal cows under sub tropical region of India.

MATERIALS AND METHODS

Experimental animals and study area

The present study was conducted on Sahiwal (N = 314) cows that have attained first calving maintained at Livestock Research Centre, ICAR-National Dairy Research Institute, Karnal (Haryana), India, during 2016–2017. The experimental animals were housed under loose housing system. The feeding management practices and feed ingredients were same for all animals in the herd. Limited concentrates and ad libitum green fodders were provided to meet the nutrient requirement of the animals.

Data collection for different variables

The different traits body weight at different age i. e. Birth, 6 Months (6M), 12 Months (12M), 18 Months (18M), 24 Months (24M), 30 Months (30M), Weight at First Calving (WFC), were considered for study. The records were classified into four periods P1 (2001-2004); P2 (2005-2008); P3 (2009-20102); P4 (2013-2017). Each year was divided into the four seasons viz. like S1: winter (December-March), S2: summer (April-June), S3: rainy (July-September), and S4: autumn (October -November). These data were collected from birth register and history-cum-pedigree sheets maintained in the Livestock record unit of Animal Genetics and Breeding Division and Livestock Research Centre, ICAR- National Dairy Research Institute, Karnal.

The data on birth weight and age at first caving were classified into different groups based on the following Sturge's formula (1926).

$$C = R / [1 + 3.322 \log_{10} N]$$

Where,

$[1 + 3.322 \log_{10} N]$	=	Number of classes
N	=	Number of observations
R	=	Range (maximum-minimum)
C	=	Width of each class

STATISTICAL ANALYSIS

The descriptive analysis for mean, standard error and coefficients of variation of all traits were carried out by using standard statistical procedures (Snedecor and Cochran, 1994). The data were subjected to least-squares analysis of variance using the technique described by Harvey (1990) for unequal and non-orthogonal data to study effect of non-genetic factors. The model was used with assumptions that different components being fitted into the model are linear, independent and additive. The statistical models used for different traits were as follows:

For Birth Weight

$$Y_{ijk} = \mu + S_i + P_j + e_{ijk}$$

where,

Y_{ijk} = Birth weight of k^{th} born in i^{th} season and j^{th} period
m = Overall population mean
S_i = Effect of i^{th} season of birth (i = 1 – 4)
P_j = Effect of j^{th} period of birth (j =1 – 4)
e_{ijk} = Random error, assumed to be normally and independently distributed with mean zero and constant variance *i.e*. NID (0, σ 2*e*).

For other Body Weights

$$Y_{ijk} = \mu + S_i + P_j + b_{zx} (Z_{ijk} – Z) + e_{ijk}$$

where,

Y_{ijk} = Body Weight of k^{th} cow born in i^{th} season and j^{th} period
μ = Overall population mean
S_i = Effect of i^{th} season of birth (i = 1 – 4)
P_j = Effect of j^{th} period of birth (j =1 – 4)
Z_{ijk} = Birth weight to be taken as a co variable with other body weights used in the model
Z = Average birth weight of the herd
b_{zx} = Regression of body weight under study on birth weight
e_{ijk} = Random error, assumed to be normally and independently distributed with mean zero and constant variance *i.e*. NID (0, σ 2*e*)

For Age at First Calving

$$Y_{ijk} = \mu + S_i + P_j + e_{ijk}$$

Where,

Y_{ijk} = AFC of k^{th} cow born in i^{th} season and j^{th} period
μ = Overall population mean
S_i = Effect of i^{th} season of birth (i = 1 – 4)
P_j = Effect of j^{th} period of birth (j = 1 – 4)
e_{ijk} = Random error, assumed to be normally and independently distributed with mean zero and constant variance *i.e*. NID (0, σ 2*e*)

For other First Lactation Traits

$$Y_{ijk} = \mu + S_i + P_j + b_{zx} (Z_{ijk} – Z) + e_{ijk}$$

Where,

Y_{ijk} = First lactation trait of k^{th} cow calved in i^{th} season and j^{th} period
μ = Overall population mean
S_i = Effect of i^{th} season of calving (i = 1 – 4)
P_j = Effect of j^{th} period of calving (j =1 – 4)
Z_{ijk} = *AFC* to be taken as a co variable with other first lactation traits used in the model
Z = Average *AFC* of the herd
b_{zx} = Regression of first lactation trait under study on *AFC*
e_{ijk} = Random error, assumed to be normally and independently distributed with mean zero and constant variance *i.e*. NID (0, σ 2*e*)

Prior to estimation of genetic parameters, the data were adjusted for different significant non genetic factors and the adjusted records were used for subsequent analysis. The heritability, genetic and phenotypic correlations were estimated only from those progeny groups of sires having a minimum of five daughters. Paternal half-sib correlation (intrasire correlation among daughters) method was used to estimate heritability of different traits. The genetic and phenotypic correlations among different body weights and first lactation traits were estimated from the analysis of variance and covariance among sire groups as given by Becker (1975).

RESULTS AND DISCUSSION

The overall least squares means for different body weights and first lactation traits were 19.49 ± 0.15 kg, 80.11 ± 1.39 kg, 129.01 ± 2.01 kg, 193.15 ± 2.53 kg, 250.25 ± 3.05 kg, 297.93 ± 3.35 kg, 282.04 ± 3.28 kg, 352.42 ± 3.62 kg for birth, 6M, 12M, 18M, 24M, 30M and WFC (Table 3), 1176.89 ± 15.45 days, 1812.06 ± 64.24 kg, 312.13 ± 8.05 days, 463.59 ± 9.88 days and 182.28 ± 10.02 days (Table 4) for AFC, FL305DMY, FLL, FCI and FSP respectively.

Effect of non-genetic factors

Analysis of variance revealed highly significant effect (P ≤ 0.01) of period of birth on all the different growth traits under investigation (Table 1). In accordance with this study, Gandhi and Kumar (2014) and Manoj *et al.* (2014) also observed highly significant effect of period of birth on all the different growth traits in Sahiwal calves. Effect of season of birth was significant (P ≤ 0.05) on W6, W12, W18 and W24 whereas BW, W30 and WFC were not significantly affected by season of birth (Table 1). Our findings were in agreement with the findings of Manoj *et*

Table 1: Least Squares Analysis of Variance (M. S values) for various body weights at different age in Sahiwal cattle

Source of variation	Season	Period	Regression on birth wt	Residual	R^2 Value (%)
Birth wt	12.81	22.39**		5.90	6.66
6M wt	787.27*	1673.14**	2502.89**	207.14	18.62
12Mwt	1255.51*	8542.79**	2457.50**	435.56	34.28
18M wt	2848.07*	18108.58**	7885.86**	586.79	37.50
24M wt	2776.16*	21864.89**	15883.24**	700.66	33.34
30M wt	817.22	22452.30**	25674.92**	1108.14	37.76
WFC	1162.25	26675.41**	45621.67**	1209	47.20

** $P \leq 0.01$, *$P \leq 0.05$.

Table 2: Least squares analysis of variance (Mean squares only) for different FLTs in Sahiwal cattle

Traits	Season	Period	Regression on AFC	Residual	R^2 value (%)
AFC	1740.19	297059.52**		15603.05	22.92
FL305DMY	391231.39	2220923.59*	2562252.2**	385868.59	15.75
FLL	6095.90	9133.37*	1014.66	6646.41	12.86
FCI	3597.42*	7932.57**	15546.28	5812.05	12.08
FSP	5374.91	15920.99**	12479.58	8164.57	15.69

** $P \leq 0.01$, *$P \leq 0.05$.

al. (2014). Contrary to present finding Singh *et al.* (2011) reported significant influence of season on birth weight in Sahiwal calves. Heifers born of rainy and autumn season had higher body weights at different ages over the heifers born of other two seasons. Though non significant, the heifers born during autumn season had higher and heaviest body weight (357.94 ± 7.08 kg) at age of first calving. The exposure of autumn born calves to favourable winter season during initial phase of life would have attributed to higher growth rate during first six months of their age leading to healthy foundation health. Summer born calves were exposed to hot humid rainy season not favorable for higher growth rate. The least squares analysis of variance showed highly significant ($P \leq 0.01$) regression of body weights at 6M, 12M, 18M, 24M, 30M of age and first calving on birth weight in Sahiwal cows. Effect of various non genetic factors on first lactation traits is presented in Table 2. Analysis of variance revealed significant effect ($P \leq 0.01$) of period on all the first lactation traits under investigation. This was in conformity with the findings of Kumar and Gandhi (2011), Manoj *et al.* (2012), and Raja and Gandhi (2015). Contrary to present findings Kathiravan *et al.* (2009), Narwaria *et al.* (2015) and Praveen (2016) reported non significant effect of period on FCI and FSP. Effect of season of calving was found to be non significant on different first lactation traits expect FCI ($P \leq 0.05$). Similar to our findings Kumar and Gandhi (2011) and Manoj *et al.* (2012) reported non significant effect of season of calving on first lactation traits. On the other hand Narwaria *et al.* (2015) observed significant effect of season on different first lactation traits under investigation. Animals calved during summer season had lower FL305DMY than those calved during rainy and autumn season had highest FL305DMY, though no significant differences were found out in milk yield. It can be assumed that low milk yield in the summer was found out because of temperature stress during the summer season. The regression of FL305DMY on age at first calving was found to be statistically highly significant ($P < 0.01$) in Sahiwal cattle for overall data.

Heritability, genetic and phenotypic correlation

The estimation of genetic parameters is an essential part of animal breeding as they estimate gene transmission from one generation to the next. It helps to select superior

Table 3: Least Squares Mean and SE for weight at Birth, 6, 12, 18, 24, 30 months and WFC in Sahiwal cattle

Over all	N	BW(kg)	6M wt (kg)	12M wt (kg)	18M wt (kg)	24M wt (kg)	30M wt (kg)	WFC (kg)
	314	19.49 ± 0.15	80.11 ± 1.39	129.01 ± 2.01	193.15 ± 2.53	250.25 ± 3.05	297.93 ± 3.35	352.42 ± 3.62
Season								
Winter	130	19.98 ± 0.21	81.00^{b} ± 1.79	126.74^{a} ± 2.60	193.27^{b} ± 3.27	241.97^{a} ± 3.94	299.76 ± 4.33	349.12 ± 4.68
Summer	93	19.62 ± 0.25	76.81^{a} ± 1.79	130.33^{c} ± 2.60	188.75^{a} ± 3.26	250.33^{b} ± 3.94	293.91 ± 4.33	347.90 ± 4.68
Rainy	60	19.04 ± 0.31	79.09^{b} ± 2.16	129.46^{b} ± 3.13	195.05^{c} ± 3.93	254.23^{c} ± 4.75	296.35 ± 5.21	354.74 ± 5.63
Autumn	31	19.33 ± 0.43	83.55^{c} ± 2.71	129.50^{b} ± 3.94	195.52^{c} ± 4.94	254.47^{c} ± 5.97	301.68 ± 6.56	357.94 ± 7.08
Period								
2001-2004	70	19.97^{a} ± 0.29	80.16^{b} ± 2.03	137.02^{b} ± 2.95	202.57^{c} ± 3.71	263.90^{c} ± 4.47	319.16^{c} ± 4.92	365.63^{c} ± 5.31
2005-2008	84	19.63^{a} ± 0.28	88.46^{c} ± 1.89	139.04^{b} ± 2.75	207.33^{c} ± 3.45	266.49^{c} ± 4.17	309.40^{c} ± 4.58	353.52^{b} ± 4.95
2009-2012	78	19.63^{a} ± 0.28	77.86^{ab} ± 2.06	120.13^{a} ± 2.99	173.27^{a} ± 3.75	224.65^{a} ± 4.53	270.01^{a} ± 4.98	336.33^{a} ± 5.38
2013-2017	82	18.72^{b} ± 0.28	73.96^{a} ± 1.95	119.85^{a} ± 2.84	189.42^{b} ± 3.56	245.95^{b} ± 4.30	293.14^{b} ± 4.73	354.22^{b} ± 5.11

a, b, c dissimilar superscript indicates significant difference between season and period.

Table 4: Least Squares Mean and SE for first lactation production traits in Sahiwal cattle

Over all	N	AFC (days)	FL305DMY (kg)	FLL (days)	FCI (days)	FSP (days)
	314	1176.89 ± 15.45	1812.06 ± 64.24	312.13 ± 8.05	463.59 ± 9.88	182.28 ± 10.02
Season						
Winter	150	1162.71 ± 19.97	1775.35 ± 95.01	308.48 ± 11.90	431.11^{a} ± 11.22	157.85 ± 11.38
Summer	95	1161.37 ± 19.96	1758.14 ± 102.01	306.72 ± 12.78	469.03^{ab} ± 13.21	187.67 ± 13.39
Rainy	43	1180.27 ± 24.02	1864.79 ± 115.47	307.79 ± 14.47	471.11^{ab} ± 18.46	189.67 ± 18.71
Autumn	26	1203.22 ± 30.21	1849.98 ± 144.13	325.56 ± 18.06	483.09^{c} ± 23.34	193.95 ± 23.66
Period						
2004-2006	29	1101.19^{a} ± 22.65	1814.60^{b} ± 114.43	297.38^{a} ± 14.34	423.31^{a} ± 22.54	148.22^{a} ± 22.85
2007-2010	121	1148.77^{a} ± 21.11	1980.00^{c} ± 102.28	322.08^{b} ± 12.81	458.51^{b} ± 12.46	182.30^{b} ± 12.63
2011-2014	79	1238.89^{b} ± 22.93	1667.84^{a} ± 109.94	302.46^{a} ±13.77	461.74^{b} ± 14.52	174.76^{b} ± 14.72
2015-2017	85	1218.72^{b} ± 21.78	1785.82^{b} ± 111.89	306.63^{a} ± 14.02	510.78^{c} ± 13.98	223.85^{c} ± 14.17

a, b, c dissimilar superscript indicates significant difference between season and period.

individuals in breeding programme for improving future populations (Bourdon, 2000). Genetic parameters that are of interest include heritability, genetic and phenotypic correlation estimates. The measures of heritability of various traits and their phenotypic and genetic correlations are the parameters which determine the genetic improvement in the population. The estimates of heritability for BW, W6, W12, W18, W24, W30 and WFC were 0.12 ± 0.28, 0.67 ± 0.34, 0.49 ± 0.33, 0.19 ± 0.29, 0.19 ± 0.30, 0.42 ± 0.32 and 0.43 ± 0.22 respectively (Table 5). Similar to present findings, different researchers (Gandhi and Kumar 2014 and Manoj *et al.* 2014) also revealed lower estimates of heritability for these traits in various breeds of cattle including Sahiwal. On contrary the direct heritability estimates of these traits from our study was lower compared with previous estimates in different native and exotic breeds of cattle including Sahiwal calves (Yin and Konig 2018). Singh *et al.* (2011) reported a moderate estimate (0.29± 0.10) of heritability for birth weight in Vrindavani calves. The heritability estimates of weight at twenty four months, thirty months and calving were higher in present investigation. Genetic parameters of different first lactation traits are presented in Table 5. The heritability estimate for AFC, FL305DMY, FLL, FCI and FSP obtained in the present study were low to medium and had reasonably low standard errors. The

Table 5: Estimates of heritability (diagonal), genetic correlations (above diagonal) and phenotypic correlations (below diagonals) for growth traits in Sahiwal cows

	BW	W6	W12	W18	W24	W30	WFC	AFC	FL305DMY	FLL	FCI	FSP
BW	0.12 ± 0.28	0.16 ± 0.32	0.23 ± 0.54	-1.26 ± 0.23	-1.71 ± 0.35	-0.75 ± 0.12	-0.21 ± 0.11	0.56 ± 0.21	0.02 ± 0.23	-0.34 ± 0.11	0.01 ± 0.10	0.12 ± 0.24
W6	0.22 ± 0.17	0.67 ± 0.34	0.68 ± 0.32	0.73 ± 0.22	-0.05 ± 0.32	-0.76 ± 0.21	-0.86 ± 0.32	-0.75 ± 0.11	0.27 ± 0.17	-0.26 ± 0.32	0.27 ± 0.21	0.27 ± 0.14
W12	0.22 ± 0.11	0.56 ± 0.13	0.49 ± 0.33	0.59 ± 0.33	0.12 ± 0.08	-0.35 ± 0.11	0.54 ± 0.22	-0.61 ± 0.12	-0.46 ± 0.14	-0.48 ± 0.16	0.09 ± 0.02	0.12 ± 0.10
W18	0.19 ± 0.11	0.41 ± 0.21	0.56 ± 0.22	0.19 ± 0.29	0.29 ± 0.22	-0.69 ± 0.21	-0.75 ± 0.12	-1.08 ± 0.22	-0.69 ± 0.32	-0.90 ± 0.46	3.04 ± 0.76	0.67 ± 0.43
W24	0.21 ± 0.09	0.19 ± 0.07	0.39 ± 0.21	0.68 ± 0.26	0.19 ± 0.30	0.47 ± 0.21	0.43 ± 0.22	-1.88 ± 0.09	-0.52 ± 0.45	-0.32 ± 0.11	0.23 ± 0.13	0.15 ± 0.08
W30	0.23 ± 0.22	0.09 ± 0.11	0.27 ± 0.22	0.54 ± 0.11	0.67 ± 0.21	0.42 ± 0.32	0.82 ± 0.43	0.03 ± 0.11	0.24 ± 0.21	0.10 ± 0.32	0.22 ± 0.14	0.09 ± 0.08
WFC	0.19 ± 0.12	0.03 ± 0.11	0.21 ± 0.10	0.32 ± 0.24	0.43 ± 0.11	0.54 ± 0.35	0.43 ± 0.22	-0.61 ± 0.23	0.39 ± 0.21	-0.23 ± 0.11	0.11 ± 0.04	0.22 ± 0.11
AFC	0.06 ± 0.01	-0.19 ± 0.11	-0.27 ± 0.21	-0.31 ± 0.21	-0.34 ± 0.11	-0.31± 0.24	0.24 ± 0.32	0.11 ± 0.09	0.16 ± 0.07	0.12 ± 0.21	0.32 ± 0.24	0.49 ± 0.23
FL305 DMY	0.02 ± 0.04	0.05 ± 0.06	0.15 ± 0.06	-0.01 ± 0.06	0.10 ± 0.05	0.12± 0.06	0.16 ± 0.05	0.01 ± 0.11	0.26 ± 0.11	0.93 ± 0.38	-0.15 ± 0.24	0.49 ± 0.24
FLL	-0.08± 0.04	-0.02 ± 0.06	0.03 ± 0.05	-0.01 ± 0.05	0.07 ± 0.05	0.03± 0.05	0.013 ± 0.05	-0.01± 0.01	0.67 ± 0.04	0.09 ± 0.02	0.70 ± 0.21	0.78 ± 0.23
FCI	0.006 ± 0.04	-0.09± 0.05	0.151 ± 0.05	-0.09 ± 0.05	-0.01 ± 0.05	0.02 ± 0.05	0.021 ± 0.02	0.03 ± 0.04	0.25 ± 0.05	0.53 ± 0.04	0.02 ± 0.05	NE
FSP	0.02 ± 0.04	-0.08± 0.05	-0.14 ± 0.05	-0.07 ± 0.05	0.01± 0.05	0.01± 0.05	0.01± 0.05	0.03 ± 0.01	0.24 ± 0.11	0.54 ± 0.21	0.96 ± 0.43	0.03 ± 0.03

results indicated that these production traits are influenced more by additive genetic variability and hence there is a scope for improvement. The heritability estimate of AFC was found to be low (0.11 ± 0.09) which was in agreement with the findings reported by Manoj *et al.* (2012), Verma (2015) and Parveen *et al.* (2018). Comparatively higher estimates of heritability were reported by Hussain *et al.* (2014). Moderate heritability estimate was observed for FL305DMY (0.26 ± 0.11). Manoj *et al.* (2012) reported almost similar heritability in Sahiwal cattle. The moderate value of heritability of trait in present study revealed that the trait was more influenced by environmental factors and improvement of this trait could be done by better feeding, breeding and managemental practices.

The estimate of genetic correlation of birth weight with W6 and W12 were significantly positive indicating presence of maternal effect till age of one year body weight. But the genetic correlations of birth weight with body weight at 18M to till first calving were significantly negative and ranged from -1.26 to -0.21. It suggested that selection for heifers with high body weight should not be practiced on the basis of early body weight till one year of age in Sahiwal cows. The young stage growth traits are usually influenced by maternal effect, hence selection for getting heavy weighted heifers must not be practiced on the basis of early recorded young growth traits. The genetic correlation between body weight at 6M, 12M, 18M, 24M, WFC and AFC was negative and significant (-0.75 ± 0.11, -0.61 ± 0.12, -1.08 ± 0.22, -1.88 ± 0.09, -0.61 ± 0.23 respectively) which is desirable. Most of the growth traits had moderate phenotypic correlations with each other. The genetic correlations between first lactation traits were significantly medium to high and positive which indicate simultaneous performance enhancement in one trait while selecting other. FL305DMY is expected to improve the performance of first lactation traits through correlated response and selection of animals on the basis of FL305DMY would lead to advantageous enhancement in all these correlated production, and reproduction traits. However association of FL305DMY with FCI was observed to be low, negative, and non-significant. This result was in agreement with the findings reported by Parveen *et al*. (2018). The genetic correlation of FLL was high and positive with FL305DMY and FCI and low with AFC. The results indicated that the longer FLL is expected to improve the FL305DMY since cows with high FLTMY tended to have longer lactation length whereas higher correlation of FLL with FCI could be due to the reason that FLL is one of the components of calving interval. Similar findings were also reported by Parveen *et al*. (2018). The phenotypic correlations of FL305DMY with FLL, FCI and FSP were observed to be positive, low to high and significant. Hence, this association suggested that higher FL305DMY is likely to improve the performance of other related production and reproduction traits. However, the correlation of FL305MY with AFC was found to be low and non-significant. Findings similar to the present study were also observed by Banik and Gandhi (2010) and Parveen *et al*. (2018). Even though phenotypic correlations amongst body weights and first lactation traits were mostly found to be non-significant, highly significant phenotypic correlations were observed between AFC and different body weights like 6M, 12M, 18M, 24M, 30M and WFC. Similarly, phenotypic correlations between FL305DMY and body weights at 6 and 30M were significant ($P < 0.05$), whereas those between FL305DMY and WFC was highly significant ($P < 0.01$). Highly significant phenotypic correlations were also observed in case of 12M body weight with FCI and FSP.

CONCLUSION

During different season of the sub tropical region, the physiological rhythmicity of economic traits in Sahiwal cows has got affected. The non-significant effect of season of calving on first lactation traits may due to inherent potential of adult cows to adapt to various seasons. This seasonal and periodical rhythmicity reflects a thermoregulatory adaptive mechanism to maintain the growth and production performance in different environmental variations in the sub tropical region under an intensive system of management. The moderate to high estimates of heritability of different economic traits indicated the scope of further improvement of these traits through selection. The genetic and phenotypic correlations amongst most of the body weight and first lactation traits were higher in magnitude. Therefore it can be inferred that genetic associations could be effective for formulating selection criteria on the basis of early expressed traits in Sahiwal cattle. Moreover, good managemental practices and different quality feed ingredients should be provided during different periods to get maximum production benefits.

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