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Genetic Parameters of Growth Traits in Crossbred Sheep

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ABSTRACT : Data spread over 11 years (1986-1996) pertaining to a synthetic population developed by *inter se* mating of half-breds of Corriedale and Russian Merino with Nali maintained at CCS Haryana Agricultural University, Hisar were utilized for the estimation of genetic parameters for growth traits. The means for birth weight (BWT), weaning weight (WWT), six month body weight (SWT), yearling weight (YWT), preweaning daily gain (PRW) and post weaning daily gain (POW) were 3.35 kg, 10.79 kg, 13.28 kg, 18.96 kg, 82.6 gm and 27.6 gm, respectively. The effects of year and season of birth and sex of lamb were significant for all the traits under study except the effect of season of birth for WWT, SWT and PRW. No definite trend was observed over the years for the averages of body weight and gain. Lambs born during the spring season performed better for BWT, WWT and PRW while the performance of lambs born during autumn was better for the other traits included in the study. The male lambs were heavier than the females for body weight at all stages and gain in weight. The heritability estimates for WWT and PRW were low; for BWT and SWT were moderate and for YWT and POW were high. Birth weight had high heritability and high genetic correlations with subsequent body weights and gains but due to the presence of a maternal effect on BWT and WWT, a sequential selection procedure is recommended for the improvement of growth rate in sheep. (**Key Words :** Heritability, Correlations, Growth Traits, Sheep)

INTRODUCTION

India is the reservoir of 40 breeds of sheep having 5.5 per cent of population of total world sheep (DAHD, 2002). Sheep farming occupies pre-eminent position in the economy of the nation as it supports the livelihood of the people of arid and semi-arid regions of the country specially those of weaker sections of the society, comprising the small and marginal farmers and the landless agricultural laborers. Sheep farming provides substantially useful fraction of their total income particularly when crops fail due to drought and other adverse conditions.

Growth of the lambs is a reflection of the adaptability and economic viability of the animal and hence may be used as a criterion for selection among breeds and the individuals within breeds. The study of the body weights also helps or even guides the breeders to determine the optimum management practices so as to maintain the gain at optimum level. The knowledge of genetic variability with respect to each trait and co-variability existing among different traits are a beacon light for planning appropriate selection and breeding strategies for the genetic improvement of small ruminants. The literature is dotted with conflicting and sporadic reports regarding genetic parameters of growth traits in sheep (Snyman et al., 1995; Gomez et al., 1996; Sunkhyan et al., 1997; Assan et al., 2002; Sharma et al., 2004; Assan and Sagae, 2005). Therefore the present investigation was planned with a view to study the genetic variation in growth traits in a synthetic population of sheep.

MATERIALS AND METHODS

The data spreading over 11 years (1986-1996) pertaining to synthetic population developed by *inter se* mating of half-breds of Corriedale and Russian Merino with Nali maintained at CCS Haryana Agricultural University, Hisar were used for the estimation of genetic parameters. The breeding was restricted to two season viz. spring (March-April) and autumn season (September-November). The growth traits included for this investigation were: birth weight (BWT), weaning weight (WWT), six month weight (SWT), yearling weight (YWT), preweaning daily gain (PRW) and post weaning daily gain (POW). Lambs were allowed to suckle the ewes up to 90 days. The lambs were allowed to graze after weaning. They were also provided with concentrate feed after 2 months of age.

Following mixed model was used for the analysis of data:

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Table 1. Least square means along with their standard error for various growth traits

Effect	Birth weight (kg)	Weaning weight (kg)	Six month body weight (kg)	Yearling weight (kg)	Preweaning average daily gain (gm)	Post weaning average daily gain (gm)
Overall mean	3.35±0.01 (914)	10.79±0.07 (914)	13.28±0.09 (914)	18.96±0.20 (468)	82.6±0.08 (914)	27.6±0.6 (914)
Years:						
1986	3.10[dc]±0.14 (12)	10.25[bc]±0.62 (12)	11.65[bc]±0.77(12)	13.65[c]±0.51(1)	79.5[bc]±6.7 (12)	25.4[cdfe]±5.7 (12)
1987	3.24[ab]±0.05 (129)	9.57[d]±0.25 (129)	11.67[bc]±0.31 (129)	18.41[abc]±0.94 (34)	70.3[d]±2.7 (129)	23.3[f]±2.3 (129)
1988	3.23[bc]±0.06 (107)	10.59[dc]±0.26(107)	12.99[dc]±0.32(107)	18.05[abc]±0.96 (25)	81.8[cd]±2.2 (107)	26.6[ef]±2.4 (107)
1989	3.30[a]±0.06 (128)	11.35[a]±0.26 (128)	13.80[ab]±0.32 (125)	19.91[abc]±0.86 (63)	89.4[a]±2.8 (128)	28.1[def]±2.4 (129)
1990	3.29[ab]±0.06(100)	11.20[ab]±0.26(100)	14.13[ab]±0.33 (100)	20.45[abc]±0.83 (76)	87.9[ab]±2.9 (100)	32.4[cde]±2.5 (100)
1991	3.14[b]±0.08 (49)	9.33[d]±0.35 (49)	13.32[bc]±0.43(49)	20.52[abc]±1.00 (25)	68.6[d]±3.8 (49)	44.3[b]±3.2 (49)
1992	3.17[bc]±0.07 (67)	10.14[dc]±0.30 (67)	13.51[bc]±0.37 (67)	17.03[bc]±1.19 (13)	77.4[cd]±3.2 (67)	37.3[bc]±2.8 (67)
1993	3.14[bc]±0.06 (101)	10.29[dc]±0.28 (101)	14.04[ab]±0.34 (101)	21.32[ab]±0.95 (32)	79.5[bcd]±3.0 (101)	41.6[b]±2.6 (101)
1994	3.03[bc]±0.10 (24)	9.95[dc]±0.46 (24)	12.57[c]±0.57 (24)	20.70[bc]±2.55 (2)	76.9[bc]±5.0 (24)	29.0[ef]±4.3 (24)
1995	2.95[dc]±0.06 (100)	10.26[dc]±0.28(100)	13.56[bc]±0.34 (100)	23.59[a]±0.00 (100)	81.2[cd]±3.0 (100)	36.5[bcd]±2.6 (100)
1996	2.89[d]±0.06 (97)	10.20[dc]±0.27 (97)	14.98[a]±0.33 (97)	24.20[a]±0.73 (97)	81.2[cd]±2.9 (97)	53.0[a]±2.5 (97)
Seasons:						
Spring	3.36[a]±0.02 (873)	10.75[a]±0.09 (873)	13.14[a]±0.12 (873)	16.94[b]±0.44 (4612)	82.1[a]±1.0 (873)	36.6[b]±0.9 (873)
Autumn	2.91[b]±0.08 (41)	9.82[a]±0.35 (41)	13.46[a]±0.43 (41)	22.66[a]±1.37 (7)	76.7[a]±3.8 (41)	40.3[a]±3.2 (41)
Sex:						
Male	3.22[a]±0.04 (422)	10.54[a]±0.19 (422)	13.84[a]±0.23 (422)	21.90[a]±0.70 (260)	81.3[a]±2.0 (422)	36.6[a]±1.7 (422)
female	3.04[b]±0.04 (429)	10.13[b]±0.18 (429)	12.76[b] (429)	17.71[b]±0.72 (208)	77.6[b]±1.9 (429)	30.3[b]±1.6 (429)

Means superscripted by different letters differ significantly among themselves.

Table 2. Analysis of variance for various growth traits

Source of variation	d.f.	Mean squares					
		Birth weight	Weaning weight	Six month body weight	Yearling weight	Pre-weaning average daily gain	Post-weaning average daily gain
Year	10	2.968**	56.271**	86.526**	150.509**	5.313**	7.135**
Season	1	4.799**	15.104	5.492	117.994**	0.356	4.791**
Sex	1	8.145**	71.30**	287.777**	1786.029**	0.385**	8.960**
Regression	1	46.56**	889.17**	1110.331**	181.642**	66.21**	1.374**
Error	-	0.226 (900)	4.140 (900)	6.339 (900)	11.843 (454)	0.487 (900)	3.570 (900)

Figures within parentheses are the degree of freedom (d.f.) for error.
** p<0.01, * p<0.05.

$$Y_{ijklm} = \mu+S_i+P_j+T_k+B_l+b\ (A_{ijklm}-\bar{A})+e_{ijklm}$$

Where: Y_{ijklm} = is the observation on m^{th} lamb belonging to l^{th} sex born in k^{th} season and j^{th} year and to i^{th} sire; μ = is the overall population mean; S_i = is the random effect of i^{th} sire; P_j = is the fixed effect of j^{th} year; T_k = is the fixed effect of k^{th} season; B_l is the effect of l^{th} sex; b is the regression of lamb trait on dam's weight at lambing; A_{ijklm} = is the dam's weight at lambing corresponding to Y_{ijklm}; $\bar{A}$ = is the arithmetic mean of dam's weight at lambing; and e_{ijklm} = is the random error associated with each observation and assumed to be normally and independently distributed with mean zero and variance σ_e^2.

The least-squares and maximum likelihood computer program of Harvey (1987) was used to estimate the effect of various tangible factors on different growth traits. Duncan's multiple range test as modified by Kramer (1957) was employed for making all possible pairwise comparison of means. Heritability estimates for different growth traits were obtained from sire component of variances. The standard errors of heritability estimates were obtained by using formula given by Swiger et al. (1964). Genetic correlations among different traits were calculated from sire components of variances and covariances. The standard error of genetic correlation was estimated by using the formula given by Robertson (1959). Phenotypic correlations among various traits were calculated from total variances and covariances. The standard error of phenotypic correlation was computed using the formula given by Snedecor and Cochran (1968).

RESULTS AND DICUSSION

The Table 1 showed that least-squares means for birth

Table 3. Estimates of heritability (diagonal), genetic (above diagonal) and phenotypic (below diagonal) correlations along with their standard error among various growth traits

Traits	BWT	WWT	SWT	YWT	PRW	POW
BWT	0.28±0.10	0.082±0.23	-0.32±0.24	-0.54±0.21	0.65±0.38	-0.80±0.18
WWT	0.40**±0.03	0.13±0.08	0.3±0.299	-0.30±0.28	0.96±0.03	0.84±0.28
SWT	0.28**±0.03	0.76**±0.02	0.27±0.10	0.53±0.17	0.57±0.24	0.84±0.09
YWT	0.10*±0.03	0.26**±0.03	0.54**±0.02	0.70±0.20	-0.16±0.32	0.81±0.09
PRW	0.18**±0.03	0.97**±0.01	0.75**±0.02	0.25**±0.03	0.08±0.07	0.42±0.33
POW	-0.07 ±0.03	-0.07±0.03	0.58**±0.02	0.46**±0.02	-0.05±0.03	0.63±0.13

** p<0.01. * p<0.05.

weight (BWT), weaning weight (WWT), six month body weight (SWT), yearling weight (YWT), preweaning daily gain (PRW) and post weaning daily gain (POW) were 3.35 kg, 10.79 kg, 13.28 kg, 18.96 kg, 82.6 gm and 27.6 gm, respectively. Similar results have also been reported by Assan et al. (2002) for BW; Chaudhary (1988) for YWT and Singh (1995) for WWT, SWT, PRW and POW. However, lower and higher averages for these traits in other breeds are also available in literature (Snyman et al., 1995; Gomez et al., 1996; Sunkhyan et al., 1997).

The effect of year and season of birth and sex of lamb was statistically significant for all the traits under the study except the effect of season of birth for WWT, SWT and PRW (Table 2). These results are similar to the findings of earlier workers (Roda et al., 1990; Bathaei and Leroy, 1994; Snyman et al., 1995; Singh, 1995). Sharma et al. (2004) also reported significant effect of year of birth and sex of lamb on BWT and SWT in Malpura lambs. Significant effect of sex of lamb on BWT and WWT has also been reported by Assan and Makuza (2205) in mutton Merino sheep. No definite trend was observed over the years in the averages of body weight and gain. The lambs born during the year 1989 excelled in performance for BWT, WWT and PRW while the lambs born during the year 1996 performed better inters of SWT, YWT and POW. The lambs born during spring season (March-April) performed better for BWT, WWT and PRW while those born during autumn season performed better for the other traits. Male lambs were heavier than the female for the body weight at all stages and gain in weight.

Heritability estimates

Heritability estimates, genetic and phenotypic correlations with their standard error among different traits have been presented in Table 3. The heritability estimates for WWT and PRW were low indicating low level of additive genetic variance for these traits in this flock. These results are in close agreement with the work of Jurado et al. (1994). Birth weight and SWT have moderate estimates of heritability suggesting that there is considerable scope of improvement in these traits by mass selection. Similar reports for these traits are also available in the literature (Hall et al., 1994; Kushwaha et al., 1995). Assan et al. (2002) also reported moderate estimates of heritability for BWT and WWT. The estimate of heritability for YWT and POW were 0.70 and 0.63 indicating high degree of genetic variability in these traits. Alkass et al. (1991) also obtained high estimates of heritability for these traits.

Genetic correlations

Genetic correlations of BWT were moderate to high (0.32 to 0.80) with other body weights and gain in body weight. Similarly WWT also had moderate to high genetic correlation with other growth traits. The genetic correlation of WWT with pre and post weaning gains was very high (0.96 to 0.84, respectively). Six months weight had high genetic correlation with YWT, PRW and POW. The genetic correlation between PRW and POW was 0.42. Moderate to high genetic correlation of BWT with body weights at subsequent ages and gain was also been reported by Bissette et al. (1992), Burfening and Carpio (1993), Caningten et al. (1994), Kushwaha et al. (1995) and Analla (1997). Estimates of genetic correlations among WWT, SWT and YWT in the present study are in agreement with the findings of Singh and Dhillon (1992), Kushwaha et al. (1996). Estimates of genetic correlation between body weights and gain are similar with the estimates reported by McEwan et al. (1991).

Phenotypic correlations

The phenotypic correlations of BWT with other body weights and gains ranged from -0.07 to 0.40. Weaning weight had low phenotypic correlation with YWT and POW but high phenotypic correlation with SWT and PRW. Estimates of phenotypic correlations among SWT, YWT, PRW and POW were moderate to high except the correlation between PRW and POW, which was almost zero. Estimates of phenotypic correlations among body weights and gains in the present study were similar to those reported by Mukafui et al. (1990), McEwan et al. (1991) and Yamaki and Sagae (1991).

Although the BWT had high heritability and high genetic correlations with subsequent body weights and gains but it is not prudent to select only on the basis of

BWT because of the presence of maternal effect on BWT and WWT. Therefore a sequential selection procedure should be adopted for the improvement of growth rate in sheep.

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