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Relative efficiency of part lactation records in selection of Sahiwal sires

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ABSTRACT

The data on 586 Sahiwal daughters born to 50 Sahiwal sires maintained at National Dairy Research Institute, Karnal over a period of 47 years (1961–2007) were analyzed to estimate heritability and genetic correlations among first lactation 305-day milk yield (FL305DMY) and different part lactation records. The relative efficiency of sire selection based on part lactation records was also estimated. The genetic parameters, viz. heritability, genetic correlations were estimated after adjusting the data for various significant non-genetic effects. The heritability estimates were moderately high for the first four individual monthly part yields and for later months the estimates were low and not significantly different from zero. The heritability estimates for cumulative 60, 90 and 120 days were found to be statistically significant. The genetic correlations between FL305DMY and different part lactation yields were high and statistically highly significant. The relative efficiency estimates showed that selection based on individual third month yield was at least 89% as effective as on the basis of FL305DMY; while cumulative 90 days milk yield was effective by 79%. It was inferred that the selection of sires could be done with a considerable degree of efficiency on the basis of early part lactation yields especially the third month milk yield and or cumulative monthly yield up to 90 days.

Key words: First lactation traits; Genetic correlation; Phenotypic correlation, Sahiwal cattle

The part lactation records revealed a very high genetic and phenotypic relationship with complete lactation records and are useful in early selection of bulls for progeny testing (Sikka and Taneja 1981, Varshney and Tomar 1982, Singh 2006, Bansal 2009). The selection of animals on the basis of part lactation yield would not only help in early sire evaluation, but also in earlier culling of low producing animals from the herd. However, the efficiency of selection based on part lactation records in relation to animals selected based on FL305DMY will vary, which ultimately alters the rate of genetic gain. This is estimated in terms of relative efficiency of selection which explains the amount of genetic progress based on part lactation in relation to animals selected based on FL305DMY. Lerner and Cruden (1948) described the method for estimating the relative efficiency, using the information on heritability and genetic correlation estimates between complete and part lactation records assuming that the intensity of selection was same by both procedures. The present study was undertaken to estimate the heritability and genetic correlations among the FL305DMY and different part lactation records and to estimate the relative efficiency of selection based on part lactation records.

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MATERIALS AND METHODS

The data on 586 Sahiwal cows born to 50 Sahiwal sires maintained at National Dairy Research Institute, Karnal over a period of 47 years (1961–2007) were used for the present study. The first lactation traits considered for the study were first lactation 305-day or less milk yield (FL305DMY), different individual and cumulative monthly milk yields. The records of the animals with known pedigree and normal lactation were considered for this study. The records of animals with less than 300 kg of milk production or less than 100 days of lactation length were also discarded. To ensure the normal distribution, the outliers were removed and data with in the range of mean±2SD were only considered for the study. For genetic studies, sires having 5 or more daughters were only considered. According to the year of calving the total duration of the present study was divided into 16 periods of 3 consecutive year duration except the last period which was of 2 years. Each year was divided into 4 seasons namely winter (December-March), summer (April-June), rainy (July-September) and autumn (October-November).

The influence of various non-genetic factors on different first lactation production, reproduction and part lactation traits was studied by least squares analysis of variance for unequal non-orthogonal data using the technique described by Harvey (1966). The statistical model for least squares analysis of variance for first lactation 305-day or less milk yield included the effect of various non-genetic factors, viz.

season, period, age groups and days open. For the part lactation records except days open all the above factors were considered. Prior to estimation of genetic parameters, the data were adjusted for different significant non-genetic factors (season, period, age group and days open effect). Paternal half sib correlation (intra-sire correlation among daughters) method as described by Becker (1975) was used to estimate the heritability of FL305DMY and different part lactation traits. The genetic and phenotypic correlations among FL305DMY and different part lactation traits were estimated from the analysis of variance /covariance using half sib data as suggested by Becker (1975).

The relative efficiency of different part lactations was calculated according to the method described by Lerner and Cruden (1948).

RESULTS AND DISCUSSION

Heritability estimates of individual monthly milk yields: Heritability estimates for first to tenth individual monthly milk yields are presented in Table 1. Highly significant (P<0.01) heritability estimates were observed for second and third month milk yields. The heritability estimates for 7th and 10th months were non-estimable and for all other months the estimates were low and statistically non-significant (Table 1). The heritability estimates for various individual monthly part yields showed an increase up to 3 months and declined thereafter. The heritability estimate was highest for third month milk yield.

In general the heritability estimates obtained in the present study were moderately high in the first four months of lactation and for later months the estimates were low and not significantly different from zero. These results suggested that differences between cows other than additive genetic effects appear to affect milk production more in later stage of lactation than in early lactation. In addition, these results suggested that the set of genes determining early part yields and later part yields are not same. Similar to the present findings the highest heritability estimate for third month milk yield was also reported by Sharma *et al.* (1980) in Hariana cattle and SIkka and Taneja (1981) in Sahiwal cattle. On the contrary, Singh and Acharya (1969) and Shrivastava and Khan (1987) reported the highest heritability estimates for fifth month milk yield in Hariana and Sahiwal cattle, respectively.

Heritability estimates of cumulative monthly milk yields: The heritability estimates for cumulative part lactation records are presented in Table 1. The heritability estimates obtained for cumulative 60, 90 and 120 days were statistically significant (P<0.05). The heritability estimate for cumulative 210 days was non-estimable; while the estimates for all other cumulative milk yields were low and statistically nonsignificant. Similar to the individual monthly milk yields, the heritability estimates was highest for first 90 days cumulative yield and declined with the addition of more part lactation yields. The heritability estimates were moderate up to cumulative 120 days of lactation and for later cumulative yields the estimates were low and not significantly different from zero. These results suggested that the middle and later part of lactation were subjected to more environmental fluctuations than the early part of lactation. The variation among early cumulative milk yields were evidently more due to genetic factors. Further, these results suggested that the set of genes determining early part yields and remaining part yields are not same. Similar to the present findings the highest heritability estimate (0.42±0.19) for 90 days cumulative milk yield was reported by SIkka and Taneja (1981) in Sahiwal cattle. On the other hand, Sharma *et al.* (1983) reported that the heritability estimate was highest for cumulative 120 days yield in Hariana cattle. However, an upward trend of heritability estimates for cumulative part lactation yields was observed by Singh and Acharya (1969), Varshney and Tomar (1982) and Singh (2006) in different breeds of cattle.

The results of the heritability estimate of part lactation traits revealed that among the individual monthly milk yields the third month yield had maximum heritability estimate (0.3046±0.1217) and among cumulative part lactation yields the cumulative 90 days milk yield had maximum heritability estimate (0.2520±0.1139). The heritability estimate (0.3554±0.1295) of FL305DMY was comparatively higher than the individual monthly and cumulative part lactation yields. However, based on these results it was inferred that the individual 3rd month milk

Table 1. Heritability and genetic correlation estimates of various part lactation milk yields with FL305DMY in Sahiwal cattle

Milk yields	Heritability	Genetic correlation with FL305DMY
First lactation 305-day or less milk yield		
FL305DMY	0.3554**±0.1295	
Individual monthly milk yields		
First month	0.1351±0.0956	0.9241**±0.0495
Second month	0.2815**±0.1182	0.9063**±0.0480
Third month	0.3046**±0.1217	0.9630**±0.0195
Fourth month	0.1385±0.0976	0.9735**±0.0205
Fifth month	0.0099±0.0773	NE
Sixth month	0.0400±0.0847	NE
Seventh month	NE	0.6871±0.5310
Eighth month	0.0743±0.0968	0.8883**±0.1112
Ninth month	0.0097±0.0948	NE
Tenth month	NE	0.0108±0.6562
Cumulative monthly milk yields		
30 days	0.1351±0.0956	0.9241**±0.0495
60 days	0.2132*±0.1079	0.9239**±0.0427
90 days	0.2520*±0.1139	0.9339**±0.0358
120 days	0.1933*±0.1064	0.9240**±0.0504
150 days	0.0989±0.0939	0.9409**±0.0553
180 days	0.0319±0.0832	NE
210 days	NE	NE
240 days	0.0102±0.0844	NE
270 days	0.0560±0.1041	0.7649**±0.2624
300 days	0.0491±0.1232	0.9446**±0.0747

* - Significant at 5% level (P< 0.05); ** - significant at 1% level (P< 0.01).

Table 2. Relative efficiency of selection on the basis of part lactation milk yields over FL305DMY in Sahiwal cattle

Milk yields	Part yields									
	1	2	3	4	5	6	7	8	9	10
Individual monthly yields	0.57	0.81	0.89	0.61	0.31	0.37	-	0.41	0.27	-
Cumulative monthly yields	0.57	0.72	0.79	0.68	0.50	0.35	-	0.30	0.30	0.35

yield or cumulative 90 days milk yield can be used under selection programs. This would decrease the generation interval, and consequently, the response to selection for milk yield would be higher.

Genetic correlations between part and first lactation 305-day milk yield: The genetic correlation estimates of various part lactation milk yields with first lactation 305-day or less milk yield in Sahiwal cattle are presented in Table 1.

The genetic correlations between individual monthly milk yields and FL305DMY were high and statistically highly significant (P<0.01) except for the 10th month which had low (0.0108±0.6562) and non-significant genetic correlation followed by seventh month (0.6871±0.5310). The fifth, sixth and ninth individual monthly milk yields had non-estimable genetic correlations with FL305DMY. The results revealed that the genetic correlations of monthly milk yields with FL305DMY were high up to fourth month and thereafter the estimates declined. This suggested that the some genes which influence the early part yield and FL305DMY did not influence the part yields in later stage of lactation.

The genetic correlations among various cumulative monthly milk yields and FL305DMY were high, positive and highly significant (P<0.01). The cumulative 180, 210, 240 and 330 days milk yields had near to unity genetic association with FL305DMY. The highly positive and significant genetic correlations between the early cumulative yields, viz. 30, 60, 90, 120 and 150 days and FL305DMY suggested that the merit of the cows for milk production could be assessed effectively in early stages of lactation. These results were in conformity with the results of Sikka and Taneja (1981), Varshney and Tomar (1982), Shrivastava and Khan (1987), Singh (2006) and Bansal (2009).

On the basis of reasonably good estimates of genetic correlations of part lactation milk yields with FL305DMY and together with relatively higher estimates of heritability, it can be inferred that the selection of sires could be done on the basis of early part lactation yields especially the third month milk yield and or cumulative monthly yield up to 90 days. This may increase the correlated response in FL305DMY.

Relative efficiency of selection as the basis of part lactation: The relative progress possible by selection on the basis of single monthly yields and cumulative monthly yields has been presented in Table 2. The results of the relative efficiency estimation revealed that the first 4 individual monthly yields and cumulative milk yields up to 120 days were having higher estimates than the other part lactation traits. When the earlier part lactation traits were considered, the single third month gave comparatively higher efficiency (0.89). Among cumulative yields the first 90 days was comparatively more efficient (0.79) followed by first 60 days (0.72). No similar reports in Sahiwal cattle were available for comparison. Some studies have been made on the relative efficiency of part lactation records in comparison to total lactation milk yield in Holstein cattle. Madden *et al.* (1955), VanVleck and Henderson (1961) have reported that selection on cumulative production of 6 months or more was at least 95% as effective as on the basis of total lactation yield. Searle (1961) observed genetic progress as good as selection based on fourth to sixth month records as on the basis of complete lactation yields. On the contrary, Gokhale (1981) reported that the earlier parts of the lactation, viz. single third or fifth monthly milk yield gave selection efficiency 1 to 6% higher than that obtained from total first lactation yield in Murrah buffaloes.

Based on the results, it was inferred that the individual third month milk yield or cumulative 90 days milk yield can be effectively utilized for early selection of cows under a breed improvement program. Selection based on individual third month yield was at least 89% as effective as on the basis of FL305DMY; while selection on the basis of cumulative 90 days milk yield was effective by 79% in comparison to FL305DMY. The heritability estimates of individual monthly and cumulative part lactation yields revealed that the estimates declined after fourth month of lactation and 120 days cumulative milk yield, respectively. The genetic correlation between the individual monthly and cumulative milk yields were also lower for the part yields at the later stage of lactation resulting in lowered relative efficiency. However, when these early part lactation records were used for indirect selection for the FL305DMY the generation interval is reduced and the accuracy may be increased by including more number of daughters per sire resulting in increased selection response in a shorter period. Similarly, where there are difficulties in recording the daily milk yields throughout the lactation, the third individual monthly milk yield or cumulative 90 days milk yield could be another option to select sires efficiently and to formulate culling plans at an early age for the herd.

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