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Genetic studies on 305 days and test day milk yield records in Murrah buffaloes

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ABSTRACT

Data pertaining to first lactation records on 326 Murrah buffaloes, progeny of 48 bulls calved during 1987 to 2006, maintained at Buffalo Research Centre, Chaudhary Charan Singh Haryana Agricultural University, Hisar, were analyzed. The overall population means were 1 818.06 kg, 4.43 kg, 7.90 kg, 8.11 kg, 7.82 kg, 7.81 kg, 7.25 kg, 6.64 kg, 6.07 kg, 5.37 kg and 5.13 kg for 305 days milk yield and first 10 test day records TD_1, TD_2, TD_3, TD_4, TD_5, TD_6, TD_7, TD_8, TD_9 and TD_{10}, respectively. Period of calving had significant effect on TD_1, TD_7 and TD_9. However, season of calving had nonsignificant effect on all the traits under this study except for 305 days milk yield. The estimates of heritability of various traits were not significantly different from zero as standard errors of estimates were higher. The genetic correlations for all traits were moderate to high except for TD_2 with TD_7 and TD_9, where low estimates were obtained. The phenotypic correlations were moderate to high and in some cases negative.

Key words: 305 days milk yield, Buffaloes, Correlations, Heritability, Test day records

In developing countries, breeding programmes are characterized by insufficient recording systems and poor data collection, storage and processing procedures (Kahi *et al.* 2004). For this, use of test day (TD) data would offer practical solutions. Information on estimates of genetic parameters of TD records is lacking and therefore, the present study was conducted on the basis of test day records.

MATERIALS AND METHODS

The present study was conducted on data pertaining to 326 first lactation records of Murrah buffaloes maintained at Buffalo Research Centre (BRC), Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana (India) over a period of 20 years from 1987 to 2006. The duration of 20 years were divided into 4 periods of 5 years each. The 3 seasons were delineated as summer (March to June), monsoon (July to October) and winter (November to February). First test day yield was recorded from the seventh day after calving and 10 test day milk records were taken at every 4-week interval. Bulls with at least 3 progenies were considered for the present study. Lactations shorter than 150 days were excluded from the present study. Abnormal records like abortion, mastitis, chronic illness, physical injuries etc. were also excluded from the preview of present study. The least-squares solutions were obtained using the model given below:

$$Y_{ijkl} = \mu + s_i + h_j + C_k + b_1 (x_{ijkl} - \bar{x}) + b_2 (x_{ijkl} - \bar{x})^2 + e_{ijkl}$$

Table 1. Analysis of variance for 305 days milk yield and 10 test day records

Source of variation	df	Mean squares										
		305 days	TD_1	TD_2	TD_3	TD_4	TD_5	TD_6	TD_7	TD_8	TD_9	TD_{10}
Period of calving	3	307525.62	18.14**	37.79	51.62	4.37	28.79	5.72	18.07**	5.91	9.21*	38.94
Season of calving	2	427146.23*	6.93	28.75	12.86	4.64	1.16	0.98	4.54	1.32	2.89	33.14
AFC (Linear)	1	1972865.52**	11.54*	30.19	100.04*	66.20**	5.79	14.78*	17.05*	5.42	1.25	3.42
AFC (Quadratic)	1	2148.64	7.21	3.07	15.24	1.87	5.08	0.002	3.00	0.02	1.94	2.47
Error	318	156285.99	2.38	32.81	19.98	3.11	16.05	3.15	3.08	4.57	2.79	15.17
								(316)	(315)	(312)	(280)	(244)

df, degree of freedom; figures in parentheses are number of observations, *P<0.05 **P<0.01.

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where, Y_{ijkl}, l^{th} record of individual of i^{th} sire calved in j^{th} period and k^{th} season; μ, overall population mean; s_i, random effect of i^{th} sire; h_j, fixed effect of j^{th} period of calving; C_k, fixed effect of k^{th} season of calving; b_1 and b_2, linear and quadratic partial regression coefficient of age at first calving, on trait(s), respectively; x_{ijkl}, age at first calving, mean of the age at first calving, and e_{ijkl}, random error associated with each and every observation and assumed to be normally and independently distributed with mean zero and variance α^2_{e}.

The least-squares maximum likelihood computer program of Harvey (1987) was used to estimate the effect of various tangible factors on different traits under study. Duncan's multiple range test as modified by Kramer (1957) was used for making all possible pairwise comparison of means. Heritability estimates for different traits were obtained by the paternal half-sib correlation method using Henderson's method III (Henderson 1953). Genetic and phenotypic correlations were calculated from variance-covariance analysis. The standard error of phenotypic correlation was computed using the formula given by Snedecor and Cochran (1968).

RESULTS AND DISCUSSION

The least-squares means and their standard errors for 305 days milk yield and test day yields presented in Table 2. Tonhati *et al.* (2008) and Bilal *et al.* (2008) reported lower estimates for all the test day records. Up to TD_2 the trend was positive and there after the trend was negative. Similar findings were reported by Tonhati *et al.* (2008). The least-squares analysis of variance (Table 1) showed that period of calving had significant ($P<0.05$) effect on TD_1, TD_7 and TD_9 while season of calving had non-significant effect on all the traits except for 305 days milk yield. The performance of second period calvers was the best for the traits 305 days yield, TD_1, TD_3, TD_4, TD_5 and TD_6 while for the rest of test day records it was the fourth period of calving. Moreover, no definite trend was obtained in different period of calving for any trait except for TD_8 where positive trend was obtained. There were negative trends for TD_2, TD_3 and TD_5 over season of calving. The regression coefficient of AFC on 305 days milk yield (0.304 ± 0.104) indicated that with an increase of one day of AFC there will be corresponding increase in 305 days milk yield by 0.304 kg/day. There were positive regressions of TD on AFC records except with TD_{10} where a negative regression of TD was obtained.

Heritability: The estimates of heritability were low to moderate and ranged from 0.13 (TD_{10}) to 0.39 (TD_5). Similarly, Tonhati *et al.* (2008) reported the range of estimate of heritability 0.12 (TD_9) to 0.30 (TD_3) in dairy buffaloes in Brazil. For 305 days lower estimate of heritability lactation yield was reported by Jain and Sadana (2000) in Murrah buffaloes and higher estimate of heritability was reported by Sarkar *et al*. (2006). Bilal *et al*. (2008) reported lower estimates of heritability for 10 test day milk yields in Sahiwal

Table 2. Least-squares means and their standard errors for 305 days milk yield and test day milk yields

Effects	Mean ± SE										
	305 days (kg)	TD_1(kg)	TD_2(kg)	TD_3(kg)	TD_4(kg)	TD_5(kg)	TD_6(kg)	TD_7(kg)	TD_8(kg)	TD_9(kg)	TD_{10}(kg)
Overall mean	1818.06±22.46 (326)	4.43±0.09 (326)	7.90±0.32 (326)	8.11±0.25 (326)	7.82±0.10 (326)	7.81±0.22 (326)	7.25±0.10 (324)	6.64±0.10 (323)	6.07±0.12 (320)	5.37±0.10 (288)	5.13±0.25 (326)
Period of calving											
1987–1991	1653.50^{b}±108.69 (12)	3.88^{b}±0.35 (12)	5.69±0.36 (12)	6.00^{b}±0.62 (12)	7.64±0.65 (12)	7.11±0.45 (12)	6.78±0.54 (12)	5.97^{b}±0.39 (12)	5.64±0.49 (12)	5.82±0.57 (10)	4.84±0.62 (08)
1992–1996	1869.35^{a}±32.24 (95)	4.86^{a}±0.15 (95)	7.82±0.16 (95)	9.03^{a}±0.79 (95)	8.15±0.16 (95)	8.60±0.69 (95)	7.47±0.17 (95)	6.64^{ab}±0.17 (95)	5.85±.019 (94)	5.13±0.17 (88)	4.59±0.19 (80)
1997–2001	1755.61^{ab}±47.97 (92)	3.84^{b}±0.14 (92)	7.41±0.22 (92)	7.75^{ab}±0.21 (92)	7.59±0.22 (92)	7.42±0.21 (92)	6.93±0.19 (91)	6.12^{b}±0.20 (91)	5.98±0.31 (90)	5.12±0.20 (82)	4.75±0.18 (73)
2001–2006	1840.50^{ab}±37.37 (127)	4.59^{ab}±0.16 (127)	8.53±0.79 (127)	7.88^{ab}±0.17 (127)	7.76±0.16 (127)	7.58±0.16 (127)	7.35±0.16 (126)	7.09^{a}±0.16 (125)	6.32±0.15 (124)	5.72±0.16 (108)	5.94±0.64 (91)
Season of calving											
Summer	1874.76^{a}±35.68 (106)	4.73±0.16 (106)	8.15±0.14 (106)	8.33±0.17 (106)	7.91±0.15 (106)	7.93±0.16 (106)	7.35±0.16 (105)	6.44±0.16 (105)	6.07±0.27 (105)	5.39±0.16 (92)	5.01±0.16 (85)
Monsoon	1760.03^{b}±36.09 (138)	4.29±0.13 (138)	8.14±0.73 (138)	8.23±0.73 (138)	7.64±0.17 (138)	7.79±0.50 (138)	7.17±0.16 (137)	6.82±0.17 (136)	5.98±0.14 (134)	5.23±0.16 (120)	4.71±0.16 (103)
Winter	1842.44^{ab}±45.59 (82)	4.28±0.17 (82)	7.18±0.22 (82)	7.63±0.19 (82)	8.02±0.20 (82)	7.71±0.18 (82)	7.25±0.21 (82)	6.59±0.19 (82)	6.21±0.21 (81)	5.58±0.21 (76)	5.98±0.92 (64)
Regression AFC (Linear)	0.304 ±0.104	0.0008 ±0.0004	0.002 ±0.0005	0.002 ±0.0005	0.002 ±0.0004	0.0001 ±0.0005	0.0005 ±0.0004	0.001 ±0.0004	0.0002 ±0.0004	0.00004 ±0.0004	–0.0002 ±0.0005

Means with different superscripts differ significantly; number of observations is in parentheses.

Table 3. Heritabilities, genetic and phenotypic correlations for 305 days milk yield and test day records

Traits	305 days	TD_1	TD_2	TD_3	TD_4	TD_5	TD_6	TD_7	TD_8	TD_9	TD_{10}
305 days	**0.29±0.25**	0.23±0.24	0.30±0.23	0.77±0.15	0.59±0.17	0.89±0.08	0.61±0.18	0.71±0.13	0.51±0.19	0.67±0.13	0.58±0.17
TD_1	0.20*±0.05	**0.18±0.20**	0.36±0.26	0.47±0.35	0.46±0.23	0.36±0.23	0.48±0.23	0.39±0.24	0.47±0.23	0.19±0.26	0.26±0.26
TD_2	0.45**±0.05	0.19*±0.05	**0.27±0.18**	0.62±0.33	0.59±0.21	0.73±0.16	0.32±0.26	0.11±0.28	0.27±0.26	0.12±0.27	0.20±0.27
TD_3	0.52**±0.05	0.06±0.06	0.15±0.05	**0.20±0.14**	0.81±0.09	0.70±0.12	0.43±0.34	0.64±0.31	0.26±0.35	0.22±0.35	0.43±0.36
TD_4	0.56**±0.05	0.21*±0.05	0.35**±0.05	0.19*±0.05	**0.29±0.20**	0.60±0.16	0.65±0.17	0.30±0.23	0.42±0.22	0.25±0.25	0.40±0.24
TD_5	0.58**±0.05	0.27*±0.05	0.40**±0.05	0.21*±0.05	0.58**±0.05	**0.39±0.24**	0.70±0.14	0.59±0.17	0.50±0.19	0.25±0.22	0.39±0.20
TD_6	0.54**±0.05	0.22*±0.05	0.33**±0.05	0.17±0.05	0.56**±0.05	0.57**±0.05	**0.34±0.19**	0.58±0.18	0.64±0.18	0.04±0.26	0.16±0.27
TD_7	0.59**±0.05	–0.05±0.06	0.19*±0.05	0.07±0.06	0.39**±0.05	0.33**±0.05	0.44**±0.05	**0.27±0.22**	0.72±0.14	0.60±0.18	0.43±0.21
TD_8	0.47**±0.05	0.06±0.06	0.11±0.06	0.03±0.06	0.31**±0.05	0.38**±0.05	0.40**±0.05	0.42**±0.05	**0.22±0.22**	0.49±0.19	0.50±0.20
TD_9	0.58**±0.05	–0.06±0.06	0.14±0.06	–0.04±0.06	0.16±0.06	0.26*±0.06	0.19±0.06	0.35**±0.06	0.53**±0.05	**0.16±0.22**	0.72±0.13
TD_{10}	0.47**±0.06	–0.04±0.06	0.17±0.06	–0.03±0.06	0.17±0.06	0.17±0.06	0.16±0.06	0.29*±0.06	0.40**±0.06	0.65**±0.05	**0.13±0.21**

Figures above diagonal are estimates of genetic correlations; figures along the diagonal are estimates of heritability; figures below the diagonal are estimates of phenotypic correlations; *P<0.05; **P<0.01.

cattle in Pakistan. However, higher estimates of heritability for first 8 test day yield were reported by Ilatsia *et al.* (2007) in Sahiwal cattle.

Genetic correlations: The genetic correlations among 305 days milk yield and test day records ranged from 0.11 ($TD_2 \times TD_7$) to 0.89 (305 days milk yield × TD_5). The genetic correlations of 305 days milk yield with test day yields were high except with TD_1 and TD_2, where, moderate genetic correlations were obtained with other test day records. Test day records have moderate to high positive genetic correlations among themselves barring few exceptions. Tonhati *et al.* (2008) reported higher genetic correlations among test day records.

Phenotypic correlations: The phenotypic correlations among 305 days milk yield and test day records ranged from –0.05 ($TD_1 \times TD_7$) to 0.65 ($TD_9 \times TD_{10}$). The phenotypic correlations of 305 days milk yield with all 10 TD records were high, positive and significant except with TD_1. All the phenotypic correlations among TD records were positive except the relationship of TD_1 and TD_3 with TD_9 and TD_{10}. However, positive phenotypic correlations were reported by Ilatsia *et al.* (2007) in Sahiwal cattle.

In conclusion, the high genetic correlation between test day yield and lactation yield imply that both traits could genetically be considered as expression of the same trait. Estimation of breeding value based on test day milk yield would offer a solution to handle complex situations like lack of the necessary infrastructure for daily milk recording and hence cost of recording could be reduced substantially. For the estimation of genetic and phenotypic parameters, the emphasis should be on making use of large data sets to enhance the accuracy. Genetic evaluation based on relatively large data size as this would increase the accuracy and reliability of genetic and phenotypic parameters based on TD model should be carried out in future.

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