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Effect of genetic and non-genetic factors on first lactation weekly test day milk yields in Tharparkar cattle

Subhita, M Nehara, U Pannu, M Bairwa and MK Meena

Abstract
The present study was carried out to determine the effect of genetic and non-genetic factors on first lactation weekly test day milk yields of Tharparkar cattle maintained at Livestock Research Station (LRS), Beechwal, Bikaner. The overall least squares means for 43 individual weekly test day milk yields varied from 3.58 ± 0.12 kg (WTD1) to 7.47 ± 0.29 kg (WTD9). The season of calving had highly significant ($P \leq 0.01$) effect on WTD6. However, significant ($P \leq 0.05$) effect was found on WTD5, WTD18, WTD19, WTD25, and WTD41. The period of calving had highly significant ($P \leq 0.01$) effect on WTD34. However, significant ($P \leq 0.05$) effect was found on WTD19, WTD31, WTD32, WTD36, and WTD43. The sire had highly significant ($P \leq 0.01$) effect on WTD32, WTD33 and WTD34. However, significant ($P \leq 0.05$) effect was found on WTD1, WTD2, WTD30, WTD31, and WTD35. The regression of age at first calving was found highly significant ($P \leq 0.01$) on WTD24 and WTD35. However, significant ($P \leq 0.05$) effect was found on WTD6, WTD20, WTDY25-WTD29, WTD31-WTD34, and WTD41.

Keywords: Weekly test day milk yield, genetic & non-genetic factors, Tharparkar cattle

Introduction
Livestock plays a vital role in the Indian economy in terms of sustaining income and employment. Approximately two-thirds of rural communities depend upon livestock for their livelihood. The cattle population in the country is 193.46 million, contributes about 36.04 per cent of total livestock. Tharparkar is one of the major milch breed of cattle. This breed is well adapted to extreme climatic conditions and feed scarcity and produce reasonable amount of milk. Due to better heat tolerance and disease resistance, this breed was used for producing Karan Fries crossbred cattle at ICAR-National Dairy Research Institute, Karnal (Haryana).
The selection of dairy cattle based on test day milk yield is advantageous to the dairy farmer as it cuts down the cost of progeny testing. Milk yield is the most important economic trait determining economic returns to dairy farmers. Under Indian conditions, where farmer keeps 2-4 animals at their home, total lactation milk yield recording is a costly affair. Therefore, the use of the test day records is of more interest in genetic evaluations specially, sire evaluation in early age.

Material and Methods
Data recorded
The data on first lactation weekly test day milk yield records of Tharparkar cows, spread over a period of eight years (2012 to 2020) were collected from history-cum-pedigree sheets and daily milking registers, maintained at Livestock Research Station, Beechwal, Bikaner. A total of 3266 weekly test day (WTD) milk yield records were collected at an interval of 7 days, with first WTD recorded on 6^{th} day and last WTD on 300^{th} day.

Statistical analysis
The Least squares analysis was done using SPSS (Statistical Package for the Social Sciences) software version 20.0, considering the season/period of calving as fixed effect and sire as random effect and age at first calving as covariate. Data were classified into three classes according to period of calving *viz*. P1 (2012-2014), P2 (2015-2017) and P3 (2018-2020). According to season of calving data were classified into three seasons *viz*. S_1= winter (November to February), S_2=summer (March to June) and S_3=rainy (July to October).

The following mixed model was used:

$$Y_{ijkl} = u + a_i + S_j + P_k + b\,(X_{ijkl} - \bar{X}) + e_{ijkl}$$

Where
Y_{ijkl} = Observation on the l^{th} progeny of i^{th} sire, in j^{th} season of calving and k^{th}period of calving
μ = Population mean
a_i = Random effect of i^{th} sire
S_j = Fixed effect of j^{th} season of calving
P_k = Fixed effect of k^{th} period of calving
X_{ijkl} = Age at first calving corresponding to Y_{ijkl}
b = Regression coefficient of variable on age at first calving
$\bar{X}$ = Average age at first calving
e_{ijkl} = Random error, NID (0, σ^2e)

Duncan's Multiple Range Test (DMRT): Duncan's multiple range test as modified by Kramer (1957) was used for testing differences among least squares means (using the inverse coefficient matrix). The differences were considered significant, if

$$(X_i - X_j)\sqrt{\frac{2}{(C^{ii} + C^{jj} + 2C^{ij})}} > \sigma e Z p n_2$$

Where
X_i and X_j are the least squares means for i^{th} and j^{th} treatment and C^{ii}, C^{jj} and C^{ij} are diagonal and off-diagonal elements in the inverse of coefficient matrix in the least squares normal equations.

Results and Discussion
The data structure, least squares mean (LSM), standard error (SE) and effect of genetic and non-genetic factors for different first lactation weekly test day milk yields under study are shown in Table 1. The number of animals for different individual weekly test day milk yields varied due to the differences in their lactation length. The overall least squares means of different individual weekly test day milk yields varied from 3.58 ± 0.12 kg (WTD1) to 7.47 ± 0.29 kg (WTD9). Sohal (2016) [8] found least square means of fortnightly test day milk yields ranged from 3.85 kg (Test day-21) to 8.40 kg (Test day-2) in Rathi cattle. Nehara (2019) [6] reported overall least square means of fortnightly test day milk yields varied from 3.83 ± 0.136 kg (FTD21) to 6.98 ± 0.127kg (FTD4) in Rathi cattle. Thorat and Thombre (2019) [9] found overall least square mean of weekly test day milk yield varied from 1.35 ± 0.08 kg to 7.52 ± 0.08 kg during 43 and 6th week, respectively in Holdeo cattle. Dongre *et al.* (2011) [3] found overall least squares means of different individual weekly test day milk yields varied from 5.16 ± 0.14 kg (WTD 1) to 7.78 ± 0.17 kg (WTD7) in Sahiwal cattle.

Table 1: Least squares means with standard errors for individual first lactation weekly test day milk yields (kg) in Tharparkar cattle

Overall	WTD1	WTD2	WTD3	WTD4	WTD5	WTD6	WTD7
	3.58 ± 0.12	4.93 ± 0.18	5.81 ± 0.24	6.47 ± 0.24	6.76 ± 0.25	6.86 ± 0.25	7.16 ± 0.27
Sire	*	*	NS	NS	NS	NS	NS
Season of calving	NS	NS	NS	NS	*	**	NS
S1	3.45 ± 0.16	4.82 ± 0.24	5.49 ± 0.30	6.40 ± 0.31	6.62 ± 0.32[a]	6.97 ± 0.32[ab]	7.11 ± 0.35
S2	3.90 ± 0.15	5.23 ± 0.23	6.24 ± 0.29	6.76 ± 0.30	7.51 ± 0.32[b]	7.84 ± 0.31[b]	7.84 ± 0.34
S3	3.39 ± 0.26	4.74 ± 0.39	5.69 ± 0.51	6.22 ± 0.52	6.13 ± 0.55[a]	5.75 ± 0.54[a]	6.50 ± 0.59
Period of calving	NS	NS	NS	NS	NS	NS	NS
P1	3.48 ± 0.34	4.7 ± 0.51	6.5 ± 0.66	6.84 ± 0.68	7.56 ± 0.71	7.24 ± 0.70	7.98 ± 0.76
P2	3.34 ± 0.27	4.56 ± 0.41	4.88 ± 0.53	6.13 ± 0.54	6.20 ± 0.57	6.61 ± 0.57	6.93 ± 0.61
P3	3.92 ± 0.40	5.56 ± 0.61	6.04 ± 0.79	6.41 ± 0.81	6.50 ± 0.85	6.72 ± 0.84	6.53 ± 0.91
Regression of WTD on AFC	NS	NS	NS	NS	NS	*	NS
REGSN	-0.00007 ± 0.00039	-0.00006 ± 0.00059	0.00008 ± 0.00072	0.00058 ± 0.00074	0.0011 ± 0.0007	0.0018 ± 0.00079	0.001 ± 0.00082

* Significant at 1% level ($P \leq 0.01$), * Significant at 5% level ($P \leq 0.05$); NS = non-significant
Mean with different superscript differ significantly

Overall	WTD8	WTD9	WTD10	WTD11	WTD12	WTD13	WTD14
	7.20 ± 0.27	7.47 ± 0.29	7.35 ± 0.28	7.16 ± 0.27	7.19 ± 0.27	7.08 ± 0.25	6.93 ± 0.25
Sire	NS	NS	NS	NS	NS	NS	NS
Season of calving	NS	NS	NS	NS	NS	NS	NS
S1	7.09 ± 0.35	7.37 ± 0.37	7.40 ± 0.36	7.20 ± 0.35	7.05 ± 0.34	7.18 ± 0.33	7.08 ± 0.35
S2	7.80 ± 0.34	8.03 ± 0.36	7.77 ± 0.35	7.44 ± 0.35	7.52 ± 0.34	7.74 ± 0.32	7.56 ± 0.31
S3	6.71 ± 0.59	7.01 ± 0.62	6.88 ± 0.61	6.82 ± 0.60	6.99 ± 0.58	6.30 ± 0.55	6.12 ± 0.54
Period of calving	NS	NS	NS	NS	NS	NS	NS
P1	8.23 ± 0.77	8.17 ± 0.81	8.56 ± 0.79	8.26 ± 0.78	7.88 ± 0.75	7.47 ± 0.72	7.79 ± 0.70
P2	7.00 ± 0.62	7.39 ± 0.65	7.09 ± 0.64	6.77 ± 0.63	6.85 ± 0.61	6.96 ± 0.58	6.90 ± 0.57
P3	6.37 ± 0.91	6.86 ± 0.96	6.39 ± 0.94	6.43 ± 0.93	6.84 ± 0.90	6.80 ± 0.85	6.07 ± 0.84
Regression of WTD on AFC	NS	NS	NS	NS	NS	NS	NS
REGSN	0.00127 ± 0.00083	0.00154 ± 0.00086	0.00136 ± 0.00084	0.00128 ±0.00080	0.00112 ± 0.00079	0.00121 ± 0.00076	0.00115± 0.00076

NS = non significant

Overall	**WTD15**	**WTD16**	**WTD17**	**WTD18**	**WTD19**	**WTD20**	**WTD21**
	6.89 ± 0.26	6.64 ± 0.25	6.54 ± 0.24	6.43 ± 0.21	6.41 ± 0.19	6.47 ± 0.19	6.39 ± 0.21
Sire	NS	NS	NS	NS	NS	NS	NS
Season of calving	NS	NS	NS	*	*	NS	NS
S1	7.07 ± 0.33	6.79 ± 0.32	7.09 ± 0.31	6.92 ± 0.27[b]	6.8 ± 0.25[b]	6.72 ± 0.25	6.65 ± 0.26
S2	7.41 ± 0.32	7.13 ± 0.32	6.90 ± 0.31	6.90 ± 0.26[b]	6.79 ± 0.25[b]	6.84 ± 0.25	6.72 ± 0.26
S3	6.21 ± 0.56	5.98 ± 0.55	5.62 ± 0.53	5.45 ± 0.46[a]	5.63 ± 0.43[a]	5.84 ± 0.43	5.81 ± 0.45
Period of calving	NS	NS	NS	NS	*	NS	NS
P1	7.58 ± 0.72	7.88 ± 0.71	7.49 ± 0.69	7.49 ± 0.60	7.68 ± 0.56[a]	6.95 ± 0.55	7.15 ± 0.58
P2	6.47 ± 0.58	6.56 ± 0.57	6.50 ± 0.55	5.86 ± 0.48	5.90 ± 0.45[ab]	6.50 ± 0.45	6.45 ± 0.47
P3	6.63 ± 0.86	5.45 ± 0.85	5.63 ± 0.82	5.93 ± 0.71	5.63 ± 0.66[a]	5.95 ± 0.66	5.58 ± 0.69
Regression of WTD on AFC	NS	NS	NS	NS	NS	*	NS
REGSN	0.001342 ± 0.000764	0.001661 ± 0.000760	0.001355 ± 0.000746	0.001316 ± 0.000698	0.001424 ± 0.000669	0.001738 ± 0.000611	0.001520 ± 0.000644

* Significant at 5% level ($P \leq 0.05$); NS = non significant
Mean with different superscript differ significantly

Overall	**WTD22**	**WTD23**	**WTD24**	**WTD25**	**WTD26**	**WTD27**	**WTD28**
	6.17 ± 0.23	6.05 ± 0.23	5.79 ± 0.23	5.74 ± 0.21	5.68 ± 0.20	5.63 ± 0.20	5.46 ± 0.19
Sire	NS	NS	NS	NS	NS	NS	NS
Season of calving	NS	NS	NS	*	NS	NS	NS
S1	6.64 ± 0.29	6.46 ± 0.29	6.08 ± 0.29	5.96 ± 0.27[ab]	5.89 ± 0.26	5.81 ± 0.26	5.66 ± 0.26
S2	6.31 ± 0.29	6.51 ± 0.29	6.26 ± 0.29	6.30 ± 0.27[b]	6.18 ± 0.26	6.07 ± 0.26	5.94 ± 0.25
S3	5.53 ± 0.49	5.16 ± 0.50	5.02 ± 0.49	4.96 ± 0.45[a]	4.96 ± 0.43	4.98 ± 0.43	4.76 ± 0.43
Period of calving	NS	NS	NS	NS	NS	NS	NS
P1	6.67 ± 0.64	6.31 ± 0.64	6.17 ± 0.64	6.11 ± 0.59	5.91 ± 0.57	6.18 ± 0.57	5.97 ± 0.56
P2	6.12 ± 0.51	5.66 ± 0.51	5.59 ± 0.51	5.40 ± 0.47	5.34 ± 0.45	5.32 ± 0.45	5.05 ± 0.44
P3	5.69 ± 0.77	6.17 ± 0.77	5.60 ± 0.77	5.69 ± 0.71	5.78 ± 0.68	5.37 ± 0.68	5.34 ± 0.67
Regression of WTD on AFC	NS	NS	**	*	*	*	*
REGSN	0.002027 ± 0.000693	0.002039 ± 0.000696	0.002561 ± 0.000701	0.002158 ± 0.00065	0.001850 ± 0.000628	0.001809 ± 0.000642	0.001631 ± 0.000663

** Significant at 1% level ($P \leq 0.01$), * Significant at 5% level ($P \leq 0.05$); NS = non significant
Mean with different superscript differ significantly

Overall	**WTD29**	**WTD30**	**WTD31**	**WTD32**	**WTD33**	**WTD34**	**WTD35**
	5.25 ± 0.20	5.23 ± 0.20	5.04 ± 0.21	5.04 ± 0.20	4.91 ± 0.22	4.74 ± 0.20	4.58 ± 0.22
Sire	NS	*	*	**	**	**	*
Season of calving	NS	NS	NS	NS	NS	NS	NS
S1	5.44 ± 0.26	5.31 ± 0.27	5.00 ± 0.28	5.09 ± 0.28	5.00 ± 0.30	4.75 ± 0.28	4.40 ± 0.29
S2	5.68 ± 0.26	5.64 ± 0.26	5.48 ± 0.27	5.31 ± 0.26	5.25 ± 0.28	4.97 ± 0.27	5.04 ± 0.30
S3	4.61 ± 0.43	4.74 ± 0.44	4.61 ± 0.46	4.70 ± 0.44	4.48 ± 0.47	4.49 ± 0.44	4.28 ± 0.46
Period of calving	NS	NS	*	*	NS	**	NS
P1	6.44 ± 0.57	6.27 ± 0.58	6.49 ± 0.60[b]	6.55 ± 0.58[a]	5.66 ± 0.62	5.94 ± 0.59[b]	5.37 ± 0.64
P2	4.85 ± 0.45	4.53 ± 0.46	4.11 ± 0.48[a]	4.32 ± 0.46[ab]	3.96 ± 0.49	3.65 ± 0.46[a]	3.89 ± 0.51
P3	4.44 ± 0.68	4.88 ± 0.69	4.49 ± 0.72[ab]	4.23 ± 0.69[a]	5.11 ± 0.75	4.62 ± 0.70[ab]	4.46 ± 0.75
Regression of WTD on AFC	*	NS	*	*	*	*	**
REGSN	0.00168 ± 0.00067	0.00148 ± 0.00068	0.00157 ± 0.00071	0.00138 ± 0.00068	0.00135 ± 0.00073	0.00146 ± 0.00073	0.00138 ± 0.00070

** Significant at 1% level ($P \leq 0.01$), * Significant at 5% level ($P \leq 0.05$); NS = non significant
Mean with different superscript differ significantly

Overall	**WTD36**	**WTD37**	**WTD38**	**WTD39**	**WTD40**	**WTD41**	**WTD42**	**WTD43**
	4.48 ± 0.23	4.35 ± 0.25	4.52 ± 0.24	4.46 ± 0.26	4.65 ± 0.22	4.33 ± 0.22	4.29 ± 0.28	3.68 ± 0.24
Sire	NS	NS	NS	NS	NS	NS	NS	NS
Season of calving	NS	NS	NS	NS	NS	*	NS	NS
S1	4.46 ± 0.31	4.55 ± 0.33	4.72 ± 0.33	4.63 ± 0.35	4.51 ± 0.28	4.41 ± 0.28[ab]	3.95 ± 0.32	3.27 ± 0.30
S2	5.04 ± 0.32	4.75 ± 0.34	4.76 ± 0.32	4.92 ± 0.35	5.25 ± 0.30	4.96 ± 0.30[b]	4.51 ± 0.32	3.93 ± 0.27
S3	3.94 ± 0.47	3.73 ± 0.51	4.06 ± 0.49	3.71 ± 0.52	4.18 ± 0.44	3.60 ± 0.44[a]	4.39 ± 0.61	3.81 ± 0.52
Period of calving	*	NS	NS	NS	NS	NS	NS	*
P1	5.68 ± 0.67[b]	4.90 ± 0.78	5.40 ± 0.76	5.29 ± 0.80	4.85 ± 0.64	4.71 ± 0.64	5.71 ± 0.72	5.34 ± 0.62[c]
P2	3.43 ± 0.53[a]	3.73 ± 0.60	4.24 ± 0.59	4.28 ± 0.63	4.64 ± 0.50	4.88 ± 0.50	4.12 ± 0.54	3.69 ± 0.45[b]
P3	4.32 ± 0.78[ab]	4.41 ± 0.85	3.89 ± 0.85	3.69 ± 0.90	4.45 ± 0.72	3.39 ± 0.72	3.03 ± 0.78	1.98 ± 0.67[a]
Sire	NS	NS	NS	NS	NS	NS	NS	NS
Regression of WTD on AFC	NS	NS	NS	NS	NS	*	NS	NS
REGSN	0.0012 ± 0.0007	0.0012 ± 0.0007	0.0005 ± 0.0006	0.0006 ± 0.0007	-0.00004 ± 0.00059	0.00035 ± 0.00065	0.00003 ± 0.00065	-0.00026 ± 0.00067

** Significant at 1% level ($P \leq 0.01$), * Significant at 5% level ($P \leq 0.05$); NS = non significant
Mean with different superscript differ significantly

Factor affecting first lactation weekly test day milk yields

Genetic factor

Effect of sire

The effect of sire was statistically highly significant ($P \leq 0.01$) effect on weekly test day milk yields *viz*. WTD32, WTD33, WTD34 and significant ($P \leq 0.05$) effect on weekly test day milk yields namely WTD1, WTD2, WTD30, WTD31, WTD35. However, non significant effect has been observed on other test day milk yields (Table 1).

Non-genetic factors

Effect of season of calving

The season of calving had statistically highly significant ($P \leq 0.01$) effect on weekly test day milk yields *viz*. WTD6 and significant ($P \leq 0.05$) effect has been found on weekly test day milk yields namely WTD5, WTD18, WTD19, WTD25, WTD41. However, non significant effect has been observed on other test days (Table 4.5). Dongre (2012) [2] reported that season of calving had statistically highly significant ($P \leq 0.01$) effect on weekly test day milk yields *viz*. WTD5 to WTD13 and WTD38 and significant ($P \leq 0.05$) effect has been found on weekly test day milk yields namely WTD16, WTD17, WTD18, WTD19, WTD20, WTD22, WTD25, WTD28, WTD33, WTD35 and WTD41. However, non significant effect has been also observed on remaining test day milk yields. Throat and Thombre (2019) [9] found significant ($P \leq 0.05$) influence of season of calving on weekly test day milk yields as WTD5 to WTD9, WTD11 to WTD13 and WTD43 and WTD43 However, non significant effect was observed on WTD1 to WTD4, WTD10 and WTD14 to WTD41 in Holdeo cattle.

Effect of period of calving

The period of calving had statistically highly significant ($P \leq 0.01$) effect on weekly test day milk yields *viz*. WTD34 and significant ($P \leq 0.05$) effect has been found on weekly test day milk yields namely WTD19, WTD31, WTD32, WTD36, WTD43. However, non significant effect has been observed on other test days (Table 4.5). Dongre *et al.* (2011) [3] found the effect of periods of calving on all the weekly test day yields was highly significant ($P \leq 0.01$) in Sahiwal cattle. Throat and Thombre (2019) [9] found highly significant ($P< 0.01$) influence of period of calving on all 43 weekly test day milk yields in Holdeo cattle. Nehara (2019) [6] observed highly significant ($P \leq 0.01$) effect of period of calving on fortnightly test day milk yields FTD1 to FTD18, FTD20 and significant effect ($P \leq 0.05$) on FTD19.

Regression of age at first calving

The least square analysis of variance of data revealed that regression of AFC on weekly test day milk yields was highly significant for WTD24, WTD 35; significant for WTD 6, WTD 20, WTD 25, WTD 26, WTD 27, WTD 28, WTD 29, WTD 31, WTD 32, WTD 33, WTD 34, WTD 41. However, non significant effect has been observed on other test day milk yields (Table1).

Throat and Thombre (2019) [9] found that the variation due to age at first calving group was significant ($P<0.01$) on WTD 3 to WTD 5 and, non-significant on rest of the weekly test day milk yield in Holdeo cattle. Rose (2008) [7] observed that the age group had no significant effect on monthly test day milk yields in Karan fries cattle. Monalisha *et al*. (2010) [5] reported significant effect of age groups on the monthly test day milk records (35^{th} day, 155^{th} day and 275^{th} day) in Sahiwal cattle. Kokate *et al*. (2013) [4] reported effect of age at first calving on monthly test day-2 and monthly test day-3 as significant and on remaining monthly test day milk yields, it was non-significant. Nehara (2019) [6] revealed that regression of fortnightly test day milk yields on AFC were significant on fortnightly test day milk yields (FTD2 and FTD3) and non-significant on remaining fortnightly test day milk yields.

Conclusions

The overall least squares means for 43 individual weekly test day milk yields varied from 3.58 ± 0.12 kg (WTD1) to 7.47 ± 0.29 kg (WTD9). The season of calving had highly significant ($P \leq 0.01$) effect on WTD6. However, significant ($P \leq 0.05$) effect was found on WTD5, WTD18, WTD19, WTD25, and WTD41. The period of calving had highly significant ($P \leq 0.01$) effect on WTD34. However, significant ($P \leq 0.05$) effect was found on WTD19, WTD31, WTD32, WTD36, and WTD43. Non significant effect was observed on all remaining weekly test days. The sire had highly significant ($P \leq 0.01$) effect on WTD32, WTD33 and WTD34. However, significant ($P \leq 0.05$) effect was found on WTD1, WTD2, WTD30, WTD31, and WTD35.

The regression of age at first calving was found highly significant ($P \leq 0.01$) on WTD24 and WTD35. However, significant ($P \leq 0.05$) effect was found on WTD6, WTD20, WTDY25-WTD29, WTD31-WTD34, and WTD41.

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