RESEARCH ARTICLE
Open Access

Estimation of genetic parameters of weekly test-day milk yields and first lactation 305-day milk yield in Murrah buffaloes

Saroj Kumar Sahoo, Avtar Singh, A. K. Gupta, A. K. Chakravarty, Manvendra Singh and G. S. Ambhore

Dairy Cattle Breeding Division, National Dairy Research Institute, Karnal, Haryana, India.
Corresponding author: Saroj Kumar Sahoo, email: sarojvet6804@gmail.com,
AS: avtar54@gmail.com, AKG: guptaak2009@gmail.com, AKC: ak_chakravarty@yahoo.co.in,
MS: manav21vet@gmail.com, GSA: drgsambhore@gmail.com
Received: 26-09-2014, **Revised:** 11-11-2014, **Accepted:** 17-11-2014, **Published online:** 16-12-2014

doi: 10.14202/vetworld.1094-1098. **How to cite this article:** Sahoo SK, Singh A, Gupta AK, Chakravarty AK, Singh M, Ambhore GS (2014) Estimation of genetic parameters of weekly test-day milk yields and first lactation 305-day milk yield in Murrah buffaloes, *Veterinary World* 7(12): 1094-1098.

Abstract

Aim: The aim was to estimate genetic parameters of weekly test-day (TD) milk yields and first lactation 305-day milk yield (FL305DY) in Murrah buffaloes.

Materials and Methods: The data on 39059 weekly test-day milk yield (WTDY) records during first lactation of 961 Murrah buffaloes calved from 1977 to 2012 and sired by 101 bulls maintained in an organized farm at National Dairy Research Institute, Karnal was analyzed to study the effect of genetic and non-genetic factors. Least squares maximum likelihood program was used to estimate genetic and non-genetic parameters affecting WTDY and FL305DY. Heritability was estimated using paternal half-sib correlation method. The genetic and phenotypic correlations among WTDY and 305-day milk yield was calculated from the analysis of variance and covariance among sire groups.

Results: The least squares means for FL305DY was found to be 1853.49±15.88 Kg. The least squares means of overall WTDY ranged from 2.44±0.07 kg (TD-43) to 7.95±0.06 kg (TD-8). Effect of period, season and age at first calving groups was found to be highly significant ($p<0.01$), significant ($p<0.05$) and non-significant on FL305DY, respectively. The h^2 estimate of FL305DY was 0.25±0.09. The estimates of phenotypic and genetic correlations between 305-day milk yield and different WTDY ranged from 0.52 to 0.84 and from 0.19 to 0.98, respectively.

Conclusions: Our study showed that the effect of period of calving was highly significant ($p<0.01$) on FL305DY as well as all the WTDY. The estimates of phenotypic and genetic correlations were generally higher in the middle segment of lactation suggesting that these TD yields could be used as the selection criteria for early evaluation and selection of animals.

Keywords: genetic factors, Murrah buffalo, non-genetic factors, test-day milk yields.

Introduction

Today in many countries of different continents, test-day (TD) milk yield records are employed in genetic evaluations instead of 305-day total lactation milk yield of animals. India has about 51 million milch buffaloes [1] contributing about 51% [2] of the total milk produced in the country. In order to find out an alternative to daily milk yield recording, which is a costly and time consuming proposition under field conditions, some studies have been made in the past in buffaloes on TD milk yields [3,4]. Various advantages of using TD milk yield records are individual test date effects and the number of records per animal as well as the interval between records can be accounted for reducing the generation interval, better adjustment of non-genetic factors influencing the milk yield leading to more accurate genetic evaluation.

Murrah is the most important buffalo breed with superior genetic potential for milk production. Although TD milk yield records offer greater advantage compared to 305-day milk yield in selection schemes, information on estimation of genetic parameters based on TD records particularly, weekly records are limited.

The present investigation was undertaken with the objective to study the influence of various non-genetic and genetic factors on weekly TD and first lactation 305 day milk yields (FL305DY) in Murrah buffalo.

Materials and Methods

Data

A total of 39059 weekly TD milk yield (WTDY) records during first lactation of 961 Murrah buffaloes calved during 1977-2012 at the National Dairy Research Institute, Karnal were collected from the history-cum-pedigree sheets and daily milk yield recording registers. The traits considered were WTDY and FL305DY. Culling in the middle of lactation, abortion, still-birth or any other pathological causes affecting the lactation yield were considered as abnormalities and thus, such records were not taken for the study. Records of buffaloes with <800 kg of milk production and <100 days lactation length were not considered in the present investigation. To ensure the normal distribution, the outliers were removed, and data within the range of mean ± 3 standard deviation were only considered for the study. The data were analyzed to study the effect of non-genetic factors (season, period and age at first calving [AFC] groups) on 43 WTDY records (from 6^{th} day, 13^{th}, 20^{th}, and 300^{th} day of lactation) and FL305DY records. The data were classified into different seasons, periods and AFC groups. Each year was divided into 4 seasons on the basis of rainfall, temperature and humidity over the years - winter (December - March); summer (April - June); rainy (July-September); and autumn (October - November). The data spread over 36 years (1977-2012) were classified into 12 periods. The data was classified into 5 AFC sub-groups (<1120, 1120-1280, 1281-1440, 1441-1600 and >1600 days) using Sturges formula [5].

Statistical methods

Least squares maximum likelihood program of Harvey [6] was used to estimate and study the effect of genetic and non-genetic factors on WTDY and FL305DY records of Murrah buffaloes:

$$Y_{ijklm} = \mu+S_i+P_j+A_k+B_l+e_{ijklm}$$

Where, Y_{ijklm} = Observation on the m^{th} individual in i^{th} season, j^{th} period, k^{th} AFC group and sired by l^{th} bull.

μ=Overall population mean
S_i=Effect of i^{th} season
P_j=Effect of j^{th} period
A_k=Effect of k^{th} AFC group
B_l=Effect of l^{th} bull (Sire)
e_{ijklm}=Random error, NID (0, σ^2_e)

Duncan's multiple range test as modified by Kramer [7] was used for testing differences among least squares means.

Estimation of heritability

Paternal half-sib correlation method [8] was used to estimate the heritability of different characters and their genetic correlations. The sires with five or more no of progeny were included for the estimation of heritability. The data adjusted for significant effects of non-genetic factors was used for estimation of heritability. The standard error of heritability was estimated as per Swiger *et al*. [9].

Genetic and phenotypic correlations

The genetic and phenotypic correlations among WTDY and 305-day milk yield was calculated from the analysis of variance and covariance among sire groups as given by Becker [8]. The standard error of genetic and phenotypic correlations was obtained according to formula given by Panse and Sukhatme [10].

Results and Discussion

The least squares mean along with their standard errors for WTDY and FL305DY are presented in Table-1. The highest WTDY was observed in WTDY-8 (7.95 kg) and the lowest was observed in WTDY-43 (2.44 kg). In general, WTDY increased till WTDY-8 and thereafter a gradual decline was noticed till the end of lactation. The average 305-day or less milk yield was 1853.49±15.88 kg. Chakraborty *et al*. [3] also observed that the average 305-day milk yield was 1818.06±22.46 kg in Murrah buffalo. However, Patil *et al*. [11] reported the average 305-day milk yield being 1750.91±28.62 kg in Murrah buffalo.

Effect of non-genetic factors

Season

The effect of season of calving was highly significant ($p<0.01$) up to WTDY-12; significant ($p<0.05$) for FL305DY, WTDY-13, WTDY-14 and WTDY-15. Non-significant effect of season of calving was observed afterwards (Table-2). Kumar *et al*. [12] reported significant effect and Chakraborty *et al*. [3] reported non-significant effect season of calving on monthly TD milk yields in Murrah buffaloes.

Period

Highly significant effect ($p<0.01$) of the period of calving was observed for FL305DY as well as different weekly TD yields (Table-2). Rana [13], Kumar *et al*. [12] and Chakraborty *et al*. [3] also reported highly significant effect of period of calving on the monthly TD milk yields in Murrah buffaloes.

AFC groups

The effect of AFC groups on WTDY presented in Table-2. The effect was significant up to the middle of the lactation after which the effect was non-significant. Non-significant effect of AFC groups was also observed on FL305DY. Rana [13] reported the effect of AFC on monthly TD milk yields to be significant whereas Katneni [14] observed that the effect was not significant on all weekly TD yields except WTDY-43 in first lactation of Murrah buffaloes.

Genetic and phenotypic parameters

Heritability

The heritability of the WTDY is presented in Table-3. The h^2 estimate of WTDY was the lowest (0.02±0.07) for WTDY-43 and highest (0.30±0.1) for WTDY-18. Madad *et al*. [15] reported that the h^2 estimate for monthly TD milk yield ranged from 0.09 to 0.33 in Iranian buffaloes. The h^2 estimate of FL305DY was 0.25±0.09. Gupta [16] and Chakraborty *et al*. [3] reported comparatively higher h^2 estimate of FL305DY as 0.33±0.16 and 0.29±0.25, respectively.

Genetic and phenotypic correlations

The estimates of genetic and phenotypic correlations among 305-day milk yield and different WTDY are presented in Table-4. The phenotypic correlations between 305-day milk yield and WTDY were highly significant ($p<0.01$). The estimates of genetic and phenotypic correlations between 305-day milk yield and WTDY ranged from 0.19 to 0.98 and from 0.52

Table 1: Least squares means of FL305DY and different WTDY (in kg).

Trait	Mean±SE	Trait	Mean±SE	Trait	Mean±SE	Trait	Mean±SE
WTDY-1	3.93±0.05	WTDY-12	7.74±0.06	WTDY-23	6.86±0.05	WTDY-34	5.19±0.07
WTDY-2	5.52±0.06	WTDY-13	7.69±0.06	WTDY-24	6.76±0.05	WTDY-35	4.94±0.07
WTDY-3	6.49±0.06	WTDY-14	7.64±0.05	WTDY-25	6.64±0.05	WTDY-36	4.66±0.07
WTDY-4	7.17±0.06	WTDY-15	7.59±0.05	WTDY-26	6.52±0.06	WTDY-37	4.40±0.08
WTDY-5	7.60±0.06	WTDY-16	7.52±0.05	WTDY-27	6.39±0.06	WTDY-38	4.10±0.08
WTDY-6	7.81±0.06	WTDY-17	7.43±0.05	WTDY-28	6.23±0.06	WTDY-39	3.80±0.08
WTDY-7	7.92±0.06	WTDY-18	7.34±0.05	WTDY-29	6.09±0.06	WTDY-40	3.47±0.08
WTDY-8	7.95±0.06	WTDY-19	7.28±0.05	WTDY-30	5.93±0.06	WTDY-41	3.13±0.08
WTDY-9	7.90±0.06	WTDY-20	7.17±0.05	WTDY-31	5.77±0.06	WTDY-42	2.78±0.07
WTDY-10	7.90±0.06	WTDY-21	7.04±0.05	WTDY-32	5.57±0.06	WTDY-43	2.44±0.07
WTDY-11	7.79±0.06	WTDY-22	6.97±0.05	WTDY-33	5.40±0.06	FL305DY	1853.49±15.88

FL305DY=First lactation 305-day milk yield, WTDY=Weekly test day milk yields, TD=Test-day, SE=Standard error

Table 2: Mixed model ANOVA showing mean sum of squares for factors affecting WTDY and FL305DY.

Traits	Sire	Season	Period	AFC group	Error
df	100	3	11	4	842
WTDY-1	2.97**	22.6**	7.89**	4.96*	1.89
WTDY-2	3.44**	32.23**	8.31**	7.52*	2.42
WTDY-3	3.67**	44.09**	9.82**	10.22**	2.36
WTDY-4	3.78**	42.26**	9.36**	10.26**	2.34
WTDY-5	3.41**	34.84**	12.65**	10.53**	2.31
WTDY-6	3.17**	26.76**	11.82**	10.01**	2.26
WTDY-7	3.77**	24.79**	13.67**	11.95**	2.28
WTDY-8	3.69**	32.32**	14.4**	9.71**	2.24
WTDY-9	3.5**	22.43**	14.02**	7.78**	2.23
WTDY-10	3.37**	19.3**	12.78**	7.72**	2.27
WTDY-11	3.36**	13.0**	13.76**	7.45**	2.11
WTDY-12	3.01**	8.74**	13.84**	8.26**	2.08
WTDY-13	3.27**	6.07*	12.03**	8.44**	1.98
WTDY-14	2.95**	5.39*	10.62**	6.87**	1.91
WTDY-15	3.25**	1.68*	9.91**	8.96**	1.96
WTDY-16	3.0**	0.93^{NS}	9.91**	6.73**	1.94
WTDY-17	3.24**	0.65^{NS}	10.92**	6.16*	1.94
WTDY-18	3.58**	0.35^{NS}	9.96**	3.3*	2.07
WTDY-19	3.09**	0.12^{NS}	9.57**	3.05*	2.02
WTDY-20	2.82**	0.28^{NS}	7.95**	3.37^{NS}	1.97
WTDY-21	2.84**	0.62^{NS}	9.17**	4.94*	1.96
WTDY-22	3.14**	0.69^{NS}	7.96**	2.85^{NS}	2.07
WTDY-23	3.38**	1.27^{NS}	7.87**	2.9^{NS}	2.14
WTDY-24	3.12**	2.16^{NS}	7.69**	3.11^{NS}	2.23
WTDY-25	3.29**	5.44^{NS}	6.93**	3.09^{NS}	2.33
WTDY-26	3.43*	7.88*	8.27**	2.63^{NS}	2.49
WTDY-27	3.52*	7.43*	8.75**	2.25^{NS}	2.69
WTDY-28	3.62*	6.31^{NS}	8.14**	2.2^{NS}	2.72
WTDY-29	4.31**	7.04^{NS}	7.77**	1.59^{NS}	2.81
WTDY-30	4.3**	6.24^{NS}	7.36**	1.99^{NS}	2.95
WTDY-31	4.8**	4.85^{NS}	6.72*	1.86^{NS}	3.19
WTDY-32	4.55*	5.19^{NS}	6.24*	1.6^{NS}	3.37
WTDY-33	4.81*	5.03^{NS}	6.59*	1.75^{NS}	3.49
WTDY-34	5.4**	4.49^{NS}	6.09^{NS}	1.88^{NS}	3.65
WTDY-35	5.92**	4.55^{NS}	7.21*	1.79^{NS}	3.99
WTDY-36	5.96*	2.05^{NS}	8.14*	1.25^{NS}	4.52
WTDY-37	6.22^{NS}	3.7^{NS}	8.45^{NS}	2.28^{NS}	4.95
WTDY-38	6.24^{NS}	4.51^{NS}	10.22*	2.17^{NS}	5.17
WTDY-39	6.38^{NS}	4.55^{NS}	11.01*	2.15^{NS}	5.16
WTDY-40	6.14^{NS}	4.61^{NS}	12.11**	1.43^{NS}	5.07
WTDY-41	5.9^{NS}	4.34^{NS}	14.3**	2.16^{NS}	5.02
WTDY-42	5.31^{NS}	4.02^{NS}	15.76**	3.18^{NS}	4.74
WTDY-43	4.53^{NS}	4.86^{NS}	12.68**	2.48^{NS}	4.36
FL305DY	279429.93**	536070.82*	688392.12**	282918.88^{NS}	177545.5

*$p\leq0.05$, **$p\leq0.01$, NS=Non significant, FL305DY=First lactation 305-day milk yield, WTDY=Weekly test day milk yields, AFC=Age at first calving

to 0.84, respectively and the estimates were higher in the middle segment of lactation. Rana [13] reported that among monthly TD milk yields and 305-day milk yield, the genetic correlations were close to unity and

Table-3: Heritability estimates along with their standard error for FL305DY and different WTDY.

Traits	h²±SE	Traits	h²±SE	Traits	h²±SE	Traits	h²±SE
FL305DY	0.25±0.09	WTDY-11	0.25±0.09	WTDY-22	0.22±0.09	WTDY-33	0.17±0.08
WTDY-1	0.25±0.09	WTDY-12	0.19±0.09	WTDY-23	0.25±0.09	WTDY-34	0.21±0.09
WTDY-2	0.18±0.09	WTDY-13	0.28±0.09	WTDY-24	0.17±0.09	WTDY-35	0.21±0.09
WTDY-3	0.24±0.09	WTDY-14	0.23±0.09	WTDY-25	0.18±0.09	WTDY-36	0.14±0.08
WTDY-4	0.26±0.09	WTDY-15	0.28±0.1	WTDY-26	0.17±0.08	WTDY-37	0.11±0.08
WTDY-5	0.21±0.09	WTDY-16	0.24±0.09	WTDY-27	0.14±0.08	WTDY-38	0.09±0.08
WTDY-6	0.18±0.09	WTDY-17	0.28±0.1	WTDY-28	0.15±0.08	WTDY-39	0.11±0.08
WTDY-7	0.28±0.1	WTDY-18	0.30±0.1	WTDY-29	0.23±0.09	WTDY-40	0.10±0.08
WTDY-8	0.28±0.1	WTDY-19	0.23±0.09	WTDY-30	0.20±0.09	WTDY-41	0.08±0.08
WTDY-9	0.24±0.09	WTDY-20	0.19±0.09	WTDY-31	0.22±0.09	WTDY-42	0.05±0.07
WTDY-10	0.21±0.09	WTDY-21	0.19±0.09	WTDY-32	0.16±0.09	WTDY-43	0.02±0.07

WTDY=Weekly test day milk yields, SE=Standard error, FL305DY=First lactation 305-day milk yield

Table-4: Genetic and phenotypic correlations among FL305DY and different WTDY.

Trait-1	Trait-2	Genetic correlations	Phenotypic correlations	Trait-1	Trait-2	Genetic correlations	Phenotypic correlations
FL305DY	WTDY-1	0.19±0.27	0.52±0.03	FL305DY	WTDY-23	0.96±0.05	0.83±0.02
	WTDY-2	0.39±0.25	0.56±0.03		WTDY-24	0.93±0.07	0.83±0.02
	WTDY-3	0.34±0.24	0.61±0.03		WTDY-25	0.90±0.08	0.83±0.02
	WTDY-4	0.46±0.20	0.64±0.02		WTDY-26	NE	0.84±0.02
	WTDY-5	0.54±0.20	0.67±0.02		WTDY-27	NE	0.83±0.02
	WTDY-6	0.79±0.13	0.72±0.02		WTDY-28	NE	0.83±0.02
	WTDY-7	0.85±0.10	0.73±0.02		WTDY-29	0.98±0.05	0.83±0.02
	WTDY-8	0.85±0.10	0.73±0.02		WTDY-30	0.93±0.07	0.83±0.02
	WTDY-9	0.87±0.09	0.76±0.02		WTDY-31	0.93±0.07	0.82±0.02
	WTDY-10	0.86±0.10	0.74±0.02		WTDY-32	0.90±0.09	0.81±0.02
	WTDY-11	0.84±0.10	0.77±0.02		WTDY-33	0.98±0.07	0.81±0.02
	WTDY-12	0.87±0.09	0.79±0.02		WTDY-34	0.97±0.06	0.81±0.02
	WTDY-13	0.94±0.07	0.78±0.02		WTDY-35	0.96±0.07	0.80±0.02
	WTDY-14	0.91±0.07	0.79±0.02		WTDY-36	0.88±0.11	0.79±0.02
	WTDY-15	0.96±0.06	0.81±0.02		WTDY-37	0.92±0.13	0.78±0.02
	WTDY-16	0.92±0.07	0.81±0.02		WTDY-38	0.94±0.16	0.75±0.02
	WTDY-17	0.93±0.06	0.81±0.02		WTDY-39	0.91±0.15	0.74±0.02
	WTDY-18	0.88±0.07	0.80±0.02		WTDY-40	NE	0.72±0.02
	WTDY-19	0.84±0.09	0.81±0.02		WTDY-41	NE	0.70±0.02
	WTDY-20	0.92±0.07	0.82±0.02		WTDY-42	NE	0.67±0.02
	WTDY-21	0.98±0.06	0.83±0.02		WTDY-43	NE	0.64±0.02
	WTDY-22	0.93±0.06	0.83±0.02				

*NE=Non estimable, FL305DY=First lactation 305-day milk yield, WTDY=Weekly test day milk yields

phenotypic correlations were quite high and positive (0.60-0.99) in Murrah buffaloes. Chakraborty *et al.* [3] reported that among monthly TD milk yields and 305-day milk yield, the genetic correlations ranged from 0.11 to 0.89 and corresponding phenotypic correlations ranged from −0.05 to −0.65 in Murrah buffaloes.

Conclusions

Our study showed that the effect of period of calving was highly significant ($p<0.01$) on FL305DY as well as all the WTDY. Season and AFC groups have significant effect up to middle of lactation. The h^2 estimate of FL305DY was 0.25±0.09 and it ranged from 0.02±0.07 (WTDY-43) to 0.30±0.1 (WTDY-18) for weekly TD yields. The estimates of phenotypic and genetic correlations of weekly TD yields with 305-day milk yield was generally higher in the middle segment of lactation suggesting that these TD yields could be used as the selection criteria for early evaluation and selection of animals.

Author's Contribution

AS, AKG and AKC designed the experiment. MS and GSA assisted SKS in data recording and literature collection. SKS did the data analysis and prepared the manuscript. All authors read and approved the final manuscript.

Acknowledgments

We sincerely thank the Director, National Dairy Research Institute, Karnal and Head, Dairy Cattle Breeding Division for providing necessary facilities for conducting this study. Financial support in form of DST-INSPIRE fellowship is duly acknowledged.

Competing Interests

The authors declare that they have no competing interests.

References

1. 19th livestock census. (2012) Available from: http://www.dahd.nic.in/dahd/WriteReadData/Livestock.pdf. Last accessed on

05-11-2014.
2. BAHS. (2013) Basic Animal Husbandry Statistics. Department of Animal Husbandry, Dairying and Fisheries. Ministry of Agriculture, Govt. of India.
3. Chakraborty, D., Dhaka, S.S., Pander, B.L., Yadav, A.S., Singh, S. and Malik, P.K. (2010) Prediction of lactation milk yield from test day records in Murrah buffaloes. *Indian J. Anim. Sci.,* 80(3): 244-245.
4. Singh, S. and Tailor, S.P. (2013) Prediction of 305 days first lactation milk yield from fortnightly test day and part yields. *Indian. J. Anim. Sci.,* 83(2): 166-169.
5. Sturges H.A. (1926) The choice of a class interval. *J. Am. Stat. Assoc.,* 21(153): 65-66.
6. Harvey, W.R. (1990) User's Guide for LSMLMW, Mixed Model Least-Squares and Maximum Likelihood Computer Programme. Ohio State University, Columbus, Mimeo.
7. Kramer, C.R. (1957) Extension of multiple range tests to group correlated means. *Biometrics,* 13: 13-18.
8. Becker, W.A. (1975) Manual of Quantitative Genetics. 3rd ed. Washington State University, Washington, USA.
9. Swiger, L.A., Harvey, W.R., Everson, D.O. and Gregory, K.E. (1964) The variance of interclass correlation involving group with one observation. *Biometrics,* 20: 818-826.
10. Panse, V.G. and Sukhatme, P.V. (1967) Statistical Methods for Agricultural Workers. Published by ICAR, New Delhi.
11. Patil, C.S., Chakravarty, A.K., Kumar, V., Sharma, R.K. and Kumar, P. (2012) Average performance of various first lactation 305-day and test day milk yield in Murrah buffaloes. *Indian J. Anim. Res.,* 46(3): 310-312.
12. Kumar, A., Gupta, J.P., Kaswan, S. and Lathwal, S.S. (2012) Non-genetic factors influencing monthly test day milk yield records in Murrah buffaloes. *Indian J. Field Vet.,* 8(1): 41-43.
13. Rana, J.S. (2008) Genetic evaluation of Murrah buffalo sires based on part lactation and test day milk yield records. Ph.D. Thesis Submitted to CH. Charan Singh University, Meerut (UP).
14. Katneni, V.K. (2007) Studies on genetic persistency of milk production in Murrah buffaloes. Ph.D. Thesis, NDRI, (Deemed University), Karnal, India.
15. Madad, M., Zader, N.G.H., Shadparvar, A.A. and Kianzad, D. (2013) Random regression models to estimate genetic parameters for test-day milk yield and composition in Iranian buffaloes. *Arch. Tierzuecht.,* 56(27): 12.
16. Gupta, J.P. (2009) Evolving selection criteria using growth and production traits in Murrah buffaloes. M.V.Sc. Thesis, NDRI, (Deemed University), Karnal, India.

****