The Haryana Veterinarian (June, 2023) **62(1),** 54-59 ISSN 0033-4359 (P) **Research Article**

GENETIC PARAMETERS OF PRODUCTION PERFORMANCE TRAITS IN MURRAH BUFFALOES

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ABSTRACT

The data of 662 Murrah buffaloes over 24 years (1996-2019) were collected from pedigree sheets maintained at Buffalo Research Centre (BRC), Department of LPM, LUVAS, Hisar to study the genetic parameter and influence of non-genetic factors on production traits. The least squares means of production traits under study *viz*. 305 Days Milk Yield (305 DMY), Peak Yield (PY), Lactation Length (LL), Dry Period (DP), Lactation Milk Yield (LMY), Wet Average (WA), Milk yield per day of Calving Interval (MCI) and Milk yield per day of age at Second Calving (MSC) were 2258.28±26.25 kg, 11.59±0.09 kg/day, 302.07±2.78 days, 148.18±3.32 days, 2357.56±30.52 kg, 7.86±0.07 kg/day, 5.57±0.06 kg/day and 1.33±0.02 kg/day, respectively. The heritability estimates in overall lactations for 305 DMY, PY, LL, DP, LMY and WA were 0.32±0.11, 0.05±0.09, 0.14±0.09, 0.22±0.10, 0.26±0.10 and 0.28±0.10, respectively. Period of calving had a significant (P<0.01) effect on 305 DMY, PY, LMY, WA and MCI and had a significant (P<0.05) effect on MSC. Significant (P<0.01) effect of season of calving was reported on 305 DMY, PY, LL, DP and LMY and significant effect at P<0.05 level on MSC. Highly significant (P<0.01) effect of parity was found on 305 DMY, PY, LL, DP, WA and MCI; and significant (P<0.05) effect found on LMY. Most of the traits showed low and negative genetic and phenotypic correlation with DP except 305 DMY and LL. Remaining all other traits had moderate to high positive correlation among themselves. This study revealed selection played a major role in improvement of production traits and selective breeding still important to improve further along with better management.

Keywords: Correlation, Genetic, Heritability, Production traits, Murrah buffaloes

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INTRODUCTION

India is the largest producer of milk in the world. Milk production in the country has grown at a compound annual growth rate of about 6.2% to reach 209.96 million tonnes in 2020-21 from 187 million tonnes in 2019. Livestock sector contributes 4.11% GDP and 25.6% of total Agriculture GDP (BAHS, 2019). There are many recognized buffalo breeds in India, but Murrah is the most important Indian breed and the most effective milk producer not only in India but also in Asia. The home tract of this breed is in Haryana and adjoining states of Punjab, UP and Delhi. Total buffalo population in the country is 109.85 million during 2019 (20th Livestock Census, 2019).

The success of any dairy farm depends upon efficient productive and reproductive performances of a dairy animal. Different genetic and non-genetic factors influence its performance potential. The economic worth of buffalo is primarily determined by the productive status of animal. Therefore, performance traits like 305-days milk yield, peak yield, lactation length, dry period, total lactation milk yield, wet average, milk yield per day of calving interval and milk yield per day of age at second calving of Murrah buffalo require immediate attention of breeders for their evaluation. Previously, many researchers including Chakraborty *et al.* (2010), Thiruvenkadan (2011), Kumar *et al.* (2014), Jamuna *et al.* (2015), Patil (2016) and Kaur *et al.* (2020) had worked on production traits of Murrah buffalo. The current study attempted to evaluate genetic parameters as well as non-genetic factors influencing production attributes in Murrah buffalo.

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MATERIALS AND METHODS

The data related to production traits were collected from pedigree sheets maintained at Buffalo Research Centre (BRC), Department of Livestock Production and Management, Lala Lajpat Rai University of Veterinary Sciences and Animal Husbandry, Hisar. Climatic condition of Hisar is sub-tropical in nature and is situated in semi-arid region. Geographically, Hisar is situated at 29° 10' N latitude, 75° 40' E longitude and 215.2 meters altitude. A total of 1336 production records pertinent to 662 Murrah buffaloes over a period of 24 years from 1996 to 2019 were recorded.

Assuming that there was not much variation in adjacent years, entire period of twenty-four years was divided into six periods, each consisting of four consecutive years *viz*. 1996-1999 (Period 1), 2000-2003 (Period 2), 2004-2007 (Period 3), 2008-2011 (Period 4), 2012-2015 (Period 5) and 2016-2019 (Period 6). Each year was further delineated into four seasons of calving according to the geo-climatic conditions in the area *viz*.; Summer (April to June), Monsoon (July to September), Autumn (October to November) and Winter (December to March). Data up to third parity was included in the present study.

Animals having lactation shorter than 150 days, suspected outliers on the basis of histograms and abnormal records like abortion, mastitis and chronic illness were excluded from present study. Completion of minimum one lactation in the herd for studying production traits was considered for those animals that have the information of their date of birth, date of first calving, date of disposal and subsequent calving. The collected performance traits were 305 Days Milk Yield, Peak Yield (PY), Lactation Length (LL), Dry Period (DP), Lactation Milk Yield (LMY), Wet average, Milk yield per day of calving interval (MCI) and Milk yield per day of age at second calving (MSC). MCI was calculated by dividing LMY by calving interval. MSC is daily outcome of milk yield up to the second calving interval. It was calculated by dividing the LMY by total age in days up to second calving. Wet average is ratio of LMY to the LL.

In order to overcome non-orthogonality of the data, least squares and maximum likelihood computer programmes (Harvey, 1990) using Henderson's method III (Henderson, 1953) were utilized to estimate the effect of various tangible factors on performance traits and to estimate genetic and phenotypic parameters. The following statistical model was used to explain the dependent variable:

$$Y_{ijklm} = \mu + S_i + P_j + N_k + A_l + e_{ijklm}$$

Where: Y_{ijklm} = dependent variable (m^{th} record of the individual belonging to ith sire, j^{th} period, k^{th} season and l^{th} parity); μ = overall population mean; S_i = random effect of ith sire (1 to n); P_j = fixed effect of j^{th} period of calving (1 to 6); N_k = fixed effect of i^{th} season of calving (1 to 4); A_l = fixed effect of lth parity (1, 2 and 3); e_{ijklm} = random residual assumed to be normally and independent distributed with mean zero and variance σ_e^2 .

RESULTS AND DISCUSSION

The analysis of variance and least squares means are given in table 1 and 2, respectively. The least squares mean of 305 DMY was 2258.28±26.25 kg which resembled with Kaur *et al.* (2020) valued as 2258±95.73 kg and close to 2229.87±93.70 kg estimated by Pawar *et al.* (2012). The least squares mean of PY was found 11.59±0.09 kg/day which was in accordance with finding of Kumar *et al.* (2017). Least squares mean value of LL was 302.07±2.78 days. Lower values were reported by Jamuna *et al.* (2015) and higher values were obtained by Jakhar *et al.* (2016) and Kaur *et al.* (2020). DP had the least squares mean values as 148.18±3.32 days which was lower than the values of Jakhar *et al.* (2016) and higher than the estimates of Jamal *et al.* (2018). The least squares mean of LMY was 2357.56 ±30.52 kg. Lower estimates were reported by Jakhar *et al.*

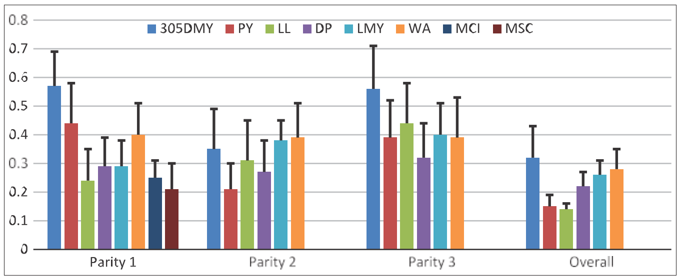

Fig. 1. Heritability estimates of production traits in different lactations

(2016) and Verma *et al.* (2017) and higher value was reported by Kaur *et al.* (2020). Least squares mean of WA was reported as 7.86±0.07 kg/day which is near to the value estimated by Jamuna *et al.* (2015). The least squares mean of MCI was 5.57±0.06 kg/day. Lower estimates were reported by Chakraborty *et al.* (2010) and Patil (2016). Least squares mean of MSC was estimated out to be 1.33 ±0.02 kg/day which was higher than the values estimated by Chakraborty *et al.* (2010) and Patil (2016).

The overall values for all the production traits under study increased from period 1 to period 6 but not in regular pattern, the values were the highest in 6th period for most of the traits as 2787.62±78.85 of 305 DMY, 13.88±0.24 of PY, 314.78±9.89 of LL, 2916.47±93.57 kg of LMY, 9.42±0.2 kg of WA, 6.67±0.23 kg/day of MCI and 1.57±0.14 kg/day of MSC but for DP highest value came in period 5^{th} as 159.95±9.33 days. The increase in the productive performance indicated the selective breeding over the pace of time.

Most of traits showed their peak value in the animals calved in winter season except LL, MCI and MSC. Values of traits having maximum value in winter are 2352.66 ±39.98 days, 11.82±0.12 kg, 165.84±6.13 days, 2460.38 ±46.77 kg and 7.97±0.1 kg of 305 DMY, PY, DP, LMY and WA, respectively. This might be due to better nutritional requirements of the animals calved in winter season. LL and MSC had its maximum value in animals calved in summer season as 313.77±4.7 days and 1.41±0.04 kg/day, respectively because of favorable climatic conditions occurred during the peak production time of animals whereas MCI found to be maximum in buffaloes calved during monsoon as 5.62±0.08 kg/day, was the result of pleasant environmental conditions and better management practices.

The study further revealed that 305 DMY, PY, LMY, WA and MCI increased with lactation order from 2142.25±31.05 kg to 2336.49±39.75 kg, 10.76±0.1 kg to 12.28±0.12 kg, 2285.12±36.21 kg to 2401.14±46.52 kg, 7.1±0.08 kg to 8.45±0.1 kg and 4.81±0.07 kg/day to 6.18 ±0.1 kg/day, respectively whereas LL and DP decreased with increasing lactation order as highest in first parity

Table 1. Analysis of variance of production performance traits.

Source	MEAN SUM OF SQUARES							
	305 DMY	PY	LL	DP	LMY	WA	MCI	MSC
Sire	488703.76 (168)	5.10 (168)	6067.58 (168)	6700.29 (168)	661240.05 (168)	3.29 (168)	1.96 (169)	0.20 (169)
Period	4401506.46** (5)	103.07** (5)	7641.51 (5)	6284.29 (5)	4755146.18** (5)	34.14** (5)	11.13** (5)	0.59* (5)
Season	1454608.14** (3)	11.94** (3)	28860.78** (3)	34229.47** (3)	2232156.64** (3)	3.45 (3)	0.616 (3)	0.68* (3)
Parity	3851721.44** (2)	198.48** (2)	100243.85** (2)	109606.46** (2)	1519838.43* (2)	154.42** (2)	114.82** (2)	-
Error	268640.57 (1157)	2.24 (1157)	4234.68 (1157)	5553.36 (1157)	369467.72 (1157)	1.61 (1157)	1.49 (795)	0.25 (444)

Where (** $P<0.01$), (* $P<0.05$); figures in parenthesis are degree of freedom

Table 2. Least square mean and standard error of production performance traits

Ind. Var.	305 DMY (kg)	PY (kg/day)	LL (days)	DP (days)	LMY (kg)	WA (kg/day)	MCI (kg/day)	MSC (kg/day)
Overall	2258.28±26.25 (1336)	11.59±0.09 (1336)	302.07±2.78 (1336)	148.18±3.32 (1336)	2357.56±30.52 (1336)	7.86 ±0.07 (1336)	5.57±0.06 (957)	1.33 ±0.02 (640)
Period of calving								
1996-1999	1816.71^{a}±86.69 (143)	10.36^{a}±0.25 (143)	299.96±10.69 (143)	133.42±14.85 (143)	1882.91^{a}±101.67 (143)	6.44^{a}±0.22 (143)	4.8^{a}±0.24 (94)	1.16^{a}±0.12 (91)
2000-2003	2159.69^{b}±56.05 (207)	11.36^{b}±0.17 (207)	302.91±6.81 (207)	147.07±8.91 (207)	2246.98^{b}±65.57 (207)	7.47^{b}±0.14 (207)	5.39^{b}±0.15 (170)	1.22^{a}±0.09 (115)
2004-2007	2173.96^{b}±51.62 (235)	10.77^{ab}±0.16 (235)	308.97±6.26 (235)	159.51±8.17 (235)	2299.52^{b}±60.53 (235)	7.44^{b}±0.13 (235)	5.21^{b}±0.14 (177)	1.31^{a}±0.08 (89)
2008-2011	2067.8^{b}±53.38 (247)	10.34^{a}±0.16 (247)	292.55±6.51 (247)	144.95±8.92 (247)	2156.47^{b}±62.48 (247)	7.6^{b}±0.15 (247)	5.22^{b}±0.15 (157)	1.16^{a}±0.09 (121)
2012-2015	2543.9^{c}±55.79 (265)	12.82^{c}±0.17 (265)	293.23±6.82 (265)	159.95±9.33 (265)	2643.00^{c}±65.48 (265)	8.80^{c}±0.14 (265)	6.10^{c}±0.15 (211)	1.56^{b}±0.08 (120)
2016-2019	2787.62^{d}±78.85 (239)	13.88^{d}±0.24 (239)	314.78±9.89 (239)	144.18±13.81 (239)	2916.47^{d}±93.57 (239)	9.42^{d} ±0.20 (239)	6.67^{d}±0.23 (148)	1.57^{b}±0.14 (104)
Season of calving								
Summer	2277.41^{ab}±39.81 (289)	11.69^{ab}±0.12 (289)	313.77^{b}±4.7 (289)	143.35^{a}±6.21 (289)	2405.69^{b}±46.56 (289)	7.89±0.10 (289)	5.56±0.10 (202)	1.41^{b}±0.04 (179)
Monsoon	2191.02^{a}±32.79 (505)	11.37^{a}±0.10 (505)	295.53^{a}±3.73 (505)	135.16^{a}±4.7 (505)	2273.18^{a}±38.23 (505)	7.72±0.09 (505)	5.62±0.08 (365)	1.38^{b}±0.04 (207)
Autumn	2212.02^{a}±39.12 (275)	11.48^{a}±0.12 (275)	290.68^{a}±4.6 (275)	148.37^{a}±6.16 (275)	2290.98^{a}±45.83 (275)	7.87±0.10 (275)	5.59±0.10 (193)	1.22^{a}±0.05 (118)
Winter	2352.66^{b}±39.98 (267)	11.82^{b}±0.12 (267)	308.28^{b}±4.72 (267)	165.84^{b}±6.13 (267)	2460.38^{b}±46.77 (267)	7.97±0.10 (267)	5.49±0.10 (197)	1.30^{ab}±0.05 (136)
Parity of calving								
First	2142.25^{a}±31.05 (614)	10.76^{a}±0.10 (614)	320.73^{b}±3.47 (614)	171.20^{c}±4.24 (614)	2285.12^{a}±36.21 (614)	7.10^{a}±0.08 (614)	4.81^{a}±0.07 (475)	-
Second	2296.09^{b}±32.88 (451)	11.72^{b}±0.10 (451)	299.32^{a}±3.75 (451)	145.90^{b}±4.88 (451)	2386.42^{b}±38.38 (451)	8.04^{b}±0.09 (451)	5.7^{b}±0.08 (300)	-
Third	2336.49^{b}±39.75 (271)	12.28^{c}±0.12 (271)	286.14^{a}±4.69 (271)	127.44^{a}±6.21 (271)	2401.14^{b}±46.52 (271)	8.45^{c}±0.10 (271)	6.18^{c}±0.10 (182)	-

Means superscripted by different letters differ significantly among themselves; figures in parenthesis are number of observations

Table 3. Heritability estimates of production traits in different lactations

Traits	Parity 1	Parity 2	Parity 3	Overall
305 DMY	0.57±0.12	0.35±0.14	0.56± 0.15	0.32±0.11
PY	0.44±0.14	0.21± 0.09	0.39± 0.13	0.15±0.04
LL	0.24±0.11	0.31± 0.14	0.44± 0.14	0.14± 0.02
DP	0.29±0.10	0.27± 0.11	0.32± 0.12	0.22±0.05
LMY	0.29± 0.09	0.38± 0.07	0.40± 0.11	0.26±0.05
WA	0.40± 0.11	0.39± 0.12	0.39± 0.14	0.28±0.07
MCI	0.25± 0.06			
MSC	0.21± 0.09			

valued as 320.73±3.47 days to 286.14±4.69 days in third parity and 171.2±4.24 days to 127.44±6.21 days, respectively. This indicated that selection was in the right direction because yield traits increased with parity as the dry period decreased over each parity. This revealed that increase in lactation order enhanced the production potential of the buffaloes.

Effect of non-genetic factors on production performance traits

Period of calving had significant effect on all production performance traits except LL and DP (table 1). The result resembled with Jamuna *et al.* (2015), Chaudhari (2015), Jakhar *et al.* (2016) and Singh *et al.* (2016) for 305 DMY, with Jakhar *et al.* (2016) for 305 DMY, PY and LMY, with Jamuna *et al.* (2016) for LL, with Dev *et al.* (2015) for WA, with Patil (2016) for WA, MCI and MSC and with Chakraborty *et al.* (2010) for MSC. However, contrasted results were obtained by Jamal *et al.* (2018) for DP, with Kumar *et al.* (2014) for LMY andwith Chakraborty *et al.* (2010) and Chaudhari (2015) for MCI. The value (least squares means) of most of the production traits were improved from period 1 to period 6 in a nonlinear pattern and were highest in the 6th period (table 1). The least squares mean of DP was lowest (133.42 ± 14.85) in period 1 and moderate (144.18±13.81) in period 6. Better management, nutrition, and judicious selection followed at the farm over time could be attributed to better performance. Season of calving (SOC) had significant effect on all the traits except WA and MCI (table 1). Likewise, significant (P<0.01) effect of SOC was obtained on 305 DMY and PY by Chaudhari (2015), on PY by Kaur *et al.* (2020), on LL and DP by Jakhar *et al.* (2016), on DP by Jamal *et al.* (2018), on LMY by Chaudhari (2015) and Thiruvenkadan *et al.* (2015), on WA by Dev *et al.* (2015), on MCI by Chaudhari (2015), on MSC by Chakraborty *et al.* (2010) and on WA, MCI and MSC by Patil (2016). Moreover, opposite results were reported by Kumar *et al.* (2014) on 305 DMY and LMY and by Jakhar *et al.* (2016) on 305 DMY.305 DMY, PY, DP, LMY, and WA had the highest value in winter season (December-March) calvers, LL and MSC had the highest value in summer season (April-June) calvers, and MSC had the highest value in monsoon season (July-September) calvers (table 1). High performance of winter calvers for productive qualities such as 305 DMY, PY, DP, LMY, and WA could be attributed to the availability of palatable lush green fodders to these animals during the advanced stages of pregnancy and early lactation.

Parity had significant effect on all the production performance traits (table 1). Likewise, Jakhar *et al.* (2016) and Kaur *et al.* (2020) reported significant effect of parity on 305 DMY, PY and LL. Thiruvenkadan (2011) and Chaudhari (2015) reported significant effect of parity on LMY, PY, WA and MCI. In other studies, Jakhar *et al.* (2016) reported significant effect of parity on DP and LMY whereas Pawar *et al.* (2012) and Kaur *et al.* (2020) obtained non-significant effect of parity on LMY. Likewise, Thiruvenkadan (2011) reported non-significant of parity on LL. Parity effect was found to be ineffective on DP by Chaudhari (2015) and Jamal *et al.* (2018). The study revealed that 305 DMY, PY, LMY, WA and MCI were increased with lactation order whereas LL and DP decreased with increasing lactation order (table 1). Better performance of 305 DMY, PY, LMY, WA and MCI in later

Table 4. Heritability, genetic (below diagonal) and phenotypic correlation (above diagonal) among overall lactation traits

Traits	305 DMY	PY	LL	DP	LMY	WA	MCI#	MSC#
305 DMY	0.32±0.11	0.60**±0.17	0.57**±0.18	-0.08±0.01	0.86**±0.15	0.61**±0.24	0.77**±0.19	0.64**±0.16
PY	0.85±0.05	0.15±0.04	0.24**±0.11	-0.06±0.02	0.63**±0.18	0.44**±0.15	0.61**±0.21	0.46**±0.15
LL	0.59±0.08	0.57±0.11	0.14± 0.02	0.08±0.02	0.61**±0.14	0.09±0.02	0.29**±0.05	0.44**±0.15
DP	0.01±0.12	-0.02±0.13	-0.08±0.13	0.22±0.05	-0.03±0.01	-0.15*±0.05	-0.49**±0.11	-0.15**±0.09
LMY	0.92±0.02	0.80±0.06	0.71±0.07	-0.05±0.12	0.26±0.05	0.49**±0.15	0.69**±0.20	0.60**±0.19
WA	0.72±0.06	0.70±0.08	0.14±0.12	0.02±0.12	0.58±0.08	0.28±0.07	0.61**±0.19	0.39**±0.13
MCI	0.84±0.03	0.75±0.04	0.33±0.08	-0.47±0.08	0.80±0.03	0.74±0.04	0.25±0.21	0.51**±0.19
MSC	0.79±0.04	0.67±0.06	0.52±0.07	-0.24±0.09	0.78±0.04	0.67±0.06	0.73±0.05	0.21± 0.02

Where *P<0.05, **P<0.01, # first lactation only parity could be attributed to physiological maturity.

Heritability estimates of production performance traits

Heritability estimates of production performance traits in different lactations have been shown in table 3. Heritability estimates for first lactation performance traits ranged from 0.21±0.09 (MSC) to 0.57±0.12 (305 DMY), for second lactation 0.21±0.09 (PY) to 0.39±0.12 (WA), for third lactation 0.32±0.12 (DP) to 0.56±0.15 (305 DMY) and for overall production performance traits ranged from low (0.14±0.02) of LL to high (0.32±0.11) of 305 DMY. 305 DMY was found to be moderately heritable which correlates to the findings of Dev *et al.* (2015) and Patil (2016). Heritability of LL was low (0.14±0.09) which resembles with Thiruvenkadan et al. (2010) and moderate value (0.36±0.09) was obtained by Jakhar *et al.* (2016). DP was estimated out to be moderately (0.22±0.10) heritable which lied in same plane with Jakhar *et al.* (2016). LMY was found to be moderately (0.26±0.10) heritable, which is similar to the value (0.23±0.18) reported by Pareek and Narang (2014). Moderate (0.28±0.10) value of heritability was reported of WA which was related with the findings of Dev *et al.* (2015) and Patil (2016). MCI and MSC were also found to be moderately heritable which was in accordance with the findings of Chakraborty *et al.* (2010) and Patil (2016).

Genetic and phenotypic correlation of production traits

In overall lactation, the phenotypic correlation was maximum (0.86±0.15) for 305 DMY and LMY and lowest (0.15±0.05) for DP and WA, both of which were significant.The genetic correlation was lowest (-0.08± 0.13) between LL and DP while it was highest (0.92±0.02) between 305 DMY and LMY. There was negative genetic correlation exist between DP with PY, LL and LMY, except 305 DMY and WA valued as -0.02±0.13, -0.08±0.13 and -0.05±0.12, respectively. DP showed negative phenotypic correlation with 305 DMY, PY, LMY, WA, MCI and MSC except LL, valued as -0.08±0.01, -0.06±0.02, -0.03±0.01, -0.15±0.05, -0.49±0.11 and -0.15±0.09, respectively. Perusal of table 4 revealed that all the production traits under study have significant phenotypic correlations among themselves except that with DP and phenotypic correlations of LL with WA. Similarly, all the production traits have high genetic correlation among themselves except with DP and genetic correlation of LL with WA.

In overall lactation, the low and positive genetic correlation was found between 305 DMY/DP, LL/WA and DP/WA valued as 0.01±0.12, 0.14±0.12 and 0.02±0.12, respectively. The low and negative genetic correlation existed between PY/DP, LL/DP and DP/LMY found to be -0.02±0.13, -0.08±0.13 and -0.05±0.12, respectively. All other traits were found to be highly positive genetic correlation. The low positive and significant ($P<0.05$) phenotypic correlation existed between LL with DP and WA values as 0.08±0.02 and 0.09±0.02, respectively. The low and negative phenotypic correlation existed between DP with 305 DMY and WA was -0.08±0.01and -0.15±0.05, respectively.

Chakraborty *et al.* (2010) estimated thatgenetic and phenotypic correlations between LMY and PY were high and positive. Various researchers *viz.* Singh *et al.* (2011) reported high and positive genetic and phenotypic correlations between various production traits in different breeds of buffaloes. Chaudhari (2015) reported that the genetic and phenotypic correlation of LMY was high and positive with 305 DMY (0.983±0.008 and 0.940±0.014), PY (0.852±0.065 and 0.549±0.038) and LL (0.906±0.055 and 0.733±0.030) in Murrah buffaloes; low phenotypic correlation between LL and PY was 0.126±0.045. Patil (2016) reported that the heritability estimates for production traits were found to be moderate ranging from 0.24±0.17 (PY) to 0.30±0.21 (MCI). Patil (2016) reported that LMY had high and positive genetic and phenotypic correlations with all the productiontraits except with PY. In this study, PY had moderate and significant ($p<0.01$) phenotypic associations and high genetic correlations with WA, MCI and MSC. In addition to this, WA, MCI and MSC had high genetic and phenotypic correlations among themselves. Similarly, high positive genetic and phenotypic correlations among LMY, PY, WA, MCI and MSC were also reported by Singh and Barwal (2012) and Dev *et al.* (2015). However, in this study, DP had negative correlation with most of the productive traits except 305 DMY and LL. Remaining all other traits were moderate to highly positively correlate with each other, which was in same frame with the reports of Dev *et al.* (2015) and Patil (2016).

From the results, we can conclude that all the production performance traits were in synchronization with each other and there was positive and significant correlation was found between the traits except with DP. DP had negative correlation with most of productive traits which indicated that the increase in production traits would lead to decrease in dry period which is a prime requisite for a farm to run efficiently. This study revealed that there was improvement in productive performance of the animal over the period of time, most of productive traits were found to be moderate to high and positively correlated showing the extent of enhanced production potential of buffaloes, and decrease in dry period and its negative correlation with other productive traits showed the effectiveness of breeding programmes in the herd. Based on this study, winter season calvers were excel in their production performance and from the critical appraisal of heritability, genetic and phenotypic correlations between the traits, it can be recommended that the selection should be based on MSC because it had moderate heritability and appreciably high genetic and phenotypic correlations with other production performance traits. Furthermore, traits those are having moderate to high estimates of heritability further could be improved genetically through sire selection.

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