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Effect of Non-Genetic Factors on Productive Traits in Jersy-Sahiwal Crossbred Cows in Andhra Pradesh

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ABSTRACT

The overall least square means of first lactation milk yield (kg), average dailymilk yield (kg), first lactation length (d), fat (%), protein (%), lactose (%) and solids- not-fat (%) were found to be 2572.27±41.12, 8.42±0.13, 296.68± 3.46, 4.52±0.02, 3.47±0.01, 4.08±0.02 and 8.40±0.01, respectively. Location and age at sexual maturity had a significant effect on first lactation milk yield and average daily milk yield. Season of birth had significant effect on protein was non-significant on other components of milk. Year of birth had significant effect on protein and solids-not-fat but not on fat and lactose. Location had a significant effect on fat andlactose only. Age at sexual maturity had a significant effect on lactose and SNF whereas, fat and SNF were non-significant. Season of calving had a significant effect on lactose and SNF and had non-significant effect on first lactation milk yield, average daily milk yield, first lactation length, fat, protein, services per conception for second pregnancy and first service period. Year of calving had significant effect on first lactation milk yield, average daily milk yield, first lactation length, fat, lactose and SNF but non significant for protein, services per conception for second pregnancy and first service period were non-significant. Heritability estimates of first lactation milk yield, average daily milk yield, first lactation length, fat, lactose, protein and SNF were 0.44±0.10, 0.20±0.10, 0.15±0.02, 0.09±0.06, 0.04±0.06, 0.13±0.11 and 0.06±0.11, respectively.

HIGHLIGHTS

- Progeny testing is the method commonly employed in sire selection.
- The estimated overall means indicates production potential of crossbred Jersey cows (Jersey × Sahiwal) under progeny testing program.

Keywords: Calving, Heritability, Least Square means, Progeny and Solid-Non-Fat

The economic success of dairy cattle depends upon the good production and optimum reproduction performance of the herd (Chakravarthy *et al*., 2017). To bring about the most rapid increase in productive potentialities of the cattle, breeding and selection methods need to be developed for Indian breeds in their native tract. In the last several years, farmers have been increasingly interested in crossbreeding. The performance of crossbreeding depends on many factors like breed selection and compatibility for the crossing (Rasa *et al*., 2013).

Cross breeding is the quickest way to increase production performance of nondescript cattle with exotic breeds such as Jersey, Holstein Friesian which is underway in India for the last four decades. Crossing *Bos indicus* with *Bos taurus* dairy breeds has been widely used to combine the high milk production potential of exotic breeds with the adaptability of the local ones. Among exotic breeds of cattle, Jersey is suitable for crossbreeding to Indian climate (Hadge *et al.,* 2012). Jersey is a small dairy

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cattle breed with low maintenance requirements, high milk yield with better fat per cent and well adaptable to tropical parts of India. Among the Zebu cattle of India, Sahiwal is considered as the best milch breed of India recognized for its highest milk production and adaptability to varied environmental conditions (Chakravarthy *et al*., 2017). Due to these inherent characteristics, this breed has been used for evolution of hardy cattle strains in different countries of world. Sahiwal is also famous for its resistance to internal and external parasites and adequate milk production under subsistence production set up. It has been exported to other countries both for rising as purebred and for the production of synthetics (Rehman *et al.,* 2014). Chittoor district of Andhra Pradesh has 1.10 million cattle, out of which 0.56 million are Jersey × Sahiwal crosses. In Chittoor district germplasm of most of the cattle had been stabilized at 50 per cent Jersey × Sahiwal level. This breed is considered to be average milk yielder with draught and disease resistant traits, and well adapted to local management conditions of Chittoor district (Varaprasad *et al*., 2013a). Hence, assessment of performances production and milk composition traits of crossbred dairy animal will not only provide insight on genetic potential of this category of diary animals but also provide inputs to refine or review the ongoing breeding programme in Andhra Pradesh. Therefore, the present study was undertaken to evaluate the production and milk composition traits of crossbred Jersey cattle (Jersey x Sahiwal cattle). This information will also be useful for divulge action plans to make scientific interventions on production and reproduction of this germplasm to exploit its maximum genetic potential.

MATERIALS AND METHODS

The present study was conducted under progeny testing program of Chittoor district of Andhra Pradesh. Data on productive traits *viz*., the first lactation milk yield (kg), average daily milk yield (kg), first lactation length (d) and milk composition traits like fat (%), protein (%), lactose (%) and solids- not-fat (%) were recorded on total of 600 Jersey × Sahiwal crossbred progeny maintained under "Progeny Testing Programme in Chittoor Andhra Pradesh Livestock Development Agency and NDDB. Least-squares method (Harvey, 1987) was used to study the effect of various non-genetic factors like season of birth i.e., summer (S1), monsoon (S2) and winter (S3), year of birth (2014 and 2015), location (eastern and western mandals) and age at sexual maturity (300-600, 601-900 and 901-1200) on various productive and milk composition traits. Least squares method is used to determine a regression line of bestfit by minimizing the sum of squares created by a mathematical function. Heritability estimates were computed for various traits based on the dataadjusted for non-genetic effects by paternal half-sib correlation method as per Becker (1985).

STATISTICAL MODEL

Sire was treated as random effect and other non-genetic factors (season, period, location and ASM) were taken as fixed effects in statistical model is $Y_{ij} = \mu + S_i + e_{ij}$., ($Y_{ij}$ = j^{th} dependent single trait of daughter of i^{th} sire., μ = Population means, S_i = Effect of i^{th} sire and e_{ij} = Random error assumed to be distributed normally and independently with mean zero and constant variance *i.e.,* NID (0, σ^2_e)).

RESULTS AND DISCUSSION

Productive Traits

First lactation milk yield (FLMY)

A non-significant effect of season of calving was observed on first lactation milk yield in the present study which is concurrence with the findings Hadge *et al.* (2012). In contrast, a significant effect of season of calving on first lactation milk yield was reported by Zewdu *et al.* (2015) in Holstein Friesian × Deoni crossbred cows (Table 1). A significant effect (P≤0.01) of location and year of calving was observed on first lactation milk yield which is in agreement with the observations of Hadge *et al.* (2012) and Hassan and Khan (2013). Similarly, ASM had a significant effect (P≤0.05) on FLMY, which is contradicting with the findings of Varaprasad *et al.* (2013c). Cows belonging to western mandals recorded higher (2849.24±74.15 kg) first lactation milk yield when compared to cows of eastern mandals (2506.99±37.87 kg). Animals born during winter season had highest first lactation milk yield followed by those born during monsoon and summer. The animals born in winter season and reared at western mandals recorded the highest milk yield which could be due to availability of abundant green fodder and favorable climatic conditions.

Table 1: Least-square means for productive traits, milkcomposition, SPC for second pregnancy and FSP in Jersey × Sahiwal crossbred cows

Effects	n	FLMY (kg)		ADMY (kg)		n	FLL (d)		n	Fat (%)		Protein (%)		Lactose (%)		SNF (%)	
		Mean	SE	Mean	SE		Mean	SE		Mean	SE	Mean	SE	Mean	SE	Mean	SE
Overall	600	2572.27	41.12	8.42	0.13	281	301.87	3.10	600	4.52	0.02	3.47	0.01	4.08	0.02	8.40	0.01
Location		**		**		NS			*			NS		**		NS	
EM	483	2506.99^{a}	37.87	8.21^{a}	0.12	227	299.59^{a}	4.08	483	4.60^{a}	0.02	3.53^{a}	0.01	4.16^{a}	0.01	8.46^{a}	0.01
WM	117	2849.24^{b}	74.15	9.34^{b}	0.24	54	293.24^{a}	5.83	117	4.38^{b}	0.04	3.45^{a}	0.02	4.18^{a}	0.03	8.43^{a}	0.03
Season of calving		NS		NS		NS			NS			NS		*		**	
S1	190	2549.29^{a}	77.60	8.89^{a}	0.25	141	295.24^{a}	6.26	190	4.51^{a}	0.05	3.48^{a}	0.02	4.19^{a}	0.03	8.54^{a}	0.03
S2	139	2577.88^{a}	90.08	8.59^{a}	0.29	79	309.74^{a}	5.23	139	4.52^{a}	0.05	3.47^{a}	0.03	4.19^{b}	0.03	8.45^{b}	0.04
S3	271	2591.94^{a}	51.92	8.78^{a}	0.17	61	300.64^{a}	4.51	271	4.45^{b}	0.03	3.41^{a}	0.01	4.13^{c}	0.02	8.35^{b}	0.02
Year of calving		**		**		*			**			NS		**		*	
2016	52	2912.84^{a}	93.45	9.55^{a}	0.31	51	307.98^{a}	5.58	52	4.49^{a}	0.06	3.49^{a}	0.03	4.38^{a}	0.04	8.54^{a}	0.04
2017	372	2563.36^{b}	37.57	8.39^{b}	0.12	230	295.77^{b}	2.74	372	4.59^{a}	0.02	3.42^{a}	0.01	4.17^{b}	0.01	8.38^{b}	0.01
2018	176	2498.16^{b}	70.02	8.19^{b}	0.23	—	—	—	176	4.33^{b}	0.04	3.44^{a}	0.02	3.84^{c}	0.03	8.40^{b}	0.03
Age at sexual maturity		*		*		NS			NS			NS		*		*	
300-600	223	2707.93^{ab}	54.52	8.86^{ab}	0.18	129	300.02^{a}	3.61	223	4.52^{a}	0.03	3.45^{a}	0.01	4.05^{a}	0.03	8.41^{a}	0.02
601-900	341	2509.03^{a}	49.94	8.22^{a}	0.16	132	293.76^{a}	6.11	341	4.55^{a}	0.03	3.47^{a}	0.01	4.16^{b}	0.02	8.33^{a}	0.02
901-1200	36	2448.12^{b}	130.75	8.02^{b}	0.43	20	292.07^{a}	14.97	36	4.47^{a}	0.09	3.50^{a}	0.04	4.01^{a}	0.07	8.48^{a}	0.06

** Significant at $P \leq 0.01$, * Significant at $P \leq 0.05$ and NS- Non-significance; Means followed by the same super script(s) in each effect do not differ significantly ($P<0.05$) n = number of animals; FLMY - First lactation milk yield; SNF- Solids-Not-Fat; ADMY- Average daily milk yield; FLL-First lactation length; S1-Summer; S2-Monsoon; S3-Winter; EM- Eastern mandals; WM-Western mandals.

In contrast, cows born in summer and reared in eastern mandals recorded lowest milk yield which might be due to adverse effects of hot and humid climatic conditions and less availability of green fodder. From these finding it could be inferred that, cows with early age at sexual maturity, early age at first conception and early age at first calving recorded higher lactation milk yield which is following with the natural trend in dairy cattle. This could also be due to introduction of new sires into the progeny testing programme (Varaprasad *et al.,* 2013c).

The overall means first lactation milk yield (2572.27±41.12 kg) recorded in this study was on par with the means reported by Choudhary *et al.* (2017) in Tharparkar × HF F1 crossbred cows (2631.91±62.83).

However, lower means of first lactation milk yield was reported by Varaprasad *et al.* (2013b) in Jersey × Sahiwal cows (2154.07±16.88). Increase in the milk yield in the present investigation might be due to inheritance of superior germ plasm, improved management practices, effective services of progeny testing programme and increased awareness of farmers.

Table 2: Estimates of heritability's for productive and milk composition traits of Jersey × Sahiwal crossbred cows

Sl. No.	Trait	Heritability± S.e.
1	First lactation milk yield	0.44±0.10
2	Average daily milk yield	0.20±0.10
3	First lactation length	0.15±0.02
4	Fat	0.09±0.06
5	Protein	0.13±0.11
6	Lactose	0.04±0.06
7	Solids-Not-Fat	0.06±0.11

The heritability estimates of first lactation milk yield were 0.44±0.10, (Table 2), which is agreement with the heritability estimates reported by Ankuya *et al.* (2016) and Hossen *et al.* (2012) in Kankrej cattle (0.45±0.17) and Sahiwal crosses (0.45±0.03). The lower heritability estimates can be paved to present study of 0.253±0.08, 0.23±0.102 and 0.11±0.03, respectively were reported by Singh and Singh (2016), Goshu *et al.* (2014) and Lodhi *et al.* (2016) in Sahiwal, HF and Indian crossbred cows. However, higher heritability estimates were reported by Miglior *et al.* (2007) in Holstein (0.518).

Average daily milk yield (ADMY)

A highly significant effect (P≤0.01) of location and year of calving was observed on average daily milk yield. Results pertaining to effect of year of calving on ADMY were in contrast to the findings of Verma and Takur (2013) in Red Sindhi × Jersey crossbred cows. A significant effect of age at sexual maturity was observed on average daily milk yield. A non-significant effect of season of calving was observed on ADMY in the present study coincided with the findings of Verma and Thakur (2013) in Red Sindhi× Jersey crossbred cows for effect of season of calving (Table 1).

Cows belonging to western mandals recorded higher ADM than those from eastern mandals revealing the significant effect of location, which might be due to abundant availability of green fodder and favorable climatic conditions in western mandals. The overall least square means of ADMY (8.42±0.13) in this study was higherthan the ADMY means of 5.94±0.10 kg as reported by Singh and Singh (2016) in Sahiwal cows. However, higher mean average daily milk yields of 10.33±0.11 was reported by Sreedhar *et al.* (2013) in Jersey × Sahiwal cows.

The heritability estimates of ADMY (0.20±0.10) (Table 3) were in congruence with Demeke *et al.* (2004) in Boron, Frisian and Jersey crosses (0.19±0.03). However, lower range of 0.046 to 0.282 in Sahiwal cattle was reported by Ilatsia *et al.* (2007a) and a lower mean value of 0.49±0.09 was reported by Singh and Singh (2016) in Sahiwal cattle.

First lactation length (FLL)

A significant effect (P≤0.05) of year of calving was observed on first lactation length which was in congruence with Hassan and Khan (2013). A non-significant effect of age at sexual maturity recorded in the present study on the lactation length was in agreement with Varaprasad *et al.* (2013b) in Jersey × Sahiwal crossbred cows.

Non-significant effect of season of calving found on lactation length confirmed the findings of Varma andTakur (2013) in Red Sindhi × Jersey crossbred cows and Tewari *et al.* (1995) in Jersey × Sahiwal half breds. Whereas, these values are contradiction to the findings of Katoch *et al.* (1990) in Jersey cattle and Mishra *et al.* (1997) in Jersey × Red Sindhi cows.

The longest lactation length was observed in animals born during rainy season (309±5.23 d) followed by those born in winter and summer seasons. But these values are contrast to the findings of longest lactation length in cows during summer season were reported by Mishra *et al.* (1997) in Jersey × Red Sindhi cows (427.98 d) and Singh and Nagarcenkar (1997) in Sahiwal cows (291.80 d).

The location was found to have non-significant effect on lactation length. Cows reared in eastern mandals have maximum lactation length compared to those of western mandals indicating that hot and dry climatic conditions favor long-overdue conception rate resulting in maximum lactation length in eastern mandals (Table 1).

The overall least square means of first lactation length (301.87±3.1 d) was coincide with the means reported by Varaprasad *et al.* (2013) in Jersey ×Sahiwal crossbreds (300.16±0.06 d).

The higher means of lactation length was reported by Chakravarthi *et al.* (2017) and Japheth *et al.* (2017) in Sahiwal cows (348.25±29.42), Tharparker × HF F1 crossbred cows (373.13±15.09) and Karanfries (365.10±3.34). However, the lowermeans of 235±14, and 247.14±33.69 were reported by Rehman and Khan (2012), and Hadge *et al.* (2012) in Sahiwal and Sahiwal × Jersey crossbred cows.

The heritability estimates of lactation length are recorded as 0.15±0.02 which is in accordance with the findings of Dahlin *et al.* (1998) in Sahiwal cattle who reported the heritability estimates of lactation length as 0.15. However, lower heritability estimates of 0.06 and 0.0620±0.039 were reported by Lakshmi *et al.* (2010) and Javed*et al.* (2001) in HF × Sahiwal and Sahiwal cattle, respectively. The higher heritability estimates of 0.20±0.14 were reported by Ankuya *et al.* (2016) in Kankrej cattle.

MILK COMPOSITION

Fat

Season of calving and age at sexual maturity was found to have a non-significant effect on fat (%). However, Nyamushamba *et al.* (2014) in Red dane and Jersey cattle and Painkra (2007) in Sahiwal cows have reported contradicting findings. Highest fat per cent was observed in monsoon season of calving (4.52±0.05). The year of calving (P≤0.01) and location (P≤0.05) had a significant effect on fat (%). The mean fat (%) was highest in eastern mandals when compared with those of western mandals showingthe significant effect of location on fat (%).

The overall least square means of total fat (%) was 4.52±0.02. This finding is in concurrence with the finding of Sreedhar *et al.* (2013) in Jersey × Sahiwal crossbred cows (4.54±0.16). Coffey *et al.* (2016) reported higher mean values of fat per cent in Jersey and Jersey× Sahiwal cows as 5.42. However, lower mean values of 3.98±0.16, 3.31±0.18 and 4.29 (%)were reported by Chakravarthi *et al.* (2017), and Gaikwad *et al.* (2011) in Sahiwal, and Gir cows, respectively. From these findings it was confirmed that Jersey × Sahiwal crossbred cows were found to have higher fat (%) when compared to Indigenous breeds (Ongole and Gir). This might be due to the inheritance of traits from new sires that were inducted in the progeny testing programme.

The heritability estimates in the present study were found to be 0.09 ±0.06. A higher heritability values can be paved to present study were reported by Miglior *et al.* (2007), Hossen *et al.* (2012) in Holstein (0.555) and Sahiwal crosses (0.37±0.04).

Protein

The effect of season of calving was non-significant on protein (%). Similarly, non-significant effect of season of calving was reported by Nyamushamba *et al.* (2014) in Red dane and Jersey cattle which was contradicting the findings of Painkra (2007) in Sahiwal cows. The location was found to have non-significant effect on protein (%). Cows reared in eastern mandals had shown maximum protein (%) when compared to western mandals confirming the significant effect of location on protein (%).

The overall least square means of protein (%) (3.47±0.001) in the present study was on par with the results of Sreedhar *et al.* (2013), Krovvidi *et al.* (2013) Jersey × Sahiwal cows (3.50±0.01) and Ongole cattle (3.51±0.08), respectively. The higher means of protein (%) were reported by Coffey *et al.* (2016) in Jersey (3.96). However, Petraskiene *et al.* (2011) reported lower means of protein (%) in Holstein, Red Holstein and Swedish Red in the order of 3.36±0.005, 3.35±0.01 and 3.39±0.01, respectively.

The heritability estimates of protein (%) (0.13±0.11) was lower than the values reported by Miglior *et al.* (2007) in Holstein (0.576).

Lactose

The overall least square means of lactose (%) was found to be 4.08±0.02. The higher means for lactose (%) were reported by Krovidi *et al.* (2013), in Ongole (5.12±0.07). A significant effect of season of calving (P≤0.05) observed on lactose (%) in the present study was in agreement with the findings of Painkra (2007) in Sahiwal cows. Year of calving (P≤0.01), ASM (P≤0.05) and location (P≤0.01) had significant effect on lactose (%). The heritability estimates of lactose (%) (0.04±0.06) was found to be lower than the values reported by Miglior *et al.* (2007) in Holstein (0.478).

SNF

A significant effect of season of calving (P≤0.01) on SNF was observed, which was similar to the findings reported by Painkra (2007). Year of calving (P≤0.01), year of birth (P≤0.01) and ASM (P≤0.05) were found to have significant effect on SNF. A non-significant effect of location on SNF was observed.

The overall least square means of SNF (%) (8.40±0.01) recorded in Jersey × Sahiwal cows was found to be lower than the means reported by Sreedhar *et al.* (2013) in Sahiwal × Jersey cows (8.67±0.10), Krovvidi *et al.* (2013) in Ongole cattle (9.34±0.12) and Rao (2010) in Jersey × Sahiwal cows (9.39±0.12). However, lower means of 8.36±0.05 were reported by Chakravarthy *et al.* (2017) in Sahiwal cattle. In the present investigation, heritability estimates of SNF (%) was recorded as 0.06±0.11. Higher heritability estimates for SNF (%) in Sahiwal crosses (0.46±0.01) were reported by Hossen *et al.* (2012).

CONCLUSION

The estimated overall means of various production and milk composition traits in this study indicates current production potential of (Jersey × sahiwal). The values obtained for different production and milk production parameters provide inputs to refine or review the ongoing breeding programme for the genetic improvement of crossbred Jersey cattle germplasm.

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