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RESEARCH ARTICLE

Association of climatic variables with lactation peformance of Deoni cows in subtropical region of India

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Abstract : The study was undertaken to evaluate the effect of different macro climatic variables on lactation length and lactation milk yield of Deoni cattle. Milk data of Deoni cows with 438 of lactation records and the meteorological data over a period of 15 years (1995-2009) were obtained from Cattle Cross Breeding Project, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani and University Meteorological Observatory, respectively. It was observed that lactation milk yield and lactation length was highest (542.97 ± 16.40 lt and 289.07 ± 9.85 days) among the cows calved during winter season as compared to rainy (515.91 ± 26.99 lt and 277.04 ± 5.3 days) and summer season (480.24 ± 18.52 lt and 274.53 ± 7.29 days). All the climatic variables considered in the study accounted for 43 per cent , 82 per cent and 86 per cent direct variation on lactation milk yield and 37 per cent, 42 per cent and 47 per cent direct variation on lactation length in rainy, winter and summer season, respectively, as verified by the value of co-efficient of determination (R^2). This research indicates that Deoni cows were not sensitive to seasonal changes on their lactation length, but causes direct variation in the range of 82 to 87 per cent in lactation milk yield in winter and summer seasons. As Deoni cows are originated in this region they did not suffer much from heat stress but if favourable conditions are provided to animals, their productivity will be increased in future.

Key words : Climatic factors, Lactation milk yield, Lactation length, Regression, THI

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INTRODUCTION

Animal life has constant struggle against the forces of nature and one important force is climate. Climate affects animals both directly with expansion on their systematic function and indirectly by governing the availability of nutrient (Thokal *et al.*, 2004). Among the various factors affecting animal productivity climate is one. Change in climate is stressful for livestock. The country lies in subtropical zone and prevail extreme weather conditions. There is also wide variation in climate. The summers are very hot and winters are very cold but at present the main factors affecting the climate is global warming. It has also serious impact on agriculture yield. Due to decrease in crop yield the overall growth and performance of livestock is affecting negatively (Kathilankal, 2003). The consequences of climate change phenomena are now visible everywhere including in animal farm industry (Lal, 2002) and considered as the serious

long term threat to agriculture. Due to increased environmental temperature animal undergo heat stress (Mandal *et al.,* 2002). Heat stress seems to be one of the intriguing factors making animal production challenging in many geographical locations in the world (Koubkova *et al.,* 2002). Milk production is also affected as animal bodies undergo heat stress and production of animal also drops (West, 2003).

The ecosystem is sensitive to change in climate, it is necessary to examine the impact of climate on various sectors within the ecosystem. Changing parameters like relative humidity, wind speed and sunshine hours were found to have significant correlation with milk yield in indigenous breed (Upadhya *et al.,* 2009). All over the world various scientist do work on the climatic parameters influencing milk production.

In Marathwada region, Deoni is one of the important dual-purpose cattle breeds native to adjoining areas of Maharashtra, Andhra Pradesh and Karnataka states. Deoni as other indigenous cattle of India have been evolved through several generations of natural selection in the humid and subtropical climate. The importance of animals lies in their draught power capacity, heat tolerance, disease resistance, adaptability to harsh agro-climatic conditions and ability to survive and perform under scarcity of feed and fodders. All these favourable traits made this breed popular. Cattle Cross Breeding Project, Vasantrao Naik Marathwada Agriculture University, Parbhani, Maharashtra located in subtropical region of India has maintained Deoni cattle. The information on the effect of environmental variables on lactation milk yield and lactation length of these cattle is lacking. Hence, this research is planned to measure variation in lactation performance (lactation yield and lactation length) due to environmental factors in Holdeo (HF × Deoni) crossbred cattle.

RESEARCH METHODOLOGY

Study area and duration :

This study was conducted at Cattle Cross Breeding Project (CCBP), VNMKV, Parbhani, Maharashtra, India, which is located at an 19°16' North latitude and 76°74' East latitude and 409 m above mean sea level. The climate of the region is subtropical one and the region comes under assured rainfall zone with an average annual rainfall of 700-885 mm mostly received in about 70 days during June to September. On seasonal basis, it oscillates from humid to sub humid in monsoon, sub humid to semi-arid during post-monsoon and hot and dry in summer. The mean daily maximum temperature varies from 29.1°C in December to 42.5°C in May. The mean daily minimum temperature varies from 6.9 °C in December to 25.4 °C in May. The relative humidity ranges from 11 to 90 per cent. Normally, the summer is hot and general dryness persists throughout the year.

For this study, data of 119 Deoni cows during the period of 1995-2009 with 438 records of lactation and cows having at least three offspring were selected for analysis. Meteorological data (1995-2009) were obtained from the University meteorological observatory station. The complete year was divided into 3 seasons as rainy (June to September), winter (October to January) and summer (February to May).

Determination of temperature humidity index (THI) :

THI is a useful and easy way to assess the risk of heat stress. THI is calculated according to National Research Council (1971) as follows :

THI = 0.72 (dbt°C + wbt°C) + 40.6

where, dbt°C = dry bulb temperature (°C) ; wbt°C = wet bulb temperature (°C)

Determined THI values were used to identify heat stress and to examine the monthly variation of THI.

Statistical analysis :

To investigate the effect of environmental variables on lactation length and lactation milk yield, the data were analysed by using correlation and multiple regression model. The main environmental variables were also compiled as monthly minimum and maximum temperature, monthly minimum and maximum relative humidity, monthly wind speed (km/hr) and monthly sunshine (hr) as well as THI.

Data were analysed by using the statistical analysis system (SAS, 2002) software programme. The following

regression model was utilized to study the effect of different independent variables (climatic factors) on lactation length, lactation milk yield and peak milk yield.

$$Y= a+ b_1x_1+b_2x_2+b_3x_3+b_4x_4+ b_5x_5+b_6x_6+b_7x_7+ uij$$

where, Y is dependent variable; x is independent variables; a is constant; b is co-efficient of x and uij is error term.

This multiple regression equation describes an average relationship between dependent and independent variable, which is used to predict the dependent variables. The variability of model was tested with the help of co-efficient of multiple regressions (R^2). The significance of R^2 was tested with 'F' test and significance of individual partial regression co-efficient was tested with student't' test.

To determine the role various environmental factors in the variation of lactation length and lactation milk yield, stepwise regression was undertaken based on the contribution of different environmental variables. Basically, regression helps to estimate the functional relationship between the independent and dependent variables.

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads :

Environmental variables during the period of study :

The average monthly environmental variables *viz.*, ambient temperature, relative humidity, sunshine hours, wind speed and temperature humidity index are presented in Fig. 1 during the period of study (1995-2009). The environmental condition observed in the table clearly indicate that the study area is under humid to sub humid in monsoon, sub humid to semi-arid during winter and hot and dry in summer.

Effect of environmental variables on lactation length and lactation yield of Deoni cattle in rainy season :

Average lactation yield and lactation length of Deoni cattle was recorded as 515.91 ± 26.99 lt and 277.04 ± 5.3 days in rainy season, respectively. It is evident from Table 1 that different climatic factors not established significant association with lactation length and lactation milk yield in rainy season. All the correlation co-efficient values except minimum humidity (-0.179) and minimum temperature (-0.30) were negative and non-significant, while all other climatic parameters were positive but non-significant relation with lactation length. The values were moderate degree being 0.036 to -0.30 and 0.049 to -0.179 in Deoni cattle. This trend indicates the increase of lactation length with decrease in minimum temperature and humidity.

With regards to lactation yield it was observed that correlation co-efficient values were negatively non-significant

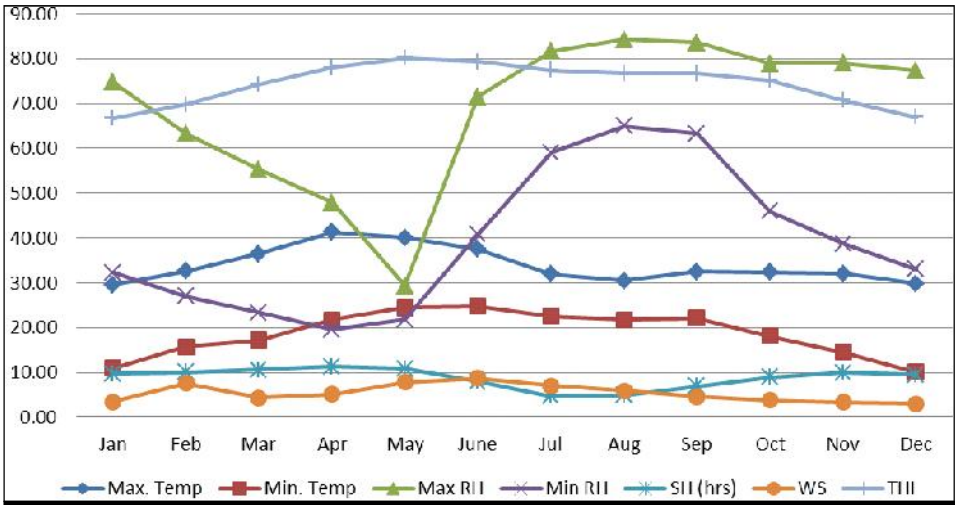

Fig. 1 : Month wise averages of environmental components (1995-2009)

except humidity, which shows negative non-significant relation with milk yield for Deoni cattle.

All the considered environmental variables accounted for 43.40 per cent and 37.80 per cent variation in lactation milk yield and lactation length, respectively. The value of co-efficient of determination (R^2) value did not reach the level of significance. This shows that lactation yield and lactation length could not be influenced consistently by climatic factors. The lactation milk yield is increased with lactation length in present study. A strong regression co-efficient has been noted between lactation length and lactation yield. Shinde and Taneja (1986) also observed that regression co-efficient of lactation length on milk yield was highly significant. In contrast findings were reported by Khan and Chaudhary (2000) and Shaffiq and Ahmed (2002).

Effect of environmental variables on lactation yield and lactation length of Deoni cattle in winter season :

Generally winter climate condition favours the milk production in animal due to pleasant climate and availability of quality fodder. Average lactation milk yield and lactation length was recorded as 542.97 ± 16.40 lt and 289.07 ± 9.85 days in winter season, respectively. These indicated that lactation milk yield in Deoni cattle was more in winter season than rainy and summer season, confirming the general consideration of suitability of cattle under cold climate. It is evident from Table 2 that environmental factors except maximum temperature establish significant negative association with lactation length and THI establish significant negative association with lactation yield. It can be accessed from the table that milk yield is decreased with decrease in maximum temperature as value being from 0.144 to -0.606; whereas, relative humidity level showed that with decrease in humidity level lactation yield is increased up to certain level.

Table 1 : Correlation and Regression co-efficients for lactation length and lactation milk yield in Deoni cattle during rainy season

Variables	Mean ± SE	LL				LMY			
		r	b	SE of (b)	t value	r	b	SE of (b)	t value
Max Temp (°C)	33.06 ± 0.20	0.036 ^{NS}	-5.08	9.72	-0.52 ^{NS}	- 0.189 ^{NS}	-14.02	86.71	-0.16^{NS}
Min Temp (°C)	22.91 ± 0.20	-0.30^{NS}	-8.48	5.61	-1.51 ^{NS}	-0.144 ^{NS}	-27.45	50.04	-0.54 ^{NS}
Max Hum (%)	81.30 ± 0.66	0.049 ^{NS}	1.47	2.46	0.60 ^{NS}	0.153 ^{NS}	-3.76	21.95	-0.17 ^{NS}
Min Hum (%)	57.58 ± 1.17	-0.179 ^{NS}	-2.99	2.86	-1.04 ^{NS}	0.359 ^{NS}	2.37	25.53	0.092 ^{NS}
SH (hrs)	06.12 ± 0.16	0.157 ^{NS}	-2.43	8.99	-0.27 ^{NS}	-0.317^{NS}	-67.36	80.19	-0.84 ^{NS}
WS (km/hr)	08.96 ± 0.18	0.127^{NS}	-0.14	14.50	-0.009 ^{NS}	-0.069^{NS}	56.89	129.29	0.44 ^{NS}
THI	68.89 ± 4.16	0.084 ^{NS}	3.96	4.40	0.90 ^{NS}	-0.111^{NS}	10.17	39.25	0.25 ^{NS}
LMY= 515.91 ± 26.99 lt		R^2 = 0.378		'F' value = 0.410		R^2 = 0.434 'F' value = 0.199			
LL= 277.04 ± 5.3 days									

* and ** indicate significance of values at P=0.05 and P=0.01, respectively; r = Correlation co-efficient, b = Estimated regression co-efficient, max Temp (°C) = Maximum temperature, Min Temp (°C) = Minimum temperature, Max Hum = Maximum humidity, Min Hum = Minimum humidity, SH = Sunshine hours, WS = Wind speed, THI= Temperature humidity index LMY = Lactation milk yield LL = Lactation length

Table 2 : Regression co-efficients for lactation length and lactation milk yield in Deoni cattle during winter season

Variables	Mean ± SE	LL				LMY			
		r	b	SE of (b)	t value	r	b	SE of (b)	t value
Max Temp (°C)	31.04 ± 0.24	-0.606*	-4.66	4.25	-1.096 ^{NS}	-0.015 ^{NS}	43.36	74.78	0.57 ^{NS}
Min Temp (°C)	13.36 ± 0.33	0.144 ^{NS}	15.41	13.91	1.108 ^{NS}	-0.395 ^{NS}	39.40	244.67	0.16 ^{NS}
Max Hum (%)	77.20 ± 0.81	-0.166 ^{NS}	0.36	2.91	0.124 ^{NS}	0.105 ^{NS}	2.28	51.23	0.044 ^{NS}
Min Hum (%)	36.98 ± 0.83	0.236^{NS}	-3.84	9.09	-0.42 ^{NS}	0.313 ^{NS}	-21.32	159.90	-0.13 ^{NS}
SH (hrs)	09.57 ± 0.10	0.443 ^{NS}	13.09	20.07	0.65 ^{NS}	0.291 ^{NS}	96.99	352.97	0.27 ^{NS}
WS (km/hr)	03.28 ± 0.11	0.486 ^{NS}	-27.50	33.15	-0.82 ^{NS}	0.197 ^{NS}	-82.69	583.06	-0.14 ^{NS}
THI	70.00 ± 0.30	-0.380 ^{NS}	-25.14	24.23	-1.03 ^{NS}	-0.577*	-250.8	426.25	-0.58 ^{NS}
LMY = 542.97 ± 16.40 lt		R^2=0.423 F=0.868				R^2=0.828 F=0.427			
LL = 289.07 ± 9.85 days									

** and * indicate significance of values at P=0.01 and P=0.05, respectively; r = Correlation co-efficient, b = Estimated regression co-efficient, max Temp (°C) = Maximum temperature, Min Temp (°C) = Minimum temperature, Max Hum = Maximum humidity, Min Hum = Minimum humidity, SH = Sunshine hours, WS = Wind speed, THI= Temperature humidity index LMY = Lactation milk yield LL = Lactation length; NS=Non-significant

Multiple regression values indicate that one unit decrease in ambient temperature decreases lactation length by -4.66 days, respectively. On the other hand, maximum and minimum temperature had influenced negatively non-significant on lactation yield. All the considered environmental variables accounted for 82.8 per cent and 42.30 per cent variation in lactation milk yield and lactation length, respectively. However, R^2 value does not exceed the level of significance for lactation yield indicating influence of environmental factors on lactation yield. Bajwa *et al*. (2004) observed that year and season of calving both significantly ($P < 0.01$) affected milk yield and lactation length. Similar findings were observed by Chauhan *et al.* (1974) and Das and Balaine (1980).

Effect of environmental variables on lactation yield and lactation length of Deoni cattle in summer season:

Generally summer climate condition at location of study was hot dry. Average lactation milk yield and lactation length was recorded as 480.24 ± 18.52 lt and 274.53 ± 7.29 days in summer season, respectively. Correlation co-efficient values for THI were non-significant for lactation length, but it is positively significant with lactation milk yield. THI and humidity has contributed more variation in milk yield as 'r' value ranges between 0.230 to -0.020 for humidity and 0.541 for lactation yield. However the humidity level has strong positive role in milk production variation in Deoni cattle and lactation length indicating decrease in milk yield with increase in humidity level. The results of Kulkarni *et al.* (1998) are supporting the present trend of effect of humidity on lactation yield and lactation length.

From Table 3, it is seen that all the considered environmental variables accounted for 47.00 per cent and 86.50 per cent variation in lactation length and lactation milk yield, respectively. Moreover, R^2 value was non-significant at 5 per cent level indicating consistency in effect of climatic factor on lactation length and lactation yield. This trend calls upon the need of preservation of indigenous breeds at their breeding tract and improvement in productivity by providing thermal comfort to cattle through proper orientation ans ventilation arrangement in barn. In contrast with Afzal *et al.* (2007) and Hyder *et al.* (2007) observed that buffaloes calving in spring showed highest and those calving in summer showed lowest milk yield. The results of Jadhao *et al*. (1996) and Kulkarni *et al.* (1998) are supporting the present trend on effect of humidity on lactation milk yield and lactation length.

Conclusion :

This research indicates that Deoni cows were suitable for survival in their breeding tracts. High temperature with high humidity had a detrimental effect on lactation length and lactation milk yield. This research indicates that Deoni cows were not sensitive to seasonal changes on their lactation length, but causes direct variation in the range of 82 to 87 per cent in lactation milk yield in winter and summer seasons. This indicates that Deoni cows are exposed to negative effects of heat stress in relation to lactation milk yield in this region and demanding additional productive strategies like improving environment, management and comfort level of cows for increasing their lactation performance. As climatic variables causes Deoni cows are originated in this region they did not suffer much from heat stress but if favorable conditions are provided to animals their productivity will be increased in future.

Table 3 : Regression co-efficients for lactation length and lactation milk yield in Deoni cattle during summer season

Variables	Mean ± SE	LL				LMY			
		r	b	SE of (b)	t value	r	b	SE of (b)	t value
Max Temp (°C)	37.92 ± 0.34	0.284 ^{NS}	8.02	8.85	0.90 ^{NS}	0.410 ^{NS}	150.37	176.01	0.85^{NS}
Min Temp (°C)	22.52 ± 0.31	0.340 ^{NS}	2.24	10.71	0.20 ^{NS}	0.284^{NS}	-169.51	212.92	- 0.79 ^{NS}
Max Hum (%)	53.60 ± 0.77	-0.058 ^{NS}	17.31	5.48	3.15**	0.230 ^{NS}	35.11	109.13	0.32 ^{NS}
Min Hum (%)	25.86 ± 0.35	-0.121 ^{NS}	- 9.04	3.64	-2.48 *	-0.020 ^{NS}	-68.81	72.39	-0.95 ^{NS}
SH (hrs)	11.04 ± 0.10	-0.111^{NS}	-30.33	20.12	-1.50 ^{NS}	0.046 ^{NS}	- 500.65	400.16	-1.25 ^{NS}
WS (km/hr)	06.23 ± 0.10	0.252^{NS}	-16.41	9.63	-1.70 ^{NS}	0.092^{NS}	100.90	191.62	0.52 ^{NS}
THI	75.87 ± 0.12	0.379 ^{NS}	3.34	2.76	1.21 ^{NS}	0.541*	33.72	54.94	0.61 ^{NS}
LMY =480.24 ±18.52		R^2 = 0.47	F value = 0.632			R^2 = 0.865	F value = 0.575		
LL = 274.53±7.29									

** and * indicate significance of values at P=0.01 and P=0.05, respectively; r = Correlation co-efficient, b = Estimated regression co-efficient, max Temp (°C) = Maximum temperature, Min Temp (°C) = Minimum temperature, Max Hum = Maximum humidity, Min Hum = Minimum humidity, SH = Sunshine hours, WS = Wind speed, THI= Temperature humidity index LMY = Lactation milk yield LL = Lactation length; NS=Non-significant

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