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Effect of Temperature Humidity Index on Production Performance of Red Sindhi Cattle Maintained at Organised Farm

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Abstract

According to the IPCC report, currently, global warming is likely to impact the productivity of dairy animals due to their sensitivity towards the temperature changes. Red Sindhi is one of an important milch breed of cattle in India which is maintained at Division of Animal Husbandry and Dairy Science, College of Agriculture, Dhule (M.H). The data collected from 1991 onwards on lactational milk yield in kg (LMY), 300 days' milk yield in kg (300 DMY) and Peak milk yield in kg (PMY) were utilized to study the effect of THI on production performance of Red Sindhi cattle. The meteorological data collected from local station. The least square technique was used to study the effects of period of calving, season of calving and lactation order. Then, data were corrected for the significant effect of period of calving, season of calving and lactation order and the corrected data were used to access the effect of THI on production performance in Red Sindhi Cattle. The overall least squares mean for LMY (kg), 300 DMY (kg) and PMY (kg) were 1892.57 ± 43.16 kg, 1878.22 ± 46.35 and 9.65 ± 0.15 respectively. The effect of period of calving was significant on LMY, 300 DMY and PMY ($P<0.01$). The variation due to season of calving and lactation order ware non-significant on all production traits under study in Red Sindhi cattle. Similarly, the effect of THI on lactational milk yield (kg), 300 days' milk yield (kg) and Peak milk yield (kg) were showed non-significant effect which indicate that the Red Sindhi cows are well acclimatized to the local climate if optimum feeding with sound management are provided.

Key words : *Red Sindhi, THI, non-genetic factor, production traits, heat stress.*

Introduction

Red Sindhi is an important milch breed of cattle. This breed originated from the Karachi district, Sindh state of Pakistan and now considered to be an important dairy breed in India. These cows are small sized, heavy animals with good milker, having colour varies from dark red to light red. These cows are reputed indigenous breed for the milk production, reproductive efficiency and heat tolerance. Currently, Global warming is likely to impact productivity of dairy animals due to their sensitivity to temperature changes. Air temperature, humidity, wind velocity and solar radiation are the main climatic factor, these affects production and reproduction performance of cattle in tropical climate due to heat stress. The heat stress is the point where the cow cannot dissipate an adequate quantity of heat to maintain body thermal balance.

Many indices have been proposed to measure the level of heat stress. THI is one of them for studying the heat stress, because temperature and humidity information can easily be obtained from local meteorological station as well as in cattle shed also by using small data logger meteorological unit. THI is a single value depicting the integrated effects of air temperature and humidity associated with the level of heat stress.

THI is extensively used in hot region all over the world to evaluate the effect of heat stress on dairy cows and is currently used to estimate cooling necessity of dairy cattle in order to improve the efficiency of management strategies to alleviate the negative effect of heat stress. The work on Red Sindhi cattle breed in Maharashtra was very scanty. Therefore, present investigation entitled "Effects of THI on productive performance of Red Sindhi cattle at organised farm" maintained at Division of Animal Husbandry and Dairy Science, college of Agriculture, Dhule was planned.

Materials and Methods

Location and Climate : The Division of Animal Husbandry and Dairy Science, College of Agriculture, Dhule is located in northern side of Maharashtra state spread between Latitude 20 38' to 21 61' N and Longitude 73 50' to 75 11'E. It is located at the heights varies between 300 to 600 Meters above Mean sea level. Climate of district is hot and dry and temperature ranges between 45^{0}C Max to 6^{0}C Min with an average rainfall 592 mm.

Source of data : The data pertaining to production performance of Red Sindhi cattle available from the history cum-pedigree sheets maintained at Division of Animal Husbandry and Dairy Science, College of

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Agriculture, Dhule (M.H) during the period from 1991 onwards were used for the present study.

Classification of data : The cows calved during the entire period were divided into four periods as P_1 (1991-1996), P_2 (1997-2002), P_3 (2003-2008), and P_4 (2009 and above). Similarly, on the basis of calving season data were grouped for rainy (June- September), winter (October-January), summer season (February-May) coded as S_1, S_2 and S_3 respectively. Also, data were grouped on the basis of lactation order from 1 to 6 and coded as L_1 to L_6 for the present study.

Temperature humidity index : The THI was calculated by adopting National Research Council formula (1) as suggested by (2).

$$THI = \{(1.8 \times T_{db}) + 32\} - \{0.55 - (0.0055 \times RH) \times \{(1.8 \times T_{db}) - 26\}$$

Where, T_{db} – Dry bulb temperature (°C); RH – Relative humidity (%).

THI values : The calculated THI values were classified into five groups to study the effect of THI on production traits viz., THI1 (<80), THI2 (80-83), THI3 (83-86), THI4 (86-89), THI5 (>89).

Statistical analysis : The data were analysed by using least square technique as per (3) model considering period of calving, season of calving, lactation order as a fixed effect and all the production traits as dependant variables (Model-I).

Model-I

$$Y_{ijkl} = \mu + S_i + P_j + L_k + e_{ijkl}$$

Y_{ijkl} - Observation of l^{th} parameters for i^{th} season of calving, j^{th} period of calving and k^{th} lactations order

μ - Overall mean

S_i - Eeffect of i^{th} season of calving (i=1,2,3)

P_j - Effect of j^{th} period of calving. (j=1,2,……..,4)

L_k - Effect of k^{th} lactation order (k=1,2,3,……..,6)

e_{ijkl} - Random error associated with NID ~ (0, ó^2)

Correction of data : The data on different production traits were corrected for the significant effects of period of calving, season of calving and lactation order and corrected data were used to assess the effect of THI on production traits (Model-II).

Model-II

$$Y_{ij} = \mu + THI_i + e_{ij}$$

Y_{ij} - Observation on jth parameters for i^{th} THI value range

μ - Overall mean

THI_i - Effect of ith THI value range

e_{ij} - Random error associated with NID ~ (0, ó2)

Duncan's Multiple Range Test (DMRT) : Duncan's multiple range test as modified by (4) was used to make pair wise comparison among the least squares means within the different groups with the use of inverse elements and root mean squares for error.

Results and Discussion

Effect of period of calving, season of calving and lactation order : The influence of period of calving on LMY, 300DMY and PMY were significant (P<0.01, P<0.1) in Red Sindhi cattle (Table-1). The significant effect of period of calving on LMY, 300 DMY and PMY was also reported by (5) in HF x Gir and their interbreds, (6) in Gir triple cross cows and (7) in Deoni cows. However, non-significant effect of period of calving on LMY was noticed by (8) in Jersey crossbreds.

The overall least squares mean of LMY, 300DMY and PMY in Red Sindhi cattle were observed as 1892.57 ± 43.16 kg, 1878.22 + 46.35 and 9.65 + 0.15 respectively (Table 2). In Red Sindhi cattle, lactation milk yield (kg) of cows calved during P3 (2107.20 ± 67.13) and P2 (1987.60 ± 56.00) was at par with each other and significantly higher than P4 (1795.40 ± 80.92) and P1 (1680.10 ± 116.73). The difference in 300 DMY of cows calved during period P2 (2042.10 ± 64.00 kg), P3 (1998 ± 60.82 kg) and P4 (1863.31 ± 94.66) was at par with each other and significantly higher than and P1 (1608.81 ± 111.33 kg). Significant difference in LMY and 300DMY might be due to variation in management and feeding of cows during different periods. The PMY of cows calved during period P4 (10.28 ± 0.28 kg), P2 (10.21 ± 0.20 kg) and P3 (10.04 ± 0.24 kg) were at par with each other and significantly higher than those calved in P1 (8.09 ± 0.41 Kg). The results revealed that the PMY linearly increased in cows calved during period P1 to P4 in Red Sindhi cattle. Similar results were noticed by (9) in Red Sindhi, (10) in Tharparkar, and (7) in Deoni cattle.

The effect of season of calving on LMY, 300DMY and PMY ware non-significant in Red Sindhi cattle (Table-1). These results were corroborated with (6) in Jersy, (10) and (11) in Phule Triveni cows, However, the highest LMY was observed in cows calved during season S1 (1928.15 ± 64.60 kg) followed by S3 (1885.66 ± 70.42 kg) and lowest in S2 (1863.91 ± 64.92kg). The highest 300 DMY was observed in cows calved during S1 (1927.07 $\pm$ 64.76 kg) followed by S3 (1863.60 $\pm$ 77.86kg) and lowest in S2 (1843.98 $\pm$ 65.98kg) season. The highest PMY was observed in cows calved during S3

Table-1 : Least square analysis of variance (mean square values) of production traits as affected by non-genetic factor.

Traits	Period of Calving	Season of Calving	Lactation Order	Error
LMY	1089526.42**	71176.56	376938.10	236485.81
300 DMY	588617.99**	64743.88	177471.37	119415.17
PMY	24.88**	3.63	6.49	6.49

**p < 0.01,*p < 0.05

Table-2 : Least square means of production traits in Red Sindhi cattle.

Effect	Traits		
	LMY	300 DMY	PMY
Overall Mean (μ)	1892.57 + 43.16 (202)	1878.22 + 46.35 (101)	9.65 + 0.15 (202)
Period of Calving (Years)			
P_1 (1991-1996)	1680.10c + 43.16 (19)	1808.81b + 111.33 (12)	8.09b + 0.41 (19)
P_2 (1997-2002)	1987.60ab + 116.73 (87)	2042.10a + 64.00 (38)	10.21a + 0.20 (87)
P_3 (2003-2008)	2107.20a + 56.00 (55)	1998.65a + 60.82 (35)	10.04a + 0.24 (55)
P_4 (2009 and above)	1795.40bc+ 80.92 (41)	1863.31ab + 94.66 (16)	10.28b + 0.28 (41)
Season of Calving			
S_1 (Rainy)	1928.15 + 64.60 (71)	1927.05 + 64.76 (38)	9.76 + 0.23 (71)
S_2 (Winter)	1863.91 + 64.92 (71)	1843.98 + 65.98 (37)	9.39 + 0.23 (71)
S_3 (Summer)	1885.66 + 70.42 (60)	1863.60 + 77.86 (26)	9.81 + 0.25 (60)
Lactation Order			
L_1	1981.31 + 72.40 (47)	1774.36 + 53.77 (39)	9.19 + 0.25 (47)
L_2	1792.61 + 74.74 (46)	1708.58 + 86.43 (17)	9.03 + 0.26 (46)
L_3	1827.88 + 82.41 (38)	1934.70 + 98.45 (13)	9.99 + 0.29 (38)
L_4	1971.88 + 93.42 (30)	1880.01 + 105.56 (12)	9.79 + 0.33 (30)
L_5	2078.38 + 109.26 (22)	2025.87 + 114.75 (11)	10.11 + 0.39 (22)
L_6	1803.39 + 120.88 (19)	1945.78+ 123.89 (9)	9.81 + 0.43 (19)

Similar superscripts within the rows does not differ significantly. Figure in parenthesis indicate number of observation

(9.81 ± 0.25 Kg) season followed by S1 (9.79 ± 0.23) and lowest in S2 (9.39 ± 0.23) (Table-2).

The effect of order of lactation on LMY, 300DMY and PMY were statistically non-significant in Red Sindhi cattle (Table-1). These results corroborated with (12) in HF cows and (7) in Deoni cows. However, the highest LMY was observed in L5 (2078.38 ± 109.26) lactation followed by L1 (1981.31 ± 72.40), L4 (1871.88 ± 93.42), L3 (1827.88 ± 82.41), L5 (1803.39 ± 120.88) and which was lowest in L2 (1792.61 ± 74.74) lactation. The 300 DMY (kg) of cows during L5 lactation (2025.87 ± 114.75) was higher than L6 (1945.78 ± 123.89), L3 (1934.70 ± 98.45), L4 (1880.01 ± 105.56), L1 (1774.36 ± 56.77), and L2 (1708.58 ± 86.43 kg). Similar, results were observed by (6) in Jersey cows. The highest PMY was observed during L5 (10.11 ± 0.39 Kg) followed by L3 (9.99 ± 0.29), L6 (9.81 ± 0.0.43), L4 (9.79 ± 0.33), L1 (9.19 ± 0.25), and lowest in L2 (9.03 + 0.26) lactation. In present investigation no specific trend of LMY, 300DMY and PMY were noticed for different lactations in Red Sindhi cattle (Table-2).

Effect of THI : The effect of THI on all the production traits showed statistically non-significant difference on all the production traits under study (Table-1). Similar results were noticed by (13) in HF cows. However, present results did not agree with (14) crossbred dairy cows (Table-3).

The highest LMY (kg) was observed at THI3 (1933.71 ± 65.82) and lowest at THI4 (1788.59 ± 71.56). There was specific trend of decreasing LMY THI2 (1920.09 ± 101.20), THI1 (1795.12 ± 150.10), THI4 (1788.59 ± 71.56) and increasing LMY for THI3 (1933.71 ± 65.82) and THI5 (1930.49 ± 55.18) (Table-4). Similarly, the highest 300 DMY(kg) was observed at THI3 (1953.28 ± 65.22) and lowest at THI2 (1769.50 ± 115.29). The highest PMY (kg) was observed in cows in THI3 (10.7 ± 0.23), which was lowest in THI2 (9.09 ± 0.35) (Table 4). No specific trend of decreasing or increasing LMY, 300 DMY and PMY were observed from THI1 to THI5.This indicated that the Red Sindhi cattle are well acclimatized to varied climatic condition because, no specific trend was observed in different THI groups.

Conclusions

The overall least square means for LMY (kg), 300 DMY (kg), PMY (kg) were 1892.57 ± 43.16 kg, 1878.22 ± 46.35 kg, 9.56 ± 0.14 kg respectively. The reproduction traits viz., LMY,300DMY and PMY were significantly affected by period of calving only. While, season of calving and

Table-3 : Least squares analysis of variance (mean square values) for dry Period as affected by THI.

Traits	THI	Error	F cal
LMY	195440.95	225314.87	0.86
300 DMY	134648.33	106341.38	1.26
PMY	6.53	2.77	2.35
LL	747.31	4124.14	0.18

Table-4 : Least square means of production traits in Red Sindhi cattle as affected by THI.

Effect	Traits			
	LMY	300 DMY	PMY	LL
Overall Mean (μ)	1873.60 + 42.55 (202)	1858.82 + 39.93 (100)	9.56 + 0.14 (202)	305.89 + 5.68 (202)
	Temperature Humidity Index (THI)			
THI_1 (<80)	1795.12 + 150.10 (10)	1865.46 + 123.25 (7)	9.97 + 0.52 (10)	308.88 + 15.68 (10)
THI_2 (80-83)	1920.09 + 101.20 (22)	1769.50 + 115.29 (8)	9.09+ 0.35 (22)	296.15 + 7.52 (22)
THI_3 (83-86)	1933.71 + 65.82 (52)	1953.28 + 65.22 (25)	10.07 + 0.23 (52)	306.15 + 9.02 (52)
THI_4 (86-89)	1788.59 + 71.56 (44)	1783.42 + 63.95 (26)	9.21 + 0.25 (44)	310.15 + 9.68 (44)
THI_5 (86-89)	1930.49 + 55.18 (74)	1922.42 + 55.12 (35)	9.48 + 0.19 (74)	305.60 + 7.55 (74)

Similar superscripts within the rows does not differ significantly. Figure in parenthesis indicate number of observation

parity were not affected on the production traits. Similarly, the THI showed non-significant effect on all production traits under study. It might be indicating that Red Sindhi Cattle are well adopted breed in Dhule district of Maharashtra and their production performance cannot be affected under climate change situation.

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