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Effect of microclimatological changes on milk production in crossbred cows

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Abstract

The climate change has major impact on animal health, production and reproduction. The climate change may vary from high or low temperature, low, high and erratic rain fall & other contributing factors like wind speed & direction, light intensity, moisture level and relative humidity. The present experiment was carried out on crossbred cows (56 cows from calving to 60 days) maintained at Livestock Research Station, College of Veterinary Science & A. H., VASREU, KU, Anand, Gujarat. In the experiment the correlation between environmental factors like wind speed, light intensity, temperature (morning and noon), relative humidity (RH) and milk yield (morning and evening) were studied. The results revealed that highly significant (P<0.001) and negative correlation was observed between morning & evening milk yield with morning & noon temperature (-0.117 & -0.109) and RH (-0.045 & -0.124), respectively for micro climatological parameters. Similarly for macro climatological parameters highly significant (P<0.001) positive correlation was observed between morning milk yield and wind speed (0.009) while negative and highly significant correlation was observed for temperature (-0.190) and RH (-0.122). The climatic factors – morning and noon, temperature and relative humidity significantly affecting morning and evening milk production and effect was negative.

Keywords: Crossbred cows, temperature, humidity, milk yield, light

Introduction

Total milk production of India was recorded 230.58 million tonnes during 2022-23 (BAHS, 2023). India has about three times as many ‘dairy’ animals as compared to USA with ten times less milk production from dairy cattle. Climate change imparts critical challenge to the development of livestock sector in India and is rapidly changing to a less adequate one in terms of livestock production. Meteorological parameters which stimulus the ambient temperature which having direct effect on the animal comfort, production, reproduction as well as on health. High ambient temperature should not be considered the only factor leading to reduction in cow milk yield but others are also there *viz*., Humidity, air velocity, air direction, direct sunlight and insulation can significantly affect animal physiology, acting together on their thermoregulation. The boom in temperature between 2 to 3 °C in the entire country along with amplified humidity resulting from climate change is likely to aggravate the heat stress in dairy animals and other livestock affecting the milk production, reproduction and growth (Das, 2018) [7]. At a temperature of 29 °C and 40% relative humidity the milk yield of Holstein, Jersey and Brown Swiss cows was 97, 93, and 98% of normal, but when relative humidity increased to 90%, yields were 69, 75, and 83% of normal (Bianca, 1965) [3]. It was observed that milk yield in crossbred cows was reduced by 1 gm, (P>0.05), 44 gm (P<0.01), 65 gm (P>0.05) and 234 gm (P<0.01) per unit increase of AT, RH, THI and T maximum (Das and Singh, 2016) [6]. With this, the study was carried out to observed the effect of microclimatological changes on milk production in crossbred cows.

Combinations of environmental factors affecting productive and reproductive efficiency of efficiency of crossbred cows includes air flow, environmental temperature, humidity and solar radiation. Amongst these factors, impact is much higher of environmental temperature and the relative humidity (Kadzere *et al*., 2002) [10].

Materials and Methods

- **Experimental location, duration and animals:** The present experiment was conducted on lactating crossbred cows maintained at Livestock Research Station, VASREU, K.U., Anand. For the study, total 56 cows were included and all the observation were recorded from 5th day of calving up to 60 days.

- **Observations recorded**

1. **Temperature and Relative humidity:** Data loggers (Gemini® Tinytag data loggers – 773247 and 771646) were kept inside the shed where lactating cows were tied during the experimental phase to record microclimatic parameters *viz.*, Temperature (°C) (minimum and maximum) and Relative humidity (%).
2. **Light Intensity and wind speed:** Light Intensity (lux) and wind speed (km/hr) was measured daily using Lux meter (Lutron® LM-8010) and Anemometer (Lutron® AM 4201) in the morning at 8.00 a.m. and during afternoon hours at 2.00 p.m.
3. **Daily milk yield:** Daily morning and evening milk yield records of crossbred cows were utilized for analysis. Milk yield data of first five days after calving were not taken for analysis. Total 60 days milk yield data were utilized for the experiment.
4. **Statistical Analysis:** Daily milk production records of total 56 crossbred cows with 60 days of milk yield were for utilize for the study. Correlation between morning & evening milk yield with micro and macroclimatic factors was carried out using SPSS software.

Result and Discussion

Perusal of the data present in Table 1. Indicates the average of milk yield and various climatic factors (Micro-climatic factors & Macro-climatic factors).

Table 1: Average of milk yield and various climatic factors recorded during experimental period.

	Parameters	
Production	Morning Milk Yield (kg)	6.43±0.034
	Evening Milk Yield (kg)	6.39±0.034
Micro climatic factors	Morning Wind Speed (km/hr)	2.04±0.044
	Noon Wind Speed (km/hr)	2.60±0.040
	Morning Light Intensity (Lux)	776.41±9.317
	Noon Light Intensity (Lux)	976.86±11.375
	Morning Temperature (°C)	25.64±0.060
	Noon Temperature (°C)	38.07±0.083
	Morning Relative Humidity (%)	63.02±0.033
	Noon Relative Humidity (%)	39.06±0.453
Macro climatic factors	Wind Speed (km/hr)	5.37±0.264
	Temperature (°C)	34.93±0.068
	Relative Humidity (%)	85.55±0.190

Perusal of the data shown in Table 1, during the experimental and data recording phase, average morning and evening milk yield (kg) was recorded 6.43±0.034 and 6.39±0.034. THI was recorded 74.05 for morning and 83.83 for afternoon by using the formula THI = (1.8 × T + 32)- [(0.55- 0.0055 × RH) × (1.8 × T- 26)], where T = air temperature (ºC), and RH = relative humidity (%) and reported that THI thresholds for heat stress in cattle as following: comfort (THI < 68), mild discomfort (68 to 72), discomfort (72 to 75), alert (75 to 79), danger (79 to 84) and emergency (THI> 84) (NRC, 1971) [12]. During the experiment phase animals were in mild discomfort zone during morning hours while in danger zone during evening hours. This may be because of majority of the data that recorded were from march onwards and merely few ended with December that results in higher THI values that may affect the overall comfort zone of animals and finally milk production. Even with this variation in comfort zone of animals the data of the milk yield indicates that the difference between morning and evening milk production does not differs significantly but numerically higher in morning milk yield but it is negligible in quantity.

Mylostyvyi and Chernenko (2019) [11] also reported THI values in the range of < 68 to 89.9 in their experiment carried out in the months from May to August, 2019 to find out relationship between environmental factors and milk production. Air temperature (ºC) and Relative humidity (%) reported by them was comparatively lower (50.6 to 63.9) and (15.6 to 24.2) than the present study.

Zewdu *et al.* (2014) [16] reported environmental temperature in the range of 11.92 to 39.37 ºC, Humidity in the range of 19.10 to 71.67 and THI in the range of 59.10 to 84.01 % in their study on effect of macroclimatic factors on milk production and reproductive efficiency of Holstein Friesian X Deoni crossbred cows.

Upadhyay *et al.* (2012) [15] reported increased THI from February onward and exceeded 75 from March onward and in April ranged between 81 and 85 and THI exceeded 85 (86-95) during May in Murrah buffalo houses in India.

Bouraoui *et al.* (2002) [4] reported that if the THI value is between 35 and 72, the conditions for temperature stress occurrence are not met, and there are no conditions for the reduction of milk yield. Akyuz *et al.* (2010) [1] noticed that the mild stress is experienced just when the value passes critical 72, moderate stress at 79 and at the end the dangerous level with values higher than 89.

Table 2: Pearson correlation coefficient between daily milk yield and different macro climatic factors

		Macro climate				
		Milk Yield (Morning)	**Milk Yield (Evening)**	**Wind Speed**	**Temp.**	**R.H.**
Macro climate	Wind Speed	0.009**	0.005	1.000		
	Temp.	-0.190**	-0.180**	0.012	1.000	
	Relative Humidity (R.H.)	-0.122**	-0.134**	0.001	-0.032	1.000

Table 2 represents effect of macro-climatological parameters of milk production where, relationship between morning and evening milk yield with environmental temperature indicates positive and highly significant relationship between morning milk yield with wind speed while for evening milk yield non-significant and positive relationship was recorded.

Macroclimatic temperature was negatively correlated with morning and evening yield but highly significant difference was observed for evening milk yield.

Similarly, negative and highly significant effect of relative humidity was observed for both the milkings.

Bhan *et al.* (2013) [2] reported temperature (ºC) in the range of 11.0 to 39.0, while relative humidity (%) in a range of 37.70 to 86.30 with THI in the range of 61.9 to 80.9.

Mylostyvyi and Chernenko (2019) [11] reported significant and positive correlation (+0.399) between relative humidity and daily milk yield, while significant and non-significant negative correlation was recorded between atmospheric temperature (-0.186) and THI (-0.113).

Table 3: Pearson correlation coefficient between daily milk yield and different micro climatic factors

Parameters			Micro Climate							
	MY (M)	MY (E)	WS (M)	WS (N)	LI (M)	LI (N)	Temp. (M)	Temp. (E)	RH (M)	RH (N)
MY (M)	1.000									
MY (E)	0.0967**	1.000								
WS (M)	0.023	0.021	1.000							
WS (N)	0.0199	0.020	0.292**	1.00						
LI (M)	0.100**	0.113*	0.100**	0.137**	1.000					
LI (N)	0.266	0.039*	0.036*	0.179**	0.379**	1.000				
Temp. (M)	-0.117**	-0.109**	0.021	-0.003	-0.027	-0.032	1.000			
Temp. (N)	-0.109**	-0.105**	0.034	0.039*	0.044**	0.032	0.024			
RH (M)	-0.045**	-0.060**	0.033	-0.072**	-0.243**	-0.187**	-0.086**	-0.051**	1.000	
RH (N)	-0.124**	-0.145**	0.009	-0.091**	-0.344**	-0.326**	0.007	-0.13	0.424**	1.000

M; Morning, N; Afternoon, E; Evening, MY; Milk Yield, WS; Wind Speed, LI; Light Intensity, Temp; Temperature, RH; Relative Humidity.

Data presented in Table 3 shows correlation between daily milk yield and different micro-climatic parameters. Morning and evening milk yield have positive and significant to highly significant relationship was observed with morning light intensity, whereas positive and non-significant relationship was recorded between morning and afternoon wind speed with milk yield. Highly significant and negative correlation was observed between morning and afternoon temperature and relative humidity with morning and evening milk yield.

Effect of THI on daily milk yield was also observed in other studies. Cincović and Belić (2009) [5] have reported that, when THI reaches 72, a daily milk yield per cow decline by 0.2 kg. West (2003) [15] stated that the daily milk yield per cow of Holstein breed decrease in average by 0.88 kg, per each unit of increase in THI. According to Gantner *et al.* (2011) [9] the highest amount of daily loss (>0.9 kg/day) was determined in heifers. Study of Zimbelman *et al.* (2009) [17] has shown that the daily milk yield decreased around 2.2 kg/day by THI values from 65 to 73. Bouraoui *et al.* (2002) [4] showed that when the THI index increases from 68 to 78, the decline of milk yield production totals 4 kg, and for each THI unit increase, above 69, daily milk yield per cow reduces for another 0.41 kg. Ravagnolo & Misztral (2000) [13] determined that milk yield declined by 0.2 kg per unit increase in THI when THI exceeded 72. Falta *et al.*, (2008) [8] have also found that for THI values above 72, a milk yield decline of 4 kg occurs.

Zewdu *et al.* (2014) [16] also reported environmental temperature in the range of 11.92 to 39.37 ºC, Humidity in the range of 19.10 to 71.67 and THI in the range of 59.10 to 84.01 % in their study on effect of macroclimatic factors on milk production and reproductive efficiency of Holstein Friesian X Deoni crossbred cows.

Conclusion

From the present study, it can be concluded that there is a highly significant negative correlation between morning and evening milk yield and morning and noon temperature and relative humidity (RH), respectively, for microclimatic parameters. Similarly, for macroclimatic parameters, a highly significant positive correlation was observed between morning milk yield and wind speed, while a negative and highly significant correlation was observed between milk yield and RH.

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