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Effect of Climatic Stress on Milk Production in Jersey Crossbred Cows Herd

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Abstract—*Climatic stress is a limiting factor for expression of optimum production performance of crossbred cattle under tropical conditions. Factors like environmental temperature, humidity, rainfall, photoperiod etc. are important factors that affect animal production. Among these, thermal humidity index (THI) is an important index that encompasses major environmental variables influencing animal productivity. Present study was conducted in Jersey crossbred cow to investigate the impact of THI on daily productivity performance of the whole herd. The daily THI was classified into 2 categories viz. slight to moderate (<80) and high stressful conditions (≥80) during the period from year 2010 to 2013. When THI exceeded 80, the morning milk yield (kg) and overall herd average (kg/day) were found to be significantly (P<0.05) decreased. On overall basis, 66.6% days of the year was low to moderate (THI below 80) and rests 33.4% days were severe stressful (THI ≥80) for the cows. The daily herd average (kg/cow) and percentage of lactating cows in herd between two environmental stress conditions were 4.61 ± 0.01 vs 4.44 ± 0.02, and 72.92 ± 0.17 vs 69.95 ± 0.21, respectively. The study revealed that there was reduction of 170 gm milk per cow per day in the herd under high stressful conditions. However, in the present study, milk fat percentage and solids not fat percentage did not differ significantly between mild and sever environmental stressful conditions. It was concluded that days with higher thermal humidity index (≥80) showed significant reduction in daily herd average; however, milk fat and solids not fat percent remained unaffected in Jersey crossbred cows herd.*

1. INTRODUCTION

Environmental factors like temperature, humidity, rainfall etc. are some of important aspects in addition to genotype, feed quality, health care etc. that influence the production and reproduction of domestic animals. Due to rise in environmental temperature and humidity, stress in animal increases and there by cardinal physiological reactions are directly and indirectly affected. Thermal humidity index (THI) is a combined indicator of environmental variables that gives better precession in judging the alteration in physiological response, voluntary feed intake, body growth and changes in milk production of lactating cows. It suggested that the temperature higher than 25°C with relative humidity more than 50% has negative impact on animal productivity [11]. As the micro-climatic condition depends upon rearing environment of animals, there is a need to study the effects in change of different micro environmental components on livestock productivity. Therefore, the aim of the present study was to assess the effect of changes of THI on milk production in Jersey crossbred cows that might help developing suitable measures for improvement in economic milk production.

2. MATERIALS AND METHODS

Present study was conducted in a dairy herd of Jersey crossbred cattle maintained at Eastern Regional station, ICAR-National Dairy Research Institute, Kalyani, West Bengal. Lactating cows were maintained at institute farm in loose housing system with concrete floor and asbestos sheet roof. Cows were provided Barseem, Oat, Mustard in Rabi season, and Maize, Cowpea, Jowar and Napier in Kharif season as green fodder and paddy straw as dry fodder as per requirement during shortage of green fodder. Concentrate ration was adjusted with production levels of cows as per standard practice of the farm. Water was provided *ad libitum* in the water trough. Milking was done twice daily i.e. morning at 6 am and evening at 3 pm. Regular data were recorded on milk yield of cow, and meteorological parameters as per standard procedure. Temperature humidity index (THI) was calculated as per Armstrong [1]. The daily THI was sub-grouped into 2 categories viz. slight to moderate (THI<80) and high stressful conditions (THI≥80) during the period from year 2010 to 2013. Data were analyzed using ANOVA and descriptive statistics as per Snedecor and Cochran [10].

3. RESULTS AND DISCUSSION

Month-wise variations in the ambient temperature (°C), relative humidity (%), temperature humidity index (THI), maximum and minimum temperature in the campus of dairy herd were analyzed and reported in Table 1. The highest ambient temperature was observed in the month of April, followed by May, while the highest humidity was determined in the month of August followed by July and September with negligible differences among the months. The highest THI (mean ±SE) was recorded in the month of June (80.46 ± 0.22) flowed by April, May, July and August.

Table 1: Macro-climate conditions (mean±s.e.) at the location of dairy herd during measuring months (year 2010-2013)

Months	Average Temperature (°C)	Average RH (%)	THI	Maximum Temperature (°C)	Minimum Temperature (°C)
January	16.80 ± 0.22	69.29 ± 0.73	61.84 ± 0.32	23.82 ± 0.24	9.79 ± 0.31
February	21.11 ± 0.23	65.03 ± 0.61	67.39 ± 0.32	28.63 ± 0.25	13.59 ± 0.27
March	27.01 ± 0.24	63.38 ± 0.74	75.30 ± 0.34	33.95 ± 0.20	20.07 ± 0.32
April	29.89 ± 0.22	68.14 ± 0.69	79.55 ± 0.29	35.97 ± 0.24	23.80 ± 0.26
May	29.41 ± 0.19	75.60 ± 0.72	79.44 ± 0.24	34.49 ± 0.22	24.33 ± 0.26
June	29.87 ± 0.18	80.92 ± 0.78	80.46 ± 0.22	33.97 ± 0.27	25.78 ± 0.19
July	28.82 ± 0.10	84.96 ± 0.50	79.31 ± 0.14	32.26 ± 0.14	25.37 ± 0.12
August	28.66 ± 0.12	85.73 ± 0.51	79.14 ± 0.15	31.99 ± 0.16	25.32 ± 0.12
September	28.78 ± 0.11	84.04 ± 0.80	79.19 ± 0.15	32.16 ± 0.16	25.40 ± 0.11
October	27.23 ± 0.17	80.47 ± 0.69	76.83 ± 0.25	31.57 ± 0.18	22.89 ± 0.23
November	23.21 ± 0.17	71.90 ± 0.62	70.74 ± 0.26	29.12 ± 0.17	17.30 ± 0.24
December	18.57 ± 0.23	71.55 ± 0.69	64.40 ± 0.32	25.09 ± 0.25	12.04 ± 0.30
Over all	25.73 ± 0.13	75.24 ± 0.29	74.40 ± 0.19	31.01 ± 0.12	20.45 ± 0.17

Due to rise in temperature and humidity the animals are exposed to stress conditions and exposition of dairy cows under stressful conditions for extended periods decrease the ability to dissipate heat. As per values of monthly average THI in the present study, climatic conditions during March to October were stressful to dairy cows. Overall basis, during the study period morning environment was comfortable (THI below 72) in 52.22% days, 46.94% days were moderately stressful (THI 72 to below 80) and 0.84% days were severely stressful (THI 80 and above), whereas, in afternoon 11.47% days were comfortable, 21.48 % moderately stressful and 67.05% days were severely stressful to crossbred Jersey cows. The observed records indicated that afternoon environment in 88% days during study period were invariably stressful for dairy cows. Morning environment, which is supposed as calm and cool, even then nearly 47% days were moderately stressful.

In the present study, macro-climatic conditions affected the milk yield of Jersey crossbred dairy herd. The overall herd average (kg/day) in low to moderate (THI below 80) stressful conditions was 4.61 ± 0.01 vis á vis 4.44 ± 0.02 in severe stressful conditions (≥80), which differed significantly (p=0.000). The results indicated that there was reduction of 170 gm milk per cow per day in the herd under high stressful conditions. The wet average of the herd did not show significant difference. The average fat percentage and solids not fat per cent were 4.85 ± 0.03 and 8.66 ± 0.01 in low to moderate stressful conditions, whereas, in high stressful conditions the values were 4.80± 0.01 and 8.68 ± 0.00, respectively. There were no significant differences in fat and solids not fat per cent between two sub-groups of environment (Table 2).

Table 2: Mean±SE of production parameters of Jersey crossbred cows herd for THI groups

Parameters	Low to moderate stress score (THI below 80)	Severe stress score (THI≥80)	Pooled	P value
Herd average (kg)	4.61 ± 0.01	4.44 ± 0.02	4.55 ± 0.01	0.000
Wet average (Kg)	6.34 ± 0.02	6.36 ± 0.03	6.34 ± 0.02	0.541
Average fat %	4.85 ± 0.03	4.80± 0.01	4.83 ± 0.02	0.251
Average Solids not fat%	8.66 ± 0.01	8.68 ± 0.00	8.67 ± 0.01	0.210

Almost similar finding was reported [8] in Holstein cows maintained in Georgia daily milk yield was reduced by 0.2 kg per unit increase of THI above 72. It was also observed that average weekly milk yield / cow (Kg), average monthly milk yield / cow (Kg) were decreased by 0.062 and 0.069 kg respectively. For fat and protein, the test yield was 0.92 and 0.85 kg at a temperature-humidity index <72, respectively, and declined at a rate of 0.012 and 0.009 kg per degree of the temperature-humidity index, respectively. Under Mediterranean climatic conditions, milk yield drops by 0.41 kg per cow per day for each point increase in the value of THI above 69 [2]. Highly significant (P<0.01) decrease of daily milk yield as well as of daily fat and protein content due to enhanced THI was observed in all cows regardless the parity class and in all three climatic regions i.e. East, Mediterranean and Central Croatia [5]. Under Indian conditions, in Holstein Friesian crossbred cows [3] it was reported that average daily milk yield / cow (Kg), average weekly milk yield / cow (Kg), average monthly milk yield / cow (Kg), daily total milk yield of cows (Kg) were reduced by 0.886, 1.868, 2.471 and 4.375 kg, respectively per unit increase of temperature humidity index. Milk yield was reduced by 0.43 lit/ day/ cow in

crossbred cows and 0.16 lit / day / cow in Sahiwal cows per unit increase of THI [9]. In Frieswal (Holstein Friesian X Sahiwal) crossbred cows, it had been observed that with per unit increase in maximum temperature from 15 ˚C to > 40 ˚C, minimum temperature from 15 ˚C to > 30 ˚C and RH from 40 % to > 80 % there were reduction in wet average by 0.29, 0.22 and 0.19 per cent and herd average by 0.24, 0.36 and 0.13 per cent, respectively [7].

Exposure of lactating cows to environmental temperature, humidity, solar radiation for extended period reduce heat loss capability of animals and at the same time they produce metabolic heat for production and body maintenance. Thus, heat produced and accumulated heat in body due to failure of complete dispersion of acquired heat load joined with decreased cooling capability, causes heat stress in animals. As a consequence cardinal physiological parameters are elevated and feed intake, metabolism, body weight and milk yields are decreased to help alleviate the heat imbalance. In the present study the THI in morning time also beyond the comfortable limit of 72 in about 47% days, which indicated that lactating Jersey crossbred cows under the present environment might not get the opportunity to fully disperse the previous day's accumulated heat. Johnson et al. [6] determined that with the termination of the hot season, in high-producing cows, the productivity does not completely return to normal since the energy deficit cannot be fully compensated. Milk production is affected by heat stress when THI values are higher than 72, which corresponds to 22 ˚C at 100 % humidity, 25 ˚C at 50 % humidity, or 28 ˚C at 20 % humidity [4]. The climatic conditions, as reported in the present study, the temperature, humidity and THI induced stress conditions in Jersey crossbred cattle and resulted in reduction in milk production. Higher variation in deteriorate effect of exceeded THI on daily milk yields and components as reported in various study were due to environmental factors, location and duration of study, breeds differences involved in the investigation etc.

4. CONCLUSIONS

Based on analysis of macroclimatic conditions of the site of dairy herd, it was concluded that days having higher thermal humidity index (≥80) showed significant reduction in daily milk herd average in Jersey crossbred cows; however, milk fat and solids not fat percent did not show significant changes. The findings will help developing management tactics to reduce the adverse effects of micro environmental changes on animal productivity. It was suggested that during heat stress period, with the aim of thermal stress amelioration, it is necessary to regulate management strategies in the dairy herd depending upon situation and location specific environmental conditions.

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