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Minor Modification in Asbestos Roof of Cow Shed for Reduction of Heat Stress in Dairy Cows during Summer Season

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Thermo neutral zone (TNZ) is the range of ambient temperature & humidity in which animals feel comfortable and their production level is optimum. When temperature humidity index (THI) goes above 72, the dairy cows begin to show symptoms of mild heat stress, which affects the milk production in dairy animals during summer season in India. Asbestos and GI sheet are commonly used as roofing material in many cattle farms throughout the world. This experiment was carried out on apparently healthy cross bred jersey cows receiving balanced ration during the month of May in the livestock farm of OUAT, Bhubaneswar for one week. The existing cattle shed was partitioned into three compartments by raising brick walls, each having the dimension of 30 x 25 ft size. The asbestos roof of first one was covered with 90 % grade green shed-net. Over the asbestos roof of second compartment, heat reflective white colour was painted and asbestos roof of third one was left as such. From 8.00 AM to 5.00PM, the THI of the normal asbestos roof shed varied from mild to

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moderate heat stress range. But THI of both shed-net covered shed and heat reflective colour painted shed was found to be within the mild heat stress range i.e. 72-79 during noon indicating a comfortable ambient condition for the animals in summer season when the outside ambient temperature went up to 40 ^{0}C during noon. No significant (P>0.05) change in the milk production was observed among the groups during the week. However, a decrease (P<0.05) of 0.43, 0.25 and 0.38 L in milk yield of the cows was observed when they were kept under normal asbestos shed, heat reflective colour painted shed and shed-net covered shed, respectively. From the study, this can be concluded that the impact of heat stress on milk production can be reduced by painting the rood of the shed with heat reflective colour paint.

Keywords: Heat stress; heat reflective paint; shed-net; housing; THI; milk yield.

1. INTRODUCTION

Thermo neutral zone is the range of ambient temperature & humidity in which animals feel comfortable. In this zone the health and performance of animals are found to be better. When temperature humidity index (THI) goes above 72, the dairy cows begin to show symptoms of mild heat stress [1,2]. Armstrong [3] considered THI <72 as a thermal comfort zone for dairy cows (assuming the THI does not drop below the thermo-neutral zone) and 72 to 79 as mild heat stress, 80 to 90 as moderate heat stress and >90 as severe heat stress. Heat stress is one of the leading factor affecting milk production in dairy animals during summer season in India [4,5,6]. Gantner et al. [7] observed a highly significant (P<0.01) decrease of milk yield, fat and protein content due to heat stress condition. Asbestos and GI sheet are commonly used as roof material in many cattle farms throughout the world [8,9]. But during hot summer, these roofs being good conductor of heat, contribute significantly to heat stress in animals. Roof material plays a key role in determination of thermal heat exchange in animals [10]. Reports also suggests that, Agro-net shading of roof is an efficient way to reduce heat stress [11,12,13,14]. This experiment was conducted to study the effect of modification of asbestos roof of cow shed by painting with heat reflective colour and covering with shed-net to mitigate heat stress in summer season.

2. MATERIALS AND METHODS

This experiment was carried out on apparently healthy cross bred milking jersey cows receiving balanced ration during the month of May in the livestock farm of OUAT, Bhubaneswar for one week. The cows were fed with a concentrate mixture (Table 1) and hybrid napier grass based ration. The nutrient content of the concentrate mixture is depicted in Table 2.

Table 1. Composition of the concentrate mixture fed to the cattle during experiment

Sl No	Ingredient	Quantity (Kg)
1	Maize	36.00
2	Soybean Meal (SBM)	20.00
3	Wheat Bran (WB)	23.00
4	Rice Bran (RB)	18.00
5	Mineral Mix	2.00
6	Salt*	1.00
	Total	100.00

*Commercial mineral mixture available in the market.

Table 2. Nutrient content of the concentrate mixture fed to the cattle during experiment

Sl No	Ingredient	Quantity (%)
1	Dry matter (DM)	86.76
2	Organic matter (OM)	90.77
3	Crude Protein (CP)	17.06
4	Ether Extract (EE)	2.45
5	Total ash (TA)	8.44
6	NDF	35.06
7	ADF	16.16
8	ADL	5.28

The existing cow shed was having asbestos roof, brick wall, concrete floor and other recommended specifications like floor space, air space, ventilation etc. It was partitioned into three compartments by raising brick walls, each having the dimension of 30 x 25 ft size. The asbestos roof of first one was covered with 90 % grade green shed-net. Over the asbestos roof of second compartment, heat reflective white colour was painted and asbestos roof of third one was left as such (Fig. 1). The ambient temperature and relative humidity of all three sheds and outside the shed were recorded on hourly basis from 8.00 AM to 5.00 PM by help of digital thermometer and hygrometers and the temperature humidity index (THI) was calculated as suggested by Habeeb et al. [1].

Fig. 1. Outside view of the experimental shed

Twelve nos. of medium yielder milking cross bred cows were randomly divided to three groups and kept in these three sheds. They were maintained as per the recommended feeding and management practices. The milk yield of each cow was recorded on daily basis during the experiment. The data obtained in the study was analyzed with one way ANOVA [15].

3. RESULTS AND DISCUSSION

During the observation from 8.00 AM to 5.00 PM, the outside temperature ranged from 31.5 to 40.1^{0}C. The inside temperature of the normal asbestos shed, during the same period ranged from 30.5 – 38.4^{0}C (Tables 3 & 4). The temperature humidity index (THI) was found to be within mild heat stress range (72 – 79) from 8.00 AM to 12.00 PM and moderate heat stress range (80 – 83) from 12.00 PM to 3.00 PM (Fig. 2). Vanitha and Baskaran [16] reported similar finding of higher temperature rage in asbestos roof shed in summer season. As per Roy and Chatterjee [17], macro and micro environment of the shed has a lot of effect on physiological stress or comfort of the animals. The inside temperature of the shed-net covered shed from 8.00 AM to 5.00 PM ranged from 30.0 – 36.3 ^{0}C with THI varying from 72 - 79 indicating mild heat stress throughout the day. Whereas, the inside temperature of the heat reflective colour painted shed during the same period ranged from 28.5 – 33.5 ^{0}C with THI value of 70 – 76 indicating mild heat stress was prevailed from 10.00 AM to 4.00 PM. It was observed that the inside temperature of the heat reflective colour painted shed was 3 - 5 ^{0}C less than the temperature of the shed-net covered shed and normal asbestos shed during noon in summer season indicating a better comfortable shed environment.

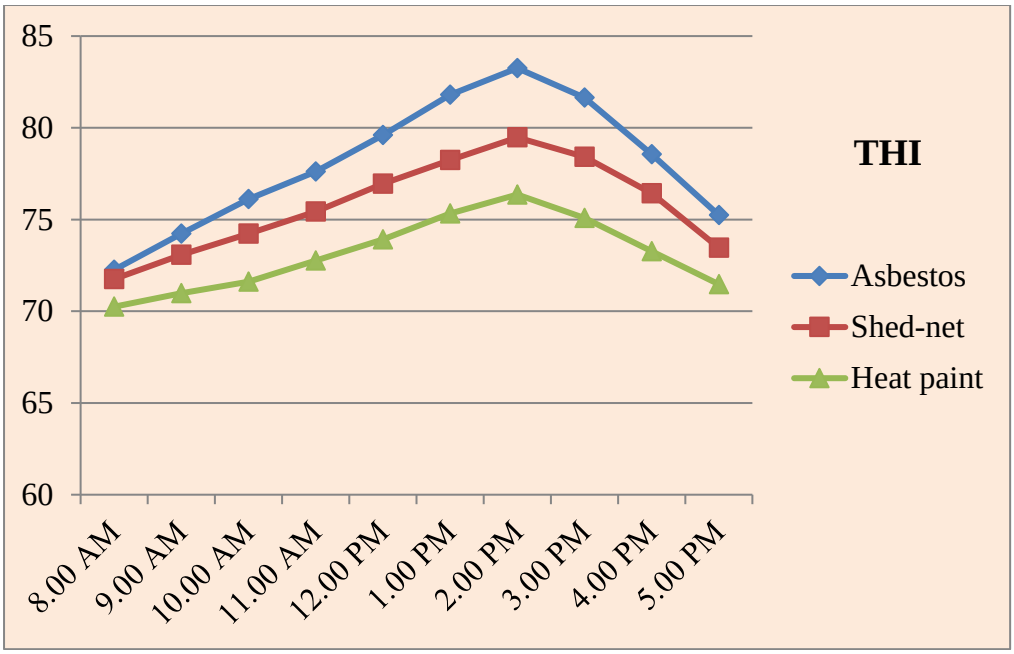

Fig. 2. Mean THI of normal asbestos roof shed, shed-net covered shed and heat reflective colour painted shed in summer

Table 3. Mean ambient conditions of normal asbestos roof shed, shed-net covered shed and heat reflective colour painted shed in summer

Time	Normal Asbestos shed			Shed net covered shed			heat reflective colour painted shed		
	Amb. Temp (^{0}C)	RH (%)	THI	Amb. Temp (^{0}C)	RH (%)	THI	Amb. Temp (^{0}C)	RH (%)	THI
8.00 AM	30.5	85	72	30.0	85	72	28.5	85	70
9.00 AM	32.0	78	74	31.0	80	73	29.0	81	71
10.00 AM	33.0	74	76	32.0	78	74	29.5	79	72
11.00 AM	34.5	66	78	33.0	75	75	30.5	77	73
12.00 PM	36.0	60	80	34.2	71	77	31.5	75	74
1.00 PM	37.5	52	82	35.4	70	78	32.7	72	75
2.00 PM	38.4	46	83	36.3	66	79	33.5	69	76
3.00 PM	37.2	50	82	35.0	62	78	32.0	65	75
4.00 PM	35.0	60	79	33.5	68	76	30.5	69	73
5.00 PM	32.6	72	75	31.0	74	73	29.0	73	71

Table 4. Daily maximum outside and inside temp (^{0}C) of normal asbestos-roof shed, shed-net covered shed and heat reflective colour painted shed in summer

Shed types	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Mean
Outside shed	39.9	40	39.9	40.1	40	39.9	39.9	40.0
Normal asbestos roof shed	38.4	38.5	38.4	38.5	38.4	38.4	38.5	38.4
Shed-net covered shed	36.2	36.3	36.2	36.3	36.3	36.3	36.2	36.3
Heat reflective colour painted shed	33.6	33.5	33.5	33.5	33.5	33.5	33.6	33.5

Table 5. Daily milk production (L) by the cows under different type of modified roofing during peak summer

Shed types	Milk Yield (L)							
	Day-1	Day-2	Day-3	Day-4	Day-5	Day-6	Day-7	Change in milk yield
Normal Asbestos shed	5.70±0.51	5.625±0.53	5.55±0.52	5.45±0.49	5.40±0.51	5.37±0.48	5.27±0.48	-0.43±0.04
Shed net covered shed	5.75±0.56	5.67±0.57	5.55±0.56	5.52±0.55	5.42±0.57	5.40±0.60	5.37±0.55	-0.38±0.04
Heat reflective colour painted shed	5.50±0.32	5.42±0.36	5.40±0.35	5.37±0.33	5.30±0.35	5.27±0.32	5.22±0.29	-0.25±0.05

Values are average of 4 reading.
Values represents Mean± SD
Negative values of change in milk yield represents drop in milk production on 7th day as compared to the 1st day

Table 6. Effect of different roofing materials on Milk yield (L) of dairy cows during peak summer

Shed types	Milk yield (start of Study) in L	Milk yield (End of Study) in L	Change in milk yield* in L
Normal Asbestos shed	5.70±0.51	5.275±0.48	-0.43 ± 0.04
Shed net covered shed	5.75±0.56	5.375±0.55	-0.38 ± 0.04
Heat reflective colour painted shed	5.50±0.32	5.225±0.29	-0.25± 0.05
P value	0.759	0.056	0.002

Values are average of 4 reading.
Values represents Mean± SD
*Represents the values differs significantly across the column

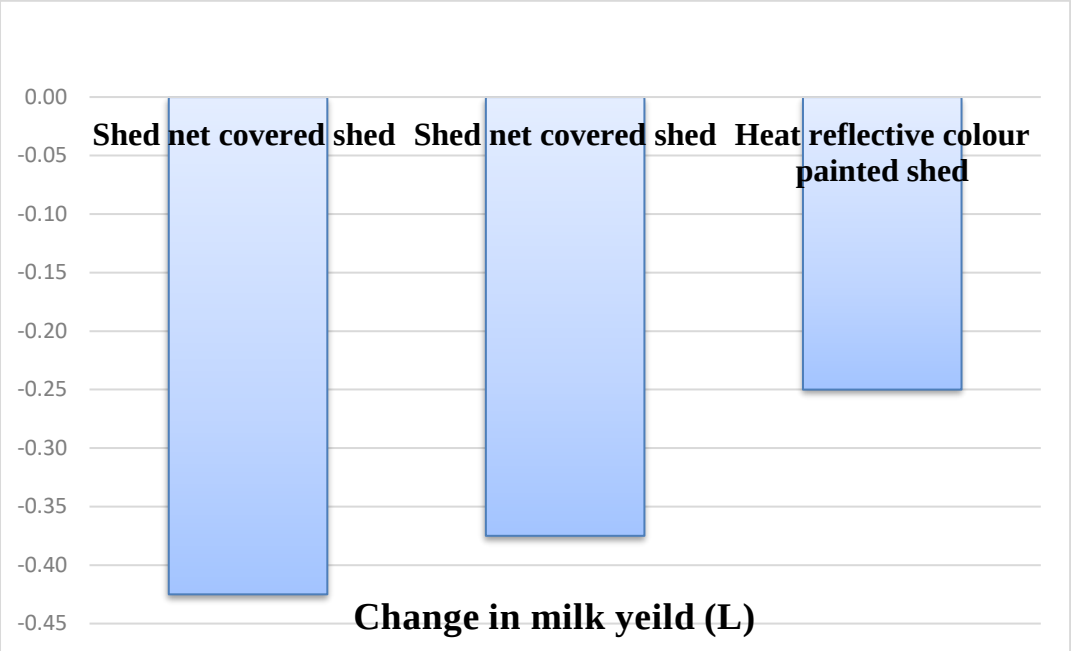

Fig. 3. Final decrease in milk yield of the cows kept under normal asbestos roof shed, shed-net covered shed and heat reflective colour painted shed in summer

The daily average milk yield of cows at the beginning of the experiment kept under normal asbestos shed was 5.73 L, which was decreased by 0.45 L over one week of observation during the experiment. West [18] observed a reduction of 0.2 kg in milk yield per unit increase in THI beyond 72 in high yielding dairy cows. Similarly, the daily average milk yield was decreased by 0.38 and 0.25 L in case of cows kept under shed-net covered shed and heat reflective painted shed, respectively during the same period (Table 6, Fig. 3).

As per Joksimovic et al. [19] there was more decreased milk production in summer than in spring season. The decrease in daily average milk yield of the cows kept under heat reflective colour painted shed was observed to be 50% less than in case of cows kept normal asbestos shed indicating that there was less heat stress on cows in heat reflective colour painted shed during the summer season. Considering the milk yield at the start and end of the study, there was no statistical difference ($P>0.05$) among the group of cows, but the drop in milk yield was significantly higher in asbestos roof animals indicating a higher level of heat stress resulting in drop in milk production. In a similar study, Mohapatra et al. [20] reported a drop of 0.2 L in average daily milk yield over one week by sprinkling water over the shed net covered roof during mid may, indicating a better microenvironment for cows in hot summer and advocated for sprinlikng over shed net covered roof top as a measure to reduce the heat stress in milch cows. In the present study, only shed net was covered without sprinkling water, thus the reduction in milk was higher as compared to the reports by Mohapatra et al. [20].

4. CONCLUSION

From 8.00 AM to 5.00PM, the THI of the normal asbestos roof shed varied from mild to moderate heat stress range. But THI of both shed-net covered shed and heat reflective colour painted shed was found to be within the mild heat stress range ie. 72-79 during noon indicating a comfortable ambient condition for the animals in summer season when the outside ambient temperature went up to 40 ^{0}C during noon. There was a decrease of 0.25 and 0.38 L in milk yield of the cows kept under heat reflective colour painted shed and shed-net covered shed, respectively. But a decrease of 0.45 L in milk yield of the cows kept under normal asbestos shed was recorded indicating more environmental stress on animals. Hence, the heat reflective colour painting over the dairy animal shed during peak summer may reduce the heat stress in dairy animals and tend to minimize the drop in milk production during hot environmental condition.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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