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Effect of body cooling systems on micro-climatic variable in semi -loose house for animals during hot-dry and hot-humid conditions of costal india

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Abstract: To study the effect of cooling system on microclimate variable three treatments based on animal body cooling systems i.e., shelter without cooling system (control, T_1),with fogging (T_2) and with showering (T_3) in semi-loose house were designed. Common environmental variables like maximum and minimum temperature and relative humidity were recorded during hot-dry and hot-humid conditions. The maximum temperature (^oC) was found significantly (P< 0.05) lower during hot-dry condition under fogging system (T_2- 32.28 ± 0.23) than other treatments (T_1- 33.89 ± 0.29 and T_3-33.17 ± 0.26). Moreover, during hot-humid condition showering (T_3-31.09 ± 0.16) was also significantly (P< 0.05) effective. Overall average maximum microclimatic temperature (^oC) in T_1, T_2, and T_3 was lower as compared to open macroclimatic. Relative humidity (%) was significantly (P< 0.05) higher in hot-humid as compared to hot-dry condition in respective treatments, (T_1-79.09 ± 1.09 Vs 65.53 ± 1.00, T_2-85.10 ± 0.86 Vs. 76.84 ± 0.73, T_3-80.58 ± 1.05Vs. 67.83 ± 0.95 and open 79.94 ± 1.12 Vs 55.64 ± 1.07). During afternoon (2:30 PM) the per cent THI was found significantly (P< 0.05) lower under fogging (T_2-80.22 ± 0.20) and showering (T_3- 80.38 ± 0.21) as compared to control (T_1-82.43 ± 0.21) during hot-dry condition. Overall result of treatments showed that the afternoon percent THI was significantly (P< 0.05) lower under showering (T_3-80.65 ± 0.17) than other treatments (T_1 -83.31 ± 0.17 and T_2-81.94 ± 0.15) and it was significantly (P< 0.05) different within cooling treatments like T_2 and T_3. This study showed significant effect of cooling system. Moreover fogging was better as it utilized less water, as compared to showering during hot dry condition.

Keywords: Fogging, Micro climate, Showering, THI

INTRODUCTION

The housing normally buffers the extremes of climatic condition to lower peak stress on animal and provide protection from predators. It should also create a micro- environment inside the animal house, which protects the animal from stressful atmosphere and allow efficient labor utilization. Global warming and weather change may be a threat to livestock production. Especially late summer, this severe hot –humid condition ought to cause more heat stress on cattle and buffaloes compared to early summer with hot-dry condition, which adversely affect their milk production, composition and physio-biochemical status. The effects of environmental variables on livestock are important in terms of welfare and performance. The temperature- humidity index (THI) has been used widely as indicator of thermal stress in livestock and the it forms the basis of the Livestock weather safety index. In many countries, cooling treatment have been tried to keep the animals in comfort during hot season of the year with varying results. Evaporative cooling through fans, foggers, sprinklers and splashing of water has become a common practice to improve milk production (Avendano-Reyes *et al.,* 2006 and Fulsoundar, 1985) as well as feed utilization (Kamboj *et al.,* 2000 and West, 2003) and to decrease rectal temperature, pulse and respiration rate (Marai *et al.,* 1995, Davis and Mader, 2002, Singh *et al.,* 2005, Aggarwal and Singh, 2008, Rahangdale *et al.,* 2010) in dairy animals. Livestock Research Station, Navsari (Gujarat) which is located under heavy rainfall conditions having maximum temperature during summer months with high relative humidity. Scanty reports are available on effect of cooling systems during hot-dry and hot-humid conditions in coastal area. Keeping in view the above researchable issues the present study was carried out to find out the influence of different cooling systems on micro-climate in semi loose housing system for animal during hot-dry and hot-humid conditions.

MATERIALS AND METHODS

The study was conducted at Livestock Research Station, Navsari Agricultural University, Navsari, District: Navsari, Gujarat State. The sheds were built on semi loose-house pattern with face to face type arrangement. The experiment was conducted from 14^{th} week of the year 2012 (April 2, 2012) to 29^{th} week the year of 2012 (July 22, 2012).This period was divided into two condition as below. In control (T_1) group, the

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Table 1. Average maximum temperature (°C) of microclimate under different treatment groups (control Vs cooling) and macroclimate during hot-dry and hot-humid conditions.

Condition	Periods of condition	Microclimate			Macroclimate
		T_1 (Control)	T_2 (Fogging)	T_3 (Showering)	Open
Hot-Dry (2 months)	I	34.70±0.73	32.13±0.45	33.61±0.58	35.40±0.73
	II	35.37±0.52	33.99±0.49	34.67±0.51	37.08±0.45
	III	32.74±0.31	31.29±0.23	32.10±0.28	33.74±0.34
	IV	32.76±0.34	31.69±0.22	32.29±0.31	34.19±0.31
	Overall	$33.89^{bß}$±0.29	$32.28^{aß}$±0.23	$33.17^{bß}$±0.26	$35.10^{cß}$±0.29
Hot-Humid (2 months)	I	31.94±0.19	30.89±0.10	31.39±0.16	33.65±0.18
	II	32.04±0.26	31.10±0.19	31.39±0.21	33.51±0.29
	III	32.19±0.53	31.16±0.44	31.59±0.45	31.76±0.35
	IV	30.26±0.13	29.80±0.15	30.00±0.14	30.92±0.16
	Overall	$31.61^{b\lambda}$±0.19	$30.74^{a\lambda}$±0.14	$31.09^{a\lambda}$±0.16	$32.46^{c\lambda}$±0.20
Overall		32.75^{c}±0.20	31.51^{a}±0.15	32.13^{b}±0.18	33.78^{d}±0.22

Mean with superscript (a,b,c,d) in a row and (λ,ß) in a column differ significantly between treatments and conditions respectively at P < 0.05.

Table 2. Average minimum temperature (°C) of microclimate under different treatment groups (Control Vs Cooling) and macroclimate during hot-dry and hot-humid conditions.

Condition	Periods of condition	Microclimate			Macroclimate
		T_1(Control)	T_2(Fogging)	T_3(Showering)	Open
Hot-Dry (2 months)	I	24.76±0.30	24.96±0.30	25.11±0.30	22.74±0.42
	II	25.89±0.28	26.04±0.27	26.18±0.27	23.25±0.40
	III	27.08±0.15	27.29±0.16	27.44±0.16	25.36±0.24
	IV	27.92±0.13	28.13±0.13	28.27±0.13	26.38±0.27
	Overall	$26.41^{b\lambda}$±0.20	$26.61^{b\lambda}$±0.20	$26.75^{b\lambda}$±0.20	$24.43^{a\lambda}$±0.26
Hot-Humid (2 months)	I	28.25±0.29	28.42±0.29	28.56±0.28	27.94±0.20
	II	28.09±0.28	28.29±0.28	28.43±0.28	26.91±0.42
	III	27.14±0.23	27.34±0.23	27.49±0.23	26.26±0.30
	IV	27.00±0.20	27.20±0.20	27.34±0.20	26.27±0.25
	Overall	$27.62^{bß}$±0.14	$27.81^{bß}$±0.14	$27.96^{bß}$±0.14	$26.85^{aß}$±0.17
Overall		27.02^{b}±0.13	27.21^{b}±0.13	27.35^{b}±0.13	25.64^{a}±0.19

Mean with superscript (a,b,c,d) in a row and (λ,ß) in a column differ significantly between treatments and conditions respectively at P < 0.05.

semi loose housing without body cooling, the foggers were operated daily during daytime hot hours from 12:00 to 15:00 hours in the respective experimental shed. The fogging cooling system (T_2) was automatically controlled by an electronic timer and run for 3 min after an interval of every 2 min (36 min/hour) throughout the experimental period. Showering (T_3) system consisted of nozzles in a line placed underneath roof at 9 feet height from the floor. The showers were operated daily during daytime hot hours from 12:00 to 15:00 hours in experimental shed. The shower cooling was manually controlled and run for 2 min after an interval of every 15 min from 12:00 to 15:00 hours throughout the experimental period. Daily data on climatic variables viz. maximum temperature, minimum temperature, mean temperature, relative humidity at outside environment were collected from Meteorological department of Agriculture college, NAU, Navsari. The microclimatic data were recorded daily throughout the experimental period, once in the morning at 07:30 hour and again in the afternoon at 14:30 hour by the sensor humidity data loggers.

RESULTS AND DISCUSSION

Maximum temperature: The condition and treatment wise maximum temperature means have been presented in Table -1. The analysis of mean of maximum temperature recorded under macroclimate was significantly (P< 0.05) higher than the microclimate of treatments during hot-dry and hot- humid conditions. During hot-dry condition under fogging (T_2) the temperature was significantly (P< 0.05) lower as compared to other treatment groups, showering (T_3) was lower than control group, however the effect was not significant this might be due to absence of fog and mist formation in the showering as water droplets size is larger in showering which has less cooling effect. During hot-humid condition the temperature under fogging (T_2) and showering (T_3) was found significantly (P< 0.05) lower than other treatment groups. Comparison of mean between hot-dry and hot-humid conditions in their respective groups showed significantly (P< 0.05) less microclimatic and macroclimatic temperature in hot-humid condition. This

Table 3. Average relative humidity (%) of microclimate under different treatment groups (control Vs cooling) and macroclimate during hot-dry and hot-humid conditions.

Condition	Periods of condition	Microclimate			Macroclimate
		T_1(Control)	T_2(Fogging)	T_3(Showering)	Open
Hot-Dry (2 months)	I	67.41±1.73	79.86±1.01	69.84±1.62	56.10±2.02
	II	57.33±2.28	70.32±1.59	59.99±2.21	48.83±2.70
	III	69.30±0.96	79.49±0.70	71.31±0.86	60.08±1.05
	IV	68.10±0.89	77.70±0.56	70.19±0.78	57.56±1.19
	Overall	$65.53^{b\lambda}$±1.00	$76.84^{c\lambda}$±0.73	$67.83^{b\lambda}$±0.95	$55.64^{a\lambda}$±1.07
Hot-Humid (2 months)	I	71.84±1.14	79.59±0.94	73.61±1.10	71.61±1.62
	II	74.64±1.64	81.18±1.32	76.31±1.61	76.98±1.73
	III	82.33±1.87	87.43±1.27	83.68±1.78	83.80±1.89
	IV	87.54±0.92	92.21±0.64	88.73±0.88	87.38±0.78
	Overall	$79.09^{a\beta}$±1.09	$85.10^{b\beta}$±0.86	$80.58^{a\beta}$±1.05	$79.94^{a\beta}$±1.12
Overall		72.31^{b}±0.98	80.97^{c}±0.68	74.21^{b}±0.93	67.79^{a}±1.03

Mean with superscript (a,b,c,d) in a row and (λ,ß) in a column differ significantly between treatments and conditions respectively at $P < 0.05$.

Table 4. Average afternoon (2:30PM) THI (%) values of microclimate under different treatment groups (control Vs cooling) and macroclimate during hot-dry and hot-humid conditions.

Condition	Periods of condition	Microclimate			Macroclimate
		T_1(Control)	T_2(Fogging)	T_3(Showering)	Open
Hot-Dry (2 months)	I	81.53±0.43	80.12±0.53	79.61±0.48	82.92±0.47
	II	82.65±0.48	80.45±0.45	80.71±0.41	83.49±0.57
	III	82.55±0.39	80.03±0.37	80.11±0.34	83.64±0.31
	IV	83.00±0.25	80.30±0.27	81.10±0.31	83.96±0.27
	Overall	$82.43^{b\lambda}$±0.21	$80.22^{a\lambda}$±0.20	$80.38^{a\lambda}$±0.21	$83.50^{c\lambda}$±0.21
Hot-Humid (2 months)	I	83.01±0.27	81.25±0.33	79.95±0.27	83.99±0.35
	II	85.21±0.42	83.33±0.37	81.72±0.41	84.98±0.38
	III	84.19±0.47	82.32±0.60	80.26±0.42	83.59±0.51
	IV	84.38±0.29	82.26±0.33	80.92±0.30	83.74±0.19
	Overall	$84.20^{c\beta}$±0.21	$82.29^{b\beta}$±0.23	$80.71^{a\lambda}$±0.20	$84.07^{c\lambda}$±0.20
Overall		83.31^{c}±0.17	81.94^{b}±0.15	80.65^{a}±0.17	83.79^{d}±0.15

Mean with superscript (a,b,c,d) in a row and (λ,ß) in a column differ significantly between treatments and conditions respectively at $P < 0.05$.

decrease in maximum temperature in microclimate and macroclimate might be due to humidity of climate. The reduction in maximum temperature (°C) under loose housing with cooling systems as compared to outside environment and control shed might be due to evaporative cooling effect of water showering and fogging during hot hours of the day. The present result of better comfort under cooling system was almost similar with the finding of Fulsoundar (1985) who reported superiority of shelter having splashing with tap water as compared to control with respect to maximum temperature (37.88+0.34 Vs 38.34+ 0.30) and usefulness of cooling system fan plus misting was also reported by Chaiyabutr *et al*. (2011). Frazzi *et al.,* (2002) reported decrease in temperature and improved ventilation as well as increased lying time of cow. Moreover, Jegoda (2013) observed effect of fogging system which reduce the maximum temperature (37.62°C Vs. 38.21°C) summer. Chauhan (2010) reported superiority of cooling system especially with reference to shelter type. In same experiment author reported better climate under RCC (Reinforced Cement Concrete) shed as compared to thatch roof and under tree. Igono *et al*., (1987) used spray nozzle as cooling device and reported significant in temperature inside shelter (30.8°C Vs. 27.0°C).

Minimum temperature: The condition and treatment wise minimum temperature means have been presented in Table -2. The mean of minimum temperature recorded under macroclimate was significantly ($P< 0.05$) lower than the buffaloes maintained in loose housing system with and without body cooling systems during both the conditions. Moreover, the variation due to treatment was not significant ($P< 0.05$). The mean of microclimatic and macroclimatic temperature in hot-dry condition was significantly ($P< 0.05$) lower than hot-humid condition. Overall microclimatic minimum temperature was significantly ($P< 0.05$) higher than macroclimate. Probably RCC roof and maximum closure from all three sides of the shed might have checked the excessive loss of temperature from inside to outside. Similar to present finding by Chauhan (2010) who reported higher level in minimum temperature (13.03 ± 0.74°C) in RCC shed in all the conditions especially in winter. Results were also supported by Fulsoundar (1985), Morover, the effect of cooling was not too effective, to reduce the temperature of microclimate during treatment time.

Relative humidity: The condition and treatment wise relative humidity (RH) means have been presented in Table -2. Relative humidity (%) was significantly ($P< 0.05$) higher under fogging (T_2) shed as compared to other treatment groups (T_1 and T_3) during both conditions. It was also significantly ($P< 0.05$) higher in T_3 and T_1 than open during hot-dry condition, however the difference was not ($P< 0.05$) significant during hot-humid condition. It might be due to evaporative cooling effect of water sprinkling through fogging during hot-dry condition and high humidity in climate during hot-humid condition. Chaiyabutr *et al*. (2011) reported mist fan cooling was effective (14.7%) and showering (0.8%) by Fulsoundar (1985). Jegoda (2013) similarly observed superiority of fogger by 2.29% of relative humidity which is very less as compared to present result.

Temperature humidity index: The condition and treatment wise means of percent THI at afternoon (2:30 PM) have been presented in Table 4. Afternoon (2:30 PM) percent THI was found significantly ($P< 0.05$) lower under fogging (T_2) and showering (T_3) as compared to control (T_1) during hot-dry condition while, it was significantly ($P< 0.05$) lower for showering (T_3) than other treatments and varies significantly ($P< 0.05$) with each other during hot-humid condition. In both conditions the per cent THI of macroclimate was significantly ($P< 0.05$) higher as compared to T_2 and T_3. Per cent THI was significantly ($P< 0.05$) higher in hot-humid as compared to hot-dry condition in T_1 and T_2. Results indicated that providing water showering and fogging under loose housing system considerably reduced air temperature and increased relative humidity during hot hours of the day in hot-dry condition, however, the condition worsens in fogging in hot-humid condition be due to combined humidity of both environment and fogging. Fulsoundar, (1985) observed higher THI in control at 7:30, 12:30 and 14.30hrs. as compared to treatment (splashing with tap water).THI differ was more during afternoon 0.34 (afternoon) >0.26 (noon) >0.11 % in morning. This so better comfort due to splashing and splashing was more effective during afternoon. Similarly Frazzi *et al.,* (2002) observed low THI with fan and misting. Igono *et al*., (1985) observed reduction in THI due to spray treatment was 1.7 which is very close to our treatment i.e. 2.66 (T_3) and 1.37 (T_2). Chaiyabutr *et al*., (2011) observed significant effect of mist fan cooling with respect to THI was (79.9 ± 0.46 Vs. 83.2 ± 0.44).

Conclusion

The maximum temperature was recorded under macroclimate which was higher than microclimate with and without intervention. The fogging system was superior over showering system with respect to microclimatic temperature, however, the relative humidity was higher in fogging as compared to showering especially in hot humid condition. This suggested superiority of fogging under hot dry system however showering under hot humid condition. Keeping in view scarcity of water in coastal area, shelter with fogger is supposed to improve microclimatic variables.

REFERENCES

Aggarwal, A. and Singh, M. (2008). Changes in skin and rectal temperature in lactating buffaloes provided with showers and wallowing during hot-dry season. *Tropical-Animal-Health-and-Production*, 40: 223-228.

Avendano-Reyes, L.,Alvarez-Valenzuela, F. D.,Correa-Calderon, A., Saucedo-Quintero, J. S.,Robinson, P.H. and Fadel, J. G. (2006). Effect of cooling Holstein cows during the dry period on postpartum performance under heat stress conditions. *Livestock Science*, 105: 198-206.

Chaiyabutr, N., Boonsanit, D. and Chanpongsang, S. (2011). Effects of Cooling and Exogenous Bovine Somatotropin on Hematological and Biochemical Parameters at Different Stages of Lactation of Crossbred Holstein Friesian Cow in the Tropics. *Asian-Aust. J. Anim. Sci.,* 24: 230 – 238.

Chauhan, H.D. (2010). Effect of housing systems on production performance and behaviour of Kankrej cows during different seasons. Ph.D. Thesis, Submitted to Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar.

Davis, S. and Mader, T.(2002). Effect of altered feeding and sprinkling on performance and body temperature of steers finished in the summer, Nabraska Beef Report., pp. 61–65.

Frazzi, E.,Calamari, L. and Calegari, F. (2002). Productive response of dairy cows to different barn cooling systems. *Transactions of the ASA*, 45: 395-405.

Fulsoundar, A.B.(1985). Effect of body cooling by splashing water on physiological responses, milk production and compositions in female Mehsani buffaloes. Ph.D. thesis, Gujarat Agri. University Sardarkrushinagar.

Igono, M.O., Johnson, H.D., Steevens, B.J., Krause, G.F. and Shanklin, M.D. (1987). Physiological, productive and economic benefits of shade spray and fan systems versus shade for Holstein cows during summer heat. *Journal of Dairy Science,* 70, 1069-1079.

Jegoda, M.D. (2013). Impact of water sprinkling (foggers) on performance of mehsana buffaloes in summer season. M.V.Sc. Thesis, Submitted to Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar.

Kamboj, M. L., Paul, S. S. and Chawla, D. S. (2000). Influence of wallowing on efficiency of feed utilization and reproductive performance of Nili-Ravi buffalo heifers, Annual Report, CIRB- 1999-2000.

Marai, I. F. M., Habeeb, A. A., Daader, A. H. and Yousef, H. M. (1995). Effects of Egyptian subtropical summer conditions and the heat-stress alleviation technique of water spray and a diaphoretic on the growth and physiological functions of Friesian calves. *Journal of Arid Environments*, 30, 219-225.

Rahangdale, P. B., Ambulkar, D. R., Panchbhai, G. J., Kharwadkar, M. D. and Naresh Kumar, (2010). Effect of wallowing and splashing on body temperature and milk yield in Murrah buffaloes during summer. In: Proceedings of International Buffalo Congress, Vol II, 1–4 February 2010, New Delhi. pp: 102.

Singh, G., Kamboj, M. L. and Patil, N. V. (2005). Effect of thermal protective measures during hot humid season on productive and reproductive performance of Nili-Ravi buffaloes. *Indian Buffalo Journal*, 3:101-104.

West, J. W. (2003). Effects of heat-stress on production in dairy cattle. *Journal of Dairy Science*, 86:2131–2144.