International Journal of Science, Environment and Technology, Vol. 7, No 1, 2018, 225 – 231
ISSN 2278-3687 (O)
2277-663X (P)

HEAT STRESS IN DAIRY COWS - ITS IMPACT AND MANAGEMENT: A SHORT NOTES

Brijesh Patel[1*], Vaibhav Purwar[1], Varsha Jain[2], Deepanshu Gupta[3], Pratik R. Wankhede[1], Diwakar[4], Nishant Kumar[5] and Mukesh Singh[6]
[1]Ph.D. Scholar, Division of LPM, ICAR-IVRI, Bareilly, Uttar Pradesh, INDIA
[2]Veterinary Assistant Surgeon, Veterinary Hospital, Bhendri, Dhamtari, Chhattisgarh
[3]Ph.D. Scholar, Division of Physiology, ICAR-IVRI, Bareilly, Uttar Pradesh, INDIA
[4]Ph.D. Scholar, Division of LPM, NDRI, Karnal, Haryana, INDIA
[5]Scientist, ARGO, NDRI, Karnal, Haryana, INDIA
[6]Principal Scientist, Division of LPM, ICAR-IVRI, Bareilly, Uttar Pradesh, INDIA
E-mail: romi10888@gmail.com ([*]*Corresponding Author*)

Abstract: An imbalance between metabolic heat production inside the animal body and its dissipation to the surroundings results to heat stress (HS) under high air temperature and humid climates. Heat stress has several serious and economically deleterious effects on cattle. The most important effects of heat stress in dairy cows are increased body temperature, reduced feed intake, milk production, increased somatic cell count and lower reproductive performance. The provision of cooling shed and dietary manipulation is the most important management tool to reduce heat load in dairy cows.
Keywords: Heat stress, Health, Production and Reproduction.

Introduction

Climate change, in particular global warming, will affect the health and welfare of farm animals, both directly and indirectly (IPCC, 2007). Environmental factors, such as temperature and light, exert significant effects on the production, health and immunity of animals. Heat stress in tropical countries is a problem of great concern among farmers and livestock producers as it causes great economic loss in terms of both production and reproduction traits of animals. Crossbred cattle are more susceptible to physical distress when exposed to heat stress as compared to other farm animals. Heat stress in dairy cows is caused by a combination of environmental factors (temperature, relative humidity, solar radiation and air movement) (Ghosh *et al*., 2017). Heat stress occurs in animals when there is an imbalance between heat production within the body and its dissipation. Heat stress is the sum of external forces to a homoeothermic animal that acts to shift body temperature from the resting state. Heat stress reduces feed intake, milk yield, growth rate and reproductive performance (Patel *et al*., 2017) which lead to major economic losses to the dairy farmers

*Received Jan 21, 2018 * Published Feb 2, 2018 * www.ijset.net*

especially in tropical countries. The upper critical temperature for lactating cows is in the range of 24 to 27^{0C}. The temperature humidity index (THI) commonly is used to indicate the degree of stress. When the THI exceeds 72, high producing dairy cows are affected adversely.

Importance of Thermal Humidity Index

Temperature-humidity index (THI) is the most common estimate of heat stress in the dairy industry (Armstrong, 1994). It combines the impacts of dry bulb temperature and relative humidity but does not include solar radiation or wind speed. Thus, THI is a good indicator of heat stress in housing structures (Collier *et al.,* 2008). Ravagnolo *et al* (2000) reported that the milk yield declined @ 0.2 kg per unit increase in THI when THI exceeded 72. The authors concluded that THI could be used to estimate the effect of heat stress on production. Bouraoui *et al.* (2002) reported that the THI was widely used in hot areas all over the world to assess the impact of heat stress. It is commonly considered that THI equal to 72 is the threshold of environmental heat stress in cows. Thatcher *et al.* (2010) reported that dairy cows were exposed to heat stress when THI exceed above 72 and when it exceed 88, then animals is exposed to severe heat stress condition.

Impact of heat stress on dairy cows

Body Temperature

Physiological parameters like rectal temperature, skin temperature, and udder skin temperature gives an immediate response to the climatic stress and consequently the level of discomfort to the animals. Rectal temperature (RT) is taken directly inside the body cavity which is typically slightly higher than skin temperature. Change in rectal temperature has been considered as an important measure of physiological status as well as ideal indicator for assessment of stress in animals (Johnson, 1980; West, 2003). McDowell *et al.* (1996) reported that even a rise of less than 1°C in rectal temperature was enough to reduce performance in most dairy animals. RT is generally considered to be a useful measure of body temperature and changes in RT indicates changes of a similar magnitude in deep body temperature. RT is considered as a good index of body temperature even though there is a considerable variation in different parts of the body core at different times of the day.

Bernabucci *et al.* (2002) assessed the effect of hot season (39.5 ± 0.2^0C) in transition dairy cows and found that temperature differed ($P<0.01$) significantly (39.5 vs. 39.1°C). Koubkova *et al.* (2002) reported significant increase in RT from 37.3 to 39.3°C when high yielding HF cows were exposed to high temperature conditions

Dry matter intake (DMI)

The NRC predicts that the DMI for a 600 kg cow producing 40 kg milk will decline from 18.7 kg at 20^{0C} to 16.7 kg at 35^{0C} (9%). However, the energy that is consumed during hot weather is used less efficiently for milk production because of greater maintenance costs, which are estimated to be 20% greater when environmental temperature are 35^{0C} than they were 20^{0C}. Ronchi *et al.* (2001) reported that dry matter intake decreased by 23% in heifers managed at 32^{0C} and 70% relative humidity. Holter *et al.* (1997) established a significant negative correlation between THI and DMI for cows and suggested that the effect of THI is probably mediated through the effects of increasing body temperature of cow.

Milk yield (MY)

Reduced milk production is the first perceived consequence of heat stress. Heat stress affects the productive performance of dairy animals by reducing their dry matter intake (DMI), feed efficiency and milk yield (Gantner *et al.,* 2011). Reduced feed intake during heat stress is the major reason for reduced milk production in dairy cows (Baumgard *et al*., 2012). The optimum environmental temperature for lactation depends on species, breed and degree of tolerance to heat or cold. The milk yield of Holstein cattle declines at temperature above 21°C, in case of Brown Swiss and Jersey cattle it declines at about 24 to 27°C whereas milk yield of Zebu cattle declines only above $34^{°C}$ (Hafez, 1968). The most significant factors affecting milk yield during hot weather in South Carolina were the total numbers of hours when THI exceeded 74 during the preceding four days, and the number of hours exceeding THI 80 on the preceding day) (Ghosh *et al*., 2017).

Udder health

Heat stress results in increases in Somatic cells count (SCC) (Ghosh *et al*., 2017). Somatic cells in milk are predominantly white blood cells or leukocytes which are present as one of the primary protective mechanisms of the mammary gland which is slough off from the lining of mammary gland during normal course of milking (Harmon, 1994).The majority of somatic cells are leukocytes (white blood cells) which become present in increasing numbers in milk usually as an immune response to a mastitis-causing pathogen - and a small number of epithelial cells, which are milk-producing cells shed from inside of the udder when an infection occurs. SCC of a parameter derived from this count, is often used to distinguish between infected and uninfected quarters. Nelson *et al*. (1969) reported a positive relationship between high summer environmental temperature and SCC in milk. The high somatic cell counts observed in hot humid condition due to harsh climatic condition of high humidity and ambient temperature leading to stress condition and increase in susceptibility of infection (Hogan *et al*., 1989).

Reproduction

The patterns of reproductive behavior of farm animals vary with the variation in climatic conditions. Pronounced variations observed in the signs of estrus, rates of conception and frequency of calving are generally attributed to climatic factors. Heat stress resulted in decreased growth rate, average daily gain and feed intake, estrus frequency, estrus duration, calving rate and increased in inseminations per conception (Patel *et al*., 2017). Rabiee *et al*. (2010) reported that secretion of gonadotropin-releasing hormone from the hypothalamus and the gonadotropins, luteinizing hormone (LH) and follicle stimulating hormone (FSH) from the anterior pituitary gland affected by heat stress.

Management of heat stress

Increase water availability to cows

Normal water supply recommendations are inadequate in the summer. Water intake increases by up to 50% as the THI approaches 80. Waterer space available and water intake per animal becomes very important. During heat episodes, Mader *et al*. (1997a) found that as much as three times the normal waterer space (7.5 vs. 2.5 cm of linear space per animal) may be needed to allow for sufficient room for all animals to access and benefit from available water.

Change the feeding routine

The two most important changes are mix and feed more often and feed a greater proportion of feed at night, 60 to 70% of feed. Watch for feed heating in the bunk – clean bunks out more often Increase airflow / ventilation. Open up the sides of the barn to maximize the natural ventilation. Install fans in the barn. The most important areas to increase ventilation are the holding area, along the inside of the feed bunk and over the stalls. (Kundu *et al*., 2013).

Ration specification changes

Some the key changes for lactating cows: increase the ration concentration but do not compromise fibre levels, add fat to the ration, increase potassium to 1.4 – 1.6% (West, 2002), increase sodium to 0.45 – 0.5%, increase magnesium to 0.3 – 0.4%. This requires a careful selection of mineral sources to ensure that chloride levels are kept low. Consider a modest increase in protein but don’t over feed a fraction.

Shed Cooling

Use a fan, foggers and fine mist in the barn to cool the air. This will help reduce the heat load on the cows. Breathing cooler air will help cows cool faster. Make sure misters are effective and that they don't inadvertently simply increase the humidity.

Feed additives during summer

Purwar *et al.,*2017 also found reduction in heat stress in KF heifer by supplementation of protected fat (2.5% of DMI), yeast (10 g/animal/day), niacin (6 g/animal/day), zinc (40 mg/kg DMI), and chromium (1.5 mg/kg DMI). Similarly Patel *et al.*, 2017 also found reduce heat stress by supplementation of 80 and 120 ppm zinc to KF cows.

References

[1] Armstrong, D. 1994. Heat stress interaction with shade and cooling. *J. Dairy Sci.*, ***77***(7): 2044-2050.

[2] Baumgard, L.H., and R.P. Rhoads. 2012. Ruminant nutrition symposium: Ruminant production and metabolic responses to heat stress. *J. Anim. Sci.* **90**(6): 1855-1865.

[3] Bernabucci, U., Ronchi, B., Lacetera, N. and Nardone, A. (2002). Markers of oxidative status in plasma and erythrocytes of transition dairy cows during hot season. *J. Dairy Sci.,* ***85***(9): 2173-2179.

[4] Bouraoui, R., M. Lahmar, A. Majdoub, M. Djemali, and R. Belyea. 2002. The Relationship of temperature-humidity index with milk production of dairy cows in a Mediterranean climate. *Anim. Res*., **51**:479-492.

[5] Collier, RJ., Collier, J.L., Rhoads, R.P. and Baumgard, L.H. 2008. Invited review: genes involved in the bovine heat stress response. *J. Dairy Sci.*, ***91*****(2):** 445-454.

[6] Gantner, V., Mijic, P., Kuterovac, K., Solic, D. and Gantner, R. 2011. Temperature-humidity index values and their significance on the daily production of dairy cattle. *Mljekarstvo*, **61**:56–63.

[7] Ghosh, C.P., Kesh, S.S., Tudu, N.K. and Datta, S., 2017. Heat Stress in Dairy Animals-Its Impact and Remedies: A Review. *Int. J. Pure App. Biosci*, ***5*****(1):**953-965.

[8] Hafez, E.S.E.1968. Adaptation of domestic animals. Edition, illustrated. Publisher, Lea & Febiger

[9] Harmon, R.J. 1994. Physiology of mastitis and factors affecting somatic cell counts. *J. Dairy Sci.,* ***77***(7): 2103-2112.

[10] Hogan, J.S., Smith, K.L., Hoblet, K.H., Todhunter, D.A., Schoenberger, P.S., Hueston, W.D., Pritchard, D.E., Bowman, G.L., Heider, L.E., Brockett, B.L. and Conrad, H.R., 1989.

Bacterial counts in bedding materials used on nine commercial dairies1. *Journal of dairy science*, ***72*****(1):** 250-258.

[11] Holter, J.B., West, J.W., and McGilliard, M.L. 1997. Predicting ad libitum dry matter intake and yield of Holstein cows. *J. Dairy Sci.*, ***80***(9): 2188-2199.

[12] IPCC (Intergovernmental Panel on Climate Change: AR4), 2007. The Intergovernmental Panel on Climate Change 4th Assessment Report. Jackson Institute, University College, London.www.ipcc.ch/

[13] Johnson, H.D. 1980. Depressed chemical thermogenesis and hormonal functions in heat. In: Environmental Physiology Aging, Heat, and Altitude. Elsevier /North Holland, New York. 3–9.

[14] Koubkova, M., Knizkova, L., Kunc, P., Hartlova, H., Flusser, J., andDolezal, O. (2002). Influence of high environmental temperatures and evaporative cooling on some physiological, hematological and biochemical parameters in high-yielding dairy cows. *Czech. J. Anim. Sci.*, ***47***(8): 309-318.

[15] Kundu, S.S., Mani, V. and Sontake, U.2013. Feeding Strategies for Cattle and Buffalo under Climate Change Scenario for Sustaining Productivity. *Climate Resilient Livestock & Production System.*

[16] Mader, T.L., J.M. Dahlquist, and J.B. Gaughan. 1997a. Wind protection effects and airflow patterns in outside feedlots. *J. Anim. Sci.* **75**: 26.–36

[17] McDowell, R.E., J.C. Wilk, and C.W. Talbott. 1996. Economic Viability of Crosses of Bostaurus and Bosindicus for Dairying in Warm Climates. *J. Dairy Sci.,* **79:**1292-1303.

[18] Nelson, F.E., Tranmal, H., Schuh, J.D., Wegner, T.N. and Stott, G.H., 1969. Criteria of abnormal milk from individual quarters during a period of high temperatures. In *J. Dairy Sci.,* **52**(6): 912.

[19] Patel, B., Kumar, N., Jain, V., Ajithakumar, H.M., Kumar, S., Raheja, N., Lathwal, SS., Datt C. and Singh. SV. 2017. Zinc Supplementation Improves Reproductive Performance Of Karan-Fries Cattle. *I. J. Ani. Repro.* ***38*** *(1):* 20-22

[20] Purwar, V., Oberoi, P.S. and Dang, A.K., 2017. Effect of feed supplement and additives on stress mitigation in Karan Fries heifers. Veterinary World, **10** (12): 1407-1412.

[21] Rabiee, A.R., Lean, I.J., Stevenson, M.A., and Socha, M.T. 2010. Effects of feeding organic trace minerals on milk production and reproductive performance in lactating dairy cows: A meta-analysis. *J. Dairy Sci.*, **93(9):** 4239-4251.

[22] Ravagnolo, O. and Misztal, I. 2000. Genetic component of heat stress in dairy Cattle, parameter estimation. *J. Dairy Sci*., **83**:2126-2130.

[23] Ronchi, B., Stradaioli, G., Supplizi, A.V., Bernabucci, U., Lacetera, N., Accorsi, P.A. and Seren, E. 2001. Influence of heat stress or feed restriction on plasma progesterone, oestradiol-17β, LH, FSH, prolactin and cortisol in Holstein heifers. *Livest prod Sci.*, ***68***(2): 231-241.

[24] Thatcher, W.W., Flamenbaum, I., Block, J. and Bilby, T.R. 2010. Interrelationships of heat stress and reproduction in lactating dairy cows. In *Proceedings of High Plains Dairy Conference* (pp. 45-60).

[25] West, J.W. 2002. Physiological effects of heat stress on production and reproduction. *Proc. Tri-State Nutr. Conf.,* 1-9.

[26] West, J.W. 2003. Effects of heat-stress on production in dairy cattle. *J. Dairy Sci.*, ***86***(6): 2131-2144.