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Infrared thermographical differentiation of estrus and non-estrus stages of dairy animals

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Abstract
The present investigation was planned to evaluate the usefulness of Infrared thermorgraphical camera for discrimination of various stages of estrus i.e. onset of estrus, standing heat and non estrus conditions in sahiwal cows. The experiments were conducted on ten healthy, cyclic sahiwal cows were maintained at DDD farm of LFC at DUVASU, Mathura. In present study the mean infrared thermographical temperature of muzzle and vulva of sahiwal cows during standing heat stage (34.72±0.21 and 39.15±0.15 ºC, respectively) were found to be significantly (p<0.01) high as compared to two other stages of estrus. Thus, from present study it was concluded that infrared thermoradiography may be used as the efficient tool for detection of estrus and its different stages in sahiwal cows.

Keywords: thermographical, estrus, non-estrus, dairy animals

Introduction
In today's world scenario India alone contributes a whopping 22% in global milk production being the highest in the world. Productive and reproductive performance of dairy animals is largely affected by their nutritional and health status and various management practices. The reproductive efficiency of the dairy animals is having a direct impact on productivity and profitability of dairy farms (Lobago *et al*., 2007) [1]. Therefore, reproduction management is a major concern in dairy industry. To get maximum profitability from dairy industry there is a need of better reproductive management of dairy animals so that they must be in regular cycle and must be bred at definite intervals. For this purpose, the concept of timed AI must be followed which is only possible with the accurate and timely detection of heat. Inefficient and inaccurate heat detection results in failure of conception during that attempt, which in turn leads to significant economic losses (Karir *et al*., 2006) [2]. The efficient and accurate detection of estrus and the timing of AI has remained major challenge to improve reproductive and economic efficiencies of dairy farms (Heersche and nebel, 1994) [3]. Low estrus detection rate contributes to reduced fertility and longevity in dairy cows. Since last decade, the dairy industry has been moving towards automated estrus detection platforms in order to achieve higher estrus detection rates without increased labor input. One of the modern methods of estrus detection may be Infrared thermography, which has successfully been used for various purposes in various farm and wild animals. Infrared thermography (IRT) is a temperature measurement tool based on the ability of all objects to emit characteristic infrared radiation as a function of their temperature (Kastberger and Stachl, 2003) [4]. This radiation is proportional to the surface temperature of the body (Bitar *et al*., 2009) [5], and is evaluated using a thermographic camera, which produces images with different color patterns depending on the temperature of the imaged objects. The temperature values in the images are strongly related to the emissivity of the object, which is defined as the relative ability of a surface to emit and absorb radiation (Rodríguez *et al*., 2013) [6]. The use of infrared thermography in animal production is innovative, low cost, fast and efficient. It provides important information without the need for physical contact with the animals (McManus *et al*., 2016) [7]. Additionally, IRT permits to detect even small changes in temperature with more precision (Knízková *et al*., 2002) [8] and has therefore, become important in experiments as a safe assessment method. Infrared thermography (IRT) has proven to be a non-invasive technology which is able to predict ovulation by measuring heat radiated from the vulva area during estrus. Therefore, keeping in view, the above facts the present study was carried out.

Material and Method

With the approval of Institutional Animal Ethics Committee of College of Veterinary Sciences and Animal Husbandry, DUVASU, Mathura experiment was conducted at District Dairy Demonstration Farm (DDDF) within the premises of Livestock Farm Complex (LFC) of U.P. Pandit Deen Dayal Upadhayay Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go Anusandhan Sansthan (DUVASU), Mathura. Ten healthy, cyclic, Sahiwal cows, which never expressed any reproductive abnormality in the past, were selected. No heifer was selected as experimental animal in order to avoid the adverse effect of any type of congenital reproductive defects. No special management practice was required for the experiment animals. They were kept along with their original herd mates in the same shed under loose housing system. The feeding and other management practices for these cows remained same as was normally practiced for other cows of the herd. The selected cows were observed for signs and symptoms of heat/estrus. The first heat was missed and thereafter these were kept under close observation from 17th day onward of first heat for appearance of onset of second heat. Differentiation of three stages of estrus viz. onset of estrus, standing heat and non estrus conditions of estrus Sahiwal cows was done by observing the thermal image temperature variation. The infrared thermograph camera (FLIR E60, Resolution 320x240 IR pixel, accuracy ±2 °C (±3.6°F) or ±2% of reading) is used to take the thermal temperature of muzzle and vulva. The image was taken from a certain distance from the objective organ and focused the camera properly. Then with the help of flir tools software, analysis of focused points on the thermeral image of objective organs was done.

Result and Discussion

The three different stages of estrus i.e. onset of estrus, standing heat and non estrus of experimental sahiwal cows in present study were differentiated by observing infrared thermographical temperature of muzzle and vulva. The results for mean squares value for infrared thermographical temperature of muzzle and vulva during different stages of estrus (Table 1) revealed a significant (P<0.01) effect of stages of estrus (onset of estrus, standing heat and non estrus) on the temperature of muzzle and vulva of experimental sahiwal cows in present study. Overall pool mean for infrared thermographical temperature of muzzle and vulva of experimental sahiwal cows in present study was observed to be 33.06 ±0.23 °C for muzzle and 37.40±0.29 °C for vulva, whereas, the mean values for onset of estrus, standing and non estrus stages of experimental cows was observed to be 32.32±0.09, 34.72±0.21 and 32.15±0.09 °C, respectively for muzzle and 37.56±0.10, 39.15±0.15 and 35.49±0.08 °C, respectively for vulva. Thus, infrared thermographical temperature of muzzle and vulva of experimental sahiwal cows was observed to be significantly (P<0.01) higher during their standing heat condition as compared to those during onset of estrus and non estrus stage of estrus (Table 1)

Table 1: Mean ± SE values for infrared thermographical temperature of muzzle and vulva of experimental sahiwal cows during their different stages of estrus

Stages of estrus	Muzzle temperature (°C)		Vulva temperature (°C)	
	Mean	SE	Mean	SE
Onset of estrus	32.32^{b}	0.09	37.56^{b}	0.10
Standing heat	34.72^{a}	0.21	39.15^{a}	0.15
Non-estrus	32.15^{b}	0.09	35.49^{c}	0.08
Overall pool mean	33.06	0.23	37.40	0.29

Values with different superscripts in the same column differ significantly (P<0.01) from each other

The infrared thermographical temperature of muzzle and vulva in sahiwal cows in the present investigation was found to be significantly different during different stages of estrus (Plates 1, 2, 3, 4, 5 & 6). The infrared temperature of muzzle found to be significantly higher in standing heat condition but no significant difference for this attribute between onset of estrus and non estrus stage of estrus could be observed (Fig 1,2). Similar findings have been reported by Roelofs *et al*., 2005 [9] and Piccione *et al*., 2003 [10], that body temperature of animals increase at the time of ovulation and vulva were. Similarly, infrared thermographical temperature of vulva of experimental sahiwal cows in present study was observed to be significantly higher during standing heat followed by onset of estrus and non estrus conditions, respectively. Hellebrand *et al*. (2003) [11] also reported that the vulva temperature change combined with the body temperature and thermal imaging technology could be used for estrus detection.

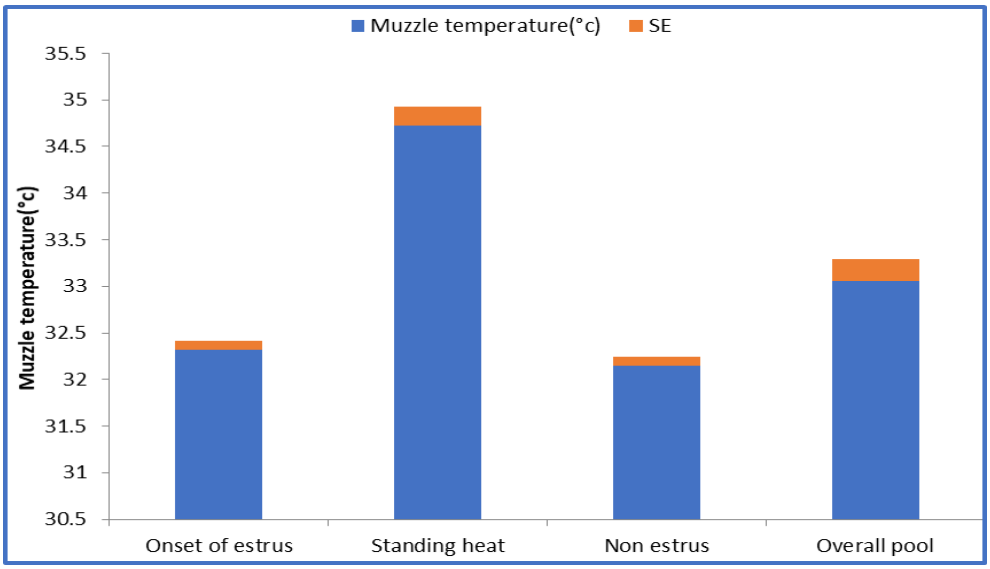

Fig 1: Mean of infrared thermographical temperature of muzzle in sahiwal cows during their different stages of estrus

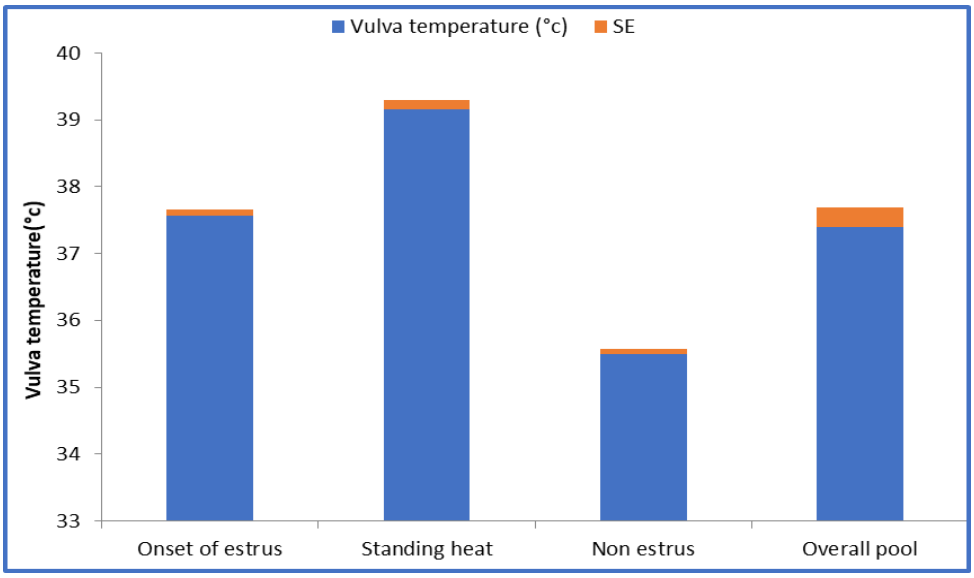

Fig 2: Mean of infrared thermographical temperature of vulva in sahiwal cows during their different stages of estrus

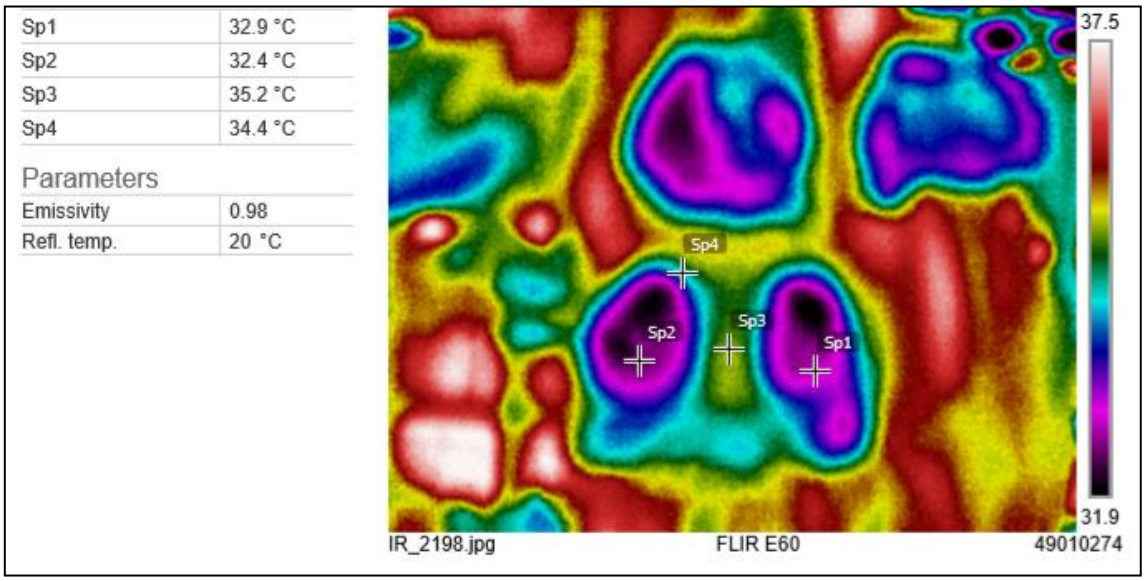

Plate 1: Plate showing average muzzle temperature at spot 1, 2, 3 and 4 during onset of estrus

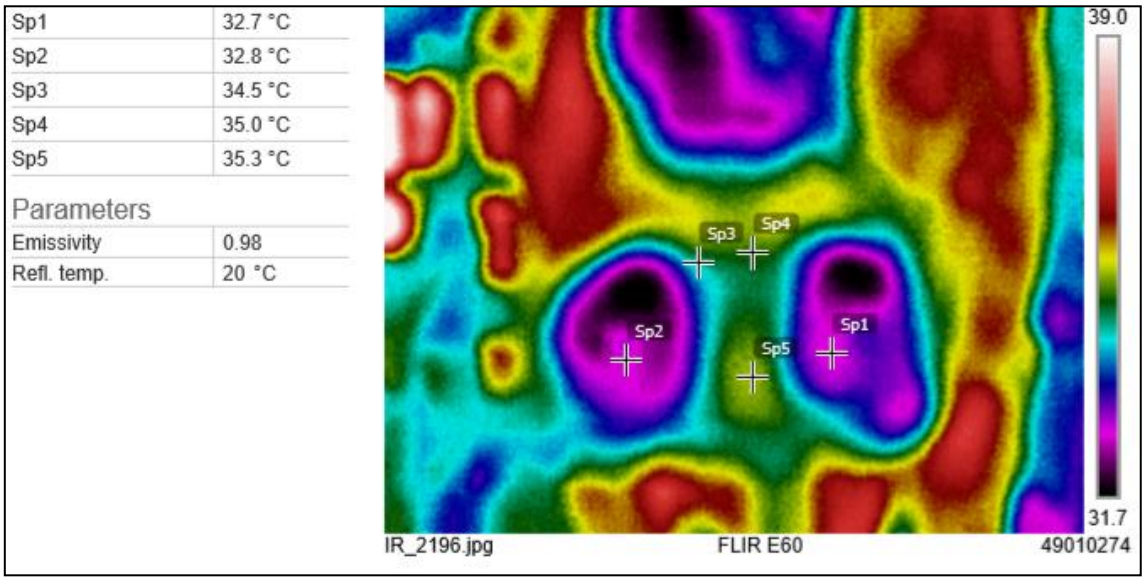

Plate 2: Plate showing average muzzle temperature at spot 1, 2, 3 and 4 during standing heat stage

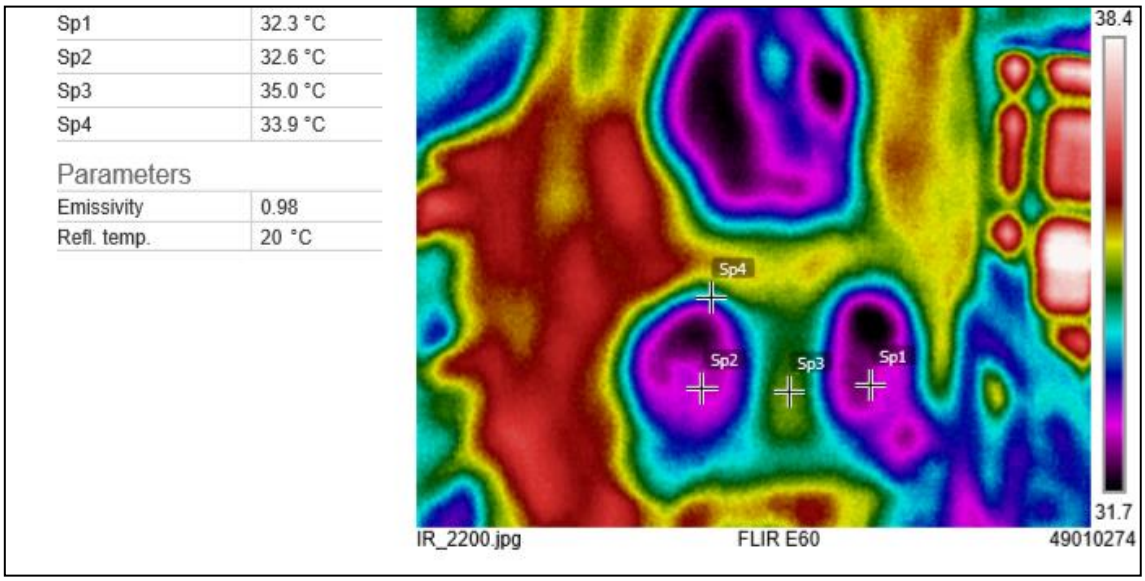

Plate 3: Plate showing average muzzle temperature at spot 1, 2, 3 and 4 during non estrus stage

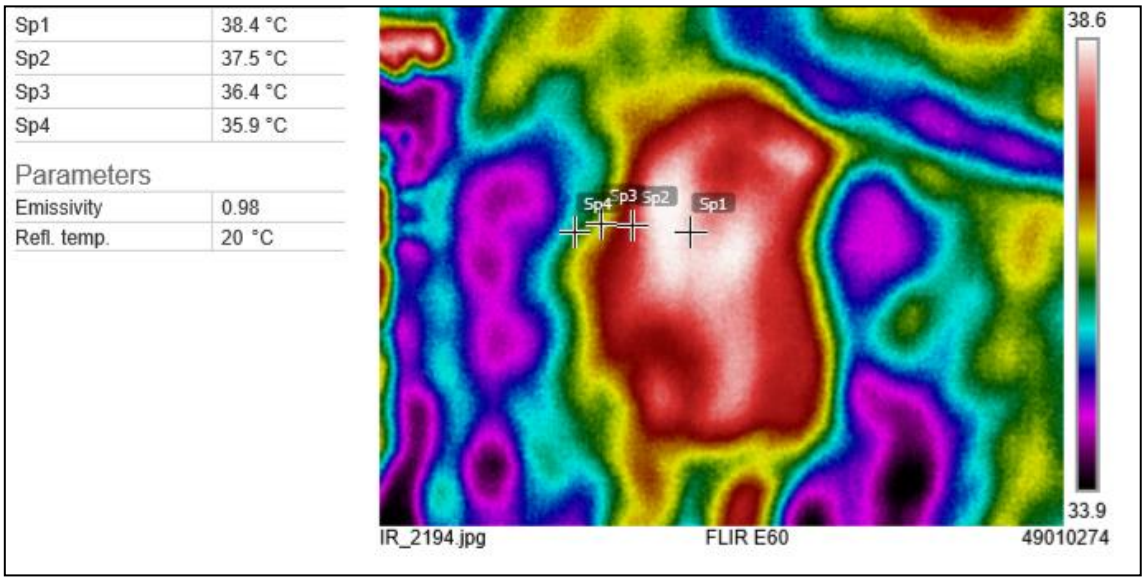

Plate 4: Plate showing average temperature of vulva at spot 1, 2, 3 and 4 during onset of estrus

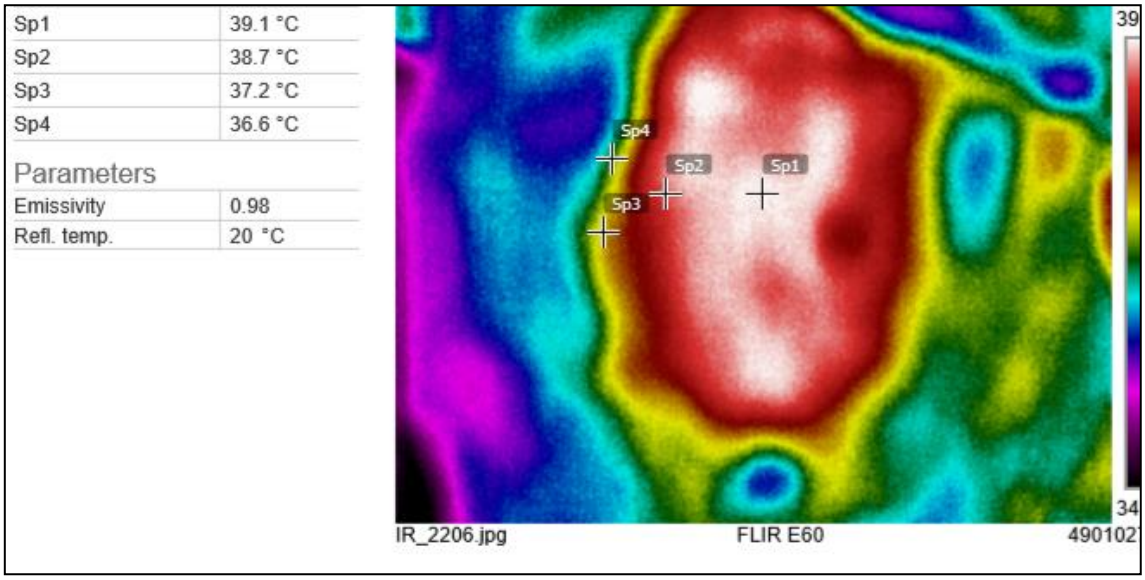

Plate 5: Plate showing average temperature of vulva at spot 1, 2, 3 and 4 during standing heat stage

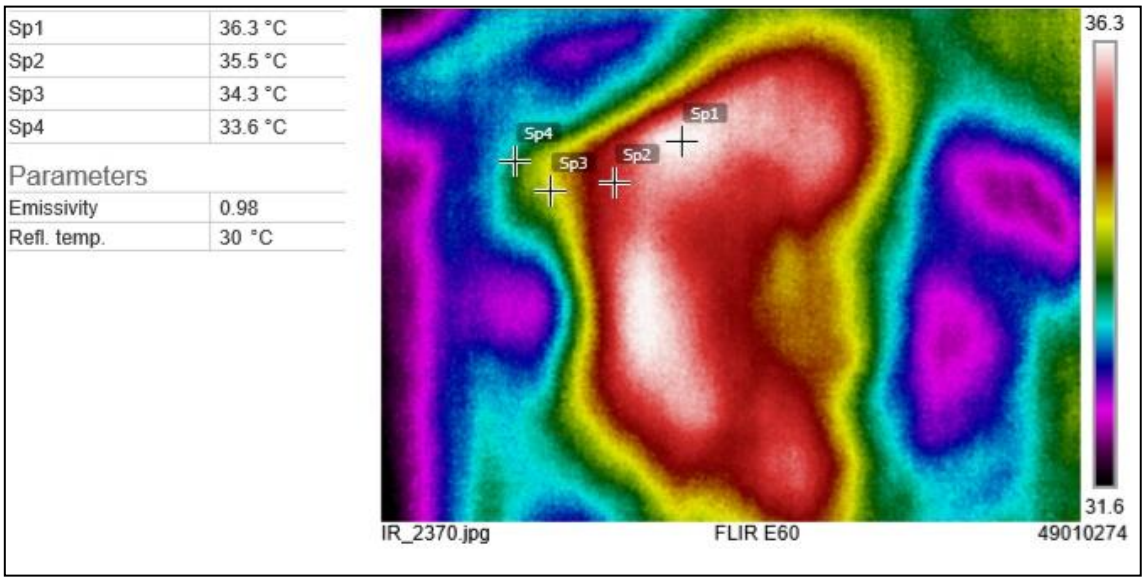

Plate 6: Plate showing average temperature of vulva at spot 1, 2, 3 and 4 during non estrus stage

Conclusion

The measurement of muzzle and vulva temperature through infrared thermography camera may be used as a non invasive device in discrimination of standing heat condition from other stages of estrus in sahiwal cows.

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