Indian Journal of Animal Sciences **81** (1): 15–18, January 2011

Influence of thermal stress on estrus behaviour and fertility of native Malpura sheep under semi-arid region of India

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Received: 30 November 2009; Accepted: 24 September 2010

ABSTRACT

Heat stress is a major limitation to reproductive function of sheep because it has deleterious effect on estrus incidences, estrus intensity and embryo production, which finally affects their productivity. Adult Malpura ewes (14) with an average body weight of 30.8 kg were randomly allocated into 2 groups of 7 each. Animals of group 1 were maintained under shed throughout the study while animals of group 2 were exposed to thermal stress (45°C/6 h/d) for 8 weeks in the hot chamber from 10: 00 to 16: 00 h and then taken back to the shed. All the animals were subjected to 15-days of pre-experimental period for getting them acclimatized to feed and micro-environment. The ewes were synchronized for estrus by administering 2 injections of $PGF_2\alpha$ (7.5 mg) at 10 days interval at their respective places. The onset of estrus, estrus duration and various sexual behaviours i.e. circling, tail fanning, head turning, standing and approaching to ram were recorded during the experiment. The ewes maintained under shed set in estrus earlier and had longer duration of estrus as compared to ewes exposed to thermal stress. The lambs born from the group 1 ewes had significantly higher birth weight than lambs from group 2 ewes. It is concluded from this study that exposure to heat stress treatment was sufficient to alter the onset of estrus, sexual behaviour, conception and lambing rates of ewes reared in the semi-arid tropical environment.

Key words: Estrus, Lambing, Sexual behaviour, Sheep, Thermal stress

The reproductive functions of the sheep are drastically affected by thermal stress because it has deleterious effect on estrus incidences, estrus intensity and embryo production (Dobson and Smith 2000, Hansen *et al.* 2001, Naqvi *et al.* 2004). However the reproductive efficiency of different breeds of sheep inhabiting in the arid and semi-arid tropical regions is relatively low due to high ambient temperature conditions and feed scarcity (Arora and Garg 1998). Thermal stress reduces the circulating estradiol-17ß concentration with consistent increase in adrenocorticotropin secretion, which in turn blocks the estradiol induced estrus behaviour (Doney *et al.* 1973). The reproductive behaviour of the animals in the environment in which they are kept should be fine-tuned to produce maximum number of offsprings most efficiently (Lindsay 1996). Most of the studies conducted on effect of thermal stress on temperate sheep or crossbred produced in tropical region exposed to thermal stress relatively lower magnitude (35° to 42°C) as compared to that existing in semi-arid tropical environment (42° to 48°C). Since sunshine hours are longest (10–12 h) and ambient temperature is elevated up to 48°C during summer day when most of the sheep are grazed in field and therefore exposed to high intensity of thermals and nutritional stress (Maurya *et al*. 2004). The production losses of such breed are likely to differ in native tropical sheep being more adapted to thermal stress. Unlike temperate and crossbred sheep information on the effect of thermal stress on sexual behaviour and estrus incidences of sheep reared in a semi-arid tropical environment is meager. Therefore this study was carried out to evaluate the effect of thermal stress upon sexual behaviour, conception and lambing rate of Malpura sheep native to semi-arid tropics.

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MATERIALS AND METHODS

The study was conducted at sheep farm of the CSWRI, Avikanagar, which is located in the semi-arid region of the country at longitude 75°–28°E and the latitude of 26°–26° N and at altitude of 320 meter above mean sea level. The annual rainfall in this area ranges from 350–550 mm. The maximum and minimum ambient temperature ranges from 8° to 47°C, respectively, while the mean relative humidity ranges from 20 to 90%. Mature cycling native Malpura ewes (14), 4–6

year-old, weighing 30.8±1.47 kg were selected at random and assigned to 2 groups (n=7/group). Malpura breed is a triple purpose hardy sheep, originated from the semi-arid tract of Western India. This medium type breed has light brown face and small tubular ears. The average body weight of Malpura ewes and ram is approximately 29.1 and 41.6 kg, respectively. All the ewes were provided a feed ration constituting 80% roughage (CP, 5.5%; TDN, 52.8%) and 20% concentrate (CP, 18%; TDN, 65%) *ad lib*. The drinking water was offered to all the ewes at 16: 00 h.

Before giving any treatment all the ewes were subjected to 15 days acclimatization period to their respective place and feed as well. The animals of group 1 were maintained in a shed made up of asbestos roofing at the height 2.4 m and open from side. Under shed the mean ambient temperature and RH were 13.9±0.05°C and 78.3±2.03 at 10:00 h and 35.5±0.48°C and 62.5±1.33% at 16: 00 h, respectively. The ewes of group 2 were exposed to thermal stress at 45°C in the hot chamber for 6 h from 10: 00 to 16: 00 h for 8 weeks. The hot chamber was made up of concrete sidewalls with asbestos roof and the space under the chamber was adequate for keeping 7 ewes. The inner side and the roof of chamber were insulated with hard wooden boards and heating was done with the aid of automatic electric heat blowers. Even heat distribution was ensured by use of 2 exhaust fans, one fan for sucking fresh air inside and other fan for removing air to outside. Natural light was provided through double glass airtight windows. The ambient temperature inside the chamber was 45°C and RH range was 43 to 54%.

Synchronization was induced by administering 2 injections of $PGF2_{\square}$ (PGF) 10 days apart. $PGF_{2\square}$ (PGF) @ 7.5 mg each at 10 days interval was injected intramuscularly after 15 days of thermal exposure (Naqvi *et al.* 2001). Estrus in ewes were detected with the aid of approned rams of proven vigour at 6 h intervals for 30 min in early morning (6.00 h), mid day (12.00 h), evening (18: 00 h) and mid night (24: 00 h). Different sexual behaviours namely circling, tail fanning, head turning, standing and approaching to ram were observed only during the first cycle of estrus. The intensity of different sexual behaviour was graded as 20, 40,60,80 and 100% as described earlier (Lynch *et al*. 1992, Maurya *et al*. 2005). The ewes in estrus were hand mated twice a day (morning and evening) with fertile rams. Ewes, which did not return to estrus up to 40 days after mating, were considered as conceived and recorded as pregnant.

The significance between different mean values of sexual behaviour, onset of estrus, estrus duration and lamb weight were analyzed using student's t- test (Snedecor and Cochran 1980). The conception rate and lambing rate in ewes was analyzed using chi-square test.

RESULTS AND DISCUSSION

In the semi-arid tropical region of India maximum ambient temperature during summer shoots up to 48°C. The maximum period of thermal stress is 10 to 12 h of the day when sheep are grazing in field and exposed to solar radiations. To simulate this condition, we exposed the animals to 45°C/6 h/day. The percentage values of sexual behaviour of native Malpura ewes of both the groups are set out in Table 1. No significant difference in the per cent circling was observed in the ewes maintained under shed as well as ewes exposed to elevated temperature in the climatic chamber. The per cent tail fanning, head turning, standing and approaching to ram behaviors were significantly lower (P<0.05) in the ewes exposed to thermal stress, compared to ewes maintained under the shed. Thermal stress reduces the normal manifestation of different sexual behaviors, which leads to decrease in productive potential of sheep. The variation in sexual behaviour pattern occurs in ewes during estrus i.e. perceptivity (active search of ram) and receptivity (acceptance of mating attempts by ram) (Banks 1964). While Lynch *et al.* (1992) stated that in Merino sheep sexual behaviour occurs in the form of circling, tail fanning, head turning, standing and approaching to ram. In present experiment, thermal stress significantly (P<0.05) lowered the tail fanning, head turning, standing and approaching to ram responses than observed in control ewes. The circling behaviour in group 2 ewes was also lower but did not reach to a level of significance. Similar observations were also reported by other workers (Dutt 1964, Thwaites 1971) who observed that interference with cyclical estrus behaviour was greater in ewes exposed to hot room conditions. The mean values of onset of estrus and estrus duration of both the group of ewes are presented in Table 2. The ewes maintained in the shed set in estrus significantly (P<0.05) earlier as compared to ewes exposed to thermal stress (group 2) after the first and also after the second PGF injection. However, the duration of estrus was significantly longer (P<0.05) in the control group ewes after both the PGF injections compared to ewes exposed to thermal stress. Imposing thermal stress on the ewes before mating was shown to delay in exhibition of behavioral stress (Sawyer 1979 a,b). The reason for delay may be due to alteration in LH release and decrease in the estrogen secretion in ewes exposed to thermal stress. In the present study the ewes in group 2 had been exposed to thermal stress prior to synchronization treatment. The delay in onset

Table 1. Effect of thermal stress on sexual behaviour of ewes (mean±SE)

Attributes	Shed	Hot chamber
Circling (%)	34.29±2.49[a]	29.44±2.69[b]
Head turning (%)	88.23±2.53[a]	76.55±2.73[b]
Tail fanning (%)	91.42±1.76[a]	80.55±1.30[b]
Standing (%)	92.38±1.76[a]	79.55±1.90[b]
Approaching to ram (%)	82.38±2.39[a]	66.11±2.66[b]

[a,b]Means with different superscript in same row differ significantly (P<0.05).

of estrus in heat stressed ewes may be attributed due to disruption or retardation of growing follicles, which changes the normal cyclical estrus behaviour in ewes (Mackenzie *et al.* 1975).

After mating of ewe during the first cycle, significantly (P<0.05) higher number of ewes in group 1 conceived as compared to group 2 ewes. One ewe from group 1 and 3 ewes from group 2 returned to estrus and were mated. The cycle-wise conception rate is depicted in Table 2. In the present study thermal stress resulted in considerable decrease in conception rate. The conception rate to the first hand mating was 85.7% in the group 1 and 57.1% in group 2 ewes. The cumulative conception rate after second hand mating did not differ significantly amongst both the groups of ewes. All the ewes of group 1 lambed but in group 2 ewes out of 6 conceived ewes only 5 ewes lambed. The mean value of lambing rate and lamb born form the ewes exposed to thermal stress and maintained under shed is depicted in Table 2. The lambing rate differed significantly (P<0.05) between control and treated groups. The lambs born from the ewes in group 1 had significantly (P<0.05) higher birth weight than those of ewes exposed to thermal stress. In the present experiment thermal stress resulted in considerable decrease in the conception rate. The conception rate pertaining to the first mating as well as after 2 consecutive mating was relatively lower in the ewes exposed to thermal stress. The lower conception rate in the thermally exposed ewes might be due to the deleterious effect of heat stress on the dominant follicle, secretion of prostaglandin, which may be leading to luteolysis and embryonic loss. Thwaites (1971) and Naqvi *et al.* (2004) reported that the ovulation in the ewes occurs towards the end of estrus and high ambient temperature may increase ovum wastage and could lead to lower conception and lambing rate. The lambing rate differed significantly (P<0.05) among control and treated group. All the ewes of group 1 lambed but in group 2 ewes, out of 6 conceived ewes only 5 ewes lambed. Sawyer *et al.* (1979) reported in low lambing rate in the merino ewes who were exposed to thermal stress before estrus and insemination. The lambing rate in the present study indicated embryonic or fetal loss because of the previous effect of heat stress. Lambs born from heat stressed ewes were reported to be low weight than from control ewes maintained in a cool environment (Shelton 1964, Alexander and Williams 1971). It may be concluded from this study that simulated thermal environmental condition can alter the onset of estrus, sexual behaviour, conception and lambing rates of ewes reared in the semi-arid tropical environment. There is a need to develop suitable strategies to reduce the effect of thermal stress, which may prevent the high occurrence of thermal stress induced- infertility in sheep and economic losses to the farmers.

Table 2. Effect of thermal stress on reproductive efficiency of ewes

Attributes	Shed	Hot chamber
No. of animals	7	7
No. of animals exhibited heat	7	7
Onset of estrus (h)	40.6±1.12 [a] (7)	45.7±1.04 [b] (7)
Estrus duration (h)	25.4±1.36[a] (7)	19.5±1.13[b] (7)
Ewes conceived at first cycle No. (%)	6 (85.7%) [a]	4 (57.1%) [b]
Ewes mated at second cycle No. (%)	1	3
Ewes conceived at second cycle No. (%)	1 (100%) [a]	2 (66.6%) [b]
Overall conception No. (%)	7 (100%) [a]	6 (85.7%) [a]
Animals lambed No. (%)	7 (100%) [a]	5 (71.4%) [b]
Body weight of lambs (kg)	3.47±0.06 [a] (7)	3.06±0.07 [b] (5)

[a,b]means with different superscript in same row differ significantly (P<0.05).

ACKNOWLEDGMENTS

The facilities permitted by the Diector and technical assistance rendered by Dr. Pramod Kumar Verma and Mr N L Gouttam of CSWRI during the experiment are highly acknowledged.

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