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Improvement in Reproductive Performance of Boron Supplemented Karan Fries Cows During Hot and Humid Season

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ABSTRACT

The Present investigation was conducted on eighteen pregnant Karan Fries (Holstein Friesian × Tharparker) cows and was divided into three equal groups. Control group was fed with only basal diet. T_1 and T_2 group was fed with basal diet along with 250 ppm and 500 ppm Boron/day from 30 days before to 60 days after calving. Temperature humidity index, reproduction parameters were calculated and analysed. There was significant ($P<0.05$) reduction in postpartum oestrus interval, days of first observed estrum, service period and number of services per conception and significant ($P<0.05$) increase in the size of dominant follicle was observed by ultrasonography. Increase in conception rate, reduced incidence of retention of placenta, postpartum metritis was noticed in boron supplemented groups. Hence supplementation of boron at both levels found to be effective in improving reproductive performance of Karan Fries cows during hot humid condition.

HIGHLIGHTS

- Boron supplement reduced postpartum oestrus interval, days of first observed estrum, service period and number of services per conception
- Boron supplementation increased the size of dominant follicle.

Keywords: Boron, Crossbred, Heat stress, Reproduction

India is having bovine population of about 302.79 million according to (2019) 20th livestock census and out of which 51.36 million animals were crossbred/exotic cattle with average milk production of about 8.09 kg per day and the milk production is counted to be 28% of total milk production (2019-2020). Cross-breed cows have early puberty, early age at first calving, and calving interval and are more susceptible to the infectious and metabolic diseases during the transition period and heat stress. The point where the animal cannot be able to dissipate an adequate amount of heat to maintain the thermal balance of the body is heat stress. Heat stress calculated by combined measure of both environmental and relative humidity (Hill and Wall, 2015) which increases the body temperature of animals (Lambertz *et al.,* 2014). Heat stress when Temperature humidity index exceeds beyond 72 results in negative effect on reproduction parameters (Dash *et al.,* 2016). The reproductive behaviour changes with the change in the climatic conditions and season of birth and mating. Major changes noticed in the sign of conception rate and calving intervals which is mainly due to climatic changes. The blood flow to the periphery increases which imparts high temperature to the reproductive organs during heat stress, and the elevated temperature is not conducive for the embryo leads to embryo mortality and reduces

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breeding efficiency of animals in farm. El-Tarabany and El-Bayoumi, 2015 observed decrease in conception and the pregnancy rate of Holstein cattle to 16.1% and 12.1%, respectively, at high THI of 80-85, fertility rate of postpartum inseminated cows was decreased during hot summer months than cold winter (Khodaei-Motlagh *et al.,* 2011). Experiment conducted by Almoosavi *et al.,* 2021 pointed out that the animal in heat stress condition showed reduced DMI of about 20 % compared to cows in cooled condition, which in turn leads to negative energy balance in postpartum animals, that caused reduced plasma insulin, IGF-I and glucose concentrations. Reduction of these results in poor quality oocyte, poor detection of estrus and impaired development of follicles.

Boron listed as essential trace mineral has significant effects on major function in increasing the SOD, glutathione peroxide and total antioxidant activity during heat stress where the oxidative stress will be more that cause reproductive failure, embryonic development, hormone secretion, mineral metabolism and immunity (Kabu and Akosman, 2013 and Boyacioglu *et al.,* 2017). Boron is gaining the attention of the animal nutritionist as one of the numerous trace minerals and identified as an essential mineral in animals and affects metabolism of oestrogen, insulin and glucose in animals. Maintenance of anti-oxidant status of animals by increasing the SOD, Glutathione peroxidase, total antioxidant activity, helps in retention of calcium and magnesium (Basoglu *et al.,* 2017) as major mineral deficiency leads to infertility. Therefore, present study was conducted to investigate the effect of dietary boron on various reproductive parameters of Karanfries cows during heat stress condition.

MATERIALS AND METHODS

Experimental location

Study was conducted at Livestock Research Centre, National Dairy Research Institute, Karnal, Haryana, India which is situated at the latitude of 29° 43" N and latitude of 76° 58" E that is 250 meters above the main sea level. The minimum and maximum temperature of the study area were near to freezing during winter and above 42 ºC during summer respectively.

Selection and management of experimental animals

An experiment was conducted on 18 pregnant crossbred karanfries (Holstein Friesian × Tharparker) and were divided into three equal groups' viz. C (control), T_1 and T_2 (Treatments) of six animals in each group based on bodyweight, parity and EPA (Table 1). Control was fed with only basal diet. T_1 and T_2 group was fed with basal diet along with 250 ppm and 500 ppm Boron/day from 30 days before to 60 days after calving. The basal diet for three groups was similar comprising of concentrate mixture (16-18% CP and 70% TDN with ingredients as mentioned in table 2) and green fodder maize dividing the ration in the ratio of 30:70 respectively.

Table 1: Details of experimental animals (Mean ± S.E)

Groups	Body weight (Kg)	Parity	Estimated Producing Ability
1	447.5 ± 24.39	2.25	3514.50 ± 159.00
2	418.16 ± 22.01	2.00	3524.66 ± 84.21
3	458.66 ± 41.02	2.66	3644.33 ± 384.44

Table 2: Ingredient composition (%) of concentrate

Ingredient	Parts (%)
Maize	26.92
Oats	5.90
Wheat bran	17.95
GNC	15
Mustard cake	8.9
Cotton seed cake	7.9
Gram chunni	7.0
Rice bran	7.0
Common salt	1
Mineral mixture	2
Sodium bicarbonate	0.25

Supplementation of boron

Boron was supplemented daily from 30 days before to 60 days after calving by mixing 250 ppm and 500 ppm as boric acid based on dry matter intake in small amount of concentrate feed.

Parameters observed

After calving the animals which were failed to shed the foetal membrane for more than 12 hrs were considered as the case of retained foetal membrane (RFM). The animals were observed for the signs of oestrus subsequently both morning and evening hours. The day of first observed estrus, service period, number of services per conception, conception rate was recorded and the size of dominant follicle was recorded on the day of estrum by B-mode ultrasonography.

STATISTICAL ANALYSIS

The data were analysed using the one-way ANOVA of statistical package for the Social Sciences (SPSS for windows, V21.0; SPSS Inc., Chicago, USA). Duncan test was used for post-hoc comparison of different treatment means and statistical differences were considered significant at $p<0.05$.

RESULTS AND DISCUSSION

Elevated environmental temperature along with high humidity (hot and humid season) pertain to heat stress condition. Average THI values recorded was 82.35 during July, 86.30 during August, 83.7 during September and 77.45 during October with the average of about 82.45. The observations of THI during the experimental period indicated heat stress condition throught the experiment where comfort zone of animal lies within the THI of 72 in case of crossbred cattle.

The plasma boron values significantly ($p<0.001$) high in 250 ppm and 500 ppm supplemented groups as compared to control supplemented only with basal diet with the Mean ± SE values of control, T1 and T2 groups were 0.57 ± 0.007, 3.21 ± 0.04 and 3.87 ± 0.02 respectively. A previous study has also reported higher plasma boron level following supplementation of 200 ppm and 400 ppm Boron to murrah buffalo (Sharma *et al.,* 2020).

In contrast to the reproductive parameters, control animals had high incidence of retained foetal membrane and metritis cases (Table 3). The days of first observed oestrus, days of first insemination and service periods were reduced in the boron supplemented groups significantly compared to control animals. There was significant decrease in the number of services per conception and increase in conception rate of the treatment group animals. On ultrasonography examination of the size of dominant follicle on the day of oestrum, it was noted that the follicle size was large in treatment groups of animals (Fig. 1 USG of dominant graffian follicle).

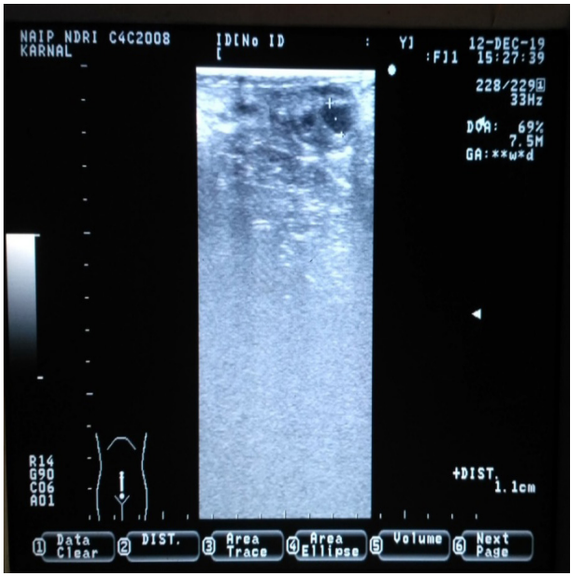

Fig. 1: Ultrasonography image of large follicle of crossbred different groups of KF cows

Kumar *et al*. (2018) found that antioxidant activity found to be decreased ($p<0.05$) during summer in Hariana cattle as compared to winter. When THI exceeds beyond 72, negative effect on reproduction parameters of cattle (Dash *et al*., 2016), decreased fertility rate in postpartum cows inseminated during hot summer months (khodaei-Motlagh *et al*., 2011). Khan *et al*. (2013) found that significantly ($P<0.05$) reduced pregnancy rate at day 60 is 20.5 % in HS-HS condition while 32.6 % in TN-TN, 30.2 % in TN-HS and 31.8 % in HS-TN groups. Schuller *et al*. (2014) observed reduced conception rate from 31% to 12 % and also observed that negative effect of heat stress on conception rate was observed from the day 21 to 1 day before breeding. Boron by virtue of its antioxidant properties, reduces cortisol level and TAC level which in turn increase the level of reproductive hormones like LH have increased reproductive performance of animals that may be due to indirect effect of Boron and also another research finding of Small *et al*. (1997) stated that the concentration of boron in serum generally higher ($p<0.05$)

Table 3: Effect of boron supplementation on reproductive performance of Karan Fries cattle (n=6 in each group)

Parameters	0 ppm boron	250 ppm boron	500 ppm boron
Time to shed placenta (hours)	5.51 ± 0.74	4.72 ± 0.67	4.62 ± 0.55
Abortion	1 (16.6%)	1 (16.6%)	1 (16.6%)
Cattle with retained foetal membrane	2 (33.3%)	1 (16.6%)	1 (16.6%)
Cattle with metritis	2 (33.3%)	1 (16.6%)	1 (16.6%)
1st observed heat (days)	81.50^{a} ± 5.14	56.00^{b} ± 3.92	58.50^{b} ± 10.07
Days of first insemination (days)	118.20^{a} ± 5.75	91.20^{b} ± 9.90	98.33^{b} ± 5.73
Service periods (days)	142.00^{a} ± 11.86	105.25^{b} ± 12.24	104.80^{b} ± 10.17
Service per conception	2.25^{a}	1.5^{b}	1.5^{b}
Size of dominant follicle (mm)	12.63 ± 0.14^{b}	14.26 ± 0.22^{a}	14.61 ± 0.20^{a}
Conception rate (%)	66.6	80	83.33

in the beef heifers and cows that conceived on day 21 when the concentrations were higher ($p<0.05$) than at the estrum. Ahuja *et al.* (2017) reviewed that calcium, phosphorus, magnesium and some major minerals were required for combat the condition of retained placenta, prolapsed uterus, reduce number of services per conception and improve reproductive efficiency. Phosphorus and calcium deficiency in blood were linked to low progesterone level which could affect the fertility. Apart from major minerals, trace minerals also important for reproductive health (Chester-Jones *et al.,* 2013 and Kumar *et al.,* 2011).

Supplementation of 40 ppm boron to the lambs with normal and low calcium diet significantly increased the antioxidant status of the animal which aids in ameliorating the stress (Bhasker *et al.,* 2017). A study shown that boron supplementation at 200 ppm and 400 ppm significantly increased plasma calcium, vitamin D3 levels and also numerical increase in plasma Phosphorus, Magnesium, Zinc levels of boron supplemented groups (Sharma *et al.,* 2020). Even there is no traceable literature on the direct effect of Boron on improvement in reproduction, but it is evident that boron supplementation improved antioxidant activity of the animals and also increases in progesterone, plasma mineral levels and role in oestrogen hormone helps in improvement of reproduction parameters.

CONCLUSION

Present study found that supplementation of boron at 250 and 500 ppm improved the reproductive efficiency in terms of postpartum interval, postpartum oestrus interval, days of first observed estrum, service period and number of services per conception size of dominant follicle of Karan-fries dairy cow that may be due to function of boron on antioxidant activity, plasma mineral and reproductive hormonal level.

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