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IMPACT OF CLIMATE CHANGE ON REPRODUCTIVE FUNCTIONS OF MURRAH BUFFALOES

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ABSTRACT

Global warming due to climate change is likely to aggravate the thermal/heat stress in buffaloes, affecting their reproductive and productive performance. Stress levels during a day have been worked out using Temperature Humidity Index (THI) calculated from dry bulb and wet bulb temperature monitored every ten minutes during 2005-07. The analysis revealed that THI starts increasing in afternoon from February onwards and exceed 75 for 2-3 h in the afternoon from March onwards. For more than 1500 h during the year THI ranges 76-80 and for other 1500 h between 81-85. THI exceeding 85 (86-95) are observed during May for more than 115 h and total number of hours increases to 300-350 during July and August. Climate change scenarios constructed for India revealed that maximum temperature (T max) rise of 4.54, 4.42, 3.07 and 4.38°C, respectively during Dec-Feb, Mar-May, Jun-Aug and Sep-Nov and very less change in precipitation is likely to increase uncomfortable days (THI>80) from existing 40 days (10.9% of the year) to 104 days (28.5% of the year) for a projected temperature rise as per Had CM3-A2 scenario and 89 days for an average temperature rise of 2.95°C as per B2 scenario for time slices 2079-2099. Increased number of heat stress days with THI >80 (by 160 % for A2 scenario) are likely to have a negative impact on estrus symptoms, duration and conception of buffaloes. Data analysis showed that buffaloes have a typical rhythmic pattern with one or two peaks during the year and low reproductive activity during summer. A higher thermal stress on lactating buffaloes is likely to have a negative impact on gonadal functions. The study concluded that likely temperature rise due to global warming may negatively impact reproductive functions of buffaloes and increase the incidence of silent estrus, short estrus and change reproductive rhythm and production efficiency of buffaloes.

Key words: Climate change, THI, reproductive functions, buffalo, estrus.

INTRODUCTION

The biological rhythms are innate and keep organisms in tune with their environment. The responsiveness to various environmental stimuli or exogenous cues plays an important role in the functioning of internal biological clocks. The environmental factors such as ambient temperature, light and dark, noise, and even interactions with other members of the same species help to keep biological cycles in phase with periodic fluctuations in environment. All living organisms thus respond to environment stimulus and have specific time frame for adaptive response. For many livestock species, the most important interval measured by their internal clocks is the 24-hour cycle of light and darkness. Internal biological clocks also enable them to synchronize their reproductive functions/breeding season with the most favourable environmental conditions congenial for raising their young ones. The information on periodicities of livestock activities is limited available and no information is available on activities that occur in buffaloes each season and annually in relation to the sun and moon. The information on periodicities of tropical livestock activities is also limited. Therefore, a study was planned to observe the changes in reproductive rhythm and assess likely impact of temperature rise on reproduction of buffaloes in relation to increased stress days due to projected global warming.

MATERIALS AND METHODS

Weather conditions at Karnal, Haryana (Latitude 29.43 N and longitude 77.2 E, 250M above MSL) during winter are cool and Tmax are near 20°C, Tmin 2-3°C. During summer temperature rise to more than 42°C and during hot-humid period humidity adds to discomfort and ambient temperatures remain more than 33-34°C. Meteorological data (1994 to 2006) of Karnal was obtained from weather stations of CSSRI and NDRI, Karnal. Dry bulb Temperature (Tdb) and wet bulb Temperature (Twb) were used to calculate temperature-humidity index (Mc Dowell, 1972). Buffaloes maintained at the National Dairy Research Institute were housed in free stalls, open on all sides with asbestos roof on mangers/ feeding area. All buffaloes were maintained on feeding schedules specific to their milk yield and provided ad lib dry matter/ green and water. Concentrate mixture consisting of maize, barley, oil cakes was provided for maintenance, milk production and pregnancy.

Reproduction records of Murrah buffaloes for the period 1994-2006 maintained at the institute were analyzed for trends in reproduction, estrus expressed, AI, number of pregnancies and conception rate. Effect of non-genetic factors like air temperature, humidity and THI was analyzed on reproduction of buffaloes. Data was analyzed by two way ANOVA and regression coefficient by using SYSTAT 2007 software.

RESULTS AND DISCUSSION

Uncomfortable period during the year were calculated from variations in a day occurring on the basis of temperature-humidity index (THI) computed from hourly records of dry bulb and wet bulb for the twelve months at Karnal, Haryana. Uncomfortable period was high during summer (April to June) and rainy season (July to September). The THI starts increasing in afternoon from February onwards and exceed 75 for 2-3 h in the afternoon from March onwards. For more than 1500 h during the year THI ranges 76-80 and for other 1500 h between 81-85. THI exceeding 85 (86-95) are observed during May for more than 115 h and total number of hours increase to 300-350 during July and August. The severe stress days with THI>85 are predominantly observed from May to August. Decline in THI during night in hot dry summer (April and May) due to decrease in temperature provide opportunity to animals for heat dissipation. However, after onset of monsoon in late June or early July difference between morning and evening THI is reduced and animals get limited opportunity for recovery from thermal stress. During hot dry summer months (May and June) THI value (80 or more) increase by more than 450% as compared to comfortable March (65 h vs. 295 h). Climate change scenarios were constructed for India with projected maximum temperature (T max) rise of 4.54, 4.42, 3.07 and 4.38˚C, respectively during Dec-Feb, Mar-May, Jun-Aug and Sep-Nov for Had CM3-A2 scenario for time slices 2079-2099 (Ruosteenoja et. al , 2003) and very less change in precipitation is likely to increase uncomfortable days (THI>80) from existing 40 days (10.9% of the year) to 104 days (160 % increase).

Buffaloes express estrus throughout the year. Buffaloes have distinct estrus rhythm during normal ambient conditions and reproductive functions are influenced by change in Tmax and Tmin. A perusal of monthly and yearly variation in estrus expression during the 1994-2006 period indicated that animals have a typical rhythmic pattern with one or two peaks during the year. The low reproductive activity was observed during summer, when intensity of solar radiation is high and duration of sun shine is more (figure I). The frequency of estrus was pronounced during cool periods and buffaloes start exhibiting estrus after onset of monsoon. More buffaloes exhibit estrus when THI is near comfortable level (THI<70) in morning. The deviations from mean, in estrus during the years were observed mainly from July onwards reaching a peak in September or October months (figure II). A majority of buffaloes exhibited signs of estrus from September to November when ambient temperatures were low and comfortable. Climate change scenarios constructed for India revealed that maximum temperature (T max) rise of 4.54, 4.42, 3.07 and 4.38˚C, respectively during Dec-Feb, Mar-May, Jun-Aug and Sep-Nov and very less change in precipitation is likely to increase uncomfortable days (THI>80) from existing 40 days (10.9% of the year) to 104 days (28.5% of the year) for a projected temperature rise as per Had CM3-A2 scenario and 89 days for an average temperature rise of 2.95˚C for Had CM3 B2 scenario for time slices 2079-2099. Increased number of heat stress days with THI>80 (by 160 % for A2 scenario) are likely to have a negative impact on estrus symptoms, duration and conception of buffaloes.

Reproductive efficiency of buffaloes has been observed to greatly influenced by temperature. Estrus expression and intensity of heat in buffaloes is weak during summer as compared to winter with a diurnal pattern (Madan and Prakash, 2007). High ambient temperature also shortens the duration of estrus and symptoms of estrus expression. Plasma Progesterone level and its cyclic variations influence the estrus expression that occur mainly due to cyclic changes in corpus leuteum (Bachalaus *et al*., 1979). Circulating levels of progesterone, estradiol and luteinizing hormone in buffaloes were low in hot months and responsible for poor expression of estrus and low conception in buffaloes (Rao and Pandey, 1982, 1983). Follicle stimulating hormone level in buffaloes during summer season was also low than breeding season indicating that thermal stress during summer is the main cause for low reproductive efficiency of buffaloes. During summer low hormonal levels also influence the diurnal pattern of estrus expressions and number of heat symptoms in buffaloes (Prakash, 2002, Madan and Prakash, 2007). Low level of nutrition coupled with high environmental temperature stress has been attributed to long anestrus periods in buffaloes (Kaur and Arora, 1984).

This study on the likely impacts of global warming under climate change scenarios indicate that projected temperature rise will increase duration of thermal stress on lactating buffaloes and negatively impact gonadal functions. Inadequate feed & fodder availability, water availability during prolonged stress may have negative impact on buffalo heifers, their heat expression and conception. The rise in uncomfortable days with THI>80 by 160 % for HADCM3 A2 scenario for time slices 2079-2099 particularly in Northern India is likely to lengthen the age of buffalo maturity, puberty, estrus symptoms/expression, duration and conception of buffaloes. The impacts may be more pronounced in

vulnerable milch buffalo populations unprotected on stressful days with high heat load due to low heat dissipation from skin surface or inadequate cooling. Therefore, adaptation and heat abatement measures need to be employed to reduce thermal stress, fertility losses and other health consequences.

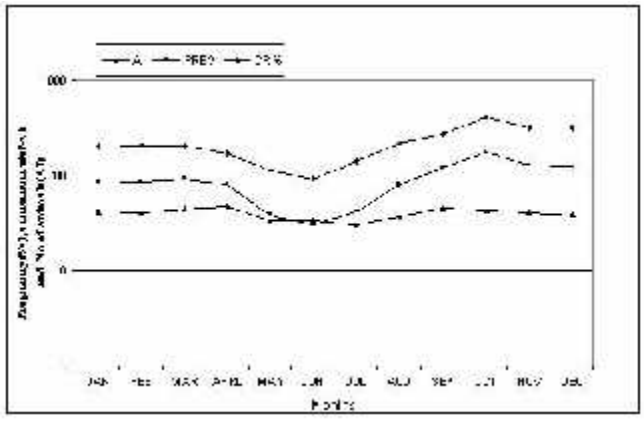

Fig.1 Reproductive function of buffalo during different months of a year

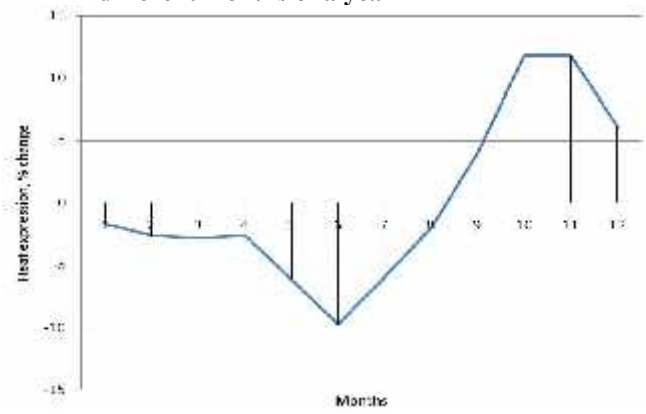

Fig. II Average estrus deviations during different months in buffaloes (N= 4543, 1994-2006)

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