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R.C. Upadhyay, S.V. Singh, A. Kumar, S.K. Gupta & Ashutosh

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Impact of Climate change on Milk production of Murrah buffaloes

R.C. Upadhyay, S.V. Singh, A. Kumar,
S.K. Gupta, Ashutosh

National Dairy Research Institute, Karnal, India

Corresponding author: R.C. Upadhyay. National Dairy Research Institute, Karnal-132001, India - Email: ramesh5304@rediffmail.com

ABSTRACT: Global warming is likely to impact productivity of buffaloes due to their sensitivity to temperature changes. Air temperature, humidity, wind velocity and solar radiation are the main climate variables that affect buffalo production in tropical climate. In the present study sensitivity of lactating Murrah buffaloes to sudden temperature (Tmax, Tmin) change and THI have been analyzed from milk production and climatic records (1994-2004) of Karnal. Algorithms were developed and validated on lactating buffaloes during 2005-2006 at the Institute. A sudden change (rise or fall) in Maximum/Minimum temperature during summer and winter was observed to affect milk production. The decline in minimum temperature (>3°C) during winter and increase (>4°C) during summer than normal were observed to negatively impact milk production upto 30% on the next or subsequent days after extreme event. The return to normal milk production depended on severity and time period of thermal stress/ event occurrence. The R^2 was very low for cool period observed during Feb- April/Sept-Nov and actual effect on milk production was minimum. This indicated that low THI had a relatively small effect on milk production performance. The lactation period of animals are shortened during extreme summer when THI were more than 80 and reproductive functions were also adversely affected. Thermal stressed buffaloes did not exhibit estrus or exhibited estrus for short period. The potential direct effects of possible climate change and global warming on summer season milk production of Murrah buffaloes were evaluated using widely known global circulation model UKMO to represent possible scenarios of future climate. Both milk production and reproductive functions of Murrah buffaloes are likely to be affected due to warming effects.

INTRODUCTION - Milk production and reproductive functions of buffaloes are negatively impacted by temperature rise during summer and also by sharp temperature decline in winter. The high temperature causes stress due to increased body heat leading to low heat dissipation from the body surface. High heat load in lactating buffaloes reduces their milk production and shorten duration of lactation periods. Information on milk production of Murrah buffaloes with specific emphasis on climate change is not available therefore an attempt has been made to find out sensitivity of lactating Murrah buffaloes to changes in temperature during extreme summer. The impact of temperature rise and decline has been analyzed on the milk production and reproductive functions.

MATERIAL AND METHODS - The records of Murrah buffaloes maintained at the Institute were used to correlate milk production with changes in Temperature and Temperature Humidity Index (Johnson et al., 1963). The sensitivity of lactating Murrah buffaloes to sudden temperature (Tmax, Tmin) change and THI were analyzed from day to day milk production changes and changes based on climate data records (1994-2004) of NDRI and /or CSSRI, Karnal. Algorithms for milk production and THI were developed and validated on lactating buffaloes during 2005-2006 at the Institute. Impact of high temperature on milk production was assessed and decline in milk production was calculated. The potential direct effects of possible climate change in 2020/2050 and global warming on summer season milk production of Murrah buffaloes were also evaluated using widely known global circulation model UKMO (SAS region-23) to represent possible scenarios of future climate (Ruosteenoja *et al.,* 2003).

RESULT AND CONCLUSIONS - The impact of temperature rise/ change was assessed on milk production of Murrah buffaloes and a decline in milk production was observed with a rise in THI and temperature (Figure 1 and 2).

Figure 1. Impact of THI on Milk Yield (Kg/day) of Murrah Buffaloes.

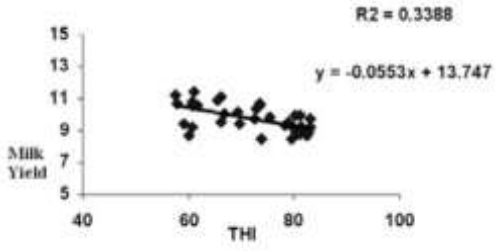
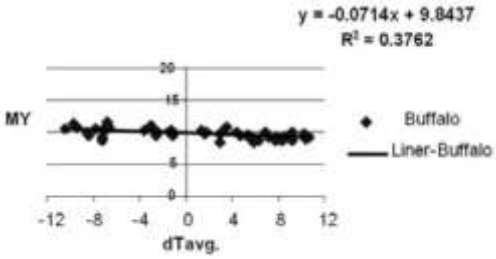
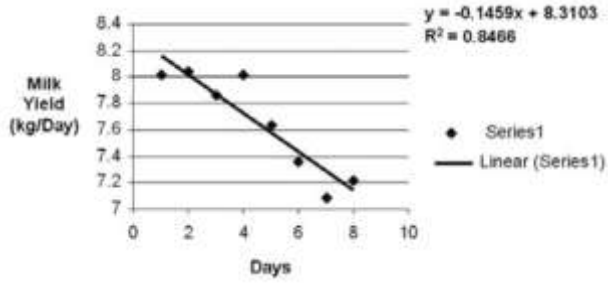


Figure 2. Sensitivity of Murrah Buffalo milk production to Change in temperature.



A sudden change in temperature (rise or fall in Maximum/Minimum temperature) during summer and winter caused a negative impact on milk yield of buffaloes. The decline in minimum temperature (>3°C) during winter (Figure 3) and increase in T max (>4°C) during summer than normal were observed to negatively impact buffalo milk production. The extent of decline in milk yield were less at mid lactation stage than either late or early stage. The decline in yield varied from 10- 30% in first lactation and 5-20% in second or third lactation.

Figure 3. Effect of cold wave on milk production of Buffaloes during winter.



The negative impact of sudden temperature change i.e. cold wave or heat wave on milk yield of buffaloes were not only observed on following day but also on the next or subsequent day(s) after extreme event, thereby indicating that extreme events cause a cumulative effect change on milk production of buffaloes. The return to normal milk yield took 2- 5 days with a variable response in individual buffaloes. The decline and return to normal yield was also dependant on T max and Tmin on days following extreme event and time period of thermal stress/ event occurrence. The R^2 was non- significant and very low for cool period observed during Feb- April/Sept-Nov and actual effect on milk production was minimum. This indicated that low THI (75) had a relatively small effect on milk production performance. The lactation period of buffaloes was shortened by several days (3-7 days) during extreme summer when THI were more than 80. The expression of estrus and reproductive functions were also negatively affected (Table 1). Excessively distressed buffaloes with rectal temperature more than 40 °C did not exhibit estrus or if exhibited estrus symptoms were for short duration and often remained undetected. The potential direct effects of possible climate change in 2020/2050 and global warming on summer season milk production of Murrah buffaloes were also evaluated using widely known global circulation model UKMO to represent possible scenarios of future climate. A temperature rise of 1.0 or 1.2° C for India (Region 23) as per HADCM3 A2/B2 scenario during March – August with little change in precipitation will marginally affect buffalo production system due to a small change in THI to which animals have capacity to adapt, but both milk production and reproductive functions of Murrah buffaloes will be adversely affected by projected temperature rise of more than 2° C over existing temperatures for time slices 2040- 2069 and 2070-2099.

Table 1. Heat Expressed and Conception rate in Buffaloes (%).

Months	THI	% Heat Express	% Conception Rate
January	59.42	7.58	41.09
February	62.94	7.77	40.58
March	68.62	7.81	44.23
April	75.72	6.34	47.34
May	80.91	4.24	33.63
June	81.22	3.42	32.97
July	77.58	5.26	30
August	77.19	8.22	36.07
September	77.67	10.17	44.65
October	72.93	15.39	42.44
November	62.98	11.82	40.63
December	58.77	11.97	38.56

The global warming and rise in temperature during summers will also negatively impact reproductive functions and milk production of buffaloes. The incidence of silent heat or poor expression will be more common at high temperatures during summer of 2015 and beyond particularly in buffaloes that have limited access to water for either drinking and/ or wallowing. These buffaloes at high temperatures may also fail to conceive due to silent heat

or poor expression of heat, loss of conception, causing long dry periods and inter calving intervals (Roy, 1969) ultimately affecting milk production. The negative impact on buffalo production will be more pronounced due to inadequate or limited water availability for wallowing.

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