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Large Scale Analysis Of Tick Infestation And Physiological Responses In Native And Cross Bred Cattle Populations Reared In Central Plains Of Uttar Pradesh, India

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Abstract: Tick and tick-borne diseases cause major economic losses to world's dairy sector. India, being tropical country also faces tremendous challenges from wide arrays of ticks that infest all kind of dairy animals. As we understand that any kind of stresses can disturb the physiological parameters of dairy animals that can impact the animal productivity and over-all performance. In this study therefore, an effort was made to evaluate the physiological responses of tick infested and non-infested native (Sahiwal) and cross bred cattle populations in the central plains area of Uttar Pradesh, India. A total of 3570 animals of indigenous and crossbred cattle from organized and unorganized cattle farm located in and around Lucknow, Uttar Pradesh area was surveyed across seasons (winter, hot summer and hot humid) to assess the prevalence of tick infestation and their effect on physiological responses. The present study revealed that the crossbred cattle were most susceptible to tick infestations. The prevalence of tick infestation was significantly ($P < 0.05$) higher in humid season in both indigenous (Sahiwal) and crossbred cattle. The tick infestation rate (%) in Sahiwal cows were 5.2 and 7.52 in hot summer and humid seasons, respectively. However, in crossbred cattle, the tick infestation rate was 59 (± 0.25) and 69.24 (± 1.60) in hot summer and humid season, respectively. In the cattle maintained at unorganized farm, the prevalence rate (%) of tick infestation in non-descript cattle was found to be 39.27 ± 1.57 , 45.08 ± 1.12 and 27.47 ± 2.01 , during hot summer, humid and winter season, respectively. Whereas in the crossbred cattle from unorganized cattle farms, tick infestation rate was 58.93 ± 1.07 , 69.05 ± 4.09 and 47.78 ± 6.71 during hot summer, humid and winter season, respectively. The physiological responses in tick-infested cattle were found to be significantly ($P < 0.05$) different in the present study. In tick non-infested Sahiwal cattle, the RT decreased significantly ($P < 0.05$) in winter season. Likewise, PR of tick-infested and non-infested cattle significantly ($P < 0.05$) decreased in winter season. While the RR significantly increased in tick-infested cross bred cattle in humid season, followed by a significant ($P < 0.05$) decrease in winter season. Furthermore, the respiration rate was significantly higher in tick-infested cross breed and non-descriptive cattle. In conclusion, the prevalence of tick infestation was higher in the crossbred cows, followed by non-descript cattle and indigenous Sahiwal cattle.

Keywords: Cattle, Cross-bred, *Bos indicus*, Sahiwal cattle, Ticks, Physiological parameters, Seasons

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Introduction

Ticks are the most important ectoparasites of livestock in tropical and sub-tropical areas, and are responsible for severe economic losses in livestock. Tick and tick-borne diseases (TTBDs) adversely impact livestock production worldwide, and also poses threat to human health by acting as reservoirs of some serious zoonoses.

Tick infestation is a major challenge to animal production, especially in tropical country like India, with the prevailing climate favoring the life-cycle of ticks. Ticks are known vector of common parasitic diseases like Babesiosis, Theileriosis, Anaplasmosis and related infections which causes significant mortality and morbidity in dairy animals, negatively impacting welfare and economy of production. The productivity of dairy animals gets severely compromised by various tick and tick-borne diseases (Ghosh and Nagar, 2014). The world annually loses between US\$ 13.9- 18.7 billion due to TTBDs, while the cost of controlling TTBDs alone costs US\$ 498.7 million annually to India (Minjauw and McLeod, 2003).

In India, about 106 types of tick species have been reported and amongst all, *Rhipicephalus (Boophilus) microplus* is reported to be widely prevalent and is the most damaging species infesting livestock, zoo as well as wild animals (Ghosh *et al.*, 2007). Prevalence studies have been reported from various pockets of India with regards to Ticks, however, there is lack of such study, especially with regards to seasonal prevalence, breed susceptibility, and differences in prevalence rate across organized and unorganized production set up in cows reared in and around Lucknow.

Hence, considering the limited studies on tick infestation on cattle and the role of cattle in the economy of the state, the present study was undertaken to determine the breed-wise tick infestation across seasons and their effect on

physiological parameters in the cattle of Uttar Pradesh, which will help in formulating strategies to control infestation and derive production systems devised for optimum production.

Materials and Methods

Study area and animals:

This study has included animals of Sahiwal cattle and crossbred cattle maintained in two separate organized cattle farms in and around Lucknow area, Uttar Pradesh, India. For Sahiwal cattle, the farm of Rajkiya Pashudhan Prakshetra, Chak Ganjariya (Niblet), Barabanki, Lucknow and for cross-bred cattle, a private organized farm in Malihabad, Lucknow were selected. This study also takes into account the animals selected from un-organized cattle farms of suburb of Lucknow city (Barabanki, Sultanpur, Malihabad and Unnao). The animals were surveyed across hot summer, hot humid and winter seasons to check for the prevalence of tick infestation.

A total of 3570 animals, representing indigenous and crossbred cattle were surveyed to assess the prevalence of tick infestation. A thorough epidemiological survey was conducted to check the prevalence of different species of tick in indigenous and exotic cattle in and around Lucknow region. For the epidemiological study, 775 cows, that included 525 Sahiwal (SAC) and 250 Crossbred (CBC) cows from organized farm, and 2795 cows from unorganized farm that included 1795 non-descript cows and 1000 CBC were screened.

Furthermore, 200 SAC and 30 CBC milch cows were randomly selected and subjected to recording of various physiological parameters *viz.*, Rectal Temperature (RT), Respiration Rate (RR), and Pulse Rate (PR) during the afternoon (1:00PM-2.30PM) time-point of hot summer, humid and winter seasons.

Study design:

A cross-sectional study was conducted from 2017-2019, across three different seasons to evaluate the prevalence of ticks, and identification of major tick genera and species prevalent in the study area, and the effect of tick infestation on physiological parameters of SAC and CBC cattle across three seasons.

Recording of physiological parameters:

The RT (Rectal temperature) was measured by gently inserting the tip of digital thermometer in the rectum of cows, and keeping it in contact with rectal mucosa for one minute. The RT was recorded in °F. Furthermore, the RR (Respiratory rate) was measured by noting the visual flank movement, with one outward and inward movement considered as a single breath, and the recording was made in breaths/minute. While, the PR (Pulse rate) was recorded by feeling the pulsation of middle coccygeal artery and each recording was made in beats/minute.

Tick identification, counting and collection:

The entire body surface of the animal i.e., ear, dewlap, flank, udder, perineum, groin and genitalia were thoroughly examined for the presence or absence of tick on the body surface. The prevalence of tick was counted manually by observing the number of ticks present on the animal body.

Collection of ticks:

Adult ticks were collected from different body parts of cattle. The ticks un-engorged, semi-engorged, fully-engorged were removed from the skin of cattle with the help of blunt forceps without damaging their mouth parts (Soulsby, 1982).

Preservation of samples:

Collected adult ticks from each body region were preserved in 70% ethyl alcohol in glass vials labeled with the area of collection, host breed and date of collection. The collected ticks were transported to the Parasitology laboratory of the

Department of Applied Animal Sciences, Babasaheb Bhimrao Ambedkar University of Lucknow for permanent mounting and morphological identification.

Mounting of ticks:

The preserved ticks were individually boiled in 10% potassium hydroxide (KOH) solution for 10-15 min, followed by thorough wash in water to remove KOH. The tick specimens were then dehydrated by passing them through different grades of ethyl alcohols viz. 30%, 50%, 70%, 90% and absolute (100%) alcohol, by keeping the tick specimens for 30 min in each grade of ethyl alcohol. Ticks were then transferred to xylol for clearing, cleared ticks were mounted on clean glass slide with cover slip using DPX.

Identification of ticks:

Preliminary identification was made under stereoscopic microscope and final identification was done under compound microscope according to keys and description given by Walker *et al.* (2003).

Statistical analysis:

Statistical analyses were performed using the statistical analysis software IBM SPSS Statistics 22.0. Data were analyzed by one-way ANOVA method and level of significance considered at $P < 0.05$. All the results are expressed as mean $\pm$ SE.

Results

The epidemiological study of organized farms revealed 28 cows out of 525 SAC cows to be tick infested during hot summer, and 48 cows out of total 650 SAC cows to be tick infested during the humid season in the year 2017. While in the year 2018, 19 out of 375 SAC cows, and 44 out of 575 SAC cows were found to be tick infested during hot summer and humid seasons, respectively. Furthermore, 47 out of total 80 CBC cows during summer, and 46 out of total 80 CBC cows during humid seasons in the year 2017, and 32 out of total 54 CBC cows during summer and 34 out of total 48 CBC cows during humid seasons in the

Table 1: Seasonal prevalence of tick-infestation in dairy cattle from organized and un-organized farms

Cattle breed	Prevalence (%)		
	Hot Summer	Humid	Winter
Sahiwal cow (SAC), OCF	5.2±0.13	7.52*±0.14	NR
Crossbred cow (CBC), OCF	59±0.25	69.24*±1.60	NR
Non- descriptive cattle, UOCF	39.27±1.57	45.08*±1.12	27.47±2.01
Crossbred cow (CBC), UOCF	58.93±1.07	69.05*±4.09	47.78±6.71

OCF; Organized cattle farm, UOCF; Un-organized cattle farm, NR; Not Recorded

year 2018 were found infested with different species of tick.

The epidemiological study of unorganized farms showed that in the year of 2017, 121 out of total 321 non-descript cows in hot summer, and 164 out of total 356 non-descript cows in humid seasons and 95 out of total 373 non-descript cows in winter season were tick infested. However, in the year of 2018, we observed that 156 cattle were tick-infested out of 382 during hot summer, 164 were tick-infested out of 355 in humid season and 107 were tick-infested out of 363 in winter season.

Data pertaining to CBC cows from unorganized farm, in the year 2017 revealed that 103 were tick-infested out of 178 in hot summer, and 98 were tick-infested out of 134 during humid, season and 69 were tick-infested out of 168 during winter season. However, in the year of 2018, we observed that 111 cattle were tick-infested out of 185 in hot summer, and 102 cattle were tick-infested out of 157 in humid, and 97 were tick-infested out of 178 CBC cows in winter season.

The present study revealed that the crossbred cattle were more susceptible to tick infestations. The prevalence rate of tick infestation was found significantly ($p < 0.05$) higher in humid season compared to hot summer season in both indigenous and crossbred cattle. The prevalence rate (%) of tick infestation for indigenous cattle maintained at organized cattle farm was 5.2±0.13 and 7.52±0.14 during hot summer and humid season, respectively (Table 1; Fig. 1). However, the prevalence (%) of ticks in crossbred cows was

found to be 59±0.25 and 69.24±1.60 in hot summer and humid season, respectively.

For the cattle maintained at unorganized cattle farms, the prevalence rate (%) of tick infestation in non- descript cattle was found to be 39.27±1.57, 45.08±1.12 and 27.47±2.01 in hot summer, humid and winter seasons, respectively. While the tick prevalence in crossbred cattle from unorganized cattle farm was found to be 58.93±1.07, 69.05±4.09 and 47.78±6.71 in hot summer, humid season and winter seasons, respectively (Table 1; Fig. 1).

Identified tick species:

Three species of ticks were identified: *Rhipicephalus (Boophilus) microplus*, *Hyalomma anatolicum anatolicum* and *Haemaphysalis bispinosa* in Sahiwal, crossbred and non-descriptive cattle. The *Rhipicephalus (Boophilus)* sp. was found to be the most prevalent tick species in both the cattle breeds (Sahiwal and crossbred cattle) screened in the present study.

Physiological responses:

Data related to the physiological parameters of Sahiwal and crossbred cattle has been provided in Figures 2 (a-c) and 3 (a-c). The data revealed highest RT (°F) in tick-infested Sahiwal cattle during humid season, followed by tick non-infested Sahiwal cattle during humid season. The RT in Sahiwal cattle was: 101.44±0.06, 101.45±0.06 and 101.1±0.10; and 101.41±0.12, 101.51±0.15 and 101.31±0.07 during summer, humid, and winter seasons in tick non-infested and tick-infested cows, respectively. The RT was

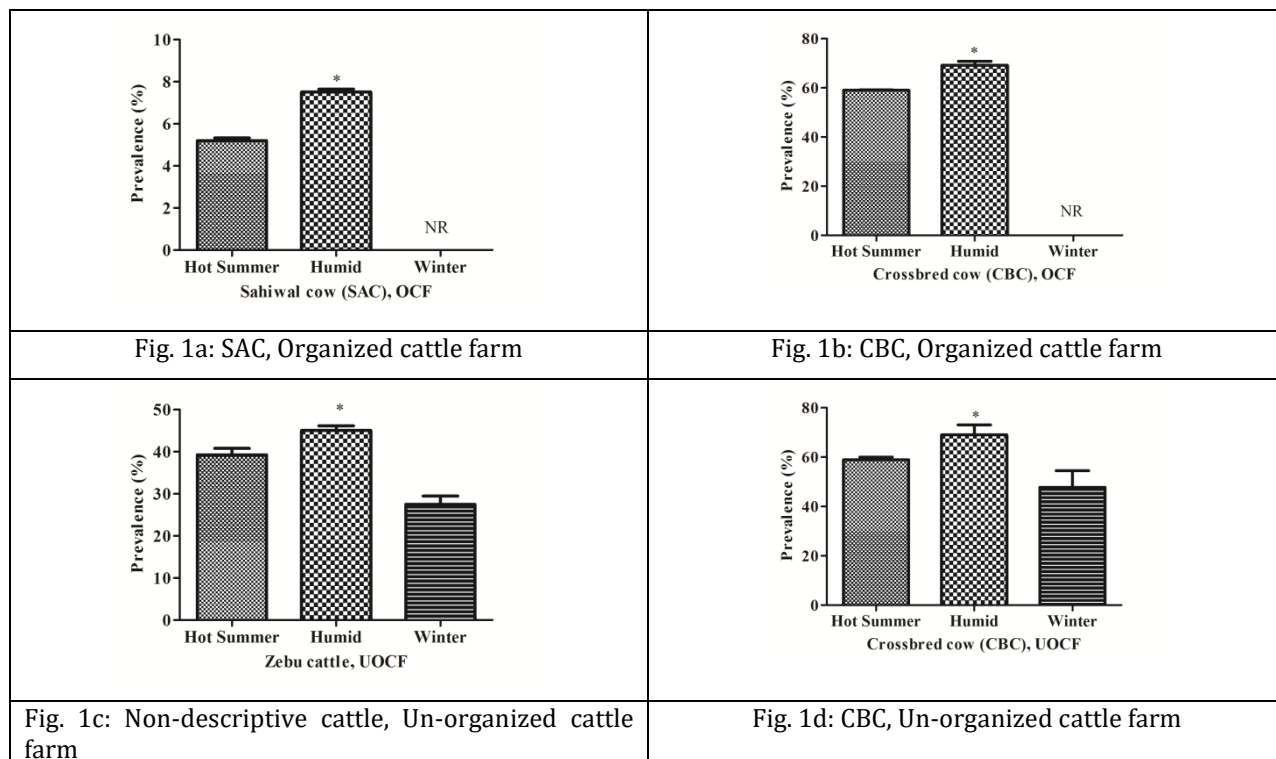


Fig. 1 : Seasonal prevalence of tick infestation in dairy cattle from organized and un-organized farms.

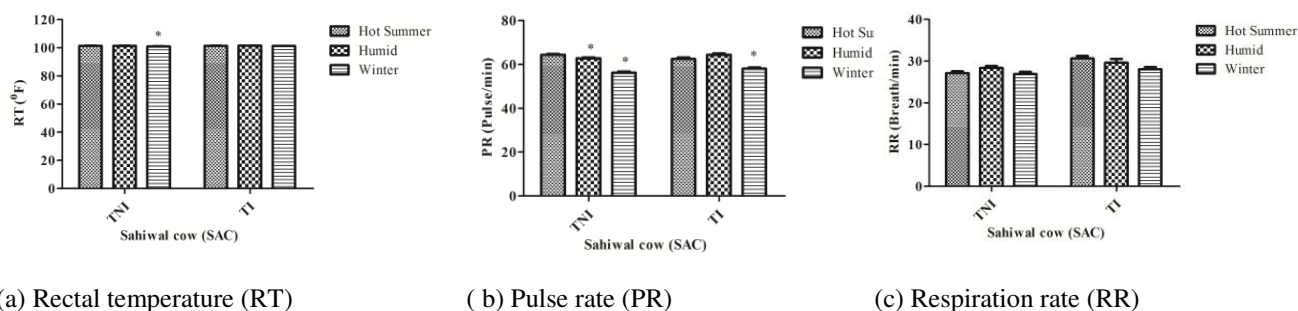


Fig. 2 (a-c): Physiological parameters of tick-infested and tick non-infested Sahiwal cattle across season. Values are presented as mean $\pm$ SEM; * indicates significant difference ($P<0.05$) in reference of the tick-infested cattle.

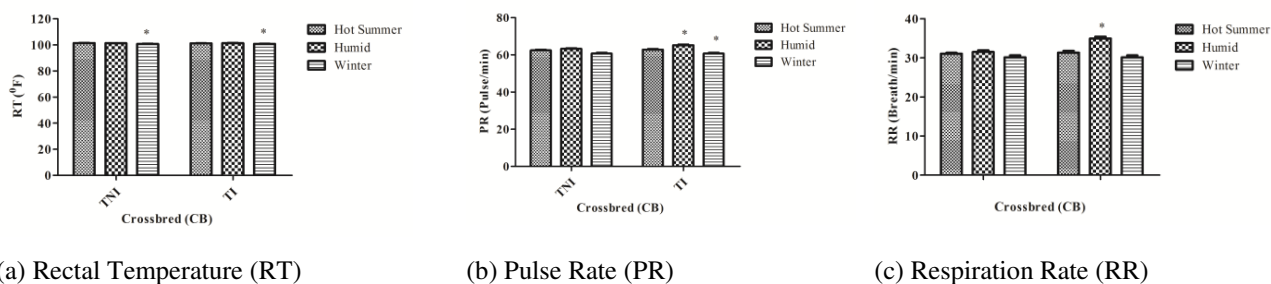


Fig. 3: Physiological effect of tick-infested and tick non-infested crossbred cattle across season, Values are presented as mean $\pm$ SEM; * indicates significant difference ($P<0.05$) in reference of the tick-infested cattle.

significantly lower during winter in tick non-infested Sahiwal cattle, while tick-infested Sahiwal cattle did not show any significant change in RT across seasons. RT in crossbred cattle was highest during the summer season in tick non-infested cows, followed by humid season in tick-infested cows. The RT (°F) in crossbred cows was: 101.48 ± 0.07 , 101.34 ± 0.08 and 100.81 ± 0.11 ; and 101.25 ± 0.08 , 101.45 ± 0.10 , 100.81 ± 0.11 during summer, humid, and winter seasons in tick non-infested and tick-infested cows, respectively. The RT in both tick non-infested and tick-infested crossbred cattle were significantly lower during the winter season.

The PR (beats/min) in Sahiwal cattle was: 64.46 ± 0.35 , 62.84 ± 0.42 , and 56.24 ± 0.50 ; and 62.40 ± 0.78 , 64.40 ± 0.65 , and 58.0 ± 0.56 during summer, humid, and winter seasons in tick non-infested and tick-infested cattle, respectively. The highest PR was recorded in tick-infested Sahiwal cattle during humid season, while the PR was significantly lower during winter season in both tick non-infested and tick-infested Sahiwal cattle. Similarly, the PR (beats/min) in crossbred cattle was: 62.40 ± 0.40 , 63.32 ± 0.32 , and 60.72 ± 0.43 ; and 62.81 ± 0.35 , 65.22 ± 0.45 and 60.72 ± 0.43 during summer, humid, and winter seasons in tick non-infested and tick-infested cattle, respectively. The PR was found highest during humid season in tick-infested crossbred cows, while the PR was significantly lower during summer and winter seasons in tick-infested crossbred cows.

The RR (breaths/min) in Sahiwal cattle was: 27.12 ± 0.42 , 28.35 ± 0.45 , and 26.90 ± 0.54 ; and 30.60 ± 0.60 , 29.60 ± 0.93 , and 28.05 ± 0.52 during summer, humid, and winter seasons in tick non-infested and tick-infested cattle respectively. The highest RR in Sahiwal cattle was found during summer season in tick-infested cows. However, no significant difference was found in RR between seasons. Similarly, the RR (breaths/min.) in crossbred cattle was: 31.08 ± 0.24 , 31.50 ± 0.45 , and 30.17 ± 0.48 ; and 31.35 ± 0.45 , 34.96 ± 0.50 , and 30.17 ± 0.48 during summer, humid, and winter seasons in tick non-infested and tick-infested

cows, respectively. The highest RR in crossbred cows was found in humid season, while the RR was significantly lower during summer and winter season in tick-infested crossbred cows. No significant difference in RR was found in tick non-infested crossbred cattle.

Discussion

This study identified three different genera of ticks to be prevalent in all the three cattle types (SAC, CBC, and non-descript), across all seasons. A similar study conducted in Gangetic plain of Uttar Pradesh reported 8 different tick species infesting cattle in the region (Singh *et al.*, 2021). However, the tick prevalence showed seasonal variations, which indicates the effect of season on life cycles of tick. In this study, the animals were infested with ticks across all seasons (hot summer, humid and winter) in a year, but the intensity of infection significantly increased in humid season. It may be because of the rainfall in humid season that creates a macro-climatic condition favoring tick growth. This is also supported by Vatsya *et al.* (2008) and Rajendran and Hafeez (2003) who found seasonal variation to be an important factor associated with tick infestation in India. With regards to the overall prevalence of ixodid ticks, maximum infestation levels were encountered in the humid season followed by summers and least in winters as the hot and humid environmental conditions in the monsoon is most conducive for the development of various developmental stages of ticks. Whereas, the cold and dry conditions of the winters is unfavorable for the survival and tick spends the winter as engorged females, nymphs, larvae and unfed adults by hiding into the cracks and crevices (Singh and Rath, 2013), thus leading to low infestation levels.

Breed related data revealed a significantly ($p < 0.05$) higher prevalence of ticks in crossbred cows, followed by non-descript cows, and indicine cows. This observation, coupled with the findings of authors from various parts of the world implicates that different cattle breeds (genotypes) show varied susceptibility/resistance to tick borne diseases, the different genetic makeup of

local animals may make them resistant to these ectoparasites (Rathera *et al.*, 2015). Also, constant exposure of infections and development of immunity against such infections might be responsible for lower susceptibility in indigenous cattle (Siddiki *et al.*, 2010). Moreover, indigenous cattle are reared with minimal tick control, exploiting their innate and acquired resistance against ticks and TTBDs (Minjauw and McLeod, 2003). On the contrary, more attention in the management of crossbred cattle gives less chance of pre-exposure of vectors and they develop minimal or no immunity, resulting in frequent occurrence of such diseases (Ananda *et al.*, 2009; Siddiki *et al.*, 2010, Alim *et al.*, 2012).

Physiological responses are one of the best indicators used to assess the effect of tick infestation in animals. The highest values for all physiological parameters viz. RT, RR, and PR, across all seasons, for both SAC and CBC was observed in tick infested animals. The physiological responses also showed a significant ($p < 0.05$) effect of season, with highest values of various physiological parameters observed during summer or hot humid season, for both breeds. The effect of heat stress coupled with excess tick burden during humid season explains the higher physiological response in both cattle breeds. Similar reports of higher RT and RR in tick infected cows was reported by Yakubu *et al.* (2013), who found that the cows of a particular breed with higher physiological parameters were more predisposed to tick infestation. The physiological perturbations associated with season and tick infestation indicates an additional burden on animals that compounds the heat stress in cows.

Conclusion

Three genera of ticks were predominantly found in the study area, with infestation observed in all cattle types, zebu, crossbred, and non-descript, across all three seasons. However, the prevalence was dependent on season, with humid season associated with highest tick infestation. Furthermore, the physiological parameters RT, RR,

and PR was found to be higher in tick infested individuals of both SAC and CBC cows, indicating stress compounded by tick burden. This study identified the most prevalent tick species in the study area, which can be used to devise strategies for control of TTBDs, for an efficient and economical animal production.

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