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Prevalence of bovine Theileriosis in some parts of Uttarakhand and Uttar Pradesh, India

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Abstract
Ticks and tick-borne haemoprotozoan infections remain a substantial constraint to cattle health and productivity, especially in tropical ecosystems, where the climate is conducive to the multiplication of vectors. The current study was initiated to evaluate the prevalence and spatial distribution of cattle theileriosis in selected districts of Uttarakhand and Uttar Pradesh, India, during a two-year period (July 2023 to June 2025). A total of 927 cattle, suspected to be positive for *Theileria* infection, were tested using microscopic examination of Giemsa-stained blood smears. The Overall prevalence of *Theileria* infection was recorded as 37.43%, out of which 30.85% were single infection and 6.58% were mixed haemoprotozoan infections. The spatial distribution indicated substantial variation, with the highest prevalence being recorded in Moradabad (51.57%), Haridwar (40.62%), and Udham Singh Nagar (38.70%). The sex-related analysis indicated almost similar incidences in males (38.33%) and females (37.37%). Age-related differences indicated higher incidences in animals above 3 years (38.91%) compared with those below 3 years (30.76%), which might be due to their prolonged exposure to ticks. The breed-related evaluation indicated higher incidences of infection in the case of Sahiwal, Jersey, and Crossbred cattle compared with Badri or local cattle, thus implying their superior adaptability or resistance to tick infection. The highest prevalence was recorded during the monsoon (46.27%) followed by winter (35.11%) and summer (33.41%) seasons, thus implying the influence of moisture content along with temperature of the local ecosystems.

Keywords: Bovine theileriosis, prevalence, epidemiology, tick-borne disease

Introduction
Due to their simultaneous ability to cause direct physical harm and serve as effective carriers of many harmful microbes, ticks are one of the most significant ectoparasites harming cattle and wildlife worldwide (Khbou *et al.*, 2021) [6]. Tick-borne illnesses pose a significant threat to sustainable livestock production due to their capacity to spread a broad range of bacterial, viral, and protozoal infections, especially in tropical and subtropical areas where tick multiplication is encouraged by climatic factors. Climate changes in recent decades, particularly increased relative humidity and ambient temperatures, have expedited developmental cycles, increased vector survival, and increased the geographic range and seasonal activity of several tick species (Kohli *et al.*, 2014b) [7, 8]. As a result, the prevalence of diseases linked to ticks has increased, causing farming systems with limited resources to suffer significant financial losses. Theileriosis, which is mostly spread by ixodid ticks and is caused by obligatory intracellular protozoa of the genus Theileria, is still one of the most significant hemoprotozoan infections of cattle. *Theileria annulata* is typically blamed for tropical theileriosis, which is particularly harmful and marked by lymphoproliferation, severe anaemia, and a high death rate. The long-term economic consequences of the disease are demonstrated by the fact that even in animals that have recovered, chronic health decline and reduced milk production severely reduce output (Sahoo *et al.*, 2017) [17]. Ruminants are more susceptible to increased clinical susceptibility due to several extrinsic and intrinsic factors, such as nutritional stress, poor hygiene, immunocompromised conditions, and emerging acaricide resistance a problem that is becoming more frequently reported and makes it more difficult to effectively control ticks and increases the risk of disease (Sahoo *et al.*, 2017) [17]. Theileriosis is still commonly recorded in India, and it is particularly common in the northern areas, such as Uttarakhand.

The impact of management strategies, breed susceptibility, and environmental factors has been highlighted by earlier research from the area that documented outbreaks and differing infection intensities across various agroclimatic zones (Kohli *et al.*, 2014a; Kohli *et al.*, 2014b; Raj *et al.*, 2018., Nagar, 2018) [7, 8, 15, 12]. The epidemiological landscape of bovine theileriosis is still dynamic despite its acknowledged significance because of livestock mobility, climatic fluctuation, and growing vector habitats. As a result, updated prevalence evaluations are crucial for building regional monitoring frameworks, directing targeted intervention actions, and comprehending the present illness.

In this regard, the current study was conducted to ascertain the prevalence of theileriosis season, age, breed and sex wise in bovine of in and around Pantnagar, Uttarakhand, to support evidence-based control strategies and provide a more thorough understanding of the disease's distribution in the area.

Materials and Methods

Study Area and Population

The study was conducted on cattle of Veterinary Clinical Complex, dairy farms and some places in both Uttarakhand (Udham Singh Nagar, Haridwar and Nainital) and Uttar Pradesh (Rampur, Moradabad and Saharanpur) for a period of two years from July 2023 to June 2025. The present investigation evaluated the prevalence of theileriosis among cattle while considering key epidemiological determinants, including breed, age, sex, season, and the specific locations from which the animals were sampled. Blood samples from 927 cattle that were clinically suspected of having theileriosis and displaying symptoms such as fever, anorexia, lacrimation, lymph node swelling, salivation and emaciation were obtained from the Veterinary Clinical Complex, dairy farms, and a few other locations in Uttarakhand (Udham Singh Nagar, Haridwar, and Nainital) and Uttar Pradesh (Rampur, Moradabad, and Saharanpur).

Collection and Microscopic Examination of Blood Samples

Animals suspected of having theileriosis were subjected to approximately 2 ml of blood draw from their jugular vein, which was collected into a BD Vacutainer® tube with EDTA and stored at 4 °C for further examination. Blood samples obtained from the Teaching Veterinary Clinical Complex in Pantnagar, dairy farms and some places in both Uttarakhand (Udham Singh Nagar, Haridwar and Nainital) and Uttar Pradesh (Rampur, Moradabad and Saharanpur) were microscopically examined using the Giemsa staining method at the Department of Veterinary Parasitology, GBPUA&T, Pantnagar. Accordingly, under an oil immersion lens of 100 x magnification, blood smears were carefully examined for *Theileria* spp. piroplasm (Soulsby, 1982) [19].

Results and Discussion

A total of 927 dairy animals were screened for *Theileria* infection, of which 347 (37.43%) were found positive, including 30.85% with single infection and 6.58% with mixed haemoprotozoan infections (Figure 1). The current study was in accordance with the findings of the work done by Kumar *et al.* (2018) [9] where they found the prevalence of bovine theileriosis to be 38.8% in the state of Telangana. Kohli *et al.* (2014) [7, 8] and Sharma *et al.* (2021) [18] have also said that the prevalence of theileriosis in cattle was 27.2% and 24.13% respectively in the Tarai region of Uttarakhand. The higher prevalence of single infections could be due to constant tick exposure.

Significant variation was observed across districts, with the highest prevalence reported in Moradabad (51.57%), followed by Haridwar (40.62%), Udham Singh Nagar (38.70%), Rampur (35.13%), Saharanpur (34.11%), and Nainital (27.68%) (Table 1). Single infections of *Theileria* were reported to be highest in prevalence among all the districts, and the maximum prevalence was recorded in Udham Singh Nagar (33.64%) and Rampur (34.43%). Conversely, mixed infections were recorded highest in Moradabad (20.00%) and Haridwar (12.50%), whereas the lowest were recorded in Rampur (2.70%) and Nainital (3.95%). Such variations in prevalence are presumably influenced by the differences in climatic, relative abundance of ticks, grazing habits, rearing practices, and efficiency of tick control measures employed in different districts. Moradabad and Haridwar districts have warmer climate and humidity, thus acting as ideal environmental conditions for the persistence of both ticks and *Theileria* species. Similar geographical variations in prevalence of bovine theileriosis have been reported earlier by Kohli *et al.* (2014) [7, 8]; Kumar *et al.* (2018) [9]; Niranjan *et al.* (2023) [13] and Rawte *et al.* (2024) [16].

The total prevalence of *Theileria* infection in males and females was found to be 38.33% and 37.37%, respectively (Table 2) but it was not significantly different between the two sexes. This finding suggests that sex does not play a major biological role in susceptibility to *Theileria* infection, consistent with earlier reports (Sahoo *et al.* 2017) [17]. Single infection with *Theileria* parasites prevailed in both males and females, contributing 33.33% and 30.68% to total infection, respectively, while combined infection prevailed at 5.00% and 6.68% in males and females, respectively. The results eliminate variations in infection due to sexes and imply a better susceptibility to infection risks related to management and grazing practices, rather than within-sex susceptibility. Similar findings were observed by Khawale *et al.* (2019) [4], which showed a higher infection rate among males (40%) than in females (20.96%), and similar results were obtained by Khalifa *et al.* (2025) [5], which found no difference in bovine Theileriosis infection between males and females. Radostits *et al.* (2018) [14] also emphasized a non-significant biological difference due to sex in the development and occurrence of disease. However, slightly higher prevalence in males might relate to managemental exposure patterns such as grazing or lack of routine acaricide application in bullocks or breeding males.

A higher prevalence of *Theileria* infection was found in animals older than or equal to 3 years (38.91%), in comparison with those under 3 years (30.76%) (Table 3). For both age groups, single infections were mostly found, which constituted 32.05% and 25.44% in adults and younger animals, respectively, in comparison with mixed infections for 6.86% and 5.32%, respectively. The higher susceptibility found in older animals could be explained by their cumulative exposure to tick infestation for an extended period, mainly in extensive grazing patterns, hence increasing the chances of repeated encounters with the vectors. Moreover, the lower exposure for young animals to pasture and hence lower challenge by ticks would contribute to lower probabilities of infection in comparison with older

ones. The current results are in accordance with the earlier findings, which indicated that the higher prevalence of theileriosis was in adults in comparison with the lower age groups (Mahmud *et al.* 2015; Brahma *et al.* 2018) [10, 1]. The lower prevalence in the current study in the calf population would also be contributed by the temporary immunity passed from the colostrum antibodies, mainly against the schizonts, sporozoites, and piroplasm forms of *Theileria* spp., as reported by Morzaria *et al.* (1988) [11].

Breed wise prevalence of bovine theileriosis showed a considerable variation among various breeds of cattle studied (Table 4). The highest prevalence of infection was observed in Sahiwal breeds (44.44%), followed by Jersey (42.10%), crossbred (37.84%), and HF cross breeds (34.89%), and the lowest one in Badri breeds (8.33%). In all breeds, pure infections with *Theileria* parasites were found to be predominant, while mixed infections were recorded largely in crossbred, HF cross, and Sahiwal cattle. The higher prevalence in exotic as well as crossbred cattle might be associated with relatively low adaptive resilience, compared with the other breeds. Similar findings have been observed by Brahma *et al.* (2018) [1], where a higher prevalence rate of theileriosis was recorded in HF cross cattle (54.04%) compared to Jersey crossbred (50.26%) and Sahiwal cattle (41.18%). Similar findings have also been recorded by Tiwary *et al.* (2022) [20], where a higher prevalence rate was recorded in crossbred cattle (41.95%) compared to other breeds, as well as by Devi *et al.* (2025) [2], where higher parasitic infection was recorded in Jersey (80%) and HF cross cattle (35.75%) compared to Sahiwal cattle (66.67%). However, relatively low prevalence might be accounted for in Badri cattle because of their higher genetic resistance, adaptability, and natural tolerance to ticks, as well as to hemoparasitic infections, to some degree, considering their likely lowered susceptibility to disease under field circumstances.

The higher prevalence of *Theileria* infection was noted during the monsoon season, which accounted for 46.27%, followed by winter at 35.11% and summer at 33.41% (Table 5). Of these, the single infections predominated in all seasons, amounting to 41.56% in the monsoon, 25.95% in winter, and 27.31% in summer. The mixed infection rate was comparatively low, with 9.16% in winter, followed by 6.09% in summer and 4.70% in the monsoon season. The relatively higher prevalence during the monsoon period is attributed to favourable climatic conditions in terms of increasing humidity, moderate temperature, and dense vegetation that all combine to enhance tick survival, reproduction, and host-vector contact rates. A similar trend was reported by Mahmud *et al.* (2015) [10] and Tiwary *et al.* (2022) [20], who also observed maximum prevalence of bovine theileriosis during the monsoon compared to summer and winter seasons. However, Nagar. (2018) [12] and Harit. (2021) [3] recorded a high prevalence during the summer months, indicating that the seasonal variation in disease incidence may depend on regional climatic dynamics, management practices, and vector ecology.

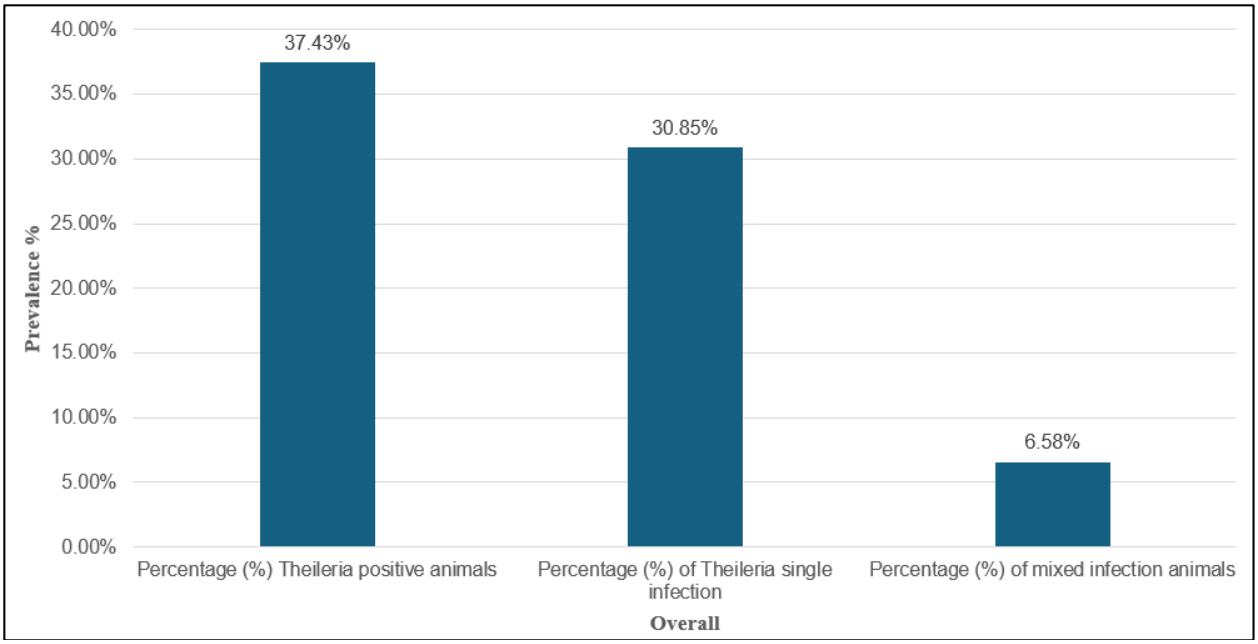

Fig 1: Overall Prevalence of Theileriosis

Table 1: Area-wise Prevalence of Theileriosis

S. No	District	Number of screened animals	Number of *Theileria* positive animals	Percentage (%) *Theileria* positive animals	Number of *Theileria* positive animals (single infection)	Percentage (%) of *Theileria* single infection	Number of mixed infection animals	Percentage (%) of mixed infection animals
1.	Nanital	177	49	27.68%	42	23.72%	7	3.95%
2.	Udham Singh Nagar	434	168	38.70%	146	33.64%	22	5.06%
3.	Haridwar	64	26	40.62%	18	28.12%	8	12.5%
4.	Moradabad	95	49	51.57%	30	31.57%	19	20%
5.	Rampur	74	26	35.13%	24	34.43%	2	2.70%
6.	Saharanpur	85	29	34.11%	26	30.58%	3	3.52%

Table 2: Sex-wise Prevalence of Theileriosis

S. No	District	Number of screened animals	Number of Theileria positive animals	Percentage (%) Theileria positive animals	Number of Theileria positive animals (single infection)	Percentage (%) of Theileria single infection	Number of mixed infection animals	Percentage (%) of mixed infection animals
1.	Male	60	23	38.33%	20	33.33%	3	5%
2.	Female	867	324	37.37%	266	30.68%	58	6.68%
	Total	927	347	37.43%	286	30.85%	61	6.58%

Table 3: Age-wise Prevalence of Theileriosis

S. No	Age	Number of screened animals	Number of Theileria positive animals	Percentage (%) Theileria positive animals	Number of Theileria positive animals (single infection)	Percentage (%) of Theileria single infection	Number of mixed infection animals	Percentage (%) of mixed infection animals
1.	Young <3 years age	169	52	30.76%	43	25.44%	9	5.32%
2.	Adult ≥ 3 years age	758	295	38.91%	243	32.05%	52	6.86%
	Total	927	347	37.43%	286	30.85%	61	6.58%

Table 4: Breed-wise Prevalence of Theileriosis

S. No	Breed	Number of screened animals	Number of Theileria positive animals	Percentage (%) Theileria positive animals	Number of Theileria positive animals (single infection)	Percentage (%) of Theileria single infections	Number of mixed infection animals	Percentage (%) of mixed infection animals
1.	Crossbred	510	193	37.84%	162	31.76%	31	6.07%
2.	HF Cross	278	97	34.89%	77	27.69%	20	7.19%
3.	Sahiwal	108	48	44.44%	38	35.18%	10	9.2%
4.	Jersey	19	8	42.10%	8	42.10%	0	0%
5.	Badri	12	1	8.33%	1	8.33%	0	0%
	Total	927	347	37.43%	286	30.85%	61	6.58%

Table 5: Season-wise Prevalence of Theileriosis

S. No	Season	Number of screened animals	Number of Theileria positive animals	Percentage (%) Theileria positive animals	Number of Theileria positive animals (single infection)	Percentage (%) of Theileria single infection	Number of mixed infection animals	Percentage (%) of mixed infection animals
1.	Summer	410	137	33.41%	112	27.31%	25	6.09%
2.	Winter	262	92	35.11%	68	25.95%	24	9.16%
3.	Monsoon	255	118	46.27%	106	41.56%	12	4.70%
	Total	927	347	37.43%	286	30.85%	61	6.58%

Conclusion

The current research work updated on the epidemiological assessments on the prevalence of bovine theileriosis in the targeted districts of the state of Uttarakhand, along with the adjacent parts of the state of Uttar Pradesh. The data generated have shown a moderately high level of prevalence, which varies significantly based on the districts, periods of the year, age groups, and the respective breeds, even though there were no statistically significant differences among the sexes. The prevalence of the disease was generally higher in individual infection cases, followed by multiple ones, reflecting the uniform incidence of the disease due to the exposure of the animals to the ticks. The infection was also observed to a larger extent in crossbred, Sahiwal, and adult cattle, as well as in the monsoon season, recapitulate the cumulative effect of long exposure to the disease-transferring ticks, adaptability and the favourable climate. The moderate prevalence of the disease, despite being an endemic one in the Badri breeds of the cattle suggests the adaptable nature of the disease, which leaves little scope for the disease to progress further. From the observations made, it can well be noted that a comprehensive surveillance strategy, effective tick control measures, better grazing, and education of the farmers can help overcome the disease. Therefore, the work acts as a precursor to the generation of further research on effective disease control methods.

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