



Effect of seasonal and climatic factors on mange infestation in dromedary camel

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In contemporary livestock production, the significance of animals in the global economy and for food security is well established. Ensuring year-round animal health and sustainable productivity is essential (Faraz *et al.* 2019). The dromedary camel (*Camelus dromedarius*) holds considerable importance within pastoral economies, particularly as a primary source of food and income for underprivileged populations in arid and semi-arid regions of Africa and Asia. Although various factors contribute to productivity losses in the livestock, endoparasitic and ectoparasitic infestations are among the most prominent challenges affecting health and production outcomes (Patoliya *et al.* 2022). Ectoparasites including mites, ticks, and insects pose substantial limitations on the productivity and overall performance of camels, with mange ranking as the second most common parasitic disease after trypanosomiasis. Mange infestation in camels is associated with significant declines in health, growth, and production, with several studies highlighting its zoonotic potential (Feyera *et al.* 2015, Sazmand *et al.* 2019). Camel mange is a highly contagious disease primarily caused by ectoparasites of the genera *Sarcoptes*, *Chorioptes*, and *Psoroptes* that parasitize camelids (Chhabra and Gahlot 2010). Among these, *Sarcoptes scabiei* var. *cameli* is of particular concern; it is a small, rounded mite with females measuring approximately 330–600 $\mu\text{m} \times 250\text{--}400 \mu\text{m}$ and males 200–240 $\mu\text{m} \times 150\text{--}200 \mu\text{m}$ (Higgins *et al.* 1984, Kumar *et al.* 1992). Transmission occurs through direct or indirect contact with infected animals which typically induces pruritus, prompting affected camels to rub, bite, or scratch the irritated areas. These responses result in skin excoriation, parakeratotic crust formation, scab development, hair loss, and potential spreading of infestation to other body parts (Zahid *et al.* 2015). Sarcoptic mange infestation has been reported to compromise the antioxidant defence in buffaloes (Dimri *et al.* 2008) and dromedary camel (Saleh *et al.* 2011) in the past.

Mange significantly impacts camel populations which is predisposed to various stressors, especially in newly

affected geographical regions, infecting new host species with raising concerns about its climatic implications (Escobar *et al.* 2022). Climatic variables, such as temperature, humidity, wind speed and solar radiation induce multifactorial stress in livestock species and are recognized as potential threats to growth and productivity (Upadhyay *et al.* 2024). In particular, variations in geographical factors like terrain, soil type, and fluctuating temperature and humidity can influence parasitic infection rates, including mange transmission, which is modulated by the interaction between host and environmental factors. Seasonal variation in mange prevalence has been documented globally, with peak infestations reported at specific times of the year, suggesting humidity as a macroclimatic factor influencing tick infestation rates. However, studies have shown contrasting results, with increased mite prevalence and morbidity rates observed in summer (Sabra *et al.* 2012), monsoon (Omer *et al.* 2007), and winter (Mal *et al.* 2006, Abdel-Rady *et al.* 2021) seasons. These variations in mange prevalence may be attributed to environmental and microclimatic differences, seasonal timing of studies, community awareness of transmission and control methods, and management practices (Ame 2023). Acaricide treatment is the most commonly used method to control mange infestation, targeting larvae, nymphs, and adult parasites; however, limitations include re-infestation. In recurrent infestations, understanding the influence of key abiotic factors on parasite growth and persistence is essential. Addressing these factors is crucial for the sustainable management of camel health and productivity in a cost-effective manner. Monitoring effective average morbidity rate (EAMR) under varying temperature humidity index (THI) levels can reveal inflection points critical to refining management practices. This study, therefore, aimed to elucidate the association between environmental variables and the effective average morbidity rate of mange infestation in dromedary camels, contributing to the development of resilient management strategies.

MATERIALS AND METHODS

Experimental site and animals: The present study was conducted at the Camel farm of the National Research

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Fig. 1. (A) Photograph of infested camel showing the characteristic skin lesions, (B) Photomicrograph of the mite observed in the affected area

Centre on Camel (NRCC), Bikaner, Rajasthan. All animal experiments were performed in compliance with ethical standards and followed the guidelines set forth by the institute animal ethics committee (IAEC), with prior approval for collection of samples from selected animals (NRCC/IAEC/2018/02). The investigation was carried out on a herd of approximately 281 to 387 dromedary camels, comprising four breeds viz. Bikaneri, Jaisalmeri, Kachchhi and Mewari, over a period of five consecutive years (2019–2024). The camels were reared under a semi-intensive management system, housed in group pens without individual enclosures. All animals were maintained in normal health, free from any other physiological, anatomical, or infectious disorders, and were managed in accordance with standard feeding and care practices.

Isolation and identification of morbid animal: This controlled farm trial was conducted on dromedary camels naturally infested with mites. Over the five-year study period, camels of various age groups were managed under a scientifically designed husbandry system, ensuring uniform care and management practices. The camels were allowed to graze freely in nearby pastures and were rarely mixed with other livestock. All animals underwent thorough whole-body examinations for clinical signs of mange, including erythema, intense pruritus, alopecia, excoriation with moist and oozing lesions, hyperpigmentation, and crusting. Skin scrapings from body regions having skin lesions suggestive of mange infestation (hyperkeratinisation, skin wrinkles, alopecia, hyperpigmentation, crusting etc.) were collected to ensure the presence of mites, including larvae, nymphs and adults and confirm the diagnosis.

Sample collection and morbidity recording: The animals showing characteristic skin lesions of mange infestations were selected for the present study (Fig. 1). Skin-scraping samples were collected in glass vials containing 3 mL of 10% potassium hydroxide solution. The sample was gently heated for 2 to 3 min and then a drop of this mixture was put on a glass slide and examined under microscope. The mite, if present, was identified by the third and fourth pairs of legs, which did not project beyond the margin of the body and by other morphological characteristics of the

species (Soulsby 1982). The Effective average morbidity rate (EAMR) was calculated using the formula $EAMR = (\text{Number of infected or morbid animal} / \text{herd strength}) * 1000$ (Riffenburgh 2012).

Environmental variables: The changes in average maximum and minimum temperature, dry and wet bulb temperature, relative humidity, photoperiod and precipitation were recorded for 120 fortnight intervals. From these environmental data, THI was calculated using a model suitable for arid conditions: $THI = [0.8 \times \text{ambient temperature}] + [(\% \text{ relative humidity} \div 100) \times (\text{ambient temperature} - 14.4)] + 46.4$ (Mader *et al.* 2006, Upadhyay *et al.* 2025).

Data analysis: Statistical analysis of the data was performed using software version (22) of the SPSS system. To determine the degree of relationship between environmental variables and EAMR, Pearson correlation and multiple regression analyses were done.

RESULTS AND DISCUSSION

The environmental data collected over the five-year study period showed that the THI ranged from 51.6 to 96, with June, July and August identified as the most critical months. During the whole study period, the maximum ambient temperature reached 46°C, while the minimum temperature dropped as low as 1.7°C, alongside an erratic rainfall pattern, highlighting the harsh climatic variability characteristic of the desert ecosystem. The variations in average precipitation, THI and EAMR across 120 fortnight intervals are illustrated in Fig. 2.

Assessing the relationship between EAMR and the environmental factors revealed no statistically significant correlations between EAMR and T_{\max} ($r = -0.013$, $p = 0.884$), T_{\min} ($r = -0.056$, $p = 0.546$), or RH ($r = -0.175$, $p = 0.055$) (Table 1). A significant positive correlation was observed between EAMR and rainfall ($r = 0.350$, $p < 0.01$), suggesting that increased rainfall may be associated with higher morbidity rates of mange infestations in camels. Likewise, multiple regression analysis revealed rainfall as a significant predictor of EAMR, with a coefficient of 7.425 ($p < 0.01$). No significant relationship was detected

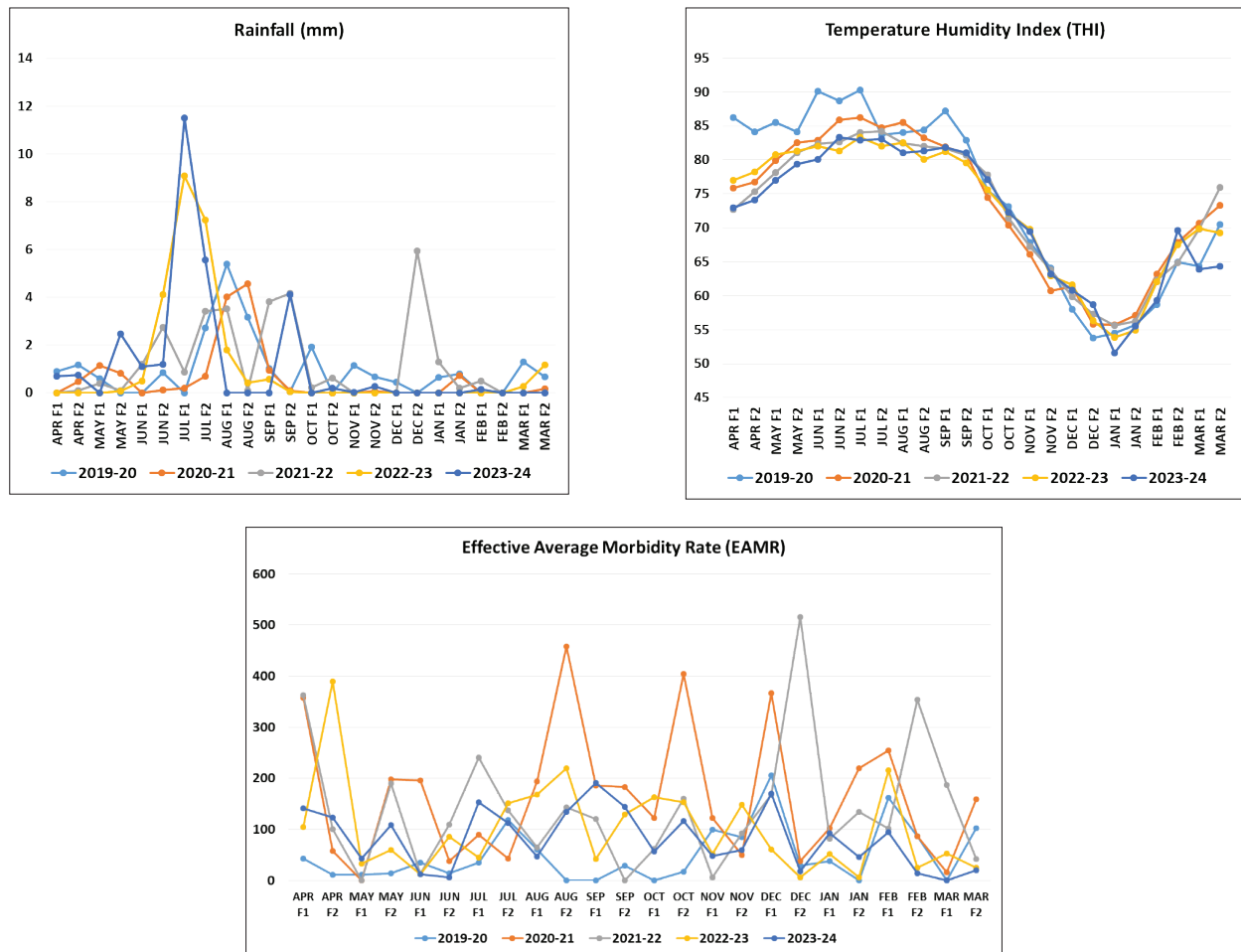


Fig. 2. The mean values of rainfall, THI and EAMR over the 120 fortnight intervals of the study

between EAMR and THI implying that factors beyond THI may influence morbidity in this context.

The results of this study indicated that mange induced morbidity was influenced by seasonal variations, with a higher prevalence of positive cases observed during the hot-humid days, while an erratic pattern was noted during the cold season, particularly on rainy days. Analysis of environmental variables revealed a significant association between rainfall and the occurrence and recurrence of mange infestations. However, no direct significant correlation was found with other environmental factors, suggesting the camel's long-term adaptability to harsh desert conditions. Previous studies have identified camel age, gender, and seasonality as significant risk factors for mange infestation, with a higher incidence reported during the winter compared to the summer (Ahmed *et al.* 2020). Similar findings were reported in the neighbouring camel population of Punjab, Pakistan, where mange posed a major health threat, particularly during the winter, with younger animals and females being more susceptible (Zahid *et al.* 2015). In contrast, Kotb and Abdel-Rady (2015) recorded a prevalence of 25% in the winter season and 12.5% in the summer, disarranging with the findings of Ashraf *et al.* (2014), who reported a higher prevalence of mange

infestation during the hot, rainy months.

The higher infestation rates during the monsoon season are likely due to favourable environmental conditions, such as increased ambient temperature, humidity and ideal grazing land conditions, which promote mange mite feeding, breeding, and development. During rainy days, low day light intensity may affect mite breeding or camel immunity, while increased vegetation and moisture support host presence and mite development, raising disease incidence. In contrast, temperature and humidity influence life cycle of mite non-linearly, being effective only within specific thresholds. Additionally, cold and dry weather reduces the survival of larvae, nymphs, engorged females, and unfed adults, leading to lower infestation rates as mites tend to hide in cracks and crevices during winter. The study also observed a rise in infection rates on other season with erratic rainfall pattern, potentiating mange related infections and lesions more evidenced.

This study revealed that humid climatic conditions significantly promote the spread of mange, particularly during the rainy season, when transmission occurs rapidly through direct or indirect contact. The findings highlight the complex influence of environmental factors on camel health, with rainfall emerging as a key predictor of EAMR

Table 1. Correlation analysis between various environmental variables, temperature-humidity index (THI), and the effective average morbidity rate (EAMR) in camels

		T _{max}	T _{min}	RH	Sunshine	Rain	THI	EAMR
T _{max}	Pearson Correlation	1						
	Sig. (2-tailed)							
T _{min}	Pearson Correlation	.925**	1					
	Sig. (2-tailed)	0						
RH	Pearson Correlation	-.257**	0.018	1				
	Sig. (2-tailed)	0.005	0.841					
Sunshine	Pearson Correlation	.471**	.242**	-.414**	1			
	Sig. (2-tailed)	0	0.008	0				
Rain	Pearson Correlation	-0.065	-0.009	0.141	-.219*	1		
	Sig. (2-tailed)	0.483	0.924	0.124	0.016			
THI	Pearson Correlation	.932**	.984**	0.084	.300**	-0.004	1	
	Sig. (2-tailed)	0	0	0.361	0.001	0.967		
EAMR	Pearson Correlation	-0.013	-0.056	-0.175	0.019	.350**	-0.065	1
	Sig. (2-tailed)	0.884	0.546	0.055	0.839	0	0.48	

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed). N=120 Fortnight intervals

for mange infestation. The findings underscore the need for timely treatment with supportive care and proactive management during and after the rainy season. The link between changing environmental conditions and rising skin infections highlights the importance of regular monitoring and region-wide surveillance to better understand infestation dynamics and mitigate zoonotic risks.

SUMMARY

A cross-sectional study was conducted from April 2019 to March 2024 in a herd comprising 281 to 387 dromedary camels with the aim of identifying vulnerable environmental conditions influencing mange infestation. Environmental data were recorded for 120 fortnight intervals, and the temperature humidity index (THI) was calculated. The mange morbidity was expressed as effective average morbidity rate (EAMR). The study found a significantly positive correlation between rainfall and EAMR ($r=0.35$, $p<0.01$), with the highest morbidity observed during both fortnights of July, the first fortnight of August, and the second fortnight of September, indicating these periods as critical for mange vulnerability. Other environmental factors, including maximum temperature (T_{max}), minimum temperature (T_{min}), relative humidity (RH), and THI, showed non-significant correlations with EAMR, suggesting they are not statistically significant predictors of mange infestations in camel. The findings demonstrate the significant impact of environmental factors, identifying rainfall as a key predictor of the EAMR for mange infestation. This study highlights the necessity for enhanced awareness among camel herders through targeted animal health extension services to plan preventive and control measures for mange infestation in camel.

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REFERENCE

- Abdel-Rady A, Mostafa W and Abdel-Raouf A M. 2021. Epidemiological investigations in Sarcoptic mange in camels with special reference in treatment. *Journal of Parasitic Diseases* **45**: 689–94.
- Ahmed M A, Elmahallawy E K, Gareh A, Abdelbaset A E, El-Gohary F A, Elhawary N M, Dyab A K, Elbaz E and Abushahba M F. 2020. Epidemiological and histopathological investigation of sarcoptic mange in camels in Egypt. *Animals* **10**(9): 1485.
- Ame M K M. 2023. Assessment of camel mange mite prevalence in Kumbi Woreda, Eastern Harergae, Ethiopia. *Journal of Pesticide Science and Pest Control* **2**(1): 10.58489/2833-0943/014.
- Ashraf S, Chaudhry H R, Chaudhry M, Iqbal Z, Ali M, Jamil T, Sial N, Shahzad M I, Basheer F, Akhter S and Yasin A. 2014. Prevalence of common diseases in camels of Cholistan desert, Pakistan. *IUFS Journal of Biology* **2**(4): 49–52.
- Chhabra M B and Gahlot T K. 2010. Mange in the camelids: A review. *Journal of Camel Practice and Research* **17**(2): 131–38.
- Dimri U, Sharma M C, Swarup D, Ranjan R and Kataria M. 2008. Alterations in hepatic lipid peroxides and antioxidant profile in Indian water buffaloes suffering from sarcoptic mange. *Research in Veterinary Science* **85**: 101–05.
- Escobar L E, Carver S, Cross P C, Rossi L, Almberg E S, Yabsley M J, Niedringhaus K D, Van Wick P, Dominguez-Villegas E, Gakuya F and Astorga F. 2022. Sarcoptic mange:

- An emerging panzootic in wildlife. *Transboundary and Emerging Diseases* **69**(3): 927–42.
- Faraz A, Waheed A, Ishaq H M and Mirza R H. 2019. Rural development by livestock extension education in southern Punjab. *Journal of Fisheries and Livestock Production* **7**(287): 2.
- Feyera T, Admasu P, Abdilahi Z and Mammed B. 2015. Epidemiological and therapeutic studies of camel mange in Fafan zone, eastern Ethiopia. *Parasites and Vectors* **8**: 1–6.
- Higgins A J, Mezaini S A and Abukhamseen A M. 1984. Observations on the incidence and control of *Sarcoptes scabiei* var. *cameli* in the Arabian camel. *Veterinary Record* **115**(1): 15–16.
- Kotb S and Abdel-Rady A. 2015. Sarcoptic mange of camel in upper Egypt: Prevalence, risk assessment, and control measures. *Journal of Advanced Veterinary and Animal Research* **2**(4): 410–17.
- Kumar D, Raisinghani P M and Manohar G S. 1992. Sarcoptic mange in camels: A review. In *Proceedings of the 1st International Camel Conference*. London: Newmarket Press, R.W. Publications, UK.
- Mader T L, Davis M S and Brown-Brandl T. 2006. Environmental factors influencing heat stress in feedlot cattle. *Journal of Animal Science* **84**(3): 712–19.
- Mal G, Sena D S and Sahani M S. 2006. Haemato-biochemical changes in camels infested with mange during winter and summer season. *Journal of Camel Practice and Research* **13**(2): 173.
- Omer M M, Ahmed A M and Abusalab S M A. 2007. A retrospective study on animal parasitic diseases diagnosed at Kassala Veterinary Research Lab (KVRL), eastern Sudan. *Veterinary Research* **1**(3): 68–70.
- Patoliya P, Raval K, Upadhyay V R, Dewry R K, Maiti S, Mondal G, Mohanty T K and Bhakat M. 2022. Tick infestation and its herbal treatment approach in India: A review. *Pharma Innovation Journal* **SP 11**(4):1323–39.
- Riffenburgh R H. 2012. Epidemiology. In *Statistics in Medicine* (Third Edition) Academic Press:535–49.
- Sabra S M, Al-harbi M S and Al-bashan M M. 2012. Considering the extent of mange disease in camels through the summer season at Taif region, KSA. *Assiut Veterinary Medical Journal* **58**(135): 60–66.
- Saleh M A, Mahran O M and Al-Salahy M B. 2011. Circulating oxidative stress status in dromedary camels infested with sarcoptic mange. *Veterinary Research Communication* **35**: 35–45.
- Sazmand A, Joachim A and Otranto D. 2019. Zoonotic parasites of dromedary camels: So important, so ignored. *Parasites and Vectors* **12**: 1–10.
- Soulsby E J L. 1982. *Helminths, Arthropods and Protozoa of Domestic Animals* (Seventh Edition). Bailliere Tindall, London: 482–86.
- Upadhyay V R, Ashutosh, Shashank C G and Singh N P. 2024. Deciphering the immune responses in late gestation Sahiwal cows under different microclimate and its carryover effect on progenies. *International Journal of Biometeorology* **68**: 1185–95.
- Upadhyay V R, Priyadarsini S, Prerna M, Kuniyal A, Prakash V, Ranjan R and Sawal R K. 2025. Revealing association of overnight thermal equilibration and production potential in Indian dromedary camels under hot-humid conditions. *Biological Rhythm Research* **56**(8): 541–51.
- Zahid M I, Maqbool A, Anjum S, Ashraf K, Khan M S and Ahmad N. 2015. Prevalence of sarcoptic mange in camels in Punjab, Pakistan. *The Journal of Animal and Plant Sciences* **25**(5): 1259–63.