Journal of Agrometeorology

(A publication of Association of Agrometeorologists)

ISSN : 0972-1665 (print), 2583-2980 (online)

Vol. No. 27 (4) : 531-533 (December - 2025)

https://doi.org/10.54386/jam.v27i4.3065

https://journal.agrimetassociation.org/index.php/jam

Short communication

Relationship in colony dynamics of honey bee (*Apis cerana* F.) to weather: Insights for sustainable beekeeping practices

SHIVANI SHARMA, KIRAN RANA*, MEENA THAKUR, SAWRAJ JIT SINGH and SIMRAN BHATIA

Department of Entomology, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, HP, India 173230

**Corresponding author: kiranentouhf@gmail.com*

Honey bees are vital for biodiversity conservation and agricultural productivity through pollination, contributing to food security and ecosystem services. Among native species, *Apis cerana* Fabricius is widespread in Asia and valued for honey, wax, and efficient pollination of fruits and vegetables (Partap, 2011). Being indigenous, it performs well in challenging climates and begins foraging at lower temperatures than *A. mellifera* (Corlette, 2011). Colony productivity, however, is strongly influenced by weather factors such as temperature, humidity, rainfall, and sunshine (Stabentheiner *et al.,* 2010; Abou-Shaara *et al.,* 2012; Taha and Al-Kahtani, 2013; Reddy *et al.,* 2015; Kaur *et al.,* 2020). Pastagia and Patel (2014) reported that relative humidity and rainfall reduced productivity, while sunshine enhanced it. Seasonal variations in brood and adult populations linked to weather were also observed by Kavitha *et al.,* (2021). Housing material further influences performance, with mud hives offering superior thermal insulation compared to wooden hives (Sharma *et al.,* 2020). This study assessed colony performance of *A. cerana* in mud and wooden hives under mid-hill and high-hill conditions of Himachal Pradesh.

The study was conducted from August 2022 to July 2023 at Nauni, Solan (1262 m amsl, mid-hill) and Katrain, Kullu (1568 m amsl, high-hill). Colonies were maintained in Indian Standard Institute (ISI) wooden hives and low-cost mud hives made of clay, cow dung, stones, and straw (Fig. 1). Monthly observations included brood area, queen prolificacy, pollen and honey stores, and bee strength. Internal hive temperature and humidity were measured with thermo-hygrometers, while external weather data were obtained from nearby observatories. Data were analyzed using R software.

The overall mean data of colony performance parameters of *A. cerana* in wooden and mud hives presented in Table 1 showed that the total brood area, sealed brood area, unsealed brood, honey stores, pollen stores, bee strength, as well as egg-laying by the queen were significantly higher in mud hives compared to wooden hives across both locations and months. However, the sealed brood area of *A. cerana* colonies did not vary significantly between the two hive types.

Correlation with weather parameters

Correlation analysis (Table 2) revealed temperature as the most consistent positive factor influencing colony performance across hive types and locations. In wooden hives at Nauni, temperature had a significant positive correlation with bee strength (r = 0.64), while other parameters showed weak associations. In contrast, mud hives at Nauni exhibited stronger correlations, with brood area and queen prolificacy (r = 0.67) and honey stores (r = 0.86) showing significant positive relationships with temperature. Relative humidity was negatively correlated with most colony parameters in wooden hives, particularly bee strength (r = -0.02) and brood area (r = -0.37), whereas in mud hives it showed weakly positive or neutral effects. Rainfall displayed non-significant associations, with only honey stores in mud hives showing a positive correlation (r = 0.67).

At Kullu, the relationships were stronger. Wooden hives showed highly significant positive correlations of temperature with brood area (r = 0.90) and queen prolificacy (r = 0.89). Relative humidity also displayed strong positive associations with brood area (r = 0.89), queen prolificacy (r = 0.90), and pollen stores (r = 0.85). Mud hives at Kullu demonstrated the strongest weather–colony links, with temperature showing highly significant correlations with brood area (r = 0.78), queen prolificacy (r = 0.77), and honey stores (r = 0.91). Relative humidity was also strongly correlated with brood area (r = 0.86), pollen stores (r = 0.86), and bee strength (r = 0.72). Rainfall exhibited weak positive trends with all parameters,

***Article info - DOI**: https://doi.org/10.54386/jam.v27i4.3065*

Received:30 May 2025; Accepted:26 August 2025; Published online : 1 December 2025

(a) Wooden hive at Solan (b) Mud hive at Solan

(c) Katrain Apiary, Kullu

Fig. 1: Study areas showing different hives

Table 1: Comparison of colony performance parameters of *A. cerana* in wooden and mud hives from August 2022 to July 2023

Colony parameters	Wooden hive	Mud hive	T-cal (p value)
Total brood (cm^2)	706.04	1004.74	0.00**
Sealed brood (cm^2)	405.50	570.07	0.06
Unsealed brood (cm^2)	299.28	433.21	0.00**
Honey stores (g)	638.50	1028.18	0.00**
Pollen stores (cm^2)	123.01	180.03	0.01*
Bee strength (bee frames/ hive)	4.45	5.74	0.00**
Prolificacy of queen (cm^2)	134.48	191.37	0.00**

p > 0.05 (non-significant); *p < 0.05 (significant at 5 % level of significance); **p < 0.05 (significant at 1 % level of significance)

though not significant (Table 2).

The combined results indicated that temperature had the most consistent and significant positive impact on colony performance, especially in Kullu. This trend aligns with Painkra *et al.,* (2017), who reported strong positive influence of maximum temperature and rainfall on honey production and colony strength. Relative humidity, on the other hand, showed mixed effects, negative in wooden hives but slightly positive or neutral in mud hives, supporting observations by Pastagia and Patel (2014). The positive association of colony growth with rainfall observed in Kullu may relate to enhanced floral resource availability. Kavitha *et al.,* (2021) observed that colony parameters like sealed brood area and adult bee population increased during cooler months and declined in monsoon, while Das and Rahman (2000) reported negative relationships of temperature, humidity, and rainfall with brood population of *A. cerana indica*.

These results emphasize the importance of hive material and location in determining colony success. Mud hives consistently supported better thermoregulation and productivity, helping colonies maintain activity during colder or more humid periods. Particularly in high-altitude zones like Kullu, mud hives enabled bees to respond more efficiently to temperature cues and sustain higher colony strength. The stronger correlation of environmental factors with bee parameters in Kullu further reinforces the role of site-specific microclimatic conditions in beekeeping. Beekeepers in hill regions should adopt mud hives to optimize colony health, brood production, and honey yield. Simple practices such as situating hives in sun-exposed areas during winter and providing ventilation during humid months can further improve internal conditions. Maintaining optimum internal hive temperatures (around 30–35°C) is key for queen activity and brood expansion. Seasonal monitoring of colonies and local climate can help farmers make timely decisions. In the present study, *A. cerana* performed better in mud hives compared to wooden hives at both Nauni and Kullu. Further research could explore the long-term benefits of mud hives and their potential use in other agro-climatic zones.

ACKNOWLEDGEMENT

Authors are thankful to All India Coordinated Research Project on honey bees and pollinators, ICAR, New Delhi for providing financial and technical help. Authors are also grateful for the support provided by Regional Horticultural Research Station,

Table 2: Pearson correlation coefficient (r) of colony parameters with weather parameters in *Apis cerana* F. colonies under different hive types and locations

Weather parameters	Colony parameters	Nauni		Kullu	
		Wooden hive	Mud hive	Wooden hive	Mud hive
Temperature (°C)	Brood area (cm²)	0.40	0.67*	0.90**	0.78**
	Queen prolificacy (eggs/day)	0.40	0.67*	0.89**	0.77**
	Honey stores (g)	0.44	0.86**	0.64*	0.91**
	Pollen stores (cm²)	-0.22	0.44	0.44	0.79**
	Bee strength (frames)	0.64*	0.53	0.53	0.56
Relative Humidity (%)	Brood area (cm²)	-0.37	0.36	0.89**	0.86**
	Queen prolificacy (eggs/day)	0.37	0.36	0.90**	0.85**
	Honey stores (g)	0.50	0.34	0.53	0.61*
	Pollen stores (cm²)	-0.25	-0.18	0.85**	0.86**
	Bee strength (frames)	-0.02	-0.05	0.68*	0.72**
Rainfall (mm)	Brood area (cm²)	-0.06	-0.02	0.48	0.25
	Queen prolificacy (eggs/day)	-0.06	-0.02	0.48	0.25
	Honey stores (g)	0.35	0.67*	0.52	0.40
	Pollen stores (cm²)	-0.39	0.03	0.22	0.45
	Bee strength (frames)	0.28	0.53	0.37	0.30

* & ** 5 % level of significance

Katrain, Kullu, and Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan Himachal Pradesh.

Funding*:* This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of Interest: The authors declare no conflict of interest.

Data Availability: Climatic and observational data are available upon request from the corresponding author.

Author Contributions: **S. Sharma:** Field data collection, Statistical analysis and writing; **K. Rana:** Conceptualization and supervision; **M. Thakur:** formatting; **S. Bhatia:** Data entry and analysis; **S. J. Singh:** analysis.

REFERENCES

Abou-Shaara, H.F., Al-Ghamdi, A.A. and Mohamed, A.A. (2012). Tolerance of two honey bee races to various temperatures and relative humidity gradients. *Environ. Exp. Biol.,* 10(1): 133-138.

Corlette, R. (2011). Honeybees in natural ecosystems. In: Hepburn H.R. and Radloff S.E. (eds.), Honey Bees of Asia. Springer-Verlag, Berlin, pp. 215-226.

Das, P.K. and Rahman, A. (2000). Brood rearing activity of *Apis cerana indica* F. in Assam. *Crop Res.,* 19(3): 469-473.

Kaur, Navdeep, Pardeep K. Chhuneja, Jaspal Singh, Amit Choudhary, and S.K. Dhillon. (2020). Effect of weather factors and nitrogen application on nectar secretion and honey production potential in sunflower. *J. Agrometeorol.,* 22(4): 457-468. https://doi.org/10.54386/jam.v22i4.453

Kavitha, T., Kathirvelu, C., Muthukrishnana, N. and Gopinand, L. (2021). Influence of weather factors on colony growth of Indian honey bee, *Apis cerana indica* Fab. *Indian J. Nat. Sci.,* 12(69): 36370-36375.

Painkra, M.K., Shaw, S.S., Thakur, R.K. and Nag, Y. (2017). Influence of weather parameters on colony performance of Indian bee, *Apis cerana indica*. *Int. J. Curr. Microbiol. Appl. Sci.,* 6: 2375-2380.

Pastagia, J.J. and Patel, M.B. (2014). Influence of weather parameters on brood rearing and foraging activities of Indian bee, *Apis cerana*. *Agric. Res. J.,* 3(4): 403-409.

Partap, U. (2011). The pollination role of honey bees. In: Hepburn H.R. and Radloff S.E. (eds.), Honey Bees of Asia. Springer-Verlag, Berlin, pp. 227-255.

Reddy, P.V.R., Rashmi, T. and Verghese, A. (2015). Foraging activity of Indian honey bee, *Apis cerana* in relation to climate variables. *J. Environ. Biol.,* 36: 577-581.

Sharma, A., Raina, R., Kapoor, R., Thakur, S.K. and Thakur, M. (2020). Mud hive technology: A new innovation for conservation of indigenous bee, *Apis cerana indica*. *J. Entomol. Zool. Stud.*, 8(3): 585-588.

Stabentheiner, A., Kovac, H. and Brodschhneider, R. (2010). Honeybee colony thermoregulation – mechanisms and contribution of individuals. *PLoS ONE*, 5(1): e8967. https://doi.org/10.1371/journal.pone.0008967

Taha, E.L.K.A. and Al-Kahtani, S.N. (2013). Relationship between population size and productivity of honey bee colonies. *J. Entomol.,* 10(3): 163-169.