



Thermoregulation in Indian bees, *Apis cerana indica* F. during Winter and Summer Seasons

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Introduction

- Honey bees are highly social insects that maintain colony survival through precise thermoregulatory behavior. In the Indian honey bee, *Apis cerana indica*, thermoregulation ensures stable brood nest temperature and humidity, which are critical for colony health, development, and productivity.
- Sensors enable continuous and non-invasive monitoring of hive temperature and humidity. They provide real-time insights into how honey bee colonies regulate their microclimate, help to understand seasonal adaptations and supporting better colony management.

Material and Methods

- Three bee colonies with full strength capacity were selected from the Apiary of Centre of Excellence in Apiculture, Department of Entomology, COA, Gangavathi during 2024-25
- The automatic monitoring systems were Govee Smart Indoor Outdoor Thermo-Hygrometer (Model No: H5178, US). Govee device was placed above the brood chamber at the centre and the outdoor sensor unit which was placed above the top cover to collect external temperature and humidity.
- Bee counter was installed at the entrance of the hive, with the solar panel oriented towards the sun.



Plate 1. Experimental setup

Objective

- Monitoring of internal and external temperature and humidity along with worker bee movement using advanced sensors.

Results and Discussion

➤ WINTER:

- From 47th to 51st SW, the mean internal temperature was $29.23 \pm 1.33^{\circ}\text{C}$, higher than the external $24.17 \pm 1.71^{\circ}\text{C}$. Internal RH averaged $76.81 \pm 3.01\%$, compared to external $74.16 \pm 6.38\%$. Mean bee traffic was 36.65 ± 14.96 incoming and 48.6 ± 15.13 outgoing.
- From 51st SW to 03rd SW, the mean internal temperature increased to $33.92 \pm 1.09^{\circ}\text{C}$, while external was $25.06 \pm 1.12^{\circ}\text{C}$. Internal RH was $74.79 \pm 2.79\%$, lower than the earlier period, while external RH was $69.28 \pm 4.97\%$. Incoming bees averaged 39.00 ± 14.73 , and outgoing 51.01 ± 19.13 . (Fig. 1; Fig. 2)

➤ SUMMER:

- From 09th to 13th SW, the mean internal temperature was $33.02 \pm 1.58^{\circ}\text{C}$, higher than external $28.71 \pm 1.52^{\circ}\text{C}$. Internal RH averaged $66.59 \pm 1.96\%$, external $61.90 \pm 4.73\%$. Bee traffic was much higher with 132.38 ± 29.15 incoming and 146.71 ± 28.67 outgoing.
- From 14th to 18th SW, the mean internal temperature rose to $33.78 \pm 0.90^{\circ}\text{C}$, while external was $30.41 \pm 1.44^{\circ}\text{C}$. Internal RH averaged $68.86 \pm 2.54\%$, external $61.94 \pm 7.37\%$. Incoming bees averaged 105.54 ± 23.57 , and outgoing 126.27 ± 25.64 . (Fig. 3; Fig. 4)
- Honey bees buffered internal temperature in the range from -2°C to 8°C and internal humidity in the range from -18 per cent to +16 per cent

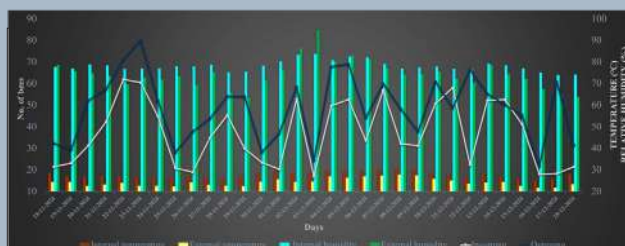


Fig. 1. Daily Average Temperature Relative Humidity and Worker Bee Movement (47th SW -51st SW)

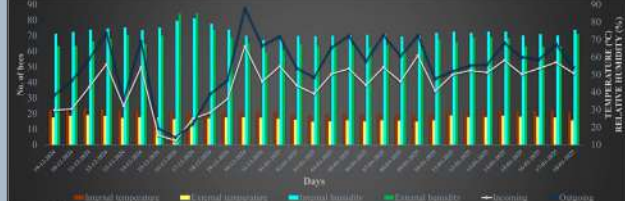


Fig. 2. Daily Average Temperature Relative Humidity and Worker Bee Movement (51st SW to 03rd SW)

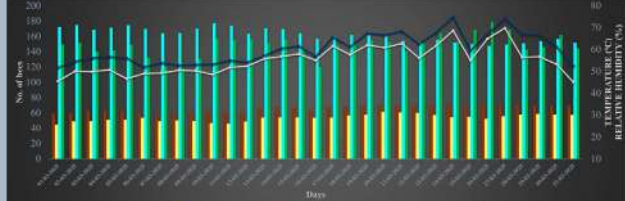


Fig. 3. Daily Average Temperature Relative Humidity and Worker Bee Movement (09th to 13th SW)



Fig. 4. Daily Average Temperature Relative Humidity and Worker Bee Movement (14th to 18th SW)

Conclusion

- In winter, bees maintained internal temperatures at $26.72\text{--}33.39^{\circ}\text{C}$ despite ambient $18.88\text{--}31.28^{\circ}\text{C}$, and in summer at $32.56\text{--}35.47^{\circ}\text{C}$ despite external $23.13\text{--}37.56^{\circ}\text{C}$.
- Internal RH remained $75.19\text{--}78.94\%$ in winter even at 90.61% outside, and $64.43\text{--}68.71\%$ in summer despite external drop to 41.34% , showing strong thermoregulation by *Apis cerana indica*.

References

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Honeybees (*Apis* spp.) are heterothermic insects, meaning they have the ability to switch between ectothermy and endothermy depending on environmental temperature fluctuations. This adaptability plays a crucial role in their foraging behavior, hive thermoregulation and overall colony survival. External temperature variations significantly influence honeybee activity, especially in terms of foraging initiation, peak activity periods and cessation of foraging for the day. In the present study, the foraging activity of Indian honeybees was monitored using a combination of advanced in-hive and external sensors over a three-month period during both winter and summer seasons. Observations were made on the daily initiation and termination of foraging activities, along with the peak periods of foraging within the day. A bee counter was employed to record the number of bees exiting and re-entering the hive, providing precise data on foraging intensity under varying climatic conditions. Additionally, environmental parameters such as temperature and relative humidity were continuously recorded both inside and outside the hive. The collected data were analyzed to establish correlations between bee activity and prevailing meteorological conditions. Special emphasis was given to identifying the exact time at which bees initiated thermoregulation during both winter and summer seasons. This aspect is critical in understanding how honeybees adapt their physiological and behavioral mechanisms to ensure colony homeostasis under different climatic conditions. The findings from this study provide insights into the relationship between environmental factors and honeybee foraging behavior, offering valuable information for beekeepers and researchers interested in optimizing hive management and improving pollination efficiency in changing climatic scenarios.