



Identified the hive designs for the Indian bee, *Apis cerana himalaya*, in the NEH region of India

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Summary

The Asian honey bee, *Apis cerana*, is a species of honey bee native to South, Southeast and East Asia. *A. cerana himalaya* colonies are known for building nests consisting of multiple combs in cavities containing a small entrance, presumably for defense against invasion by individuals of another nest. The sole purpose of a hive is to encourage the bees to construct their nest in such a way that it is easy to manage and maintain them. The influence of the hive's design on the development of the honeybee colonies has been studied. In order to test the suitable design of hives, a total of 21 hives (*Apis cerana himalaya* colonies) were established, with three hives in each design serving as replications and assigned into seven treatment groups. Based on 2-year analysis from different hive designing experiments, ISI A type with eight frames has the maximum egg laying area of (312.33 cm²), brood area of (1238.99 cm²), honey store of (530.99 cm²) pollen stores of (524.77 cm²) followed by locally made hive with (260.16 cm²), (1216.33cm²), (413.49 cm²) and (470.91 cm²) of egg-laying area, brood area, honey store and pollen store respectively and the least was found in Modified ISI A type hive with brood chamber and frame reduced by 2 inch with six frames. This shows that ISI A type with eight frames is a scientific and most advanced hive for *A. cerana himalaya*. It is recommended that the ISI A type hive be followed by the locally-made hive best for *A. cerana himalaya* in the NEH region of India.

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Introduction

The Asian honey bee, *Apis cerana* is a species of honey bee native to South, Southeast and East Asia. This species is the sister species of *Apis koschevnikovi*, and both are in the same subgenus. *Apis cerana* has three subspecies in India, according to studies conducted by the International Centre for Integrated Mountain Development (ICIMOD), namely *Apis cerana indica*, *Apis cerana cerana* and *Apis cerana himalaya* in which *Apis cerana himalaya* is found only in NEH region of India. *A. cerana himalaya* colonies are known for building nests consisting of multiple combs in cavities containing a small entrance, presumably for defense against invasion by individuals of another nest. Moreover, *A. cerana himalaya* is known for its highly social behaviour, which is reflected in its classification as a type of honey bee (Haldhar et al. 2021a&b). The sole purpose of a hive is to encourage the bees to construct their nest in such a way that it is easy to manage and maintain them. A hive is the most critical beekeeping equipment, and it should meet the biological necessities of bee colonies and be easy to operate. It is also necessary to know the honey-borne and climatic conditions and the biological characteristics of the bee species used in the area.

Beekeepers can achieve their goals of increased honey, wax, propolis, venom, and propolis, as well as increased crop production through pollination by expanding the number of honeybee colonies. Some critical factors that affect the profitability of beekeepers include the queen's quality, ecological conditions, bee flora, applied technology and resource management (Tucak et al. 2004; Thomas et al. 2002; Singh et al. 2022). The other least important factor includes the strength of the colony, the types of used hives, the age of the queen, the swarming of colonies and the applied beekeeping management practices (Al- Ghamdi et al. 2017). Choosing suitable bee hives is also one of the management practices in beekeeping. Modifications of the project of bee hives and equipment are done to facilitate work operations with bees and make their transport more accessible and more convenient.

The colony performance parameters include the strength of workers, the area of brood, egg laying area, the amount of pollen and honey stored as well as artificial feeding, which influences the foraging behaviour. Chaand et al. (2017) state that broods rearing is an essential activity of bee colonies. Honey bee productivity is highly dependent on the strength of the honey bee colony (Sharma et al. 2018). The ability of a honeybee colony to combat pests and diseases is determined by the colony's strength (Kasangaki et al. 2018). Pollen is the primary source of protein for honeybees. Due to this, a sufficient pollen supply is required for productivity and the colony's long-term life.

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Ingestion of high-quality protein helps in the development of the hypopharyngeal glands in immature honeybee workers (Irene Keller et al. 2005). Improving the performance of the hive bees can be achieved by keeping them in suitable beehives. Honey bee populations can be made more comfortable in their hives by employing materials that can maintain desirable temperature and humidity (Erdogan 2019). The qualities of wood, as an important biological raw material, define their greatest industrial applications. To determine honey bee wood preference for nesting, studies focus on the colours and non-structural chemical characteristics of the woods (Adedeji & Aiyelaja 2014). Improving the performance of the hive bees can be achieved by keeping them in suitable hives. Although there has been much recent research into the design of bee hives, there is still information on how it affects the bee family's productivity. This present study aimed to examine the influence of the hives' design on the colony development of Indian bee in the NEH region of India.

Materials and methods

The present study was conducted at the apiary of the Department of Entomology (latitude 24.8143°N and longitude 93.8903°E) College of Agriculture, Central Agricultural University, Imphal, for two years during 2020-2022.

Hive design: Seven different bee hives were designed based on the number of frames in the brood and super chamber, and the reduced size of bee hives was selected for analysis. The different bee hives were:

- ISI A type with eight frames,
- ISI A type with six frames,
- Modified ISI A type hives with brood chamber and frames reduced by 1 inch with eight frames,
- Modified ISI A type hives with brood chamber and frames reduced by 1 inch with six frames,
- Modified ISI A type hives with brood chamber and frames reduced by 2 inches with eight frames,

- Modified ISI A type hives with brood chamber and frames reduced by 2 inches with eight frames, and
- Local-made hive with no inner cover with 9 nine frames and brood chamber fixed with bottom board.

A total of twenty-one established colonies of *Apis cerana himalaya* were selected and maintained in a hive with a bottom board with a lighting space, brood chamber, super chamber, inner cover, and outer cover.

Keeping of the beehives: The beehives were kept in the apiary with an iron stand. The hives were placed in fields with similar bee forage or plants with similar resources for the bees. The observations were recorded in all of these hives at fortnightly intervals.

Colony growth parameters: Colony growth parameters such as bee strength, brood area (cm²), honey area (cm²) and pollen area (cm²) were recorded in all colonies after every 14 days intervals.

Bee strength: Bee strength was calculated by simply counting the number of combs fully covered by bees.

Area of sealed brood: The area of sealed brood, i.e., wax-capped cells containing pupae, was measured on both sides of the frame using a transparent sheet with a grid of markings 1x1(cm²). The total sealed brood area was calculated in each colony by finding out the total number of 1x1(cm²) covering the brood area in all the frames.

Area of honey storage: Honey bees make honey to store up as food for them and use during the winter months. The sealed honey area can be differentiated as the cells are slightly transparent and sunken compared to the sealed brood area. The sealed honey area was calculated by using the OHP sheet with grid markings as mentioned above and expressed in (cm²).

Area of pollen storage: Pollen is the primary source of protein for honeybees. The pollen stored area was measured on both sides of the frames in each colony by using the OHP sheet with grid markings as mentioned above and expressed in (cm²).

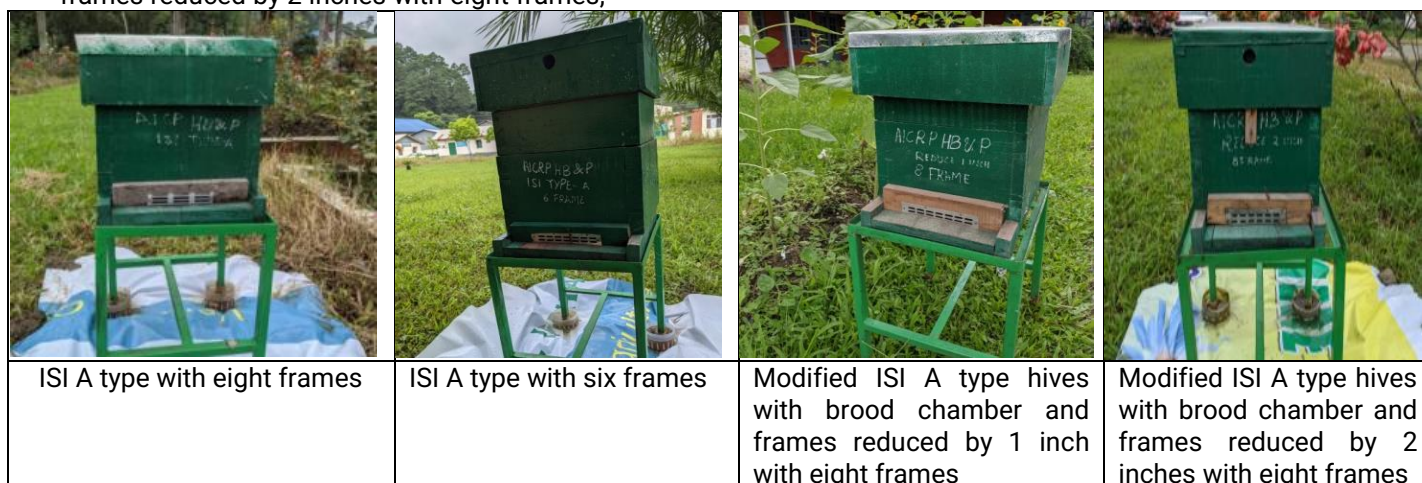




Plate 1. Different hive design for Indian bee, *Apis cerana himalaya*

Results and Discussion

Effect of different hives designing on bee strength by *Apis cerana himalaya*: The resilience of honeybee colonies in the present study was highest in treatments T1 & T7 with maximum bee strength of (8.0) eight frame each followed by T4 (7.06) frames and the least was recorded in T6 (5.16) (Table 3). Maximum bee strength

indicates that these bees are healthy and fed genetically. The relatively high mean brood area could also explain it because the sealed brood represents the next population of workers. This agrees with the study of (Harbo 1993), which showed a positive correlation was found between colony population and sealed brood area.

Table 1. Effect of different frame sizes on developmental parameters of *Apis cerana himalaya* (2020-21)

Frames parameters	ISI A type with eight frames (T1)	ISI A type with six frames (T2)	Modified ISI A type hives reduced by 1 inch with eight frames (T3)	Modified ISI A type hives reduced by 2 inches with eight frames (T4)	Modified ISI A type hives reduced by 1 inch with six frames (T5)	Modified ISI A type hives reduced by 2 inches with six frames (T6)	Locally made hive (T7)
Bee strength	8	5.33	7	7	5	5	8
Egg laying area(cm ²)	300.33	173.00	236.00	215.33	148.66	125.00	268.00
Brood area(cm ²)	1261	1005	1226.66	1029.00	973.00	937.33	1235.00
Honey stores(cm ²)	528.33	418.00	496.00	472.33	400.00	388.00	500.33
Pollen stores(cm ²)	521.00	414.00	470.66	444.33	394.00	363.66	490.33

Effect of different hives designing on egg laying area by *Apis cerana himalaya*: The mean egg laying area was recorded maximum in T1 (312.33 cm²) followed by T7 (260.16 cm²), and the least was recorded by T6 (126.33 cm²) (Table 3).

Effect of different hives designing on brood area by *Apis cerana himalaya*: Sealed brood area observed after 14 days intervals are presented in Table 5. The treatment T1 recorded the maximum brood area of 1238.99 cm² followed by T7 (1216.33 cm²) of brood area and T3 (1209.33 cm²). And the lowest brood area was recorded in T5 (919.33 cm²). Significantly, higher brood area produced in ISI A type with eight frames could be due to

a higher bee population than that of Modified ISI A type hives reduced by 2 inches with six frames. Strong honeybee colonies make more extended flights and bring back to the hive significantly more oversized loads of pollen and produce more brood than weak colonies (Table 3). This agrees with the study of (Bhusal et al. 2016), who reported that the strength of bee colonies is significantly positively correlated with the amount of brood rear colonies. This result implies that a hive that encourages population growth will produce more brood and reduce honey consumption per bee during the dearth period (Szabo & Lefkovitch 1989)

Table 2. Effect of different frame sizes on developmental parameters of *Apis cerana himalaya* (2021-22)

Frames parameters	ISI A type with eight frames (T1)	ISI A type with six frames (T2)	Modified ISI A type hives reduced by 1 inch with eight frames (T3)	Modified ISI A type hives reduced by 2 inches with eight frames (T4)	Modified ISI A type hives reduced by 1 inch with six frames (T5)	Modified ISI A type hives reduced by 2 inches with six frames (T6)	Locally made hive (T7)
Bee strength	7.6	5.3	7	7.3	5	5	8
Egg laying area(cm ²)	324.33	164.00	228.33	214.6	131.3	127.66	252.33
Brood area(cm ²)	1216.33	956.66	1192	1032.33	856.66	953.66	1197
Honey stores(cm ²)	533.00	385.00	483.00	456.00	400.00	377.00	526.00
Pollen stores(cm ²)	521.00	375.00	426.00	402.00	306.70	350.00	471.00

Effect of different hives designing on honey storage area by *Apis cerana himalaya*: Nectar is an aqueous solution secreted from floras of plants which contains sugar, mainly glucose, fructose and sucrose with traces of minerals and proteins. The maximum honey storage area was recorded in the colonies T1 (530.99 cm²), which was statistically better than all other treatments (Table 5). Treatment T3 and T4 also gave a good performance as the honey storage area recorded was (489.50 cm²) and (464.33 cm²) respectively, and the minimum honey storage area was found in T6 with 382.66 cm². Strong and healthy bee colonies stored more nectar than weak colonies.

Effect of different hive designs on pollen stored area by *Apis cerana himalaya*: The impact of varying hive designs on the colony performance parameter, namely the pollen storage area, was studied in the *Apis cerana himalaya*. The mean pollen storage area revealed that the treatment T1 had the highest overall mean pollen storage area of (524.77 cm²). This was followed by T3 (440.74 cm²), T4 (433.66 cm²) and the most minor honey storage was recorded in T6 (359.99 cm²). Strong honeybee colonies make longer flights and bring back to the hive significantly more oversized loads of pollen and tear. This agrees with the study of (Shawer et al. 1986),

who stated that pollen collected by strong colonies was higher.

Okyere-Amoateng & Abugre (2021) found that in terms of honey, beeswax, and propolis yield, bee hives made of woods namely *Tectona grandis* and *Terminalia superba* performed admirably. *T. grandis* wood is suitable for beekeeping, according to the findings. Adedeji & Aiyelaja (2014) reported that white woods (*Gmelina arborea* and *Vitex doniana*) were shown to be acceptable as cavity materials for honeybees nesting over brown wood (*Erythrophleum suaveolens*). Adedeji & Aiyelaja (2014) reported that seasons have an important role in colonisation, and the wood, *Triplochiton scleroxylon* was appropriate but prone to insect attacks. Worker activity and metabolism influence changes in CO₂ and O₂ concentrations inside the hive. Because energetic bees have a higher body temperature, their activity level may influence the release (e.g., evaporation) of extra compounds. Bloch et al. (2020) reported that hive volatiles mediate social synchronization in honey bee colonies. In our studies, it was found that compared to all other wood kinds, the lightweight wood, Malai Vembu (*M. dubia*) was more appealing to bees and aided in increased brood raising, pollen storage area, and honey storage.

Table 3. Average Mean of different frame sizes on developmental parameters of *Apis cerana himalaya* (mean of 2 years)

Frames parameters	ISI A type with eight frames (T1)	ISI A type with six frames (T2)	Modified ISI A type hives reduced by 1 inch with eight frames (T3)	Modified ISI A type hives reduced by 2 inches with eight frames (T4)	Modified ISI A type hives reduced by 1 inch with six frames (T5)	Modified ISI A type hives reduced by 2 inches with six frames (T6)	Locally made hive (T7)	Mean
Bee strength	8.00	5.33	7.00	7.16	5.66	5.16	8.00	6.61

Egg laying area(cm²)	312.33	168.50	232.165	214.99	139.99	126.33	260.16	207.78
Brood area(cm²)	1238.99	980.33	1209.33	1064.00	919.33	945.495	1216.33	1217.04
Honey stores(cm²)	530.99	401.66	489.50	464.33	400.00	382.66	413.49	440.37
Pollen stores(cm²)	524.77	377.5	440.74	433.66	378.44	359.99	377.50	426.57

Conclusion

The results of our investigation revealed that ISI A type with 8 (eight) frames has the maximum mean egg laying area of (312.33 cm²), brood area (1238.99 cm²), honey stores (530.99 cm²), pollen stores (524.77 cm²) followed by locally made hive with 260.16 cm², 1216.33 cm², 413.49 cm², 377.50 cm² of egg laying area, brood area, honey storage area and pollen storage area respectively. This shows that ISI A type is a scientific and most advanced hive for *Apis cerana himalaya*. It is recommended that an ISI A-type hive followed by a locally made hive be used, as it is the best hive for *A. cerana himalaya* in the NEH region.

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Declaration of Interests

The authors have no conflict of interest to declare.

Data Sharing

All relevant data are within the manuscript.

References

- Adedeji GA & Aiyelaja AA. 2014. Preference and suitability of Nigerian grown *Gmelina arborea* Linn. Roxb. and *Vitex doniana* sweet woods for beekeeping in Imeko, Nigeria. *International Journal of Scientific Engineering Research (IJSER)*, 5 (5):1484-1493.
- Ahmad A, Al-Ghamdi, Nuru Adgaba, Ahmed HH & Mohammad JA. 2017. Comparative analysis of the profitability of honey production using Traditional and box hives. *Saudi J. Biol Sci.*, 24 (5): 1075-1080.
- Bhusal SJ & Thapa RB. 2006. Response of colony strength to honey production: regression and correlation analysis. *J. Inst. Agric. Anim. Sci.*, 27: 133-137.
- Chaand D, Sharma D, Ganai SA, Norboo T & Sharma S. 2017. Effect of colony strength on colony build up and foraging activity of *Apis mellifera* L. *Journal of Entomology and Zoology Studies*, 5 (6): 1369-73.
- Erdogan Y. 2019. Comparison of colony performances of honeybee (*Apis mellifera* L.) housed in hives made of different materials. *Italian Journal of Animal Science*.
- Haldhar SM, Nidhi CN, Singh KI & Devi AS. 2021a. Honeybees diversity, pollination, entrepreneurship and beekeeping scenario in NEH region of India. *Journal of Agriculture and Ecology*, 12: 27-43.
- Haldhar SM, Singh KI, Gupta MK & Devi AS. 2021b. Morphometric analysis on different species of honeybees in NEH region of India. *Journal of Agriculture and Ecology*, 12: 62-73.
- Harbo JR. 1993. Effect of brood rearing on honey consumption and the survival of worker honey bees. *J. Apic. Res.*, 32 (1): 11-1.
- Kasangaki P, Nyamasyo G, Ndegwa P & Kajobe R. 2018. Assessment of honeybee colony performance in the agroecological zones of Uganda.
- Keller I, Fluri P & Imdorf A. 2005. Pollen nutrition and colony development in honey bees Part II. *Bee World*, 86 (2): 27-34. www.ibra.org.uk
- Okyere-Amoateng R & Abugre S. 2021. Enhancing the viability of the modified taungya system through bee keeping. *Journal of Sustainable Forestry*, 1-15.
- Shawer MB, Shenishen Z & El-Dakhakhni NM. 1986. Effect of colony strength on flight activity and productivity of honey bee colonies. *Bull. Soc. Ent. Egypt*, 66: 65-73.
- Siehler O & Bloch G. 2020. Colony volatiles and substrate-borne vibrations entrain circadian rhythms and are potential cues mediating social synchronization in honey bee colonies. *Journal of Biological Rhythms*, 35 (3): 246 256.
- Singh KI, Haldhar SM and Maheshwari K. 2022. Scientific cares and management of *Apis cerana himalaya*. *Pub: College of Agriculture, CAU, Imphal pp-93; ISBN: 978-81-947184-6-8*.
- Szabo T & Lefkovitch L. 1989. Effect of brood production and population size on honey production of honeybee colonies in Alberta, Canada. *Apidologie*, 20: 157- 163.
- Thomas D, Pal N & Subba Rao K. 2002. Bee management and productivity of Indian honey bees. Proceedings of the 37th International Apicultural Congress, 28 October – 1 November 2001, Durban, South Africa
- Tucak Z, Perispic M, Beslo D & Tucak, I. 2004. Influence of the beehive type on the quality of honey. *Collegium Antropologicum*, 28: 463–467.