International Journal of
Life Sciences
International Peer Reviewed Open Access Refereed Journal

Int. J. of Life Sciences, 2020; 8 (1):149-151
ISSN:2320-7817(p) | 2320-964X(o)

Original Article Open Access

Effect of seasonal fluctuations in ambient temperature on behavior of hived *Apis cerana* honey bee colony

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Manuscript details:

Received: 20.02.2020
Accepted: 25.03.2020
Published: 10.04.2020

Cite this article as:
Mangle Vijay S (2020) Effect of seasonal fluctuations in ambient temperature on behavior of hived *Apis cerana* honey bee colony, *Int. J. of. Life Sciences*, Volume 8(1): 149-151.

Available online on
http://www.ijlsci.in
ISSN: 2320-964X (Online)
ISSN: 2320-7817 (Print)

ABSTRACT

Apis cerana species occurs all over India, as *A. cerana* cerana in northern and *A. cerana* indica in southern part of India except desert region. The honey bees make flight for their food as pollen or nectar or both. The foraging depends upon availability of food, water and climatic conditions like ambient temperature, humidity, light levels, and visibility. The foraging range of *A. cerana* is about 1-1.5 km. Seasonal fluctuations in temperature affect normal working of bees. This attempt was made to study effect of ambient temperature on behavior of hived *A. cerana* bee colony at Chikhaldara. It was found that bees become most active from 8.00 am to 11.00 am and 4.00 to 6.30 pm in summer whereas 9.00 am to 12.30 pm and 3.00 pm to 5.00 pm in cold season. The optimum temperature of brood was 34 to 34.5 ^{0}C, and varies by 1 ^{0}C. Seasonal fluctuations in ambient temperature affect working efficiency of the workers. During summer, temperature rises above 34 ^{0}C, worker bees performs some extra compensatory action like fanning, foragers bring the water, avoid clustering to minimize the internal brood temperature. While in cold conditions, the brood temperature stabilize by clustering, consumes huge honey to generate heat and worker bees start to minimize space between combs, so as to reduce heat loss.

Key words: *Apis cerana*, brood, comb, cluster, fanning, foraging, hive, temperature.

INTRODUCTION

The natural range of *A. cerana* is widespread areas, temperate to tropical Asia, the size of this bee is smaller than A. *dorsata* and larger than *A. florae* of other Indian bees. These bees are cavity nesting and builds multi combs. The natural colonies are found in hallow trunk of trees, rock cavities, cracks of walls grounds. The bee builds nest in cavities at low height i.e. 5-6 feet from ground. Bees collect pollen and nectar needed for nutrition and provides ecological service of pollination. Pollen is a source of protein, nectar is a source of carbohydrates, and together they provide all the food necessary for larval growth and metamorphosis, and for adult function and development (Kotez, 2013). The foraging range of the bee is 900 to 1500 meters from the hive.

The colony of *A. cerana* is comparatively unstable than *A. mellifera*, because these bees store less honey for long period of unstable conditions, instead they move to find better conditions, (Oldroyd, *et al*. 2006). Bees abscond less often than open nesting bees like *florae* and *A*. *dorsata,* because cavity nesting helps to maintain favorable environment for survival. Tropical honeybees are able to move the whole colony throughout the year in response to change or disturbance, and to follow the honey flow, both of which increase fitness and survival (Hepburn, *et al*.,1999).

MATERIALS AND METHODS

Study area:

The present study was carried out at Chikhaldara; it is situated on Gavilgarh ranges of Satpuda Mountain in Amravati district, at the height of 3650 feet from mean sea level.

Climate: The climate of Chikhaldara, with extremes of temperature 39 ^{0}C during summer and 6^{0}C in cold season. Average rainfall is 1640 mm with 70-80 rainy days. The average relative humidity is 65 % and it remains 100% for 30-40 days and visibility becomes affected by low density clouds during through ought rainy season.

The forest around Chikhaldara is dry deciduas type along valleys, planes and slopes, but Chikhaldara plateau is with semi evergreen forest type. The typical bee flora at plateau contains *Jamun (Eugenia jambolica), Amla (Emblica offincialis), Nilgiri (Eucalyptus), Silver Oak (Grevillea robusta), Holige , Coffee (Coffea arebica), Bottle brush (Callistemon citrinus), Bakul (mimusops elengi), Pangara(Erythrina variegeta), Katesawar (Bombax ceiba), Kumbhi (Careya arvoea) Behada (Terminallia bellerica), Amaltas (Cassia fistula), Tecoma (Rhododendronsp.) and cultivated bee crops nearby areas are strawberry(Fragaria ananssa), Jagani (Guizotia abyssinica)* , traces of *black mustard (Brassica nigra)* etc. The dearth period is from at the end of May to September.

Present *A. cerana* natural colony was captured from hallow trunk of tree and hived, the strength of colony was moderate containing moderate brood and little deposition of pollen.

For the study of temperature, a thermograph and digital thermometer were used and for humidity and relative humidity, hygrograph and psychrometer were used. The rain fall was measured by non recording type of rain gauge.

RESULTS AND DISCUSSION

The present study focuses on seasonal variations in temperature during October to January for cold, and April to May for hot season, some observations during rainy season was also mentioned.

It was observed that when bulk food is available, the *A. cerana* bees become very active at 8.00 - 11.00 at morning and 4.00 pm to 6.30 pm during summer season, in winter season 9.00 am to 12.30 pm and 3.00 pm to 5.00 pm in winter season. Even at temperature of 39 ^{0}C, bee foraging was observed at Chikhaldara. Bees can tolerate body temperatures of 50 °C for short periods without lethal effects and we have measured thoracic temperatures of pollen carriers exceeding 50°C (Lensky, 1964). Abrol, (2011) expressed that, the time of day when honeybees start and finish foraging often depends on ambient temperature, as well as the availability of floral resources—the specific combination of factors is species-specific. In general, *A. cerana* tend to start foraging earlier in the day than *A. mellifera* as *A. cerana* require slightly lower temperatures, light intensity and solar radiation levels to commence flight activity than *A. mellifera*.

Table 1 : Behavior of bee with reference to ambient temperature.

Activities of bees in hive	Summer	Winter
Foraging activeness	8.00 -11.00 am , 4.00 - 6.30 pm	9.00 -12.30 pm 3.00 -5.00 pm
Foraging deactivated	> 38^0 C	< 25 ^{0} C
Fanning behavior	> 35.5^0 C	-
De clustering	> 3.5^0 C	-
Clustering starts	-	< 19 ^{0} C

In 1975, Heinrich observed that honey bees have been observed to forage at high ambient temperatures and under intense solar radiation characteristic of summer in the Sonoran Desert of southwest North America. A heat budget for foraging honey bees *(Apis mellifera* L.) indicated that at 30-35 °C all bees are in positive heat balance during flight (Paul et al.,1985).

When colony was strong with a brood, the average brood temperature was in the range of 34.0 -34.5 ^{0}C. Bees can tolerate body temperatures of 50 °C for short periods without lethal effects and we have measured thoracic temperatures of pollen carriers exceeding 50°C (Lensky, 1964).

Seasonal fluctuations in ambient temperature affect working efficiency of the workers.

Summer Season:

During summer, ambient temperature exceeds 38^0 C, the foraging activity minimizes and when the comb/ brood temperature rises above 34 ^{0}C, bees start cooling, worker bees performs some extra compensatory action like fanning, foragers bring the water, avoid clustering to minimize the internal brood temperature. They avoid clustering inside and move apart from the combs and sometimes out of hive near the entrance gate forming a cluster.

The group of bees starts fanning at the inside and outside the gate so as to enter fresh air into hive and worker bees face inward at the entrance. The worker bees make more flights for to carry more water so as to evaporation and increases humidity in the hive. To prevent danger of the colony overheating, the bees regurgitate water droplets and cover the comb by the use of proboscis with thin water film which cools hive when evaporating (Sigurd, 2000).

Winter Season:

While in cold conditions, when ambient temperature falls below 25^{0}C the foraging activity slows down, when brood temperature drops below 19^{0}C stabilize by clustering, when temperature drops further , the bees specially workers densely packed with their heads pointed inward, they covers empty combs so as to minimize space between adjacent combs this reduces heat loss . Bees consume more stored honey during cold seasons to generate heat.

CONCLUSION

On account of present study, it is concluded that, temperature affects the foraging behavior of the bees. At extremes of the ambient temperature, bees regulate internal hive temperature and comb/ brood temperature by forming cluster, moving away from brood and hive, fanning, increases flight for water, forming cluster at entrance or outside at outside. Bees consume more honey during winter season.

Acknowledgement

I am very thankful to Principal, Arts, Science and Commerce College, Chikhaldara permission to allow doing such work and motivation.

Conflict of Interest

The author declares that there is no conflict of interest.

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