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## Effect of electromagnetic radiation of cell phone tower on foraging behaviour of Asiatic honey bee, *Apis cerana* F. (Hymenoptera: Apidae)

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### Abstract

The effect of electromagnetic radiation (EMR) of cell phone tower on foraging behaviour of honey bee, *Apis cerana* F. was studied at Assam Agricultural University, Jorhat from December to May during 2012-13 and 2013-14 at an interval of 15 days. To quantify the effect of EMR, five treatments were placed at varying distance from the tower having different radiation level. The present study results revealed that the peak foraging behaviour of worker bees continues from March to May. The foraging behaviour of worker bees were observed maximum in colonies placed at 500m followed by 1000m, 300m and 200m and least at 100m distance from the tower. The results from the present investigation revealed that the *Apis cerana* colonies in close proximity to cell phones towers were most affected by the electromagnetic radiation emitted by the cell phone tower.

**Keywords:** Electromagnetic radiation, cell phone tower, *Apis cerana* F., foraging behaviour

### 1. Introduction

Apiculture is a dynamic vocation and has developed into an important industry in India. Traditional apiculture in India is mainly based on Asiatic honey bee, *Apis cerana* F. It is essential not only for honey and other hive products, but also for the pollination service provided by bees. The economic role of honey bees in worldwide pollination has been statistically valued around 153 billion Euros in the year 2005<sup>[1]</sup>. Bee losses have been recorded for more than a century<sup>[2]</sup>. A new phenomenon of sudden disappearance of bees with little sign of disease or infestation has been reported from all over the world where the bees simply leave the hive and fail to return. Colony Collapse Disorder (C.C.D) is the name given to the problem<sup>[3]</sup>. CCD has so far pointed to pesticides, air pollution and even GMOs. In the US, disappearance of bees was associated with the rising network of electromagnetic pollution where bees simply leave the hive and fail to return<sup>[4]</sup>. Studies have brought out evidence to support the theory of colony collapse disorder (CCD) among honey bees due to electromagnetic radiation from cell phones and their relay towers. The massive amount of radiation produced by towers and mobile phones is actually affecting honey bee behaviour and biology. The “waggle” dance that bees perform on the honey comb to communicate with others could be influenced by the radiation, these prevents them from returning back to their hives. The thriving hives suddenly left with only queens, eggs and hive bound immature worker bees. Recently, a sharp decline has been noticed in commercial bee population in Kerala posing a serious threat to beekeepers, hitting apiculture. Similar cases have been observed in Bihar, Punjab, and other parts of India and have been attributed to increasing electromagnetic pollution in the environment. Currently, there are more than 60 crores cell phone users and nearly 4.3 lakh cell phone towers in India to meet the communication demand. The numbers of cell phones and cell towers are increasing despite of several disadvantages<sup>[5]</sup>.

So keeping these points in view, the present experiment had been carried out to see the effect of EMR from cell phone tower on foraging behaviour of Indian honey bees, *Apis cerana* F.

### 2. Materials and Methods

The present investigation on effect of electromagnetic radiation of cell phone tower on foraging behaviour of honey bee, *Apis cerana* F. (Hymenoptera: Apidae) was carried out at

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Assam Agricultural University, Jorhat, India (26°46'N latitude, 94°12' E longitude and 86.6 meters above sea level). The observations were recorded from December to May during 2012-13 and 2013-14 at an interval of 15 days. The experiment was conducted by placing five treatments each replicated four times at varying distance from the tower viz:  
 T<sub>1</sub> = *Apis cerana* colonies placed at 100m away from the cell phone tower  
 T<sub>2</sub> = *Apis cerana* colonies placed at 200m away from the cell phone tower

T<sub>3</sub> = *Apis cerana* colonies placed at 300m away from the cell phone tower  
 T<sub>4</sub> = *Apis cerana* colonies placed at 500m away from the cell phone tower  
 T<sub>5</sub> = *Apis cerana* colonies placed at 1000m away from the cell phone tower  
 A 3-Axis RF electromagnetic field meter was used to measure the electromagnetic radiation from the cell phone tower at varying distances (Table 1)

**Table 1:** EMR frequency on *Apis cerana* colonies placed at varying distance from the mobile tower during the observation period.

EMR measurement	0m	T <sub>1</sub> (100m)	T <sub>2</sub> (200m)	T <sub>3</sub> (300m)	T <sub>4</sub> (500m)	T <sub>5</sub> (1000m)
Electric field (E) mV/m	0	159-189	76-127	75-112	63-101	65-103

The following behavioural aspects were recorded during the observation:

#### a. Flight activity

Flight activity was measured as number of worker bees leaving the hive per minute.

#### b. Returning ability

Returning ability was determined by counting the number of worker bees returning to the hive per minute.

#### c. Pollen foraging efficiency

Pollen foraging efficiency was measured as number of worker bees returning with pollen loads per minute.

#### Statistical analysis

The experimental data were statistically analysed by the method of analysis of variance developed by Fisher (1920's). The data were statistically analysed and the source of variance due to replication, treatment and error were separated out from the total variation. The significance or non-significance of a given variance was determined by calculating the respective values of "F" and by comparing the calculated value of "F" at 5 per cent probability level.

### 3. Results and Discussion

The study on effect of electromagnetic radiation on behavior of *Apis cerana* revealed that, March to May was the peak foraging period during the study period. The flight activity was observed maximum (33.29 bees per minute) in colonies placed at 500m distance from the tower followed by 1000m, 300m and 200m, where number of bees leaving the hive was recorded to be 32.42, 31.71 and 30.96 bees per minute respectively, while minimum was reported in colonies placed at 100m (28.58 bees per minute) from the tower. The returning ability of worker bees pertaining to various

treatments, the maximum 22.42 returning bees per minute was noticed in colonies placed at 500m distances followed by 1000m, 300m and 200m where the average returning ability were 21.75, 21.42 and 19.96 bees per minute respectively. The least returning ability was recorded from colonies placed at 100m distance (19.67 bees per minute) (Table 3). The study revealed that the number of worker bees returning to the hive with pollen loads per minute was not significantly affected in all the treatments. *Apis cerana* colonies in close proximity to mobile phones towers were most affected by the electromagnetic radiation emitted by the tower. Similar type of results was reported by Favre where proximity of mobile phone handsets induced honey bee workers to "pipe" [6]. The radiation produced by towers might affect the navigational skills of the honey bees and preventing them from returning back to their hives. Ferrari carried out a series of experiments that subjected foraging bees to magnetic fields, which appeared to disrupt their ability to navigate so they become less able to find their way home [7]. Similar type of results were reported by Sharma and Kumar where the number of returning bees declined in colonies with active cell phones (36.4 bees per minute) as compared to the control (39.6 bees per minute) [8]. Another important finding was that the number of bees leaving the hive also decreased following exposure to EMR of cell phone. Similarly, Sainudeen reported that after ten days of exposure to radiation the worker bees never returned hives in the test colonies [9]. In contrary to the findings, Mall and Kumar reported that there was no apparent effect of EMR on brood rearing, honey production and foraging behaviour of *Apis mellifera* colonies [10]. Similarly, Mixon *et al.* reported that there was no effect of GSM radiation exposure on aggression of honey bees. They also concluded that GSM cellular phone radiation emission do not inhibit the foraging behavior and navigational ability of honey bees, and unlikely to affect colony health [11].

**Table 2:** Effect of electromagnetic radiation of cell phone tower on flight activity of worker bees of different treatments placed at varying distance from the tower.

Treatments	Number of worker bees leaving the hive per minute at monthly interval						Mean
	Dec	Jan	Feb	Mar	Apr	May	
T <sub>1</sub>	28.50	29.25	29.00	28.50	28.50	27.75	28.58
T <sub>2</sub>	30.00	31.00	32.00	32.25	31.75	28.75	30.96
T <sub>3</sub>	31.50	31.75	32.25	32.75	31.75	30.25	31.71
T <sub>4</sub>	32.25	32.50	34.50	35.50	33.00	32.00	33.29
T <sub>5</sub>	31.00	32.50	32.50	34.50	32.25	31.75	32.42
S.Ed			0.78	1.01	0.90	0.70	
C.D (P=0.05)	N.S	N.S	1.70	2.21	1.96	1.51	

**Table 3:** Effect of electromagnetic radiation of cell phone tower on returning ability of worker bees of different treatments placed at varying distance from the tower.

Treatments	Number of worker bees returning the hive per minute at monthly interval						Mean
	Dec	Jan	Feb	Mar	Apr	May	
T <sub>1</sub>	18.00	19.50	19.25	19.50	21.00	20.75	19.67
T <sub>2</sub>	18.25	20.00	19.75	20.25	20.75	20.75	19.96
T <sub>3</sub>	19.75	19.75	20.50	22.75	22.25	23.50	21.42
T <sub>4</sub>	20.25	21.25	21.50	23.50	23.75	24.50	22.46
T <sub>5</sub>	20.00	20.25	21.75	22.25	22.50	23.75	21.75
S.Ed				0.92	0.94	0.83	
C.D (P=0.05)	N.S	N.S	N.S	2.01	2.04	1.81	

**Table 4:** Effect of electromagnetic radiation of cell phone tower on pollen foraging efficacy of worker bees of different treatments placed at varying distance from the tower.

Treatments	Number of worker bees returning the hive with pollen load per minute at monthly interval						Mean
	Dec	Jan	Feb	Mar	Apr	May	
T <sub>1</sub>	6.00	7.75	6.00	7.75	6.00	7.75	6.00
T <sub>2</sub>	7.00	8.00	7.00	8.00	7.00	8.00	7.00
T <sub>3</sub>	7.50	8.50	7.50	8.50	7.50	8.50	7.50
T <sub>4</sub>	7.75	9.25	7.75	9.25	7.75	9.25	7.75
T <sub>5</sub>	8.50	9.50	8.50	9.50	8.50	9.50	8.50
S.Ed	N.S	N.S	N.S	N.S	N.S	N.S	

#### 4. Conclusion

The results from the present investigation revealed that the *Apis cerana* colonies in close proximity to mobile phones towers were most affected by the electromagnetic radiation emitted by the tower. The flight activity and returning ability of worker honey bees were maximum in colonies placed at 500m and minimum at 100m from the tower. There was no significant difference in the pollen foraging behaviour of foragers in various treatments. Findings of several works reported sharp decline and potential health hazards in honey bee populations due to cell phone radiation and could considerably weaken the infrastructure of food webs. The EMRs may harm the health of honey bee in the long run; however, the immediate and direct impact is yet need intensive research to draw a firm conclusion.

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