

Original Research Article

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Effect of Electromagnetic Radiation of Cell Phone Tower on Development of Asiatic Honey Bee, *Apis cerana* F. (Hymenoptera: Apidae)

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ABSTRACT

Keywords

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The present investigation on the effect of electromagnetic radiation (EMR) of cell phone tower on development of Asiatic honey, *Apis cerana* F. was studied at Assam Agricultural University, Jorhat during 2012-2014. To quantify the effect of EMR, *Apis cerana* colonies were placed at varying distance from the cell phone tower, viz. 100m, 200m, 300m, 500m and 1000m having different radiation level which were measured with the help of 3-Axis RF electromagnetic field meter (model: EMF-819). It was observed that the brood area, honey hoarding capacity, pollen stores and queen prolificacy were significantly higher in colonies placed at 500m distance followed by 1000m, 300m and 200m and least at colonies placed at 100m distance from the tower. The results from the present investigation which revealed that the *Apis cerana* colonies in close proximity to mobile phones towers were most affected by the electromagnetic radiation emitted by the cell phone tower.

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 estimated around 153 billion Euros (Gallai *et al.*, 2009). Recently 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 (CCD) is the name given to the problem (van Engelsdorp *et al.*, 2009).

CCD was subjected to pesticides, air pollution and even Genetically Modified Organisms (GMO). 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 (Anon., 2007). Studies have brought out evidence to support the theory of colony collapse disorder among honey bees due to electromagnetic radiation from cell phones and their relay towers. The “waggle” dance that bees perform on the honeycomb to communicate with others could be influenced by the radiation, these prevent them from returning back to their hives. The affected 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, India 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 (Kumar, 2010). 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 (Kumar, 2010)

As far as research on electromagnetic pollution is concerned, no systematic studies have been conducted on the effect of EMR on development of Asiatic honey bee. So keeping these points in view, the present experiment had been carried out to see the effect of electromagnetic radiation from cell phone tower on development of *Apis cerana* F.

Materials and Methods

The study on the effect of electromagnetic radiation of cell phone tower on development of Asiatic honey bee, *Apis cerana* F. was carried out at 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 *Apis cerana* colonies at varying distance from the cell phone tower viz:

T₁ = *Apis cerana* colonies placed at 100m away from the cell phone tower

T₂ = *Apis cerana* colonies placed at 200m away from the cell phone tower

T₃ = *Apis cerana* colonies placed at 300m away from the cell phone tower

T₄ = *Apis cerana* colonies placed at 500m away from the cell phone tower

T₅ = *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 tower at varying distances (Table 1). The following biological aspects were recorded during the observation:

Brood area

The total area under brood comprising eggs, larvae, and pupae was measured in all the experimental colonies with the help of a 5×5sq. cm grid mounted on a comb frame (Sharma and Kumar, 2010). To work out the total brood area, the number of cells comprising eggs, larvae, and pupae were counted within the 5×5sq. cm paper grid.

Honey hoarding capacity

The area containing ripe and unripe (sealed and unsealed) nectar was measured in sq. cm with the help of 5×5sq.cm paper grid.

Pollen stores

The portion of comb containing cells filled with stored pollen was measured by the grid method expressed in sq. cm.

Queen prolificacy

Queen prolificacy was measured in terms of egg laying rate of the queen. This has been worked as per the formula given by Sharma and Kumar (2010)

$$\text{Queen Prolificacy} = \frac{\text{Total brood area (cm}^2\text{)} \times 4}{21}$$

Where,

4= Number of cells per sq. cm of comb

21= average time taken for an egg to change into an adult worker

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.

Results and Discussion

Study on the effect of EMF on colony development of *Apis cerana* revealed that the brood area in different treatments varied from 815.63-1428.25cm², 833.75-1493.50cm², 859.13-1529.75cm², 837.38-1609.50cm² and 822.88-1558.75cm² in colonies placed at 100m, 200m, 300m, 500m and 1000m

respectively. The brood area pertaining to various treatments, the maximum was recorded in the colonies placed at 500m (1235.52cm²) away from the tower followed by 1000m (1193.99cm²), 300m (1170.27cm²), 200m (1136.89cm²) whereas least were recorded from 100m (1102.15cm²) (Table 2). Sharma and Kumar (2010) also reported significant decline in colonies strength due to EMRs in *Apis mellifera*. They reported that the area under brood area declined to be 760.17cm² in tested colonies which was significantly less than the control (1975.44cm²). The present findings are in conformity with the views of Mall and Kumar (2014) where they observed that maximum brood area was found in control colonies (560.36cm²) followed by colonies kept near the tower (537.85cm²) and lowest brood area (534.81cm²) was observed in colonies equipped with cell phone. The honey hoarding capacity varied from 427.75-1000.50cm², 449.50-1051.25cm², 431.38-1109.25cm², 475.88-1189.00cm² and 471.25-1145.50cm² in treatments placed at 100m, 200m, 300m, 500m and 1000m respectively during the study period. The honey hoarding capacity were recorded to be maximum (851.57cm²) in the colonies placed at 500m followed by 1000m, 300m and 200m where the honey hoarding capacity was recorded to be 821.52cm², 788.59 cm² and 774.54 cm² respectively, while minimum was recorded in colonies placed at 100m distance from the tower (729.53cm²) (Table 3). Sharma and Kumar (2010) reported that the honey storing ability declined due to loss of returning bees and at the end of the experiment there was neither honey nor pollen or brood and bees in the tested colony resulting in complete loss of the colony. On the contrary, Mall and Kumar (2014) reported that the average honey production was found to be highest (14.43kg/hive) in colonies placed near the tower followed by cell phone equipped colonies (13.76kg/hive), while control

colonies produced 12.80kg/hive in first harvesting. The pollen stores were also significantly affected in various treatments. The mean pollen stores were recorded to be maximum in colonies placed at 500m (277.77cm²) followed by 1000m (255.11cm²), 300m (231.70cm²) and 200m (223.39cm²) and least from colonies at 100m (210.86cm²) (Table 4). The maximum pollen stores

(277.77cm²) were recorded from colonies placed at 500m distance and least (210.86cm²) from colonies at 100m. The present findings are in conformity with the views of Sharma and Kumar (2010) where they reported decrease in the area under pollen stores from 246.7cm² in control to 154.7cm² in the colonies exposed to cellphone radiation.

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

EMR measurement	0m	T ₁ (100m)	T ₂ (200m)	T ₃ (300m)	T ₄ (500m)	T ₅ (1000m)
Electric field (E) mV/m	0	159-189	66-127	65-112	63-106	65-108

Table.2 Effect of electromagnetic radiation of cell phone tower on brood area of *Apis cerana* colonies placed at varying distance from the tower

Treatments	Brood area of colonies (cm ²) at monthly interval						Mean
	DEC'13	JAN'14	FEB'14	MAR'14	APR'14	MAY'14	
T₁	815.63	928.91	929.81	1060.31	1450.00	1428.25	1102.15
T₂	833.75	919.84	962.44	1082.06	1529.75	1493.50	1136.89
T₃	859.13	960.63	995.06	1125.56	1551.50	1529.75	1170.27
T₄	837.38	1015.00	1098.38	1207.13	1645.75	1609.50	1235.52
T₅	822.88	983.28	1038.56	1158.19	1602.25	1558.75	1193.99
S.Ed.	12.06	15.91	32.75	35.63	35.86	40.57	
C.D (P=0.05)	26.27	34.67	71.35	78.49	79.00	87.95	

Table.3 Effect of electromagnetic radiation of cell phone tower on honey hoarding capacity of *Apis cerana* colonies placed at varying distance from the tower

Treatments	Honey hoarding capacity of colonies (cm ²) at monthly interval						Mean
	DEC'13	JAN'14	FEB'14	MAR'14	APR'14	MAY'14	
T₁	427.75	561.88	723.19	750.38	913.50	1000.50	729.53
T₂	449.50	589.06	761.25	788.44	1007.75	1051.25	774.54
T₃	431.38	584.53	744.94	831.94	1029.50	1109.25	788.59
T₄	474.88	625.31	821.06	897.19	1102.00	1189.00	851.57
T₅	471.25	611.72	793.88	870.00	1036.75	1145.50	821.52
S.Ed	10.79	15.30	29.82	45.95	36.73	57.06	
C.D (P=0.05)	23.54	33.33	64.96	100.11	80.03	124.31	

Table.4 Effect of electromagnetic radiation of cell phone tower on pollen stores of *Apis cerana* colonies placed at varying distance from the tower

Treatments	Pollen stores of colonies (cm ²)at monthly interval						Mean
	DEC'13	JAN'14	FEB'14	MAR'14	APR'14	MAY'14	
T₁	123.25	163.13	201.19	212.06	275.50	290.00	210.86
T₂	134.13	158.59	206.63	239.25	275.50	326.25	223.39
T₃	145.00	172.19	206.63	250.13	290.00	326.25	231.70
T₄	155.88	212.97	266.44	299.06	362.50	369.75	277.77
T₅	152.25	194.84	217.50	255.56	355.25	355.25	255.11
S.Ed	9.68	16.50	17.59	19.40	21.18	21.50	
C.D (P=0.05)	21.09	35.96	38.33	42.28	46.14	46.86	

Table.5 Effect of electromagnetic radiation of cell phone tower on queen prolificacy of *Apis cerana* colonies placed at varying distance from the tower

Treatments	Egg laying rate of queen (eggs/day)at monthly interval						Mean
	DEC'13	JAN'14	FEB'14	MAR'14	APR'14	MAY'14	
T₁	155.36	176.93	177.11	206.11	276.19	272.05	210.63
T₂	156.74	175.21	183.32	201.96	291.38	284.48	215.52
T₃	163.64	182.98	197.82	214.39	295.52	291.38	224.29
T₄	159.50	193.33	209.21	229.93	313.48	306.57	235.34
T₅	158.81	187.29	189.54	220.61	305.19	296.90	226.39
S.Ed	2.30	3.03	6.24	6.78	6.81	7.69	
C.D (P=0.05)	5.06	6.68	13.74	14.95	15.04	16.75	

The egg laying capacity of the queen differed significantly in various treatments. The egg laying rate of the queen varied from 155.36 eggs per day during December 2013 to 313.48eggs per day during April 2014. Queen prolificacy pertaining to various treatments, the maximum 235.34 eggs per day was noticed in colonies at 1000m distance followed by 500m, 300m, 200m and 100m where the average eggs laid per day were 226.39, 224.29, 215.52 and 210.63 respectively (Table 5). Sharma and Kumar (2010) reported that queen exposed to cell phone radiation produced fewer eggs (144.8) compared to control (376.2). Similar observation were also reported by Sainudeen (2011) where he reported that the queens in the test colonies produced fewer eggs/day (100) compared to the control (350). They reported that there is low egg laying rate in queens

exposed to high voltage transmission lines or exposure of the queen bees to cell phone radiation stimulated her to produce only drones. So, the electromagnetic radiation of mobile tower has direct effect on growth and development of honeybee colony.

In 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 brood area, honey hoarding capacity, pollen stores and queen prolificacy were significantly higher in colonies placed at 500m distance followed by 1000m and least at colonies placed at 100m distance from the tower. 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 honeybee in the long run; however, the immediate and direct impact is yet need intensive research to draw a firm conclusion.

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