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BIOLOGICAL AND CHEMICAL ACTIVITIES OF HONEY BEE COLONIES EXPOSED TO ELECTROMAGNETIC RADIATION OF CELL PHONE TOWERS

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ABSTRACT

The present work aimed to study the relation between honey bee colony collapse and the cell phone radiation. The study conducted at special apiaries at Sharkia governorate and the laboratories of Economic Entomology and Biochemistry Departments, Faculty of Agriculture, Menofiya University. Five hives of three bee hybrids were located closed to cell phone towers and 1 , 2 km far from towers, in addition ,bee workers were directly exposed to the waves of personal cell phone device. The obtained results in both of the two seasons indicated that the lowest values of colony strength, brood area, pollen area, and honey yield were recorded at the colonies under cell phone station and the highest values were showed at the colonies far from the cell phone station by 2 km. Statistical analysis of data indicated that there were significant differences in all values under study between hives closed to cell phone towers and those far from it. Furthermore, the biochemical parameters of exposed colonies to electromagnetic radiations of cell phone device showed significant increases in total carbohydrates, glucose, protein, total lipids and cholesterol compared with control. Vice versa , results indicated that there were significant decreases in acid and alkaline phosphates enzymes in the treated colonies compared with control. Finally, it could be concluded that cell phone radiation consider one of the major factors causing honey bee colony collapses and must be away from these radiations.

Keywords: Honey bee, Mobile phone, CCD , Biochemical changes, Electromagnetic radiation

INTRODUCTION

Honeybees *Apis mellifera* L. are one of the most important economic pollinator in the worldwide (Gallai *et al*., 2009). Researchers suspect many factors to be responsible for the losing of the bees; climatic factors are the most effective reason. Recent efforts have been made to study another potential cause responsible for bee losses (Harst et *al*., 2006; Diagnose-Funk 2007; Stever *et al*., 2007). Honeybees possess magnetite crystals in their fat body cells and they present magnetic remanence (Gould *et al*., 1978; Keim *et al*.,2002). These magnetite structures are active parts of the honeybees (Hsu and Li 1994; Hsu *et al*., 2007). Honeybees can communicate through chemical and acoustical means (Winston, 1991 and Tautz, 2008). Bees are good biological indicators for electromagnetic pollution. Cell phone radiations have been reported to be responsible for affecting the biological and physiological processes in the body of the bees. Pollution caused by electromagnetic radiations is increasing because number of cell phones towers is increasing abundantly. These cell phone radiations are affecting honeybees very badly. These radiations effect on the behavior of *Apis*

mellifera L., cause decline in colony strength and this situation may lead to colony collapse disorder (CCD) and decline in yield of hive products. A few studies reported various harmful effects of cell phone radiations on *A. mellifera* colonies, and help to understand pollution caused by electromagnetic radiations (Hamzelou, 2007, Sharma *et al.,* 2010 and Sainudeen, 2011).There has been an unprecedented growth in the global communication industry in recent years which has resulted in an increase in the number of wireless devices (TRAI, 2012). With no regulation on the placement of cell towers, they are being placed on schools, and public playgrounds, on commercial buildings, hospitals, and campuses. The public is being exposed to continuous, low intensity radiations from these towers (ARPANSA, 2011; FCC, 1999).

From the previous view of studies this work was conducted to throw a light on the biological and chemical changes of three honey bee hybrids exposed to electromagnetic radiation of cell phone towers.

MATERIALS AND METHODS

This work was conducted at special apiaries at Diarb Negm, Sharkia governorate during the period of February 2015 till September 2015, to study the relation between honey bee colony collapse and the cell phone radiation. Therefore, three groups of honeybee hybrid colonies equal in size were classified as follow:

1-First group consists of fifteen colonies located under cell towers under cell towers (five of hybrid Carniolian bees, five of hybrid Italian bees and five of hybrid Egyptian bees).

2-Second group consists of fifteen colonies located about 1 km far from cell towers (five of hybrid Carniolian bees, five of hybrid Italian bees and five of hybrid Egyptian bees).

3-Third group consists of fifteen colonies located about 2 km far from cell towers (five of hybrid Carniolian bees, five of hybrid Italian bees and five of hybrid Egyptian bees).

The colony strength,total area of broods, total area of honey and pollen were measured in all colonies at two seasons(February till may2015) and (June till August 2015) with help of a one square inch grid made of comb frame, Data collected, tabulated and statistically analyzed.

According to the above work, during September 2015 four colonies of Carniolian hybrid bees were chosen and exposed to three times of exposure (0, 10, 20, 30 min daily for 15 day) with mobile phone (G-Tide apparatus) which was adjusted on continuous working with frequency of 900 MHz. All colonies were fed with 250 ml of sugar syrup daily and at the end of the exposure time about 100 worker bees were collected from each colony and prepared for chemical analysis as follow:

Sample preparation:

Three grams of dried bee worker bodies form each exposure time were added to liquid nitrogen and homogenate, then diluted in 5 ml distilled water and centrifuged (5000 rpm), for five minutes, after that supernatant was collected and stored at 4° C until analysis.

Biochemical determinations:

Biochemical determinations were done with the grateful help of Dr. Medhat ,M. Abozeid and Dr. Kamal ,M. Mahmoud , Biochemistry Department, Fac. Agric., Menoufia Univ., Shibin El-Kom, Egypt. Total carbohydrates were determined according to Dubois *et al*. (1956), Glucose was determined colorimetrically by method described by Trinder (1969), Total lipids were analyzed according to Frings and Dunn (1970), Total protein was determined according to Tietz, (1976), The total cholesterol (TC) was analyzed calorimetrically according to Richmond (1973), Alkaline phosphatase (ALP) and acid phosphatase activities were measured by Bergmeyer, (1963).

Statistical analysis:

The obtained data was statistically analyzed using analysis of variance (ANOVA) at 5 % probability. The measurements were separated using Duncan's Multiple Range Test (DMRT) through CoStat software program (Version 6.400). CoStat version 6.400 Copyright © 1998-2008 . Cohort Software. 798 Lighthouse Ave. PMB 320 , Monterey, CA, 93940, USA.

RESULTS AND DISCUSSION

This work was conducted at special apiaries at Diarb Negm, Sharkia governorate during the period of February 2015 till September 2015, to study the relation between honey bee colony collapse and the cell phone radiation**.**

Data recorded in the Tables 1 &2 and statistically analyzed by (ANOVA test), to know the effect of cell phone towers on honeybee colonies.

Data presented in Table (1) show the effect of exposure to cell phone radiation on some characters of bee colony (colony strength, total brood area, total pollen area, and total honey bee yield) during the 1st season from (February till May 2015).

The results indicated that the mean colony strength (frames) were the highest at the colonies located at 2 km far from cell phone towers (8.60±0.28, 7.60±0.28, 7.40±0.28 frames) , and the lowest values were recorded in colonies located under cell phone towers in all bee hybrids, which were (6.00±0.28, 4.40±0.28, 4.20±0.28 frames) for Carniolan hybrid, Italian hybrid, and Egyptian hybrid, respectively .

In addition, the highest mean total brood area were (417.60±8.58, 379.00±8.58, 365.20±8.58 inch 2))for Carniolan hybrid, Italian hybrid, and Egyptian hybrid, comparing with those under phone towers (253.80±8.58 , 253.20±8.58 , 225.80±8.58 inch 2) , respectively. Also, the highest mean total pollen area were (412.00±7.59, 395.60±7.59, 383.80±7.59 inch ^{2})for Carniolan hybrid, Italian hybrid, and Egyptian hybrid, while it was (322.00±7.59 , 286.60±7.59 , 271.60±7.59 inch ^{2}) for those closed to radiate source , respectively. The highest mean honey yields were (4.58±0.12,

3.94±0.12, 3.62±0.12 kg) for Carniolian, Italian, and Egyptian hybrids, while the lowest values were recorded at hives closed to cell phone towers (2.00±0.12, 1.46±0.12, 1.48±0.12 kg) , respectively.

Table (1):Average means ± SE of some honeybee activities of three hybrids exposed to the electromagnetic radiation of mobile phone towers during the period of February 2015 to May 2015.

Distance from mobile phone towers		Colony strength (frame)	Brood area inch ^{2}	Pollen grains inch ^{2}	Honey bee kg
		Average means ± SE per colony			
Zero	Carn.	6.00±0.28 c	253.80±8.58 d	322.00±7.59 c	2.00±0.12 f
	Italy	4.40±0.28 d	253.20±8.58 d	286.60±7.59 d	1.46±0.12 g
	Egypt.	4.20±0.28 d	225.80±8.58 e	271.60±7.59 d	1.48±0.12 g
1 km	Carn.	7.00±0.28 b	331.60±8.58 c	312.80±7.59 c	2.94±0.12 e
	Italy	7.40±0.28 b	329.40±8.58 c	306.40±7.59 c	3.26±0.12 d
	Egypt.	6.40±0.28 bc	307.00±8.58 c	285.20±7.59 d	2.96±0.12 e
2 km	Carn.	8.60±0.28 a	417.60±8.58 a	412.00±7.59 a	4.58±0.12 a
	Italy	7.60±0.28 b	379.00±8.58 b	395.60±7.59 ab	3.94±0.12 b
	Egypt.	7.40±0.28 b	365.20±8.58 b	383.80±7.59 b	3.62±0.12 c
LSD 5%		0.800	24.616	21.761	0.352

means in each column followed by different letters differ significantly at (p ≥ 0.05).
Carn. = Carniolan hybrid, Italy= Italian hybrid, Egypt.= Egyptian hybrid

The obtained data in Table (2) showed the effect of exposure to cell phone radiation on some characters of bee colony (colony strength, total brood area, total pollen area and honey bee yield) during the second season from (June till August 2015).

Table(2): Average means ± SE of some honeybee activities of three hybrids exposed to the electromagnetic radiation of mobile phone towers during the period of June 2015 to August 2015.

Distance from mobile phone towers		Colony strength (frame)	Brood area inch ^{2}	Pollen grains inch ^{2}	Honey bee kg
		Average means ± SE per colony			
Zero	Carn.	5.20±0.29d	243.40±8.79d	310.00±8.03b	1.58±0.10e
	Italy	4.20±0.29e	225.40±8.79d	257.00±8.03c	1.32±0.10e
	Egypt.	4.00±0.29e	214.80±8.79de	255.20±8.03c	1.40±0.10e
1 km	Carn.	7.20±0.29b	316.00±8.79bc	304.60±8.03b	2.74±0.10d
	Italy	7.40±0.29b	319.80±8.79b	299.40±8.03b	2.94±0.10d
	Egypt.	6.80±0.29bc	287.60±8.79	269.60±8.03c	2.84±0.10d
2 km	Carn.	8.00±0.29a	376.00±8.79a	386.80±8.03a	4.08±0.10a
	Italy	7.40±0.29b	349.00±8.79b	379.00±8.03a	3.68±0.10b
	Egypt.	7.60±0.29b	342.20±8.79b	368.40±8.03a	3.28±0.10c
LSD 5%		0.822	25.202	23.031	0.283

means in each column followed by different letters differ significantly at (p ≥ 0.05).
Carn. = Carniolan hybrid, Italy= Italian hybrid, Egypt.= Egyptian hybrid

Obtained results in the second season confirmed that of first one where there were significant differences in all studied characters between hives located under cell phone towers and that located 1 and 2 km of towers. The obtained results revealed that the highest characters were recorded at the colonies located 2 km far from cell phone towersFrom the obtained results in Tables 1 and 2 , it could be observed that the hybrid Carniolan hives showed the highest tolerance against the bad effects of Electromagnetic radiation produced from cell phone towers in comparison with the other two bee hybrids , followed by Italian hybrid , while Egyptian hybrid was susceptible for radiation.

Obtained data in Table (3) showed the effect of different periods of direct cell phone radiations on some biochemical parameters of the hybrid Carniolan honey bee workers (total carbohydrates, glucose, total lipids, protein and cholesterol) in all treated hives compared with control, the results showed an increase in concentration of primary macromolecules. The control group has the lowest total carbohydrates and glucose values, while these values were increased in other hives (exposed to electromagnetic radiation). The overall increase in total carbohydrates in exposed workers was due to decreased activity as also studied by Kumar *et al*., (2013).Protein also showed the same behavior, as it can be observed increased protein concentration by increase of radiation exposure (from 10 to 3o min).The survival of the insect alive depends on the efficiency of protein synthesis process (Kumar *et al*., 2010). Any stress happens to the insect shows the impact on the various metabolic processes carried out by the insect. The total protein profile may be considered as a diagnostic tool in assessing physiological status of the insect. The major energy reservoirs of the insects are the lipids, in our study the estimation of total lipids and cholesterol showed an increase in concentration in all treated groups as compared to the control.

Table (3): Effect of electromagnetic radiation from cell phones to the hybrid Carniolan honey bee workers on some biochemical parameters (mg/g)

Exposed time (min)	Total carbohydrates (mg/g)	Glucose (mg/g)	Total lipids (mg/g)	Protein (mg/g)	Cholesterol (mg/g)
10 min	58 ± 3 c	0.9 ± 0.13 c	10 ± 2 c	102 ± 5 c	12 ± 2 c
20 min	77 ± 2 b	1.2 ± 0.18 b	14 ± 4 b	116 ± 7 b	23 ± 3 b
30 min	92 ± 4 a	1.5 ± 0.35 a	22 ± 3.5 a	138 ± 8 a	43 ± 4 a
Control	46 ± 6 d	0.65 ± 0.22 d	7 ± 2 d	88 ± 6 d	6 ± 2.5 d
LSD 5%	6	0.2	2.8	9	5.5

Values represent means ± S.E obtained from 6 replicates
means in each column followed by different letters differ significantly at (p ≥ 0.05).

Data in Table (4) showed the quantities of acid phosphatase and alkaline phosphatase enzymes. The decreased in case of all treated groups as compared to that of control group which is due to decrease activity and confusion amongst insects under the influence of electromagnetic effect. These results are in line with Kumar *et al*., (2013).

Table (4): Effect of electromagnetic radiation from cell phones to the hybrid Carniolan honey bee workers on acid phosphatase and alkaline phosphatase enzymes

Exposed time (min)	Acid phosphatase (U/mg protein)	Alkaline phosphatase (U/mg protein)
10 min	0.60 ± 0.019 b	0.98 ± 0.045 b
20 min	0.45 ± 0.078 c	0.77 ± 0.056 c
30 min	0.32 ± 0.088 d	0.64 ± 0.047 d
Control	0.80 ± 0.094 a	1.50 ± 0.087 a
LSD 5%	0.10	0.12

Values represent means ± S.E obtained from 6 replicates
means in each column followed by different letters differ significantly at (p ≥ 0.05).

CONCLUSION

It could be concluded from the obtained results that cell phone radiation disturb colonies and had bad effects on the capacity of colonies and the hive production of broods, pollen grains , and honey yield , resulting colony collapse disorder (CCD) and decline in the other hive products ,therefore, it could be recommend that beekeepers must locate their apiaries far from cell phone towers at least 2 km to avoid the bad effects of these radiations.

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النشـــاط البيولـــوجى والكيميـــائى لطوائـــف نحـــل العســـل المعرضـــة للاشـــعاعات الالكترومغناطيسية لابراج التليفون المحمول

أحمد عبدالقوى أحمد عبدالعال

قسم الحشرات الاقتصادية والحيوان الزراعى كلية الزراعة جامعة المنوفية.

تم اجراء هذه الدراسة ببعض المناحل بناحية ديرب نجم محافظة الشرقية لدراسة أثر الاشعاعات الالكترومغناطيسية التى تصدر من ابراج التليفون المحمول على بعض الانشطة البيولوجية والكيميائية لطوائف نحل العسل . تم اختيار ١٥ خلية نحل متساوية فى القوة من كل من النحل الكرنيولى هجين والايطالى هجين والمصرى هجين ووضع ٥ خلايا من كل هجين تحت ابراج التليفون المحمول وخمسة طوائف على بعد ١ كم من الابراج وخمسة اخرى على بعد ٢ كم من الابراج . واستمرت الدراسة لمدة موسمين من فبراير ٢٠١٥ – سبتمبر ٢٠١٥ . وتم قياس عدد الاقراص وحجم الحضنة وحجم حبوب اللقاح وكمية العسل خلال موسمى الدراسة . اثبتت نتائج الدراسة وجود فرق معنوى فى القياسات النحلية حيث تم تسجيل اعلى القياسات فى طوائف النحل الكرنيولى هجين التى تم وضعها على بعد ٢ كم من الابراج واقل القياسات مع النحل المصرى هجين التى تقع تحت ابراج التليفون المحمول. كما تم دراسة تاثير التعريض المباشرلشغالات نحل العسل الكرنيولى الهجين للاشعاعات الصادرة من جهاز استقبال التليفون المحمول على بعض المركبات والانزيمات . اثبتت النتائج ان هناك تأثيرا معنويا لهذه الاشعاعات حيث زادت كميات الكربوهيدرات والجلوكوز والدهون والبروتينات والكلوسترول فى النحل المعامل بالمقارنة بالكنترول فى حين قلت تركيزات انزيمى الفوسفاتيز الحامضى والقلوى فى النحل المعامل بالمقارنة بالكنترول . توصى الدراسة بعدم وضع خلايا النحل بالقرب من ابراج التليفون المحمول ووضعها على مسافة لاتقل عن ٢ كم لتفادى الاثار السيئة للاشعاعات الالكترومغناطيسية التى تصدر من شبكات التليفون المحمول على طوائف نحل العسل .