ISSN 2537_ 0715
IJSRSD (2020): Volume 3, Issue 1, August 2020
Received September 2020, Accepted October 2020

International Journal of Scientific
Research and Sustainable Development
"Plant protection"

INFLUENCE OF CELL PHONE RADIATION FROM MOBILE PHONE TOWERS ON OSCCILATION OF *VARROA DESTRUCTOR* ATTACKING HONEY BEE COLONIES

Abdelaal, A.A.A.

Economic Entomology& Agricultural Zoology Dept. Fac. Agric. Menofia Univ. Shebin Elkom, Menofia, Egypt.

ABSTRACT

The present research aimed to study the relation between honey bee colony exposed to the cell phone radiation and the oscillation in pests' rates. The study conducted at special apiaries at Sharkia governorate and the laboratories of Economic Entomology Department, Faculty of Agriculture, Menofia University. Three honey bee hybrids were located closed to cell phone towers and 1, 2 km far from towers. The obtained results in both of the two years indicated that the total high infestation were recorded in November with 74.7 varroa individual /colony under phone towers, 70.3 varroa individual /colony far from towers about 1 km and 52.3 varroa individual /colony far from 2 km as mean for all hybrids , but for every hybrid the data recorded 124 varroa individual /colony under phone towers , 88 varroa individual /colony far from towers about 1 km and 53 varroa individual /colony far from 2 km for Italian hybrid , 59 varroa individual /colony under phone towers , 92 varroa individual /colony far from towers about 1 km and 81 varroa individual /colony far from 2 km for Carniolan hybrid and finally for local hybrids were 41 varroa individual /colony under phone towers , 31 varroa individual /colony far from towers about 1 km and 23 varroa individual /colony far from 2 km . so that the research recommended rearing colonies of both Carniolan and local hybrids if the apiary nearer than 1 km and rearing Italian hybrids in farer than 1 km .The effect of exposure to cell phone radiation on the infestation rates were highly significant in Italian, Carniolan and local hybrid respectively .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 exposed colonies to electromagnetic radiations of cell phone device showed significant increases in varroa infestation. Finally, it could be concluded that cell phone radiation consider one of the major factors causing the oscillations in pests attacking honey bee colony, and may be a reason in colony collapse disorder , so that colonies must kept away from these radiations.

Keywords: Honey bee, Mobile phone, CCD, Pests, Electromagnetic radiation

INTRODUCTION

Honeybees (*Apis mellifera*) are one of the most important economic pollinator in the worldwide (**Gallai et al., 2009 ;Alnaggar et al 2018**).

De graaf et al (2006) described that American foulbrood is an infectious disease of honey bees (*Apis mellifera*) caused by the spore forming bacterium *Paenibacillus larvae*. It is represented as serious, worldwide problem for apiculture. AFB is classified on list B of the Office International des Epizooties (OIE). List B diseases are defined as transmissible diseases which are considered to be of socio-economic and may transmitted via varroa individuals.

Kanga and James (2002) mentioned that *Varroa destructor* is considered one of the most serious pests affecting honeybee, A. mellifera on a worldwide basis, causing weight loss, malformation, and a shortened life span. It also serves as a vector of diseases that may lead to 100% bee mortality.

Favre (2011) noticed that many factors to be responsible for the killing of the bees, such as the varroa mite, pesticides, viruses and farming practices in the hive. The climatic factors are the most widely cited possibilities bee colonies worldwide suddenly began to show symptoms of the colony collapse disorder (CCD), so that the colony becomes unsustainable and dies out never before have honey bees disappeared globally and at such a high rate.

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**).

Bees are good biological indicators for electromagnetic pollution. which cause decline in colony strength and this situation may lead to colony collapse disorder (CCD). 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**).

Sharma and Kumar (2010) recently a new phenomenon of sudden disappearance of bees with little sign of disease or infection has been reported from the world over. Bees simply leave the hives and fail to retur. Colony collapse disorder (CCD) is the name given to this problem.

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**).

Dabarshi (2012) indicated that electromagnetic radiation interfere with the homing instinct of bees, and adversely affect the foraging and reproductive capacity of these insects.

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**).

Asha et al (2012). Mentioned that the increasing of cell phone using cause a large negative effect on the apiculture industry in rural india .the bees avoid the hive by the exposing to the frequency range 900-1800 Mhz and as they use low frequency magnetic fields for navigation.

Odermer and odemer (2019). found that mobile phone radiation had significantly reduced the hatching ratio but not the mating success. If treated queens had successfully mated, colony development was not adversely affected. We provide evidence that mobile phone radiation may alter pupal development, once succeeded this point, no further impairment has manifested in adulthood. Our results are discussed against the background of long-lasting consequences for colony performance and the possible implication on periodic colony losses. Mobile phones can be found almost everywhere across the globe, upholding a direct point-to-point connection between the device and the broadcast tower. The emission of radiofrequency electromagnetic fields (RF-EMF) puts the surrounding environment inevitably into contact with this radiation.

From the previous view of studies this work was conducted to throw a light on the occurrence of *Varroa destructor* attacking the three honey bee hybrids exposed to electromagnetic radiation of cell phone towers and the effect of this exposure on the Oscillation of this pest.

MATERIALS AND METHODS

This work was conducted at special apiary at Diarb Negm, Sharkia governorate during the two years from February 2016 till January 2018, to study the relation between honey bee colony exposed to the mobile phone towers radiation and the occurrence of *Varroa destructor* which attacking these colonies and some honeybee activities such as (Colony strength, Brood area and bee Honey .Therefore, three groups of honeybee hybrid colonies equal in size were classified as follow:

1- First group consists of nine colonies located under mobile phone towers (three of Carniolan hybrid, three of Italian hybrid and three of local hybrid).

2- Second group consists of nine colonies located about 1 km far from mobile phone towers (three of Carniolan hybrid, three of Italian hybrid and three of local hybrid).

3- Third group consists of nine colonies located about 2 km far from mobile phone towers as control (three of Carniolan hybrid, three of Italian hybrid and three of local hybrid).

The numbers of fallen *Varroa destructor* individual on sticky board were recorded weekly and mean number of individuals were recorded for every month, the oscillation of *Varroa destructor* recorded for all two years, honeybee activities (Colony strength, Brood area and bee Honey) were recorded the Data collected, tabulated and statistically analyzed.

According to the above work, the mobile phone tower was continuous working with frequency of 900 MHz All colonies were fed with 100 ml /colony / twice weekly of sugar syrup.

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 apiary at Diarb Negm, Sharkia governorate during the period of February 2016 till Jan 2018, to study the relation between honey bee colony exposed to the mobile phone towers radiation and the occurrence of pests and diseases attacking these colonies**.**

Data recorded in the Tables 1 ,2 and 3 and statistically analyzed by (ANOVA test), to know the interaction between the honeybee hybrid and distance from cell phone towers on the occurrence of some pests on some and characters of bee colony (colony strength, total brood area, and honey bee yield).

Data presented in Table (1) and illustrated in Figure (1) showed that the occurrence of *Varroa destructor* influenced from 22.7 varroa individual /colony and 82.7 varroa individual /colony for Italian hybrid , 21.3 varroa individual /colony and 69.7 varroa individual /colony for Carniolan hybrid and 17.00 varroa individual /colony and 40.individual /colony for Local hybrid respectively.

Also, data showed that the total high infestation were recorded in November with 74.7 varroa individual /colony under phone towers, 70.3 varroa individual /colony far from towers about 1 km and 52.3 varroa individual /colony far from 2 km as mean for all hybrids , but for every hybrid the data recorded 124.0 varroa individual /colony under phone towers , 88.0 varroa individual /colony far from towers about 1 km and 53.0 varroa individual /colony far from 2 km for Italian hybrid , 59.0 varroa individual /colony under phone towers , 92.0 varroa individual /colony far from towers about 1 km and 81.0 varroa individual /colony far from 2 km for Carniolan hybrid and finally for local hybrids were 41.0 varroa individual /colony under phone towers , 31.0 varroa individual /colony far from towers about 1 km and 23.0 varroa individual /colony far from 2 km . so that the research recommended rearing colonies of both Carniolan and local hybrids if the apiary nearer than 1 km and rearing Italian hybrids in farer than 1 km .The effect of exposure to cell phone radiation on the infestation rates were highly significant in Italian , Carniolan and local hybrid respectively for the first year .

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Received September 2020, Accepted October 2020

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Table (1): Average numbers ± SE of fallen varroa destructor individual for three honey bee hybrids exposed to the electromagnetic radiation of mobile phone towers during the period of February 2016 to Jan 2017.

hybrid (a)	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sep 2016	Oct 2016	Nov 2016	Dec 2016	Jan 2017
	Mean of hybrid											
Italian	82.7^{a}	63.3^{a}	58.0^{a}	25.0^{b}	23.7^{b}	22.7^{b}	32.7^{a}	43.3^{a}	47.0^{a}	88.3^{a}	76.7^{a}	73.7^{a}
Carniolan	69.7^{b}	53.7^{b}	54.0^{b}	30.7^{a}	30.3^{a}	21.3^{b}	24.0^{b}	40.0^{b}	43.7^{b}	77.3^{b}	64.0^{b}	69.3^{b}
Local	40.0^{c}	32.3^{c}	30.0^{c}	19.0^{c}	17.0^{c}	25.7^{a}	23.0^{b}	23.7^{c}	31.0^{c}	31.7^{c}	34.3^{c}	38.0^{c}
distance (b)	Mean of distance											
Under	63.3^{b}	50.3^{a}	54.7^{a}	27.3^{a}	24.3^{a}	24.3^{a}	27.0^{a}	34.7^{b}	43.0^{a}	74.7^{a}	65.3^{a}	65.7^{a}
1km	67.7^{a}	49.0^{b}	45.7^{b}	27.0^{a}	24.0^{a}	23.3^{b}	26.7^{b}	37.7^{a}	41.0^{b}	70.3^{b}	56.0^{b}	61.7^{b}
2km	61.3^{c}	50.0^{a}	41.7^{c}	20.3^{b}	22.7^{b}	22.0^{c}	26.0^{c}	34.7^{b}	37.7^{c}	52.3^{c}	53.7^{c}	53.7^{c}
s*d (a*b)	Mean of interaction between hybrid and distance											
Italian under	90.0^{a}	67.0^{a}	66.0^{a}	22.0^{d}	21.0^{e}	21.0^{e}	31.0^{b}	44.0^{c}	48.0^{b}	124.0^{a}	102.0^{a}	94.0^{a}
Italian far 1km	88.0^{b}	67.0^{a}	59.0^{b}	32.0^{b}	28.0^{c}	21.0^{e}	36.0^{a}	52.0^{a}	51.0^{a}	88.0^{c}	71.0^{c}	66.0^{d}
Italian far 2km	70.0^{e}	56.0^{c}	49.0^{e}	21.0^{e}	22.0^{d}	26.0^{c}	31.0^{b}	34.0^{e}	42.0^{e}	53.0^{f}	57.0^{e}	61.0^{e}
Carniolan under	51.0^{f}	43.0^{e}	59.0^{b}	39.0^{a}	31.0^{a}	21.0^{e}	22.0^{d}	34.0^{e}	42.0^{e}	59.0^{e}	49.0^{f}	51.0^{g}
Carniolan far 1km	76.0^{d}	52.0^{d}	51.0^{d}	31.0^{c}	29.0^{b}	21.0^{e}	22.0^{d}	37.0^{d}	43.0^{d}	92.0^{b}	61.0^{d}	78.0^{c}
Carniolan far 2km	82.0^{c}	66.0^{b}	52.0^{c}	22.0^{d}	31.0^{a}	22.0^{d}	28.0^{c}	49.0^{b}	46.0^{c}	81.0^{d}	82.0^{b}	79.0^{b}
Local under	49.0^{g}	41.0^{f}	39.0^{f}	21.0^{e}	21.0^{e}	31.0^{a}	28.0^{c}	26.0^{f}	39.0^{f}	41.0^{g}	45.0^{g}	52.0^{f}
Local far 1 km	39.0^{h}	28.0^{g}	27.0^{g}	18.0^{f}	15.0^{f}	28.0^{b}	22.0^{d}	24.0^{g}	29.0^{g}	31.0^{h}	36.0^{h}	41.0^{h}
Local far 2 km	32.0^{i}	28.0^{g}	24.0^{h}	18.0^{f}	15.0^{f}	18.0^{f}	19.0^{e}	21.0^{h}	25.0^{h}	23.0^{i}	22.0^{i}	21.0^{i}
LSD values												
LSD 0.05 a	0.48	0.49	0.50	0.46	0.49	0.49	0.50	0.49	0.47	0.46	0.47	0.49
LSD 0.05 b	0.45	0.48	0.43	0.75	0.47	0.46	0.47	0.48	0.45	0.45	0.46	0.47
LSD 0.05 a*b	0.85	0.91	0.89	0.87	0.91	0.90	0.84	0.86	0.87	0.85	0.86	0.88

a,b,c, Differences between values having the same high script in each column within each parameter are not significant at P ≤ 0.05. Means in each column followed by different letters differ significantly at (p ≥ 0.05).

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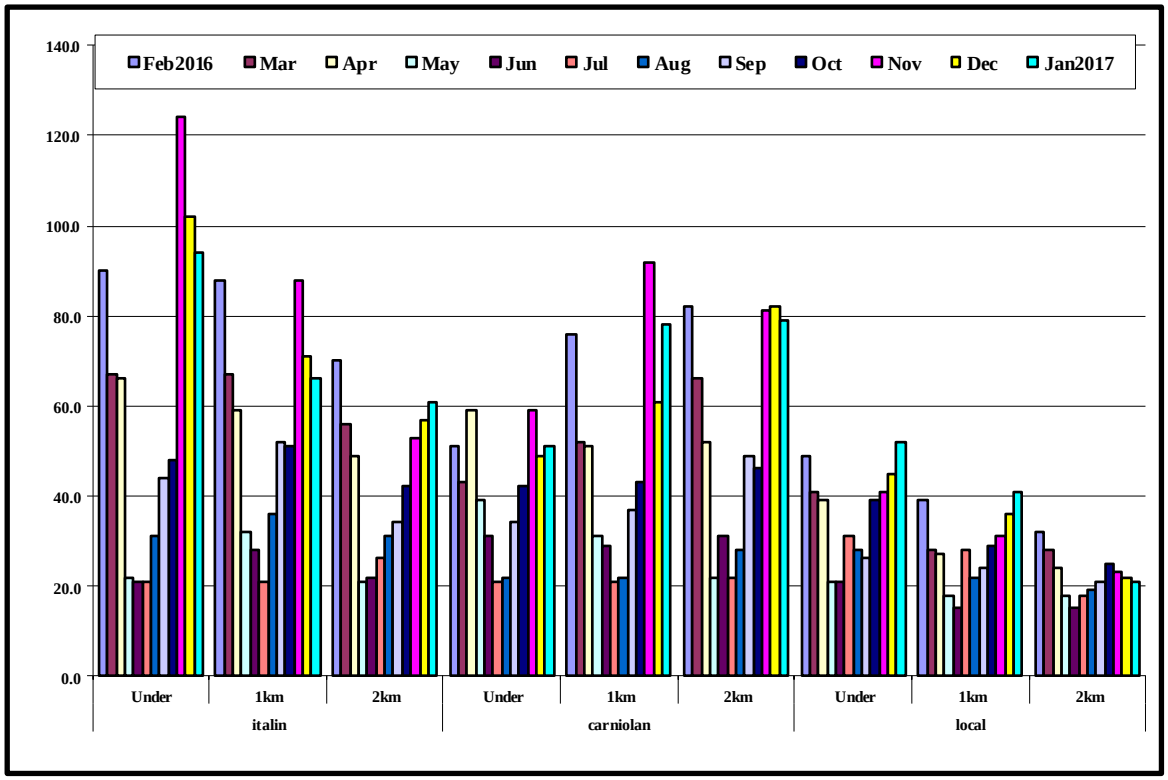

Figure(1):illustrated the mean numbers of fallen varroa destructor individual for three honey bee hybrids exposed to the electromagnetic radiation of mobile phone towers at three distances during the period of February 2016 to Jan 2017.

Data presented in Table (2) and illustrated in Figure (2) showed that the occurrence of *Varroa destructor* influenced from 20.3 varroa individual /colony and 75.1varroa individual /colony for Italian hybrid , 19.7 varroa individual /colony and 66.0 varroa individual /colony for Carniolan hybrid and 16.00 varroa individual /colony and 36.3 individual /colony for Local hybrid respectively. Also, data showed that the total high infestation were recorded in January with 60.0 varroa individual /colony under phone towers, 48.3 varroa individual /colony far from towers about 1 km and 46.7 varroa individual /colony far from 2 km as mean for all hybrids , but for every hybrid the data recorded 109.0 varroa individual /colony under phone towers , 71.0 varroa individual /colony far from towers about 1 km and 45.0 varroa individual /colony far from 2 km for Italian hybrid , 49 .0 varroa individual /colony under phone towers , 75.0 varroa individual /colony far from towers about 1 km and 74.0 varroa individual /colony far from 2 km for Carniolan hybrid and finally for local hybrids were 46 varroa individual /colony under phone towers , 31.0 varroa individual /colony far from towers about 1 km and 32.0 varroa individual /colony far from 2 km . so that the research recommended rearing colonies of both Carniolan and local hybrids if the apiary nearer than 1 km and rearing Italian hybrids in farer than 1 km .The effect of exposure to cell phone

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Received September 2020, Accepted October 2020

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radiation on the infestation rates were highly significant in Italian , Carniolan and local hybrid respectively for second year.

Table (2): Average numbers ± SE of fallen varroa destructor individual for three honey bee hybrids exposed to the electromagnetic radiation of mobile phone towers during the period of February 2017 to Jan 2018.

hybrid (a)	Feb 2017	Mar 2017	Apr 2017	May 2017	Jun 2017	Jul 2017	Aug 2017	Sep 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018
	Mean of hybrid											
Italian	73.0^{a}	58.7^{a}	51.7^{a}	23.0^{b}	22.3^{b}	20.3^{a}	27.7^{a}	37.3^{a}	39.0^{a}	75.1^{a}	70.^{3a}	63.3^{a}
Carniolan	66.0^{b}	48.7^{b}	45.3^{b}	26.7^{a}	27.0^{a}	19.7^{b}	20.7^{b}	34.3^{a}	39.0^{a}	63.0^{b}	56.0^{b}	57.3^{b}
Local	36.3^{c}	29.3^{c}	27.3^{c}	17.7^{c}	16.0^{c}	23.0^{a}	21.0^{b}	22.0^{b}	29.0^{b}	30.7^{c}	31.0^{c}	34.3^{c}
distance (b)	Mean of distance											
Under	58.0^{b}	49.0^{a}	49.7^{a}	23.7^{a}	22.7^{a}	22.3^{a}	23.0^{a}	30.0^{a}	38.7^{a}	64.4^{a}	56.7^{a}	60.0^{a}
1km	60.3^{a}	43.3^{b}	40.3^{b}	24.7^{a}	22.0^{a}	21.3^{b}	24.3^{b}	33.0^{b}	34.7^{b}	58.3^{b}	52.3^{b}	48.3^{b}
2km	57.0^{b}	44.3^{b}	34.3^{c}	19.0^{b}	20.7^{b}	19.3^{c}	22.0^{c}	30.7^{c}	33.7^{b}	46.0^{c}	48.3^{c}	46.7^{b}
s*d (a*b)	Mean of interaction between hybrid and distance											
Italian under	79.0^{a}	65.0^{a}	60.0^{a}	20.0^{cd}	19.0^{d}	19.0^{c}	23.0^{c}	38.0^{ab}	38.0a	109.0a	90.0a	90.0a
Italian far 1km	75.0^{a}	59.0^{ab}	52.0^{b}	28.0^{b}	26.0^{b}	19.0^{c}	31.0^{a}	45.0^{a}	42.0^{a}	71.0^{b}	69.0^{b}	45.0^{d}
Italian far 2km	65.0^{b}	52.0^{bc}	43.0^{cd}	21.0^{c}	22.0^{c}	23.0^{bc}	29.0^{ab}	29.0^{cd}	37.0^{a}	45.0^{c}	52.0^{c}	55.0^{c}
Carniolan under	49.0^{c}	42.0^{d}	52.0^{b}	31.0^{a}	29.0^{a}	19.0^{c}	19.0^{d}	28.0^{cd}	39.0^{a}	45.0^{c}	42.0^{d}	45.0^{d}
Carniolan far 1km	75.0^{a}	49.0^{c}	45.0^{c}	28.0^{b}	26.0^{b}	19.0^{c}	21.0^{cd}	32.0^{bc}	37.0^{a}	75.0^{b}	56.0^{c}	62.0^{bc}
Carniolan far 2km	74.0^{a}	55.0^{bc}	39.0^{de}	21.0^{c}	26.0^{b}	21.0^{c}	22.0^{cd}	43.0^{a}	41.0^{a}	69.0^{b}	70.0^{b}	65.0^{b}
Local under	46.0^{c}	40.0^{d}	37.0^{e}	20.0^{cd}	20.0^{cd}	29.0^{a}	27.0^{b}	24.0^{cd}	39.0^{a}	39.0^{c}	38.0^{de}	45.0^{d}
Local far 1 km	31.0^{d}	22.0^{e}	24.0^{f}	18.0^{d}	14.0^{e}	26.0^{ab}	21.0^{cd}	22.0^{d}	25.0^{b}	29.0^{d}	32.0^{e}	38.0^{d}
Local far 2 km	32.0^{d}	26.0^{e}	21.0^{f}	15.0^{e}	14.0^{e}	14.0^{d}	15.0^{e}	20.0^{d}	23.0^{b}	24.0^{d}	23.0^{f}	20.0^{e}
LSD values												
LSD 0.05 a	3.62	3.90	2.93	1.19	1.19	2.29	1.78	4.75	5.18	5.46	4.57	4.21
LSD 0.05 b	3.50	3.70	2.80	1.15	1.16	2.24	1.70	4.70	5.10	5.40	4.50	4.15
LSD 0.05 a*b	6.26	6.79	5.08	2.06	2.06	3.96	3.08	8.23	8.99	9.46	7.92	7.30

a,b,c, Differences between values having the same high script in each column within each parameter are not significant at P ≤ 0.05. Means in each column followed by different letters differ significantly at (p ≥ 0.05).

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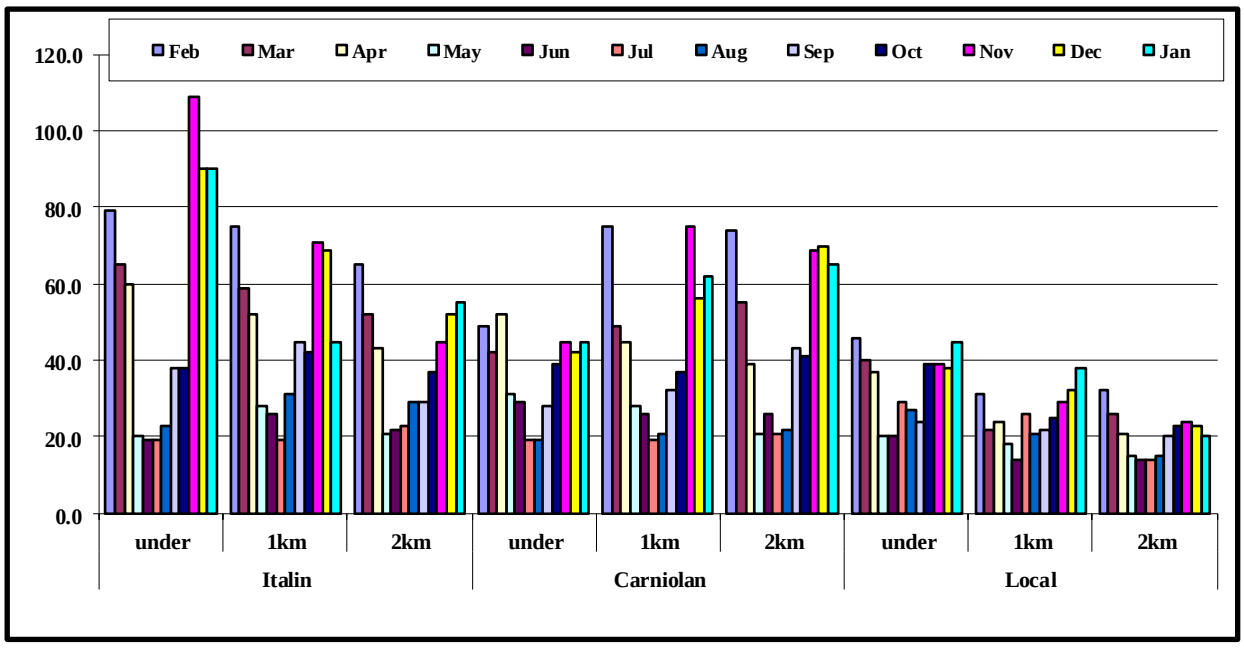

Figure(2):illustrated the mean numbers of fallen *Varroa destructor* individual for three honey bee hybrids exposed to the electromagnetic radiation of mobile phone towers at three distances during the period of February 2017 to Jan 2018.

Data in Table (3) showed the effect of exposure to cell phone radiation on some characters of bee colony (colony strength, total brood area, and honey bee yield) during the two successive seasons from (Feb. 2016 till Jan 2017).

The obtained results in the two seasons confirmed that the mean frame strength were 3.30 , 5.20 and 6.00 frame for Carniolan hybrid under towers , far 1 km and far 2 km , and 3.90 , 6.40 and 7.30 frame for Italian hybrid under towers , far 1 km and far 2 km , and for local hybrid were 4.10 , 7.80 and 7.60 frame for under towers , far 1 km and far 2 km, respectively .

The mean brood area deferred from 213.40 to 376.0 $inch^2$ for Carniolan hybrid , 245.40 to 349.0 $inch^2$ for Italian hybrid and 309.80 to 378.90 $inch^2$ for local hybrid.

Also, for honey production, the result were 1.45 to 4.68 kg/colony.,1.60 to 3.08 kg/colony and 1.70 to 4.28 kg/colony for Italian, Carniolan and Local Strains, respectively.

Table(3): Average means ± SE of some honeybee activities of three hybrids exposed to the electromagnetic radiation of mobile phone towers during the two successive seasons during the period of Feb.2016 till Jan.2017.

Distance from mobile phone towers		Colony strength (frame)	Brood area inch ^{2}	Honey bee kg
Under	Italian	3.30±0.29d	213.40±8.79d	1.45±0.10e
	Carniolan	3.90±0.29e	245.40±8.79d	1.60±0.10e
	Local	4.10±0.29e	315.80±8.79de	1.70±0.10e
1 km	Italian	5.20±0.29b	306.00±8.79b	1.74±0.10d
	Carniolan	6.40±0.29b	309.80±8.79b	1.94±0.10d
	Local.	7.80±0.29bc	377.60±8.79a	2.84±0.10d
2 km	Italian	7.30±0.29b	349.00±8.79b	4.68±0.10b
	Carniolan	6.00±0.29a	376.00±8.79a	3.08±0.10a
	Local.	7.60±0.29b	378.90±8.79a	4.28±0.10c
LSD 5%		0.822	25.202	0.283

means in each column followed by different letters differ significantly at ($p \geq 0.05$).

From the obtained results in Tables 1 and 2 , it could be observed that the hybrid Carniolan and Local hives showed the highest tolerance against the bad effects of Electromagnetic radiation produced from cell phone towers in comparison with the Italian hybrids.

Conclusion:

It could be concluded from the obtained results that cell phone radiation disturb colonies and had bad effects on the occurrence of *Varroa destructor* which attacking these colonies and the honeybee activities such as (Colony strength, Brood area and bee Honey , 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 on the occurrence of pests and diseases , which attacks colonies such as *Varroa destructor*.

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