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# EFFECT OF ELECTROMAGENIC EMITTED FROM COMMUNICATION TOWER ON THE BIOLOGICAL AND PHYSIOLOGICAL ACTIVITY OF HONEY BEE COLONIES

**[*Apis mellifera* L. Hymenoptera: Apidae] ***

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## ABSTRACT

The experiments were conducted in the apiaries of the College of Agricultural Sciences and Engineering in Al-Jadriyah area during the period from 28/2/2019 to 23/5/2019. The first location was 500 meters, the second was 150 meters from the telecommunication tower, and the third transaction was placed directly under the tower. The height of the tower was 30m and the amount of radiation emitted from it was 925 MHZ, the results of the internal activity, which measured the queen's activity in laying eggs, showed that the highest rate of activity was in the first and second treatments, with averages of (292.75 inches2), (274.58 inches2) Respectively, while the lowest rate was recorded in a transaction directly under the communications tower (151.33 inches2). The highest density rate of bees was recorded in the first treatment with an average of (5.19 frames.cell$^{-1}$) and the lowest rate was for the third treatment (3.57 frames.cell$^{-1}$). The results of the external activity of the foraging workers recorded the first treatment as the highest average (605.0 bees.hr$^{-1}$) followed by the second treatment at an average (515.8 bees.hr$^{-1}$) while the third treatment recorded the lowest average for the foraging bees (382.9 bees/hr.). The triple overlap between the site, the time, and the date recorded the second treatment as the highest rate (1610 bees.hr$^{-1}$) for the evening time, followed by the first treatment at the rate of (1580.0 bees.hr$^{-1}$) in the morning. The third treatment recorded the lowest average for the foraging bees (278.0 bees.hr$^{-1}$). The effect of the radiation emitted by the tower on the ability of bees in the metabolism showed no significant differences between the rates (wet weight, dry weight, protein ratio, fat percentage). The results of the analysis showed significant differences in carbohydrate levels (32.92%, 30.60%, and 29.74%) for the second, third, and first treatments, respectively. The ash content showed significant differences

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between the treatments, the first treatment recorded the highest rate (1.950%) The lowest rate was in the treatment under the tower (1.220%). It could be concluded that communication towers hurt the activities of the honey bee, *Apis mellifera*.

**Keywords**: The importance of honey bees، Communications towers, Disturbance and collapse of honey bee colonies.

# INTRODUCTION

Beekeeping of honey bees and the multiplication of insects is one of the most important branches of agricultural investment. Bees are one of the best and most active pollinators, representing 80% of pollinated insects of cultivated crops [17]. The loss of honey bees is a problem to both in environmental and human terms due to bee products, pollination of crops, biodiversity, etc. [6]. One-third of human food depends directly or indirectly on pollinating bees for crops, and the economic role of honeybees in pollinating plants worldwide were estimated at € 153 billion in 2005 [20] The study conducted by Jasvir [10] showed the impact of radiation from mobile phone towers on the biology of honey bees by decreasing the area of honey, pollen, and queen activity to laying eggs [16] New studies revealed a new phenomenon, which is the sudden disappearance of bees. Colony Collapse Disorder is a name given to a problem when bees simply leave the hive and fail to return [19], other evidence to support the theory of colony disruption and breakdown Colony collapse disorder of honeybees due to the amount of electromagnetic radiation emitted by mobile phone towers affects the behavior of honeybees [12]. Kimmel *et al.* [11] confirmed that electromagnetic radiation affects bee behavior and physiology. The importance of *Apis mellifera* is considered a vital indicator of the status of the surrounding environment, which is man-made and must be preserved.

# MATERIALS AND METHODS

## Selection of study location

The locations of the study at the University of Baghdad/Ajdabiya were chosen based on the area of the communication tower, which was established in 2008 with a height of 30 m and the structure of the tower of aluminum, and the tower contains four transmitters and receiving GSM (Plate 1). The amount of radiation emitted from the tower is 925 MHz, which it represents the third treatment (Plate 1, 2).

The first treatment is at 500 meters from the communication tower (Plate 3). The second treatment is at 150 M from the communication tower (plate 4).

**Plate 1: The communication tower (self-supporting tower)**

**Plate 2: The cells of bees directly under the communication tower).**

plate 4

Plate 3

## Hives preparation

Nine hives were prepared equally from the local strains the queen fertilized in the spring of 2018 and all beekeeping practices were done in the Faculty of Science and Agricultural Engineering and kept there until the experiments started (26/2/2019) then distributed to the three locations.

The first location (The cells away by 500 m from the communication tower).

The second location (The cells away by 150 m from the communication tower).

The third location (The cells of bees directly under the communication tower).

## The Effect of electromagnetic radiation on the internal activities of honey bee in the three locations

1- The egg laying by the queen:

The egg-laying area was measured by a glass board (inch2) when the experiment started on 28/2/2019 and continued weekly using colored pins.

2- The density of bee

The density of bees measured by the number of frames covered by bees was recorded in each replicate for all treatments before the start of the experiments and then every 14 days to the end of the experiment [15].

3- The activity of workers in foraging

The numbers of bees released from 8-9 A.M. and 12-1 P.M. were calculated by vision and confirmed by using digital cameras for all treatments weekly for three months [2, 8].

4- Bee body analysis

To know the effect of electromagnetic radiation on the content of the body of the bee, samples were taken at the age of 24 hours, killed by freezing, and then dried for further analysis [3].

**Rated moisture content**

The moisture percentage was estimated according to the Association of Official Analytical Chemists method [20].

Using a known weight of the sample of about 1 gm then dried in the oven at a temperature of 105 °C for 16-24 hours, and left the samples until the weight was stable, then weighed and obtained moisture using the following equation [3]

$$Percent\ Moisture = \frac{sample\ weight - sample\ weight\ after\ drying}{sample\ weight} \times\ 100$$

**Estimation of ash content**

Ash content was estimated by burning 1 g of soft samples in a Carolitc Muffle Furnace electric incinerator at 550°C for 6 hours according to the following equation.[20].

$$Ash\ content\% = \frac{ash\ weight\ after\ burning}{sample\ weight} \times\ 100$$

**Estimation of the fat percentage**

Weighed the beaker used in extraction before placing the samples, the samples were placed on the filter paper and transferred into the beaker. The machine was then activated for 6 hours with the addition of the organic hexane solvent. Samples were placed in the thimble and waited until the drops of hot solvent appeared, then distilled through the condenser, after which the recovered solvent was collected inside the glass container [7].

$$Hexane\ extract\ (\%)\ = \frac{fat\ extract\ weight}{sample\ weight} \times\ 100$$

**Estimation of total protein by the Association of Official Analytical Chemists [5] by taking a sample weight**

From each sample, 0.2 gm was taken, placed in a digestion tube, and 5 ml of concentrated sulfuric acid $H_2SO_4$ (95%) was added to each tube. Two drops of hydrochloric acid HCl samples were added and left for 16 hours for digestion and then gradually heated until the solution became clear and then distilled after the addition of 10 ml of sodium hydroxide (10 mol) and freed ammonia was collected in a flask containing 25 ml of boric acid. 2 drops of bromocresol and methyl red were then cleared by the presence of hydrochloric acid (HCl) at a standard concentration of (0.05 mol).

Then the amount of acid that changed the indicator from the green color to red was calculated according to the following equation [13].

$$Proten\ ratio = \frac{HCl\ amount\ for\ correction\ (ml) \times (0.05) HCl\ molary\ x\ (0.014)}{weight\ of\ the\ sample\ in\ grams} \times 100$$

**Estimation of carbohydrate ratio**

Carbohydrates were measured according to the Association of Official Analytical Chemists by adding 1 ml of phenol at a concentration of 5%, then adding 5 ml of concentrated sulfuric acid, and then reading it in the Spector photometer with a wavelength of 490 nm according to the equation [3].

$$\text{Carbohydrate (\%)} = \frac{\text{Spectrometer reading} \times \text{Initial attenuator} \times \text{Second attenuator} \times 100}{weight}$$

**Statistical analysis**

The experiments were designed with a Complete Randomized Design (CRD). The significant differences between the treatments were compared with the least significant difference test, and statistical analysis (2012) was used to analyze the data.

## RESULTS AND DISCUSSION

**The egg laying by the queen**

The results of the statistical analysis in Table 1 revealed that there were significant differences in the overall means of the area containing eggs (inch2) laid by the queen weekly. The first treatment sustained the higher mean (292.75 inch2) followed by the second treatment (274.58 inch2). At the same time, the third treatment showed the lowest mean (151.33 inch2). The interaction between the treatments and the periods showed significant differences. Sahib [18] confirmed that the exposure of honey bees *Apis mellifera* to microwave radios weakens the queen's ability to lay eggs and affects the density of bees in the community. Agreed with Aday [1] who found that the radiation emitted from the power towers of 900 MHZ affected the biological and physiological system of honeybee communities, due to the loss of queens in the cells placed under the tower twice during the experiment [20].

Table 1: Mean of eggs laying areas (inch2) by the queen of the treatments on different dates

| Treatment / Date | 500 m | 150 m | 0.00 m | The mean |
|---|---|---|---|---|
| 28 February | 90.00 a | 95.33 a | 56.33 b | 80.56 |
| 5 March | 199.00 a | 136.33 b | 110.33 b | 148.56 |
| 13 March | 311.33 a | 207.33 b | 148.67 c | 222.44 |
| 20 March | 288.67 a | 210.67 b | 170.00 c | 223.11 |
| 27 March | 281.33 a | 238.67 a | 164.00 b | 228.00 |
| 4 April | 333.00 a | 318.67 a | 180.67 c | 277.44 |
| 18 April | 373.00 b | 447.00 b | 183.33 c | 334.44 |
| 25 April | 465.67 b | 542.67 a | 197.33 c | 401.89 |
| LSD 5% | 45.54** | | | 26.29** |
| Mean | 292.75% | 274.58 | 151.33 | |
| LSD 5% | 16.10** | | | |

* Interaction of the locations.

** Interaction of the date. ** Interaction between locations and the date.

LSD: (P ≤ 0.01)

**Density of bees**

This study was carried out on the basis of the effect of micro-radiation on the density of bees by calculating the number of frames covered by bees. The results of the statistical analysis in Fig. 1 showed significant differences in the density of the bees of the three treatments, the first treatment recorded the highest rate compared to the second and third treatments, which were (5.19, 4.43, 3.57 frames/hive), respectively. The results of statistical analysis showed that the density of the bees of the three treatments started at low rates and then increased in the early spring in all denominations, which was correlated with mild temperatures, pollen collectors, nectar or water collectors and increased in queen activity, which necessitated adding of new frames. The third treatment showed low density of bees at the end of the experiment, and this was due to the internal impact on the activity of the honey bee, which includes (the activity of the queen in laying eggs, brood area open and closed, the area of pollen). The external influence on the density of bees includes (environmental conditions, biological enemies, and the impact of micro-radiation). The results of the statistical analysis (Fig. 1) showed significant differences in the time periods of the rate of density.

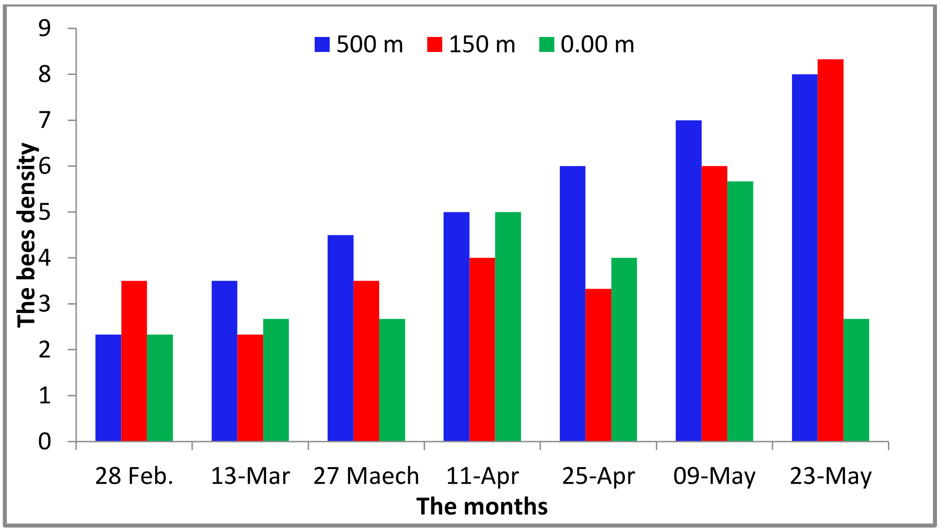


Figure 1: The bees' density (frames/hive) at different times.

The highest rate of bees (6.33 frames/hive) was in the period 23/5 while the lowest rate of bee density was in 28/2 and 13/3, the mean bee density was 2.72 and 2.83 frames/hive, respectively. These results agreed with [18] who found that the radiation emitted by mobile phones affects the flight activity and density of honey bees.

**The Foraging Bees.**

The workers bees are providing pollen grain, nectar, water, and propolis to the hive. In Table 2, there were significant differences in the mean number of bees/hours for the first treatment which was (605.0 bees/hour) followed by the second and third treatments were (515.8, and 382.9 bees/hour), respectively. The results of the statistical analysis showed that there were significant differences in the number of bees/hours between the morning and evening time for all treatments as the morning time recorded the highest mean (632.2, 509, 407.4 bees/hour) compared to the evening (577.8, 522.5, 358.5 bees/hour) for first, second and third treatment, respectively. The interaction between the site and the time recorded significant differences between the three treatments, where the evening time of the second treatment exceeded by 1610.7 bees/hour followed by the morning time of the first treatment which was (1580.0 bees/hour). The third treatment recorded the lowest rate of release bees compared with the first and second treatment rates (969.7 bees/hour) for evening time.

The temperature also has a significant effect on the activity of bees, which starts when the temperature rises above 10°C in addition to the abundance of food variety [2]. The results of the statistical analysis showed significant differences in the interaction between site and date, where the first and second treatments recorded the highest rate of prepared bees (1555.7 bees.hr$^{-1}$ and 1424.8 bees.hr$^{-1}$) respectively on 9/5. While the third treatment recorded the lowest mean (248.3 bees/ hour) as of 9/5. On the 20th of March, the three treatments recorded the lowest rates of bees foraging (69.7, 78.0, 109.3 bees.hr$^{-1}$) for the first, second, and third treatments, respectively. From the results of the statistical analysis, there were significant differences between the time (morning) and the date. The highest rate of bees was in the date 9/5 which was (1032.3 bees.hr$^{-1}$) and the lowest on the morning of 20 March which was (79.8 bees.hr$^{-1}$) The results of Table (2) revealed significant differences in the triple interaction between (location, time, date) where the second treatment recorded the highest rate of bees at the date of 9/5 and for the evening which was (1610.7 bees.hr$^{-1}$). The first treatment (1580.0 bees.hr$^{-1}$) was on the same date and in the morning.

The third treatment sustained the lowest mean of bees/hour on 9/5 in the morning time (278.0 bees.hr$^{-1}$). On 28/2, the lowest rate was 80.7 bees /hour for the first treatment followed by the third treatment 94.7 bees.hr$^{-1}$, and the second treatment was (126.7 bees.hr$^{-1}$). From these results we observed that the activity of bees regarding the bees foraging was affected directly or indirectly by differences in the time and the difference time (morning-evening) and the location of treatments in terms of distance from the telecommunications towers which, agreed with Nashaat *et al*. [15] disagreed with Menzel [14] who noted that changes in bee activity in general are associated with certain changes in brain regions, especially those called mushroom bodies.

**Table 2: Mean number of foraging bees (bees/ hour) at A.M., P.M. weekly**

| Treatment / Date | 500 m | | 150 m | | 0.00 m | | Site × Date | | | Time × Date | | Average Date |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A.M. | P.M | A.M. | P.M. | A.M. | P.M. | 500 m | 150 M | 0.00 m | A.M. | P.M. | |
| 28/2 | 80.7 b | 108.0 a | 132.0 a | 126.7 a | 126.7 a | 94.7 b | 94.3 a | 129.3 a | 110.7 a | 113.1 a | 109.8 a | 111.4 |
| 6/3 | 230.0 b | 261.3 a | 181.3 a | 113.3 b | 142.7 a | 102.7 a | 245.7 a | 147.3 b | 122.7 c | 184.7 a | 159.1 a | 171.9 |
| 13/3 | 172.7 a | 122.0 b | 253.3 a | 210.3 a | 221.3 a | 132.0 b | 147.3 c | 231.8 a | 176.7 b | 215.8 a | 154.8 a | 185.3 |
| 20/3 | 71.3 a | 68.0 a | 78.7 a | 77.3 a | 89.3 a | 129.3 a | 69.7 b | 78.0 b | 109.3 a | 79.8 b | 91.6 a | 85.7 |
| 27/3 | 586.7 a | 406.7 b | 249.3 a | 289.3 a | 294.0 a | 257.3 a | 496.7 a | 269.3 b | 275.7 b | 376.7 a | 317.8 a | 347.2 |
| 4/4 | 396.7 a | 375.3 a | 258.7 b | 345.3 a | 308.0 a | 276.7 a | 386.0 a | 302.0 b | 292.3 b | 321.1 a | 332.4 a | 326.8 |
| 11/4 | 432.0 a | 416.7 a | 266.7 b | 361.3 a | 309.3 b | 415.7 a | 424.3 a | 314.0 c | 362.5 b | 336.0 a | 397.9 a | 366.9 |
| 18/4 | 701.7 b | 741.3 a | 810.7 a | 778.7 a | 672.0 a | 526.7 b | 721.5 b | 794.7 a | 599.3 c | 728.1 a | 682.2 a | 705.2 |
| 25/4 | 1197.3 a | 1003.3 b | 684.0 a | 664.7 a | 860.0 b | 920.7 a | 1100.3 a | 674.3 c | 890.3 b | 913.8 a | 862.9 a | 888.3 |
| 2/5 | 1174.0 b | 1337.3 a | 875.3 a | 658.7 b | 846.7 b | 969.7 a | 1255.7 a | 767.0 c | 908.2 b | 965.3 a | 988.6 a | 976.9 |
| 9/5 | 1580.0 a | 1531.3 b | 1239.0 b | 1610.7 a | 278.0 a | 218.7 b | 1555.7 a | 1424.8 b | 248.3 c | 1032.3 b | 1120.2 a | 1076.3 |
| 16/5 | 805.3 a | 456.0 b | 822.7 a | 768.7 b | 872.7 a | 380.0 a | 630.7 b | 795.7 a | 626.3 b | 833.6 a | 534.9 b | 684.2 |
| 23/5 | 790.7 a | 684.3 b | 765.3 b | 788.0 a | 275.3 a | 236.0 a | 737.5 b | 776.7 a | 255.7 c | 610.4 a | 569.4 a | 589.9 |
| Mean | Location × Time | | | | | | Location | | | Time | | Overall mean |
| | 632.2 | 577.8 | 509.0 | 522.5 | 407.4 | 358.5 | 605.0 | 515.8 | 382.9 | 516.2 | 486.3 | 501.2 |
| LSD 5% | Location | Time | Date | Location × Time | | Location × Date | | Time × Date | | Triple interaction | | |
| | 12.48** | 10.19** | 25.98** | 45.00** | | 17.65 ** | | 36.74 ** | | 63.64** | | |

** Interaction of the locations, **Interaction of the time, **Interaction of the date, **Interaction of the locations between time, **Interaction of the locations between date, ** Interaction of the time between date, **Interaction of the locations between date and time.
LSD: ($P \leq 0.01$)

### Bee body analysis

Table 3 showed that there were no significant differences between all treatments regarding the rate of weight percentage (wet and dry), protein percentage, and fat percentage. On the other hand, significant differences were observed concerning ash (1.950%, 1.737%, 1.22%) and carbohydrates (29.74%, 32.92%, 30.6%) for the first, second, and third treatments .Water requirements depend on physical factors such as temperature and humidity levels of the atmosphere, which in turn affect the rates of loss from the insect's body, whether through the cuticle or the respiratory system [4], Fats in the bodies of insects are the release of lipid-loving compounds that bind with the fats of the blood hemolymph during the moulting period. However, when insects molt, a compound is formed in the cuticle which is a protein-phenol and the beta-glucoside compound remains. This means that the protein formation in the cuticle does not change during the tanning stage and that there are compounds secreted from the brain that stimulate the production of the protein that binds to chitin when ice is formed during the formation stage [13] It is likely that providing food sources rich in nutritional supplements that honey bees need, in addition to providing water sources and maintaining a stable humidity level, led to the absence of significant differences between the chemical composition of the bee's body, which includes (moisture content, fat percentage, and protein percentage) [20].

The significant differences between the treatments in ash and carbohydrate contents may be due to the radiation emitted from the towers and food (type, quality). Ferrari [9] reported that the radiation from the mobile phone towers affects the behavior of working bees and physiology where it produces chemical changes in honey bees.

Table 3: Bee body analysis.

| Treatment | Wet weight (%) | Dry weight (%) | Ash (%) | Protein (%) | Fats (%) | Carbohydrate (%) |
|---|---|---|---|---|---|---|
| 500 m | 73.763 | 26.237 | 1.950 a | 14.050 | 6.040 | 29.74 c |
| 150 m | 74.413 | 25.587 | 1.737 b | 14.203 | 5.923 | 32.92 a |
| 0.00 m | 71.993 | 28.007 | 1.220 c | 14.403 | 5.720 | 30.60 b |
| LSD 5% | NS | NS | 0.1391** | NS | NS | 1.284** |

** Interaction of the locations between ash percentages.

** Interaction of the locations between carbohydrate percentages.

LSD: ($P \leq 0.01$)

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# تأثير الاشعة الكهرومغناطيسية المنبعثة من أبراج الاتصالات في النشاط الحيوي والفسلجي لطوائف نحل العسل*

[*Apis mellifera* L. Hymenoptera: Apidae]

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## الملخص

أُجريت التجارب في مناحل كلية علوم والهندسة الزراعية في منطقة الجادرية بتاريخ 28/ 2/ 2019 وانتهت بتاريخ 2019/5/23 وزعت المعاملات على ثلاث مواقع وفي كل موقع ثلاث خلايا، كان الموقع الأول على مسافة 500m والموقع الثاني على مسافة 150m من برج الاتصالات والمعاملة الثالثة وضعت تحت برج الاتصالات مباشرة. حيث كان مقدار ارتفاع البرج 30m وكمية الأشعة المنبعثة من برج الاتصالاتMHZ 925. أظهرت نتائج النشاط الداخلي والمتمثلة في قياس نشاط الملكة في وضع البيض إذ بلغ أعلى معدل لنشاطها في المعاملتين الأولى والثانية بمتوسطات ($292.75inches^2$),( $274.58inches^2$ ) على التوالي، بينما أقل معدل سجل في معاملة تحت برج الاتصالات مباشرة ($151.33inches^2$). وسجل أعلى معدل للكثافة النحلية في المعاملة الأولى بمتوسط بلغ ($5.19frames.cell^{-1}$) وأقل معدل للمعاملة الثالثة ($3.57frames.cell^{-1}$). أما نتائج النشاط الخارجي المتمثل في سروح النحل بلغ اعلى معدل (605.5bee/hr) للمعاملة الأولى وتلتها المعاملة الثانية وبمعدل ($515.8bee/hr^{-1}$) في حين سجلت المعاملة الثالثة اقل معدل للنحل السارح ($bee/hr^{-1}$ 382.9. أما التداخل الثلاثي بين الموقع والوقت والتاريخ سجلت المعاملة الثانية أعلى معدل للسروح إذ بلغ (bee/hr. 1610) للتوقيت المسائي، تليها المعاملة الأولى وبمعدل ($1580.0bee.hr^{-1}$) صباحا. بينما المعاملة الثالثة سجلت أقل معدل حيث بلغ ($278.0bee.hr^{-1}$) صباحاً. ولمعرفة مدى تأثير الأشعة المنبعثة من البرج على قدرة النحل في التمثيل الغذائي تم تحليل جسم النحلة إذ لوحظ عدم وجود فروق معنوية بين معدلات (الوزن الرطب، الوزن الجاف، نسبة البروتين، نسبة الدهون)، وقد أظهرت نتائج التحليل فروق معنوية في معدلات الكربوهيدرات بلغت (29.74%,30.60%,32.29%) للمعاملات الثانية، الثالثة، الأولى على التوالي، كذلك ان نسبة الرماد أظهرت فروق معنوية بين المعاملات اذ سجلت المعاملة الأولى أعلى معدل بلغ (1.950%) وأقل معدل في المعاملة التي تحت البرج وبمعدل (1.220%). وعليه نستنتج ان للأشعة المنبعثة من أبراج الاتصالات تأثير على الأنشطة الحياتية لنحل العسل.

**الكلمات الدالة:** أهمية نحل العسل، أبراج الاتصالات، اضطراب وانهيار طوائف نحل العسل، نشاط طوائف نحل العسل

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[2] جامعة الجزيرة، كلية العلوم للزراعية، الخرطوم، السودان.

- **تاريخ تسلم البحث**: 13/تشرين اول/2024.
- **تاريخ قبول البحث**: 11/تشرين/2024.
- **متاح على الانترنت**: 30/حزيران/2025.