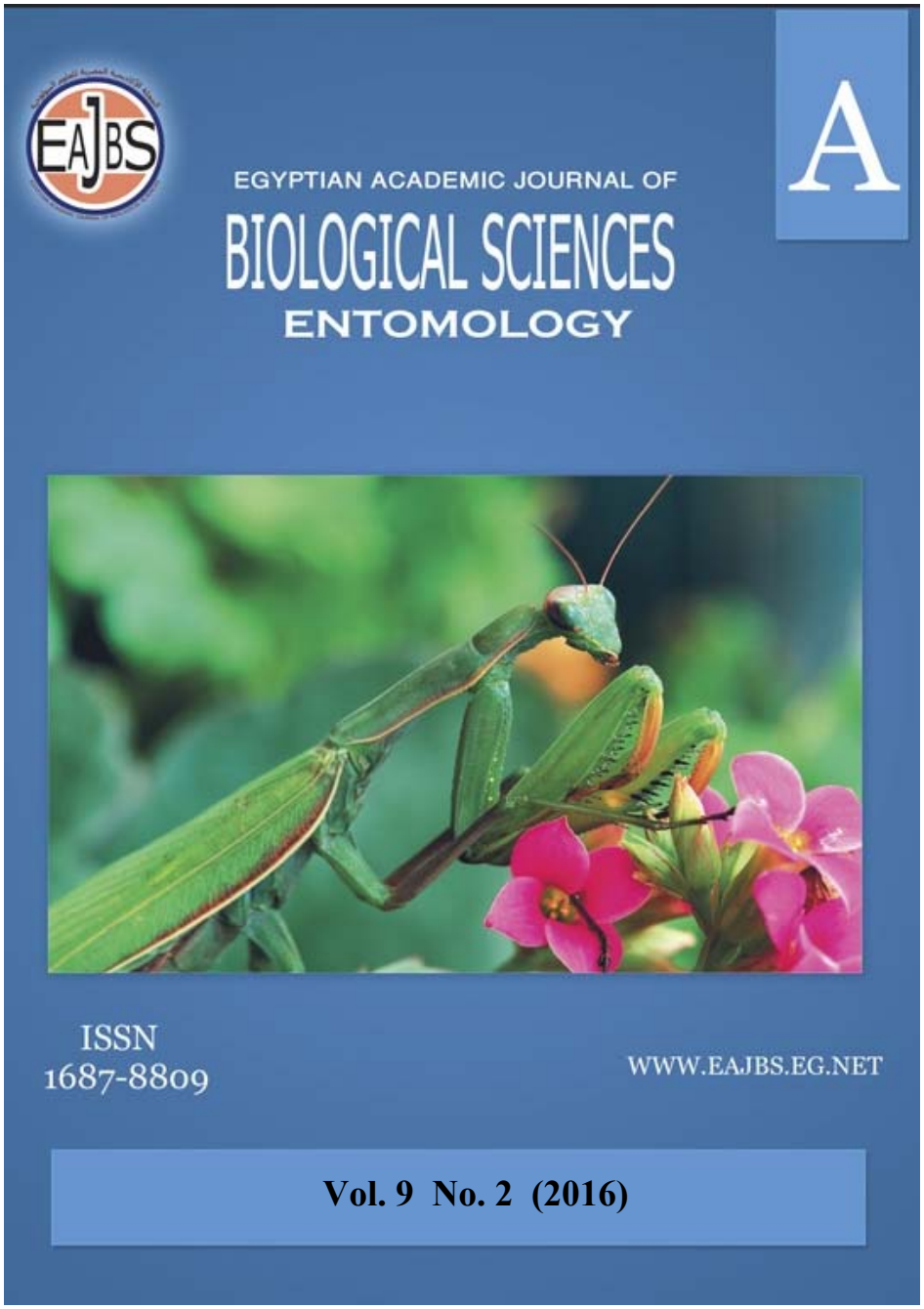

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Morphological Changes and Colony Activity in Honeybee Workers *Apis mellifera* Produced from Irradiated Queens.

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ABSTRACT

The present work was carried out to study effect of different doses of ionizing gamma irradiation on honey bee queens soon after emergence, i.e. as virgins, and also mated queens on eggs laying as number of sealed brood, and workers progeny and possible occurrence of any induced morphological changes in workers as well as their performance in colony activity as honey production.

The exposed virgin and mated queens did not affected by different low doses of radiation (20 - 200 rad), except the number of sealed brood cell produced by irradiated virgin queens was decreased at dose 200 rad, high dose of irradiation (400 rad) caused a complete died in virgin queens while mated queens irradiated by 400 rad produced significant low numbers of sealed brood.

Bee honey production was significantly decreased only when virgin or mated queens irradiated with high dose (400 rad).

No significant changes in the measurement of workers appendages, such as flagellum, hind wings, fore and hind legs as a result of exposing virgin queens to doses between 20 and 200 rad, except fore wing reduced in length and width only at dose 200 rad. In case of mated queens, the above mentioned measurement did not affected at doses between 2o and 200 rad while significant decreased in the morphological measurement was occurred at dose (400 rad).

INTRODUCTION

The honey bees *Apis mellifera* is one of social behavior insect. This behavior varies depending on the races and environmental factors (Millor *et al.,* 1999). The defensive behavior of honey bees and production of honey and propolis, and the hygiene is highly affected by weather factors such as solar radiation intensity, relative humidity, air temperature, barometric pressure, and wind velocity (Garcia *et al.,* 2013 and Southwick and Moritz 1987). The behavior of queens in laid eggs and quantity of brood dependent on quantity of pollen and season, and addition the behavior of bee workers in collecting nectar and pollen dependant on season (Abdelmegeed, 2015). Even though, predators such as wasps, natural parasites and diseases, the complex immune system in insects kept their live all over millions of years (Favre, 2011and Sahib 2011) found another factor has been introduced to their environment, electromagnetic waves which produced from mobile towers and phones effects were studied on honeybee behavior.

This study focuses on the queens behavior which exposed to the different doses of radiation on laid the eggs and brood quantity, and behavior of workers produced from this queens on honey production and morphological changes occurred due to radiation.

MATERIAL AND METHODS

The queens honey bee *Apis mellifera* which used in the present study was prepared from colonies headed with open mated local Italian queens located at the apiary belonging to Faculty of Agriculture, Ain Shams University. The Cesium Cell 137 Unit located at the National Center for Radiation Research and Technology was used for the gamma irradiation of honey bee queen of *Apis mellifera ligustica*. The dose rate calibration determined for gamma radiation at the time of the experiment was one gray per 56 seconds. To obtain dose measurements at the sample position in the gamma cell, the dosimeters were Professional beekeeping tools bee queen cage. The bee queen prisoner cage reserve tool with honey storage box the time of irradiated. The gamma dose were used; 20, 200 or 400 rad. Two groups of queens (virgin and mated) and each group divided to three groups each group contain three queens (replicates) treated with three different doses of radiation, the queens were taken from colonies and put them inside the queen cage was irradiated by gamma ray was then returned to the colonies again. Each queen cage bees were exposed at each irradiation dose and this procedure was replicated three times for each selected gamma dose. Following treatment the specimens were transferred to field and according to following:

Number of sealed brood cells

Number of sealed brood cells in colonies with queens every 13 days in the spring season can be calculated according to :

- Area of sealed brood = л x r1 x r2

л = 22/7

- Number of sealed brood cells = area of close brood x 3.875

3.875 = number of cells/1cm^2

Weight of stored honey:

Weight of stored bee honey (g) in colonies with queens at the beginning of experiment and after two months can be calculated according to:

- Area of comb honey = r1 x r2
- Number of honey cells = area of comb honey x 3.875

3.875 = number of cells/1cm^2

- Weight of honey = number of honey cells x 0.6375

0.6375= weight of honey/ one cell

Measuring the dissected parts of newly honeybee worker

The length and width of fore wing,
The length and width of hind wing,
The length of coxa, femur, tibia and tarsus in fore leg,
The length of coxa, femur, tibia and tarsus in hind leg,
by used micrometers slides

RESULTS

Effect of different doses of radiation on number of sealed brood cells.

As shown in Table 1, the number of sealed brood cells produced from virgin

and mated queens affected by different doses of radiation.

The number of sealed brood produced from virgin queens was not significant affected when the virgin queens were exposed to 20 rad but reduced in number of sealed brood was occurred when exposed to 200 rad compared with control. The number of sealed brood produced from treated mated queens with 20 and 200 rad was not significant affected but reduced in numbers of sealed brood were detected when mated queens exposed to 400 rad compared with control.

Table 1: Effect of different doses of radiation on number of sealed brood cells produced at 13 days interval in hives with treated virgin and mated queens.

	Brood cycle of treated virgin queens				**Brood cycle of treated virgin queens**			
RD	**1st**	**2nd**	**3rd**	**4th**	**1st**	**2nd**	**3rd**	**4th**
20	913.1[a]	3227.1	7216.3[a]	9286.1[a]	6393.6[a]	6686.6[a]	7280.0[a]	8843[a]
	±10.61	±182.07	±62.46	±84.91	±113.70	±146.24	±124.96	±39.10
200	572.4[b]	3069.3	4003.2[b]	7368.7[b]	6133.6 [ab]	6581.6[a]	7475.0[a]	7819.3[b]
	±8.57	±51.03	±377.22	±221.27	±120.499	±72.407	±50.616	±154.838
400	-	-	-	-	5568.3[c]	5346.6[b]	5230.0[b]	5138.6[c]
					±103.400	±34.022	±75.312	±91.383
Cont	920.4[a]	3107.7	7190.4[a]	9175.0[a]	5815.6[bc]	6592.3[a]	7466.6[a]	8702.3[a]
	±18.37	±84.10	±75.52	±89.81	±168.060	±154.363	±47.316	±72.361

*: means with the same superscript in the same column were not significantly different ($p<0.05$).

Effect of different doses of radiation on weight of bee honey production.

As shown in Table 2, the weight of honey production produced from hives with headed queens affected by different doses of radiation.

The weight of honey production produced from hives with treated virgin queen after two months was not significant affected by exposure to 20 rad, but reduced in weight of honey production occurred when virgin queens were exposed 200 rad compare with control. The weight of honey production produced from hives with treated mated queen after two months was increased when queens were exposed to 20 rad, but reduced in weight of honey production when mated queens were exposed to 200 and 400 rad compare with control.

Table 2: Effect of different doses of radiation on weight of bee honey produced (g) before expose and after two months in hives with treated virgin and mated queens.

RD	**weight of bee honey after two months**	
	Treated virgin queens	**Treated mated queens**
20	9904.5[a]±48.581	8592.6[a]±168.75
200	8299.4[b]±102.470	4891.3[c]±96.081
400	-	3843.9[d]±186.052
Cont	9895.4[a]±45.315	7905.4[b]±107.971

*: means with the same superscript in the same column were not significantly different ($p<0.05$).

Length of flagellum and length & width of fore and hind wings.

As shown in Tables 3 and 4, the length of flagellum in workers produced from virgin and mated queens which exposed to different doses of radiation was not

significant. The length and width of (fore and hind) wings in honey bee workers produced from virgin and mated queens affected by different doses of radiation, in this respect length and width of fore wing in honey bee workers produced from virgin queens was not significant when the virgin queens exposed to 20 rad compared with control but the length and width of fore wing was decreased when virgin queens were exposed to 200 rad. No significant changes in the hind wing of workers were detected with all tested doses of radiation.

In table 4, The length and width of fore wing in honey bee workers produced from mated queens was not significant when the mated queens exposed to 20 and 200 rad compared with control but the length and width of fore wing was decreased when mated queens exposed to 400 rad. The length and width of hind wing in workers produced from mated queens which exposed to 20 and 200 rad were not significant compared with control but significant decrease in the hind wings was observed with 400 rad compared with control.

Table 3: length of flagellum and (length & width) of (fore and hind) wings in bee workers produced from virgin queens treated by different doses of radiation.

		fore wing		hind wing	
R.D	**Flagellum**	**Length**	**width**	**length**	**Width**
20	2.79 ±0.037	8.94[a] ±0.073	3.27[a] ±0.068	6.10 ±0.095	2.02 ±0.040
200	2.72 ±0.040	8.70[b] ±0.063	3.06[b] ±0.049	6.07 ±0.098	1.99 ±0.066
Cont	2.75 ±0.054	9.02[a] ±0.060	3.18[a] ±0.040	6.18 ±0.051	2.00 ±0.084

*: means with the same superscript in the same column were not significantly different ($p<0.05$).

Table 4: Length of flagellum and (length & width) of (fore and hind) wing in bee workers produced from mated queens treated by different doses of radiation.

		fore wing		hind wing	
R.D	**Flagellum**	**Length**	**width**	**length**	**Width**
20	2.63 ±0.068	9.10[a] ±0.045	3.20[a] ±0.032	6.20[a] ±0.077	1.90[a] ±0.095
200	2.62 ±0.051	8.96[ab] ±0.049	3.16[ab] ±0.080	6.14[ab] ±0.097	1.79[ab] ±0.049
400	2.57 ±0.040	8.90[c] ±0.032	3.07[b] ±0.024	6.05[b] ±0.045	1.76[b] ±0.020
Cont	2.64 ±0.0200	9.13[a] ±0.024	3.18[a] ±0.040	6.21[a] ±0.058	1.89[a] ±0.058

*: means with the same superscript in the same column were not significantly different ($p<0.05$).

Length of coxa, femur, tibia and tarsus of fore and hind leg in bee workers produced from virgin queens treated with different doses of radiation.

As shown in tables 5 and 6, the length of fore and hind legs in workers which produced from virgin and mated queens was affected by the different doses of radiation.

The length of femur and tibia in fore and hind legs (Table, 5) in workers which produced from treated virgin queens were not significant at doses 20 and 200 rad compared with control. On the other hand, the length of tarsus in fore and hind legs of workers produced from treated virgin queens were not significant at dose 20 rad but decreased in length was detected at dose 200 rad compared with control.

The length of femur, tibia and tarsus in fore and hind legs in workers (Table, 6) produced from mated queens which exposed to 20 and 200 rad were not significant

compared with control, while decreased in length of femur, tibia and tarsus in fore and hind legs of workers produced from irradiated mated queens were observed at dose 400 rad as compared to control.

Table 5: Length of femur, tibia and tarsus of fore and hind leg in bee workers produced from virgin queens treated with different doses of radiation.

	fore leg			hind leg		
R.D	**femur**	**tibia**	**tarsus**	**femur**	**tibia**	**tarsus**
20	2.02	1.75	2.27^{ab}	2.62	2.96	3.74^{ab}
	±0.129	±0.084	±0.024	±0.150	±0.177	±0.080
200	1.95	1.72	2.20^{b}	2.52	2.81	3.65^{b}
	±0.100	±0.060	±0.063	±0.040	±0.107	±0.031
Cont	2.10	1.70	2.29^{a}	2.59	2.96	3.77^{a}
	±0.063	±0.045	±0.037	±0.058	±0.037	±0.024

*: means with the same superscript in the same column were not significantly different ($p<0.05$).

Table 6: Length of femur, tibia and tarsus for fore and hind leg in bee workers produced from mated queens treated with different doses of radiation.

	fore leg			hind leg		
R.D	**femur**	**tibia**	**tarsus**	**femur**	**tibia**	**tarsus**
20	2.16^{ab}	1.70^{a}	2.44^{a}	2.55^{a}	2.96^{a}	3.95^{a}
	±0.037	±0.063	±0.058	±0.045	±0.020	±0.032
200	2.13^{ab}	1.63^{ab}	2.25^{ab}	2.52^{a}	2.91^{ab}	3.87^{ab}
	±0.040	±0.024	±0.000	±0.040	±0.037	±0.024
400	2.10^{b}	1.59^{b}	2.2^{b}	2.43^{b}	2.86^{b}	3.76^{c}
	±0.032	±0.020	±0.045	±0.024	±0.037	±0.058
Cont	2.18^{a}	1.68^{a}	2.41^{a}	2.59^{a}	2.96^{a}	3.99^{a}
	±0.024	±0.040	±0.049	±0.058	±0.037	±0.020

*: means with the same superscript in the same column were not significantly different ($p<0.05$).

Finally it could be concluded that low doses (20 and 200 rad) of irradiation has no significant effected on morphological feature and colony activity of workers produced from the treated virgin queens or treated mated queens while high dose of irradiation (400 rad) caused a complete died in virgin queens, meanwhile, morphological feature, sealed brood cells and weight of honey production were significantly negative affected as compared to control (untreated queens).

In recent years radiation was used to pest control. Some insects are sensitive for radition (Mazza *et al.,* 2010) found that the Thrips were maximally sensitive to wavelengths between 290 and 330 nm. Some insects are different in their sensitive to radiation dependent on different stages such as *Trichogramma euproctidis,* (Tuncbilek *et al.,* 2012) found that the developmental and adult stages of *T. euproctidis* were exposed to gamma radiation of different doses (0-30 Gy) and ultraviolet radiation of 254 nm wavelengths (UV-C) for different durations (0-10 min) to assess their effect on each of the instars and their potential in breaking the developmental cycle of the egg parasitoid. The adult and pupa stages were more radio resistant to both gamma and UV radiation. The most interesting and unexpected result obtained for the prepupal stage was that UV radiation has a greater effect on prepupal stages than gamma radiation. Some insects are resistance for radiation (Narayanan *et al.,* 1959) found that the irradiation of eggs and first instar larvæ of *Corcyra cephalonica* Stainton with beta radiations has shown that even a dose as high as 3333 mrep/hr. does not produce any detrimental effect on the subsequent

development of the parent as well as the two successive generations. (Moller and Mousseau 2009) found that the effects of low-level radiation on bumble-bees, butterflies, grasshoppers, dragonflies and spider webs at forest sites around Chernobyl differing in background radiation by over four orders of magnitude. Abundance of invertebrates decreased with increasing radiation. These effects were stronger when comparing plots differing in radiation within rather than among sites, implying that the ecological effects of radiation from Chernobyl on animals are greater than previously assumed.

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ARABIC SUMMERY

التغيرات المورفولوجية ونشاط شغالات نحل العسل الناتجة من ملكات مشععة

سامح جرجس نصر سويرس[1]- سوسن محمد عبد المجيد[2]

-1

1- المركز القومي لبحوث وتكنولوجيا الاشعاع – هيئة الطاقة الذرية – مدينة نصر – القاهرة – مصر

2- قسم وقاية النبات – كلية الزراعة – جامعة عين شمس – شبرا الخيمة – القاهرة – مصر

استهدف البحث دراسة تأثير الجرعات المختلفة من أشعة جاما التى تعرضت لها ملكات نحل العسل بعد خروجها مباشرة وهى عذراء وملكات أخرى ملقحة على وضع البيض وكمية الحضنة المقفولة والتغيرات

المورفولوجية التى حدثت للشغالات الناتجة من تلك الملكات وتأثير ذلك على أداء الطائفة ونشاطها فى انتاج العسل. وكانت النتائج المتحصل عليها كالتالى:

لم تتأثر الملكات العذارى والملقحة المعاملة بجرعات مختلفة من التشعيع ما عدا الملكات العذارى التى ماتت نتيجة تعرضها لجرعة عالية من الأشعاع 400 راد.

كمية الحضنة المقفولة لم تتأثر عندما تعرضت الملكات العذارى لجرعة 20 راد ولكن قلت كمية الحضنة عندما تعرضت لجرعة 200 راد ولم تتأثر الملكات الملقحة لجرعات 20 و 200 راد ولكن قلت عندما تعرضت لجرعة عالية 400 راد.

انتاج العسل لم يتأثر عندما تعرضت الملكات العذارى والملقحة لجرعات 20 راد ولكن حدث خفض فى وزن العسل عندما تعرضت الملكات لجرعات عالية من الاشعاع بعد شهرين مقارنة بالكنترول.

لم تحدث أى تغييرات مورفولوجية للشغالات الناتجة من الملكات العذارى التى تعرضت لجرعات 20 و 200 راد مثل طول السوط والجناح الخلفى والأرجل الأمامية والخلفية ماعدا الجناح الأمامى حدث به خفض فى طول وعرض الجناح عندما تعرضت الملكات العذارى لجرعة 200 راد.

لم تحدث أى تغيرات مورفولوجية للشغالات الناتجة من الملكات الملقحة التى تعرضت للجرعات 20 و200 راد فى طول السوط والجناح الخلفى والأمامى والأرجل الأمامية والخلفية ولكن تأثرت عندما تعرضت تلك الملكات الى جرعة عالية من الأشعاع وهى 400 راد.