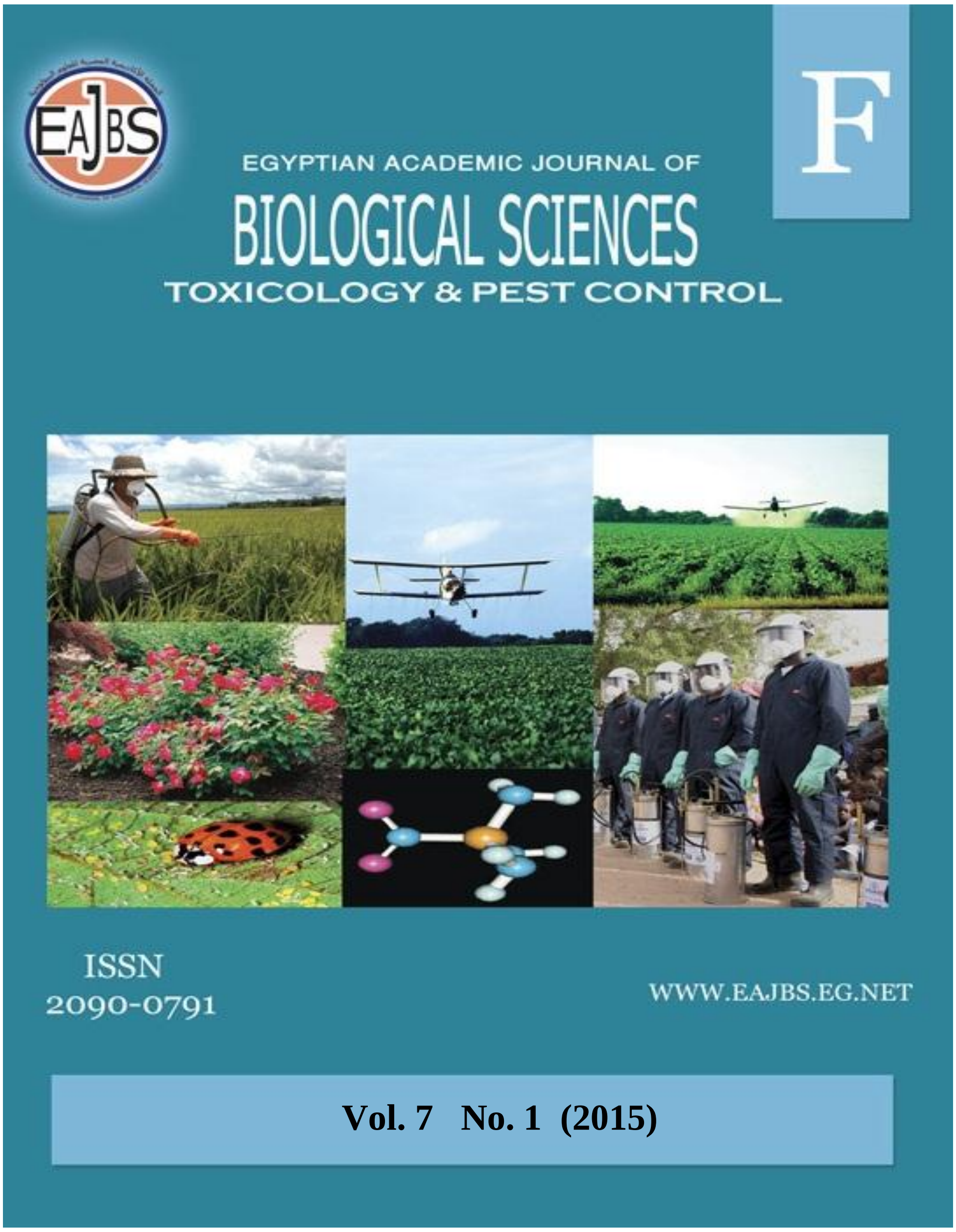
Effects of Three Essential Oils and /o r Gamma Irradiation on the Greater Wax Moth, Galleria Mellonella

Hussein Mohamed
Egyptian Atomic Energy Authority- Nuclear R…

Abdelwahab Ibrahim
Faculty of science, benha University



The journal of Toxicology and pest control is one of the series issued twice by the Egyptian Academic Journal of Biological Sciences, and is devoted to publication of original papers related to the interaction between insects and their environment.

The goal of the journal is to advance the scientific understanding of mechanisms of toxicity. Emphasis will be placed on toxic effects observed at relevant exposures, which have direct impact on safety evaluation and risk assessment. The journal therefore welcomes papers on biology ranging from molecular and cell biology, biochemistry and physiology to ecology and environment, also systematics, microbiology, toxicology, hydrobiology, radiobiology and biotechnology.

www.eajbs.eg.net

Citation :*Egypt.Acad.J.Biolog.Sci. (F.Toxicology &Pest control) Vol.7(1)pp37-47 (2015)*

Egypt. Acad. J. Biolog. Sci., 7(1): 37-47 (2015)

Egyptian Academic Journal of Biological Sciences
F. Toxicology & Pest control
ISSN: 2090 - 0791
www.eajbs.eg.net

Effects of Three Essential Oils and /or Gamma Irradiation on the Greater Wax Moth, *Galleria Mellonella*

Nehad M. Elbarky[1], Hussein F. Mohamed[2], Samira E.M. El-Naggar[2], Marwa S. Salama[2] and Abdelwahab A. Ibrahim[1]

1- Entomology Department, Faculty of Science, Banha University, Benha, Egypt.
2- Biological Applications Department, Nuclear Research Center, Atomic Energy Authority, Cairo, Egypt.

ARTICLE INFO
Article History
Received: 29/3/2015
Accepted: 20/5/2015

Key words:
Galleria mellonella
(Lepidoptera)
Gamma Radiation
Essential oils

ABSTRACT

The insecticidal activity of the essential oils peppermint, *Mentha piperita L.*, geranium; *Pelargonium graveolens L.*, basil; and *Ocimum basilicum L.* were investigated in laboratory against early fourth instar larvae of the greater wax moth, *Galleria mellonella*. The tested plant oils prolonged the larval - pupal periods and reduced both pupation and percentage of adult emergence. *O. basilicum* scored the highest larval mortality followed by *M. piperita* then *P. graveolens*. Other developmental aspects as survival and sex ratio were clearly affected by increasing the concentration increments of plant oils. The combined treatment of 100 Gy Gamma radiation and LC_{50} of *M. piperita* and *P. graveolens* had clear effect on total larval mortality and sex ratio. Pupation, adult emergence, and survival were clearly reduced in the combined treatments.

INTRODUCTION

Wax moths are serious pests of bees wax worldwide. Greater wax moth (GWM), *Galleria mellonella* L., and lesser wax moth, *Acheroia gresilla* L., are known to be harmful to deposited and stored beeswax. GWM causes the greatest damage in apiaries which lead to financial losses every year, beside damaging wax combs by larval feeding, and destroying frames and wooden parts in the hive. Adult wax moths and larvae can also transfer pathogens of serious bee diseases, *e.g.* foulbrood (Charrière and Imdorf, 1997 and Owayss and Abd-Elgayed, 2007).

Possibilities for controlling wax moth include some manipulations in the hive and other treatments to stored combs *i.e.* technical, physical, biological and chemical methods *e.g.* sulphur fumigation, acetic and formic acids evaporation and applying paradichlorobenzene (Owayss and Abd-Elgayed, 2007).

The use of chemical agents to prevent or control insect infestation has been the main method of protection against GWM, since it is the simplest and most cost-effective means of dealing with stored product pest (Hidalgo *et al*., 1998).

However, insecticides have serious drawbacks such as pest resurgence and resistance, lethal effects on non- target organisms, the risk of user´s contamination, food residues, and environmental pollution (Tapondjou *et al*.., 2002). In addition, the precautions necessary to work with traditional chemical insecticides (Fields *et al*., 2001), and the poor storage facilities of traditional farmers in developing countries, make conventional chemical control unsuiTable (Tapondjou *et al*., 2002). Thus, there is an urgent need to develop safe alternatives for the protection against this insect. Considerable efforts by many researchers have been focused on plant derived materials, potentially useful as commercial insecticides (Padin *et al.*, 2013, Wondafrash *et al.*, 2012, Sreekanth 2013 and Sharma *et al*., 2014). Since these plant materials with insecticidal properties are often active against a limited number of species , are often biodegradable to non- toxic products and are potentially suiTable for use in integrated pest management , they could lead to the development of new classes of safer insect control agents (Kim *et al* ., 2003).

The use of sub sterilizing doses of radiation to produce sexually competitive moths has been suggested by many researchers. Furthermore, by using this method, the F_1 offspring of irradiated lepidopterous species are often partially or completely sterile. So, reproduction is suppressed in at least two generations with only one release. This phenomenon is known as F_1 sterility or inherited sterility. (Abd El-Hamid, 2004). The combined effects of gamma irradiation and bioinsecticides on Lepidopterous insects have been studied by several authors (Sallam *et al*., 1991; Mohamed, 2004; Mohamed *et al*., 2004; El-Nagar *et al*., 2004; El-Shall & Mohamed, 2005; Mohamed, 2006 and El-Naggar *et al*., 2012).

The present study aimed to clarify the possibility of using certain essential oils, namely, *Mentha piperita*, *Pelargonium graveolens* and *Ocimum basilicum* alone or combined with gamma radiation in the control of this serious pest.

MATERIALS AND METHODS

Insect rearing technique

The strain of the greater wax moth, *Galleria mellonella* L. used in this study originated from egg- masses collected from infested bee hives at Qualubia Governorate. These egg- masses were surface sterilized with formalin vapor (10%) as suggested by David *et al.* (1972), and reared according to Hussein (2004). Larvae were reared on a semi-synthetic diet developed from Wiesner (1993). This media consists of: 22% corn groats (polenta), 22% wheat-flour (full com) or brushed-grain wheat, 11% milk powder (skim-milk), 11% honey, 11% glycerol, 5.5% yeast powder ("brewer's yeast", beer yeast), 17.5% bee wax at 28-30 ^{o}C and 65 ±5% R.H.

Emerged adults were collected and kept in similar empty glass containers (egg laying cages) provided with paper lids (egg laying substrate) to the glass container. Paper carrying the eggs were removed for collection and replaced by new one. Eggs were gently removed and transferred to other rearing jar containing 250gm media, closed tightly with double muslin layer to prevent the escape of neonatal larvae, and incubated. Fresh food was add frequently (1-2) times per week.

Source of irradiation

The source of gamma radiation used during the present study was from a Cobalt 60 (^{60}Co) irradiator installed in the cyclotron project, Nuclear Research Center, Abu Zaabal, Egypt; the dose rate of irradiation source was 1 Gray/ second.

Volatile oils

Three commercially available volatile oils were tested in this study.

Peppermint oil, *Mentha piperita*; geranium oil, *Pelargonium graveolens;* and basil oil, *Ocimum basilicum*. All tested oils were purchased as pure oils (Branded in Egypt) from kateo aromatic Company of medicinal and aromatic oils. The oils were extracted from the dried plants by steam distillation.

Experimental technique

Contact toxicity

Four different concentrations (0.625%, 1.25%, 2.500% and 5.00 %) of each of the tested oils were prepared from the stock solution by dilution with acetone in volumetric flasks to give the necessary concentrations. The contact toxicity was tested in Petri dishes (10 cm), each of them containing 10 larvae. Filter paper disks (Whatman No. 1) were cut (10 cm) and impregnated with series of concentrations of each essential oil. Ten replicates were run for each concentration and control (untreated and acetone). After 24, 48, 72 and 96 h from the beginning of exposure, numbers of dead and alive larvae and the percentage total larval mortality at the end of larval period were recorded. The (LC_{10}, LC_{50} and LC_{90}) values were assessed by Probit analysis (Finney, 1971). The effect of sub lethal concentrations (LC_{50}) on some biological aspects (pupation, emergence, survival and sex ratio) of the treated stage and its subsequent developmental stages were determined.

Irradiation process

Full-grown pupae of GWM (Parental male ; P_1) were irradiated 24–48 h before adult emergence (male line and female line) with 3 sub-sterilizing doses 100, 150, and 200 Gy and two sterilizing doses 250 and 300 Gy, in a 100 cc plastic cup. The fecundity and fertility were determined. Four crossing combination(5 replicates for each) were set up as follows for each dose: treated ♂♂ X untreated ♀♀, untreated ♂♂ X treated ♀♀, treated ♂♂ X treated ♀♀, untreated ♂♂ X untreated ♀♀. The later combination was used as control. The daily-deposited eggs of irradiated and non-irradiated females were collected, counted, recorded and kept for calculating the percentage of eggs hatched.

Combined effect of gamma irradiation and essential oils on certain biological aspects of *G. mellonella*

One dose level of gamma irradiation from the previous doses was chosen (100Gy) to study the combined effect of gamma irradiation with the (LC_{50}) of the two tested essential oils *M. piperita* and *P. graveolens* on some biological aspects of the greater wax moth, *Galleria mellonella* (larval mortality, pupation, emergence, sex ratio and the survival) among F_1 generation.

To continue, the F_1 generation for the male line, newly hatched larvae resulting from irradiated P_1 males were kept in groups, in glass jars, and provided with a semi-synthetic diet. The contact toxicity of three acetone concentrations (LC_{50}) of the two volatile oils has been tested as previously described. Rearing was continued in the same way until larvae reached the last larval instar, then larvae were transferred individually to small plastic vials (10 c) for pupation. For each treatment, the newly emerged males of the first generation (F_1) descendants of irradiated parental males were paired with newly emerged untreated females using all possible crosses between them in order to obtain the F_2 generation. The daily-deposited eggs of irradiated and non-irradiated females were collected, counted, recorded and kept for calculating fertility.

Statistical analysis

Data were statistically analyzed using the Analysis of Variance (ANOVA) technique and the means were separated using Duncan s multiple range test (P> 0.05) (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Data obtained in Table (1) show the effect of four different concentrations of the tested oils on 4th larval instar of *G. mellonella* at different time intervals. Results show that all concentrations tested have toxic effect on the treated larvae compared to the control. The percentage of larval mortality increased vertically by increasing the concentration and horizontally by the time of exposure. The highest larval mortality (100%) was obtained with 2.5 % of *Ocimum basilicum*.

Table 1: Effect of some volatile oils on the percentage larval mortality (Mean ± SE) of the Greater wax moth, *galleria mellonella*

Volatile oil	% Concentration	% Larval mortality after …h ± SE				% Total larval mortality in the end of larval period
		24 h	48 h	72 h	96 h	
Mentha piperita	0.625	02±1.334	4±1.528	05±1.668	07±1.529	29±5.471[ef *]
	1.250	11±2.335	20±2.984	21±3.483	28±4.670	48±4.166 [cd]
	2.500	29±3.483	49±6.746	57±5.976	60±5.778	74±3.715 [b]
	5.000	44±7.029	55±7.193	63±6.511	67±5.592	79±2.771[b]
Pelargonium graveolens	0.625	02±1.334	4±1.528	11±3.483	13±3.002	22±2.496 [f]
	1.250	11±3.147	15±4.537	20±5.379	25±6.014	38±5.337 [de]
	2.500	31±6.909	40±6.671	44±6.868	49±6.579	52±6.115 [c]
	5.000	33±6.679	40±5.582	45±4.776	50±3.654	55±2.689[b]
Ocimum basilicum	0.625	05±2.689	09±2.771	11±3.789	14±4.764	18±4.903 [f]
	1.250	66±8.724	71±8.366	72±8.412	73±8.040	77±5.787 [b]
	2.500	100±0.000	100±0.000	100±0.000	100±0.000	100±0.000 [a]
	5.000	100±0.000	100±0.000	100±0.000	100±0.000	100±0.000 [a]
Control	---	00±0.000	1±1.000	2±1.330	06±2.212	14±3.715 [f]
Acetone	----	00±0.000	3±1.529	5±2.689	13±3.961	21±3.789 [f]

* Means followed by the same letter in each column are not significantly different at (p> 0.05)

The lowest percentage of total larval mortality, 18%, was recorded at 0.625 concentrations of the same oil. Many authors recorded the mortality of Lepidopteran insects as a result of treatment with plant oils; as Sharma *et al..*, (2001); Moawad, (2001) and Pavela & Chermenskaya (2004). Our results runs parallel to what have been found by Mohamed (2012), who declared that, the effect of the plant extract (Neem) on the percentage of larval mortality of *G. mellonella* increased by increasing the period horizontally and the concentration vertically. The activity of *Pelargonium graveolens* against another insect pest was reported by Kabera *et al.,* (2011). The authors stated that this oil had high contact and oral toxicity against the maize weevil (*Sitophilus zeamais*).

Data summarized in Table (2) illustrate the biological effect of the selected oils on 4th larval instar and its subsequent developmental stages of the Greater wax moth, *G. mellonella*. Percentages pupation was reduced by increasing the concentrations of the applied oils. A complete inhibition of pupation was observed at 2.5 and 5% of *O. basilicum* followed by 21% at 5 % of *M. piperita*.

The data presented in the same Table also show that the percentage of adult emergence reduced at all tested concentrations of plant oils compared to the control. A complete inhibition of adult emergence resulted from the treatment of larvae with 2.5 % of *O. basillicum.* 5% of *P. graveolens* caused 97.50% reduction in adult emergence. Whereas, a dose of 5% of *M. piperita* resulted in 73.33% % reduction in adult emergence.

Treatments with the oils obviously decreased the survival percentages. All insects failed to survive when treated with 2.5 % of *O. basilicum.* The percentages of survival were 17% at 5 %

of *Mentha piperita* while the highest percentage of survival recorded was 78% at 0.625 % *Pelargonium graveolens*. The sex ratio was extremely affected at all concentrations of the tested oils; it was in favor of male at highest concentrations. A significant variation was found between means of larval-pupal period at all treatments.

Table 2: Effect of some volatile oils on some biological aspects of the greater wax moth, *Galleria mellonella*

Essential oil	% Concentration	Larval - pupal period / day ± SE	% Pupation ±SE	% Emergence ±SE	Sex ratio		% Survival ±SE
					Male ±SE	Female	
Mentha piperita	0.625	43.00±0.48[e]	71±5.471[ab]	91.35±03.485[ab]	0.93±0.155 [a]	1	62±5.739 [bc]
	1.250	44.00±0.71 [f]	52±4.166 [cd]	78.50±05.415[ab]	1.08±0.353 [a]	1	45±4.285 [de]
	2.500	44.10±0.94 [f]	26±3.715 [e]	66.67±10.549 [b]	1.05±0.384 [a]	1	19±5.048 [f]
	5.000	44.34±0.62 [f]	21±2.771 [e]	73.33±11.715 [ab]	0.70±0.200 [a]	1	17±3.008 [f]
Pelargonium graveolens	0.625	34.14±0.21 [a]	78±2.496 [a]	88.89±01.111 [a]	2.05±0.513 [a]	1	78±2.000 [ab]
	1.250	36.68±0.23 [b]	65±4.776 [bc]	95.14±03.307 [a]	2.02±0.728 [a]	1	59±5.670 [cd]
	2.500	37.00±0.20 [b]	48±6.115 [d]	96.67±03.335 [a]	0.87±0.165 [a]	1	46±6.004 [de]
	5.000	39.17±0.36 [d]	43±2.136 [d]	97.50±02.502 [a]	1.28±0.226 [a]	1	42±2.496 [e]
Ocimum basilicum	0.625	37.66±0.24 [b]	82±4.903 [a]	89.45±03.557 [ab]	1.81±0.481 [a]	1	74±6.000 [ab]
	1.250	38.38±0.57 [c]	23±5.787 [e]	80.00±13.343 [ab]	1.15±0.381 [a]	1	23±5.787 [f]
	2.500	00.00±0.00[g]	00±0.000 [f]	00.00±00.000 [c]	0.00±0.000 [a]	1	00±0.000 [g]
	5.000	00.00±0.00 [g]	00±0.000 [f]	00.00±00.000 [c]	0.00±0.000 [a]	1	00±0.000 [g]
Acetone	---	38.50±0.64 [c]	79±3.789 [a]	95.39±01.897 [a]	1.69±0.208 [a]	1	75±3.075 [ab]
Control	----	35.28±0.55 [a]	86±3.715 [a]	97.89±01.411 [a]	1.43±0.228 [a]	1	83±3.002 [a]

Means followed by the same letter in each column are not significantly different at ($p > 0.05$)

All treatments prolonged the larval-pupal period especially at 5 % *Mentha piperita* where it reached 44.34 days compared to 35.28 day in the control. Decrease in survival of insects treated with essential oils was also reported by many authors as Padin *et al.*, (2013) on *Tribolium castaneum* and Kazem & El-Shereif (2010) on some piercing sucking cotton pests, Sreekanth (2013) on mussel scale (Lepidosaphes piperis). Our results are in agreement with Mohamed (2012) who found that the treatment of *Galleria mellonella* with Neem extract decreased the percentage of pupation, adult emergence and survival.

Fecundity and fertility of the Greater wax moth, *G. mellonella* treated with 100, 150, 200, 250 and 300 Gy gamma radiations are shown in Table (3).

The average number of eggs laid by females was significantly decreased by increasing the irradiation doses at all treatments. The highest decrease in the average number of eggs was at the mating (Normal Male x Treated Female) among the three doses 200 Gy, 250 Gy and 300 Gy, it was 377.2, 225.6 and 177.2 respectively compared with the control treatment. While, in the treatment (Treated Males x Treated Females), the insects failed to lay any eggs. This reduction in the fecundity of treated insects may be due to the reduction in longevity, the number of oocytes per ovary and oviposition period (Soltani and Mazouni 1992). Also, fertility of the treated insects was significantly decreased by increasing the dose at all treatments when compared with the control. Fertility was sharply decreased to 3.93% at 250 Gy TM x NF, 3.00 % at 200 Gy NM x TF, and 1.04% at 250 Gy NM x TF. No eggs were hatched at 200 or 250 Gy at the mating TM x TF and at all mating combinations of the dose 300 Gy. This apparent decrease in fertility may be due to sterilization of both eggs and sperms or may be due to inability of the sperms to be transferred to females during copulation. The decrease in the fecundity and fertility of irradiated insects was noticed by many other investigators as Hofmeyr *et al.*, (2004); Tate *et al*. (2007); Aye *et al.* (2008); Mohamed (2006); El-Kholy and Abd-El-Aziz (2010); Mohamed (2012).

Table 3: Effect of gamma irradiation on fecundity and fertility of the greater wax moth, *Galleria mellonella* parents

Dose (Gy)	**Pairings** ♂ **X** ♀	**Av. No. of eggs / ♀ ±SE**	**Hatch % ±SE**
Control (0)	N X N	1919.0±222.296 [a]	92.78±0.270 [a]
100	T X N	1394.2±196.860 [b]	63.28±0.818 [b]
	N X T	1268.0±200.631 [b]	33.54±0.844 [d]
	T X T	718.0±211.957 [cd]	10.72±0.483 **f**
150	T X N	1178.0±199.592 [b]	42.04±0.777 [c]
	N X T	1030.0±153.154 [bc]	15.05±0.744 [e]
	T X T	665.8±216.141 [cde]	4.88±0.391 [g]
200	T X N	676.0±131.371 [cdef]	19.05±1.077 [e]
	N X T	377.2±044.022 [defg]	3.00±0.650 [h]
	T X T	00.0±000.000 [g]	0.00±0.000 [i]
250	T X N	630.2±152.993 [cdef]	3.93±0.804 [gh]
	N X T	225.6±048.655 [efg]	1.04±0.191 [i]
	T X T	00.0±000.000 [g]	0.00±0.000 [i]
300	T X N	610.8±137.718 [cd]	0.00±0.001 [i]
	N X T	177.2±046.639 [d]	0.00±0.000 [i]
	T X T	00.0±000.000 [g]	0.00±0.000 [i]

Means followed by the same letter in each column are not significantly different at ($p > 0.05$)

Mortality percentage, developmental period, pupation, adult emergence, sex ratio and survival of *G. mellonella* treated with the LC_{50} of both *M. piperita* and *P. graveolens* and gamma radiation 100 Gy are shown in Table (4).

In all treatments tested, irradiation and/or oils significantly increased larval mortality. The recorded mortalities were 30.50% in case of 100 Gy radiation and 51 & 55% in case of *P. graveolens* and *M. piperita,* respectively and it were 68 & 70% in case of the combined treatment with *P. graveolens* and *M. piperita,* respectively. No significant difference was found between the activities of both oils in case of separate or combined treatments.

In all treatments tested, irradiation and/or oils significantly decreased the percentage of pupation at the F_1 generation. Pupation percentages were 69.5% in case of radiation and 45 & 49% in case of *M. piperita* and *P. graveolens,* respectively and it were 29 & 32% in case of the combined treatment with *M. piperita* and *P. graveolens*, respectively. No significant difference was also found between the activities of both oils on pupation or adult emergence in case of separate or combined treatments. The sex ratio of F_1 generation skewed toward males in the control and at all treatments.

The data in the same Table (Table 4) show that the percentage of F_1 larvae survived to the adult stage was significantly decreased among all single or combined treatments. Percentages of survival were 62.0% in case of radiation and 42 & 47% in case of *M. piperita* and *P. graveolens*, respectively and it were 26 & 28% in case of the combined treatment with *M. piperita* and *P. graveolens,* respectively as compared to 91% survival in control. No significant difference was also found between the activities of both oils on survival in case of separate or combined treatments.

Table 4: Combined effect of 100 Gy of Gamma irradiation (irradiated parental male) and LC_{50} of some volatile oils (treated F_1 descending of irradiated parental male) on some biological aspects of the greater wax moth, *Galleria mellonella*

Treatment	% Larval mortality ±SE	% Pupation ±SE	% Emergence ±SE	Sex ratio Male ±SE	Sex ratio Female	% Survival ±SE
Control	10.00±3.336 [d]	93.00±1.529 [a]	98.89±1.110 [a]	1.16±0.12 [bc]	1	91.00±2.34 [a]
100 Gy	30.50±2.932 [c]	69.50±2.930 [b]	89.32±2.410 [a]	1.23±0.25 [b]	1	62.00±2.81 [b]
***Mentha piperita* (1.7%)**	55.00±2.238 [b]	45.00±2.238 [c]	92.50±5.340[a]	1.52±0.32 [a]	1	42.00±3.59 [c]
100 Gy + *Mentha piperita* (1.7%)	70.00±3.336 [a]	29.00±3.483 [d]	90.00±5.532[a]	1.12±0.30 [c]	1	26.00±3.40 [d]
***Pelargonium graveolens* (2.7%)**	51.00±2.335 [bc]	49.00±2.335 [c]	95.50±3.025 [a]	1.40±0.30 [a]	1	47.00±3.00 [c]
100 Gy + *Pelargonium graveolens* (2.7%)	68.00±4.166 [a]	32.00±4.166 [d]	90.50±3.908 [a]	1.15±0.20 [bc]	1	28.00±3.27 [d]

Means followed by the same letter in each column are not significantly different at ($p > 0.05$)

Mortalities of many Lepidopteran insects due to treatments with plant extracts and/or gamma irradiation was reported by many investigators. El- Shall *et al,* (2005) in their study on *Spodoptera littoralis,* found that ethanol, petroleum either and chloroform extracts of *Eucalyptus camaldulensis* induced serious chronic effect on larvae, pupae and adult emergence when used alone or combined with gamma radiation. As well, El-Naggar *et al*., (1992) reported that the effect of gamma irradiation and extracts from Tafla leaves *Nereum oleander* and nabk *Flacourtia indica* on *Spodoptera littoralis* either used alone or combined with gamma radiation reduced the development of larvae or pupae and inhibited adult emergence. In addition, Sileem (2004) declared that, the effect of gamma irradiation and extracts from *Malissa azedrach* fruits or *Schintis terebinthifdies* leaves on *Agrotis ipsilon,* used alone or combined, reduced the development of larvae or pupae and inhibited adult emergence. Sharma and Seth (2005) in their study of *Malia azedrach* and its combination with gamma radiation on *S. litura* found that the growth and the development of larvae were reduced.

Generally, joint treatment of irradiation plus oils tested in the present work was more efficient than oil or irradiation separately. Combination of irradiation and plant oils increased larval mortality and reduced pupation as well as adult emergence and survival. These deleterious effects of combined treatments may be due to an increase in the susceptibility of irradiated insects to oils (El-Naggar *et al*., 1992). Seth and Sehagel (1993) stated that the growth index in *S. littura* of F_1 progeny resulting from irradiated male parents decreased by increasing gamma irradiation dose. El-Naggar *et al*. (1999) stated that joint treatment of irradiation plus plant extracts was more toxicant than the plant toxicity or irradiation separately. Hazaa (2005), also stated that the growth index in *S. littura* of F_1 progeny resulting from irradiated male parents and treated with red gum plant extract, *Eucalyptus camaldulensis* was obviously reduced more than control in most treatments. Also, Mikhaiel (2011) stated that the adverse effect on growth and reproduction of the progeny of *Sitotroga cerealella* moth, descending from irradiated male pupae with 175 Gy and treated with four plants extracts was increased by increasing the concentrations applied. Similar explanations were also made by El-Shall and Mohamed (2005) on *A. ipsilon,* Fadel *et al*. (2003) on *Ceratitis capitata*, Mohamed (2012) on *Galleria mellonella* and Mohamed (2013) on *Agrotis ipsilon (Hufnagel).*

CONCLUSION

It may be concluded that LC_{50} of *Mentha piperieta* combined with the dose 100 Gy can be efficient for the effective control of *Galleria mellonella* in particular and lepidopterous pests in general. Moreover, *Ocimum basillicum* is more toxic against *Galleria mellonella* if used alone without any combination treatment. Also, we can conclude that the combined treatment with gamma irradiation and plant oils is more efficient in control than single treatments.

REFERENCES

Abd El-Hamid (2004). Effect of gamma irradiation on certain biological and physiological aspects of black cut worm *Agrotis ipsilon* (Hufn). M.Sc Thesis. Fac. Agric.Cairo Univ.

Abdel-Zaher, T.R. (1998). Using some plant extracts and their mixtures with pesticides to control cotton pestes; M.Sc. Fac. of Agric., Zagazig University.

Aye T. T.; Jae-Kyoung Shim; Dae-Myung Ha; Yong-Jung Kwon; Joong-Ho Kwon and Kyeong-Yeoll Lee (2008). Effects of gamma irradiation on the development and reproduction of *Plodia interp-unctella* (Hubner) (Lepid-optera: Pyralidae). J. Stored Products Research, 44: 77-81.

Charriere, Jean-Daniel and Imdorf, A. (1997). Protection of honey combs form moth damage. (Swiss Bee Research Centre, Fedral Dairy Research Station, Liebfeld, CH-3003 Bern. Comm. No. 24).

David, W. A. L.; Elloby, S. and Taylor, G. (1972). The Fumigant action of formaldehyde incorporated in a semi synthetic diet on the granulosis of *Pieris brassicae* and its evaporation from the diet; J. Invertebr. Pathol., 19: 76-82.

El Nagar, T, F.K.; Abdel Fattah, H. M.; Khaled, A. S. and Aly; S. A. (2012). Efficiency of Peppermint Oil Fumigant on Controlling *Callosobruchus maculatus* F. Infesting Cowpea Seeds. Life Science Journal, 9(2):375-383.

El-Kholy; M. S. and Abd-El-Aziz; N. M. (2010). Effect of gamma irradiation on the biology and ultrastructure of haemocytes of greater wax moth, *Galleria mellonella* (L.) (Lepidoptera: Galleridae). Isotope & Rad. Res., 68:1671–1676.

El-Naggar, S. E. M.; Ibrahim, S. M. and El-Shall, S. S. A. (1999). Mating Competitiveness of *Agrotis ipsilon* (Hufn.). Arab J. of Nuc. Sci. and Applications, v. 33(3): 225-231.

El-Naggar, S. E. M., Ibrahim, S. M., Mohamed, H. F. (2004). Combined and separate effects of gamma irradiation and barnoof plant extract on the dietary profile of the black cutworm, Agrotis ipsilon (Hufn.) I-Treatment of the eight days-old larvae. Seventh Arab Conference on the Peaceful Applications of Atomic Energy, Sanna, a, Yemen, 4–8 Dec.

El-Naggar, S. E. M.; Abdel-Kawy, F. K. and El-Khayat, E. F. (1992). Relative susceptibility of gamma irradiated cotton leaf worm *Spodoptera littoralis* (Boisd.) to some plant extracts. J. Annals of Agric. Sc. Moshtohor 30: 1955-1964.

El-Shall, S. A.; Alm El-Din, M. M. S. and Magdia A. M. Hazaa (2005). Biological response of the cotton leaf worm *Spodoptera littoralis* towards combination of ssed and leaf extracts from red gum *Ecualyptus camaldulensis* and/or gamma radiation; Isotope & Rad. Res., 37 (3): 677- 693.

El-Shall, S.S.A., Mohamed, H.F., (2005). The combined effect of gamma irradiation and plant extract (Barnoof) on the nutritional profile of the Black cutworm, *Agrotis ipsilon* (Hufn.) (Lepidoptera: Noctuidae), II-the effect on the F_1 progeny during the 5th and 6th instars larvae. Arab J. Nucl. Sci. Appl. 38 (2): 289.

Fadel, A. M.; El-Gengaihi, S. E.; El-Kholy, E. M. S. and Shoman, A. A. (2003). Combined effects of gamma irradiation and two plant extracts, *Nicandra physaloide* and *Dodonaea viscose* on the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann). Arab J. of Nucl. Sci. and Appl., 36(1): 163-169.

Fields, P. G., Xie, Y. S. and Hou, X. (2001). Repellent effect of pea (*Pisum sativum*) fractions against stored product insects. Journal of Stored Products Research. Volume 37, (4), Pages 359–370

Finney, D. J. (1971). Probit Analysis, 3th Edition. Cambridge University, London. 333 pp.

Hazaa, M. A. M. (2005). Influence of Red gum Plant extract, *Eucalyptus Camaldulensis*, and / or Gamma Irradiation on The nutrition and utilization of the food of the cotton leaf worm *Spodoptera Littoralis* (Boisd.). Isotope & Rad. Res., 37(6): 1547-1561.

Hidalgo, E., Moore, D. and Patourel, L. E. (1998). The effect of different formulations of *Beauveria bassiana* on *Sitophilous zeamais* in stored maize. J. Stored Product Research, 34: 71-79.

Hofmeyr, H.; Hofmeyr, M.; Bloem, S.and Carpenter, J. (2004). Control of false codling moth using sterile insect release: laboratory trials., SA Fruit J., 3(4): 55-59.

Hussein, M.A. (2004). Utilization of entomopathogenic nematodes for the biological control of some lepidopterous pest Entomology (Bio Control). Ph. D. Thesis. Faculty of Science, Ain Shams University, Egypt pp. 203.

Kabera, J.; Gasogo, A.; Uwamariya, A.; Ugirinshuti, V.; and Nyetera, P. (2011). Insecticidal effects of essential oils of *Pelargonium graveolens* and *Cymbopogon citratus* on *Sitophilus zeamais* (Motsch.). African J. Food Science 5(6): 366 – 375.

Kazem, M. G. T. and El- Shereif, S.A.E.H.N. (2010). Toxic Effect of Capsicum and Garlic Xylene Extracts in Toxicity of Boiled Linseed Oil Formulations against Some Piercing Sucking Cotton Pests. American-Eurasian J. Agric. & Environ. Sci., 8 (4): 390-396.

Kim, S., Roh, J. Y., Kim, D. H., Lee, H. S. and Ahn, Y. J. (2003): Insecticidal activities of aromatic plant extracts and essential oils against *Sitophilous oryzae* and *Callosobruchus chinensis*. Journal of Stored Products Research, 39: 293-303.

Mikhaiel, A. A. (2011). Potential of the combined use of inherited sterility and four botanical extracts for the control of *Sitotroga cerealella* (Olivoer) (Lepidoptera: Pyralidae); J. Rad. Res. Appl. Sci., 42(B): 599 - 614.

Moawad. S. Sawsan (2001). Efficiency of some natural plant oils as Protectants for Cowpea- stored seeds against *C. maculatus* (f) (Coleopteran- Brochidae). Bull. ent. Soc. Egypt, Econ. Ser 28:1-11.

Mohamed, H.F. (2013). Bioenergetics growth model for the effect of gamma irradiation and plant extract (Barnoof) on the progeny of Black cutworm, *Agrotis ipsilon* (Hufnagel) Applied Radiation and Isotopes 73: 101–108.

Mohamed, H. F. (2012). The Biological Effects of Gamma Irradiation and / or Plant Extract (Neem) on the Greater Wax Moth, *Galleria Mollenella.* Eleventh Arab Conference on the Peaceful Uses of Atomic Energy, Khartoum, Sudan, 16-20.

Mohamed, H. F. (2004). Inherited sterility induced by gamma irradiation and/or Barnoof plant extract on reproductive potential and mating ability of the black cutworm, *Agrotis ipsilon* (Hufngel) (Lepidoptera: Noctuidae). Isot. Radiat. Res. 36 (4): 713.

Mohamed, H.F., (2006). Effects of gamma irradiation and leaves extract of barnoof plant on larval development of Agrotis ipsilon (Hufngel). Arab J. Nucl. Sci. Appl. 39 (2): 255.

Mohamed, H. F., El-Naggar, S. E. M., Mohamed, A. Z. (2004). The combined effect of gamma irradiation and plant extract barnoof on the nutritional profile to the black cutworm, Agrotis ipsilon, III. The effect on some haemolymph digestive enzyme activities. J. Egypt. Acad. Soc. Environ. Dev. (C-Mol. Biol.) 5 (2): 99.

Mohamed,H.F. (2012). The Biological Effects of Gamma Irradiation and / or Plant Extract (Neem) on the Greater Wax Moth, *Galleria Mollenella.* Eleventh Arab Conference on the Peaceful Uses of Atomic Energy, Khartoum, Sudan, 16-20.

Osman, S.M. (1996). Evaluation of the biological activity of certain plant extracts on the black cutworm *Agrotis ipsilon* (Hufn.) (Noctuidae, Lepidoptera); M.Sc. Thesis, Fac. of Sci., Ain Shams University.

Owayss, A. A. and Abd-Elgayed, A. A. (2007). Potential Efficacy of Certain Plant Volatile Oils and Chemicals against Greater Wax Moth, *Galleria mellonella* L. (Lepidoptera: Pyralidae). Bull. Ent. Soc. Egypt, Econ. Ser., 33:67–75.

Padin SB, Fuse C, Urrutia MI, Bello GMD (2013). Toxicity and repellency of nine medicinal plants against *Tribolium castaneum* in stored wheat. Bulletin of Insectology 66, 45-49.

Pavela, R., Chermenskaya, T. (2004). Potential insecticidal activity of extracts from 18 species of medicinal plants on larvae of *Spodoptera littoralis*. Plant Protect. Sci., 40: 145–150.

Sallam, H.A., Elnagar, S., Ibrahim, S.M., (1991). Effects of gamma radiation on reproductive potential of the black cut worm, Agrotis ipsilion (Hufn.). Arab J. Nucl. Sci. Appl. 24:165–174.

Seth, R.K and Sehgal, S.S. (1993). Partial sterilizing radiation dose effect on the F1 progeny of *Spodoptera Litura* (Fabr.) In: Management of insect pests: Nuclear and Related Molecular and Genatic Technique. Proc. Symp. Held in Vienna 19-23 Oct. IAEA. SM. 327/400: 427-440.

Sharma, A. K. and Seth, R. K. (2005). Combined effect of gamma radiation and Azadirachtin on the growth and development of Spodoptera litura (Fabricius). Curr Sent 1028 Sci, 89 (6): 1027-1031.

Sharma, S. S.; Gill, K.; Malik, M. S. and Malik, O. P. (2001). Insecticidal, antifeedant and growth inhibitory activities of essential oils of some medicinal plants. J. Medicinal and Aromatic Plant Sciences., 22/23(4A/1A): 373-377.

Sharma1, S.; Senrung, A. and. Singh A.K.(2014). Toxic effect of neem, Azadirachta indica (A. Juss) foliage extracts against diamondback moth

(DBM*)*, *Plutella xylostella* (L.) (Lepidoptera, Plutellidae). J. Biopest 7 (supp.): 99-105.

Sileem, Th.M. (2004). Effect of Gamma Radiation and some Plant Extracts on the Black Cut Worm *Agrotis ipsilon*; M.Sc. Thesis Fac. of Agric. Benha Univ.

Soltani, N and Mazouni N. S. (1992). *Diflubenzuron and oogenesis in the codling moth, Cydia pomonella (L.) Pesticide Science 34 (3): 257–261.*

Steel, R.G.D., Torrie, J. H. (1980): "Principle and procedures of 2nd.ed. (McGraw-Hill book Co., New York., (1980).

Sreekanth, M. (2013): Field evaluation of certain leaf extracts for the control of mussel scale (Lepidosaphes piperis Gr.) in Black pepper (Piper nigrum L.) Journal of Biopesticides, 6(1):1-5

Tapondjou, L. A., Adler. C., Bouda, H. and Fontem, D. A. (2002). Efficacy of powder and essential oil from *Chenopodium ambrosioides* leaves as post-harvest grain proctentants against six-stored product beelles. Journal of Stored Products Research, 38: 395-402.

Tate, C. D; Carpenter, J. E. and Bloem, S. (2007). Influence of radiation dose on the level of F1 sterility in the Cactus moth, *Cactoblastis cactorum*(Lepidoptera: Pyralidae). Florida Entomologist 90(3):64-68.

Wiesner, A. (1993). Die Induktion der Immunabwehreines Insekts (*Galleria mellonella*, Lepidoptera). Durch Synthetische Materialien und Arteigene Haemolym-phfaktoren, Berlin

Wondafrash M, Getu E. and Terefe G. (2012). Life-cycle Parameters of African bollworm, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) affected by Neem, *Azadirachta indica* (A. Juss) Extracts. Agricultural Science Research J., 2(6): 335 - 345.

ARABIC SUMMERY

تأثير ثلاث مستخلصات نباتيه و أشعه جاما علي دوده الشمع الكبري جاليريا ميلونيلا

نهاد محمد البرقي [١] , حسين فريد محمد[٢]، سميره السيد النجار [٢]، مروه صلاح محمد سالم[٢]
عبد الوهاب عبد المقصود ابراهيم[١]
١- قسم علم الحشرات - كليه العلوم – جامعه بنها - ، مصر
٢- مركز البحوث النووية، هيئة الطاقة الذرية، القاهرة، مصر

تم اختبارتأثيربعض الزيوت النباتية كزيت النعناع والعطر والريحان فى المعمل على العمر الرابع اليرقى لحشرة دودة الشمع الكبرى جاليريا ميللونيلا. وقد أظهرت هذه الزيوت تأثيرا مثبطا للنمو وقد تمثل هذا التأثير فى طول فترة العمر اليرقى وأعمار العذارى ونقص واضح فى نسبة التعذير ونسبة الخروج للحشرات الكاملة ، كما اشتملت مظاهر تسمم اليرقات على زيادة نسبة الموت حيث سجل زيت الريحان أعلى نسبة موت يليه زيت النعناع ثم زيت العطر. أيضا تأثرت المظاهر الأخرى للنمو كالنسبة الحياتية ومعدل تثبيط النمو والنسبة الجنسية . وقد وجد أن المعاملة المشتركة للجرعة ١٠٠ جراى من أشعة جاما مع تركيز لزيت النعناع والعطر ذات تأثير واضح على نسبة الموت الكلية لليرقات حيث وصلت نسبة الموت إلى ٧٠% فى المعاملة ١٠٠ جراى + زيت النعناع وقد نقصت كلا من نسبة التعذير ونسبة خروج الفراشات الكاملة ومؤشر النمو والنسبة الحياتية نقصا واضحا خلال الجيل الأول للإشعاع المعامل بالزيوت النباتية.