EFFECT OF GAMMA IRRADIATION COMBINED WITH *B.T.*BIOCIDE TREATMENTS ON SOME INSECT PESTS IN LABORATORY

REDA, A. M. AMER, M. A. AHMED and A. E. HATEM

Plant Protection Research Institute, Agriculture Research Center, Dokki, Giza, Egypt.

(Manuscript received 1st November 2011)

Abstract

The study was done in the laboratories of Bollworms, Leafworm and piercing & sucking Research Departments of Plant Protection Research Institute during 2010. The tested pests and the biocide, Protecto were exposed to gamma irradiation doses at National Center for Radiation Research and Technology, Egypt.

Three tested insects were tested includes: pink bollworm, *Pectinophora gossypiella* (Saund.) newly hatched and fourth instar larvae, cotton leafworm, *Spodoptera littoralis* (Boisd.) 4th instar larvae and the nymph & adult of cowpea aphid, *Aphis craccivora* (Koch). Insects were exposed to three doses of gamma irradiation, 150, 250 & 350 Gy. Also, the biocide compound, Protecto (*Bacillus thuringiensis,* Kurs.) was applied on the same pests to assess the insecticidal activity of Protecto in three combinations (Protecto +150 Gy, Protecto +250 Gy and Protecto +350 Gy).

Data showed that the tested γ- irradiation doses of 150, 250 and 350 Gy increased the newly hatched larval mortality of *P. gossypiella* to 52, 65 and 85% at zero day, respectively. While, it was reached to 100% kill at third day for 350 Gy and fifth day for 150 and 250 Gy. Larval mortality of *P. gossypiella* fourth instar was reached to 100% at eight and tenth days after radiation. Also, the larval mortality of *S. littoralis* fourth instar larvae was reached to 100% at tenth and twelfth days after treatment, respectively. While, *A. craccivora* adults and nymphs mortality was reached to 100% at zero day just after treatment.

Generally, LC_{50}'s on subjected insects treated with Protecto and exposed to gamma doses were lower than untreated Protecto.

The aim of present work was to evaluate the insecticidal activity of the biocide Protecto in combination with γ-irradiation exposure against three key insect pests in laboratory.

Key words: Protecto, gamma irradiation, *P. gossypiella, S. littoralis, A. craccivora*

INTRODUCTION

The pink bollworm, *Pectinophora gossypiella* (Saund.) (Lepidoptera : Gelechiidae) is the most destructive pest infesting cotton bolls, okra, hibiscus and Jute in Egypt causing quantity and quality decrease of crops. The cotton leaf worm, *Spodoptera littoralis* (Boisduval) (Lepidoptera : Noctuidae) devastates a large host range of more than 120 host plants (Hatem *et al*. 2009). Also, cowpea aphid, *Aphis craccivora* (Koch) (Homoptera : Aphididae) is a threat to cowpea growers in all over the country. Both

nymphs and adults suck plant sap and cause serious damage right from the seedling to pod bearing stage. Due to heavy infestation, young seedlings succumb to death, whereas the older plants show severe symptoms and finally resulting in yield reduction. (Rabindra and Ramanujam, 2007).

The overuse of insecticides eventually created many of the problems as resistance, environmental pollution and adverse effects on the non-target organisms. In order to avoid the insecticidal hazards, there is a great need to develop alternative control agents with new mode of action. Among these agents is gamma irradiation as a genetic control method. Genetic pest suppression is unique among biological methods in that it involves the release of genetically modified insects to control the same species (Soon, 1986). The irradiated biocide, Dipel-2x with doses of 5, 10, 20, 40 & 80 Gy activated its insecticidal efficiency against two stages of the harmful *P. gossypiella* i.e. newly hatched larvae and eggs of 1-4 day old in laboratory and field experiments during seasons of 2004 and 2005 (Amer, 2006). The Inherited effects of gamma irradiation doses of 50, 75, 100, 125, 150 &200 Gy were studied on males and females irradiated as 7-day old pupae until the F3 generation. The fecundity and egg hatch were reduced, while, the mating and sperm did not affect. Also, increased the larval and pupal mortality of *S.littoralis* (Sallam and Ibrahim 1993). Moy *et al.,* (1997) suggested that gamma irradiation 0.15, 0.5, 0.7, 2.0 and 4.0 KGy were promising as a quarantine treatment for some fresh herbs and ornamental plants in Hawaii against aphids, mites and thrips.

Protecto, *B. thuringiensis* was used to control successfully the newly hatched larvae of *P. gossypiella* as reported by Amer & El-Nemaky (2008). In addition, Pawar and Borikar, 2005 reported that microbial pesticides are one such alternative to tackle insecticide resistant population of *S. litura*. Saranya*, et al.* (2010) found the same result against the cowpea aphid, *A. crassivora* (Koch). Chen, *et al.* (2011) indicated that consecutive cultivation by genetically modified cottons with BT genes can result in persistence of *Cry1Ac* proteins and negatively affect soil microbial and biochemical properties.

Thus, the aim of the present study was to evaluate the combined effects of the biocide compound, *Bacillus thuringiensis,* Kurs. (Protecto) exposed to gamma irradiation at doses of 150, 250 and 350 Gy against key destructive insect pests i.e. the pink bollworm, *P. gossypiella*, cotton leaf worm, *S. littoralis* and cowpea aphid, *A. craccivora*.

MATERIALS AND METHODS

1. Tested biocide

Protecto, is a commercial formulation of *Bacillus thuringiensis* (Kurs.) and it is a product of Special Unit for Producing Bioinsecticides, Plant Protection Research Institute, Agriculture Research Center, Egypt, with 32000 international toxicity units (spores and protein crystals) per mg. The active ingredient is 6.4% W.P and the application rate is 300gm/feddan.

Protecto 6.4% W.P was exposed to gamma irradiation doses of 150, 250, & 350 Gy. All irradiations were done by a Co^{60} Hendy Cell Research, National Center for Radiation Research and Technology, delivered at a dose rate 3.61 KGy/h.

2. Tested pests

A laboratory strain of the pink bollworm, *P. gossypiella* was reared at Bollworms Department, Plant Protection Research Institute, Agriculture Research Center on semi artificial diet as described by Rashad and Ammar (1985). Rearing conditions were adjusted at 27±1°C and 65-75% RH.

The cotton leafworm, *S. littoralis* fourth instars larvae of laboratory strain was reared at Cotton leafworm Department, Plant Protection Research Institute, Agriculture Research Center on castor oil leaves, *Ricinus communis* (L.). Rearing of insects was conducted following the technique described by El-Defrawi *et al*. (1964). Rearing conditions were adjusted at 27±1°C and 65-75% RH.

The cowpea aphids, *A. craccivora* adults and nymphs of laboratory strain was reared at Sucking and Piercing Department, Plant Protection Research Institute, Agriculture Research Center on *Ficia faba* beans leaves. Rearing conditions were adjusted at 27±1°C and 65-75% RH.

3. Effect of gamma irradiation doses on tested pests

Twenty five larvae of the newly hatched and fourth instar of *P. gossypiella* in 2 gm semi artificial diet Petri-dishes were exposed to gamma irradiation doses of 150, 250 & 350 Gy. Five replicates for each γ-irradiation doses were used and the control group was done. The larval mortality percent was recorded at 0 (the same day of exposure to gamma irradiation), 1, 3 & 5 days after treatment for newly hatched and added 8 &10 days for 4^{th} instars larvae.

Twenty five of fourth instar larvae of *S. littoralis* in castor oil leaves Petri-dishes were exposed to gamma irradiation doses of 150, 250 & 350 Gy. Five replicates for each gamma dose used and the control was done. The larval mortality percent was recorded at 0, 1, 3, 5, 8, 10 & 12 days after treatments.

Bean leaves infested by twenty five individuals of aphid adults and nymphs of *A. craccivora* were prepared in glass vials (4x8 cm), closed by muslin tighten by rubber band and exposed to gamma irradiation doses of 150, 250 & 350 Gy. Five replicates for each gamma dose used and the control was done. The adult or nymph aphid's mortality percent was recorded.

4. Insecticidal activity of Protecto biocide treatment combined with gamma doses

4.1. Pink bollworm, *P. gossypiella*.

Two gm of semi artificial diet/Petri-dish (9 cm diameter) were mixed with 1 ml. of each concentration from the tested biocide. The Petri- dish used as control was treated with 1 ml. distilled water mixed with 2 gm artificial diet. The tested concentrations were 40, 20, 10, 5 & 2.5 gm/L. Twenty five of newly hatched and fourth instar larvae of *P. gossypiella* were left starving for 4 hours, then exposed for about 6 hours (newly hatched) and one hour (4^{th} instar larvae) to Protecto, Protecto + 150 Gy, Protecto + 250 Gy & Protecto + 350 Gy and kept at 27±1^{o}C and 65-75% R.H. Then after the alive larvae were transferred to untreated artificial diet for 72 hours after treatment.

4.2. Cotton leafworm, *S. littoralis*.

Dipping technique was used at the present work. The castor oil leaves were dipped in tested compound concentrations of 40, 20, 10, 5 & 2.5 gm/L of the Protecto, Protecto +150 Gy, Protecto +250 Gy & Protecto + 350 Gy. The control was done by castor oil leaves dipping in water only. Five replicates/ concentration/ tested biocide were used. The leaves were left until water evaporation and kept in glass jars (11x22 cm). Each jar was supplied with 25 fourth instar larvae after starvation period for 4 hours and maintained under 27±1 ^{o}C. Then after the numbers of alive and dead larvae were counted three days after treatment.

4.3. Cowpea aphid, *A. craccivora*.

Slide dipping technique was used at the present work according to Dennehye *et al.,* (1983). Adults or nymphs aphid of *A. craccivora* (Koch.) were placed on a double slide sticky tape that had been fixed to micro slide. The slides were then dipped for 20 seconds into the concentrations of 40, 20, 10, 5 & 2.5 gm/L of the Protecto, Protecto + 150 Gy, Protecto + 250 Gy and Protecto + 350 Gy. Five replicates/ concentration/ tested biocide were used. Each slide was prepared by 10 aphid adults or nymphs of cowpea aphid/replicate. After treatments, aphids were kept in an incubator at 24 ±2^{o}C. A control group that was dipped into water only was also involved. Mortalities were recorded after 24 hours and aphids unable to move their legs when lightly brushed were counted as dead.

The mortality percentages as a result of gamma irradiation exposure were corrected by Abbott (1925).

LC_{50} & LC_{90} values were obtained by software computer probane. The efficiency of different insecticides could be measured by using Sun 's equation (1950) as follows:

$$\text{Toxicity index} = \frac{LC_{50}\ (LC_{90}) \text{ of the compound A}}{LC_{50}\ (LC_{90}) \text{ of the compound B}} \times 100$$

Where A: is the most effective compound (The compound that had the highest toxicity or the lowest value of $LC_{50 \text{ or } 90}$).

B: is the other (each) tested compound.

Larval mortality percentages, was analyzed using Costat statistical program software, 1990 and Duncan's multiple range test (Duncan, 1955) at 5% probability level to compare the differences among time means.

RESULTS AND DISCUSSION

1.Insecticidal activity of gamma irradiation exposure against the tested insect pests:

1.1. Pink bollworm, *P. gossypiella*.

1.1.1. Newly hatched larvae:

Gamma irradiation dose of 150 Gy caused 52% mortality at zero day (the same day of exposure to gamma irradiation) when the newly hatched larvae exposed to it. The percent increased to 65 and 85% for doses of 250 and 350 Gy as shown in Table (1). Amer (2006 a) reported that the percent larval mortality ranged between 39.04 – 48.44 % for 5 -80 Gy, because to its effect on the acetylcholine esterase after feeding on the irradiated diet.

Mortality percent were increased to 71, 80 & 95% at one day after exposure to gamma irradiation of 150, 250 & 350 Gy, respectively. The mortality reached to 84, 92 & 100% after 3- days. While, the larval mortality reached to 100% with 150 and 250 Gy at 5^{th} day. No mortality percent was recorded happened in the control group.

Table 1. Effect of gamma irradiation doses on the mortality percent of *P. gossypiella* newly hatched larvae.

Gamma doses (Gy)	% Larval mortality after			
	0-day	1-day	3-day	5-day
Control	0^{d}	0^{d}	0^{d}	0^{b}
150	52^{c}	71^{c}	84^{c}	100^{a}
250	65^{b}	80^{b}	92^{b}	100^{a}
350	85^{a}	95^{a}	100^{a}	-
$LSD_{0.05}$	5.408	2.105	2.663	-

Means in the same row followed by the same letter are not significantly different at $p<0.05$.

Table 2. Effect of gamma irradiation doses on the mortality percent of *P. gossypiella* 4^{th} instar larvae.

Gamma Doses (Gy)	% Larval mortality after					
	0-day	1-day	3-day	5-day	8-day	10-day
Control	0	0^{c}	0^{d}	0^{d}	0^{d}	0^{b}
150	0	8^{b}	38^{c}	65^{c}	86^{c}	100^{a}
250	0	10^{b}	53^{b}	71^{b}	91^{b}	100^{a}
350	0	14^{a}	65^{a}	90^{a}	100^{a}	-
$LSD_{0.05}$	-	2.306	3.522	2.321	2.927	-

Means in the same row followed by the same letter are not significantly different at $p<0.05$.

1.1.2. Fourth instar larvae:

Fourth instar larvae of the pink bollworm, *P. gossypiella* were exposed to gamma irradiation doses of 0.0, 150, 250 and 350 Gy. The larval mortality increased with γ doses increasing (Table 2). The larval mortality was 0.0 % at zero time after treatment. The mortality was ranged between 8 and 14% at 1^{st} day after exposure to 150- 350 Gy. The fourth instar larvae completely killed at 8^{th} day with 350 Gy and at 10^{th} day after exposure to 150 and 250 Gy. No larval mortality was recorded in the control group.

1.2. Cotton leafworm, *S. littoralis.*

Table (3) showed that untreated larvae group of *S. littoralis* recorded was 0.0% mortality. When the fourth instar larvae was exposed to gamma irradiation doses of 150, 250 and 350 Gy, no mortality recorded at zero day after treatment. The larval mortality recorded 8, 13 and 18% at 1-day after exposure to 150, 250 and 350 Gy, respectively. The mortality percent were increased to 100% at the 10-day after exposure to dose of 350 Gy. While, the larvae exposed to 150 and 250 Gy were completely killed at 12-day after treatment.

Table 3. Effect of gamma irradiation doses on the mortality percent of *S. littoralis* 4th instar larvae.

Gamma doses (Gy)	% Larval mortality after						
	0-day	1-day	3-day	5-day	8-day	10-day	12-day
Control	0	0^{d}	0^{d}	0^{d}	0^{d}	0^{d}	0^{b}
150	0	8^{c}	24^{c}	42^{c}	77^{c}	89^{c}	100^{a}
250	0	13^{b}	49^{b}	61^{b}	86^{b}	93^{b}	100^{a}
350	0	18^{a}	58^{a}	74^{a}	91^{a}	100^{a}	-
$LSD_{0.05}$	-	3.552	2.824	2.306	1.631	2.105	-

Means in the same row followed by the same letter are not significantly different at $p<0.05$.

1.3.Cowpea aphid, *A. craccivora*.

Adults and nymphs of the cowpea aphid, *A. craccivora* were exposed to gamma irradiation doses of 150, 250 and 350 Gy. Tested insects were completely killed at zero day after treatment.

2. Efficacy of tested biocide, *B. thuringiensis* against some insect pests.

The biocide compound, *B. thuringiensis* was exposed to gamma irradiation doses of 150, 250 & 350 Gy and evaluated against the pests of *P. gossypiella*, *S. littoralis* and *A. craccivora*.

2.1. Pink bollworm, *P. gossypiella*:

2.1.1. Newly hatched larvae:

Gamma irradiation doses of 150, 250 and 350 Gy was potentiated the efficacy of the biocide compound, Protecto (*B. thuringiensis*) against the newly hatched larvae of the pink bollworm as shown in Table (4). The LC_{50} were 0.45, 0.29, 0.07 and 0.052 gm/L for the Protecto, Protecto + 150 Gy, Protecto +250 Gy and Protecto +350 Gy, respectively on newly hatched larvae after 6 hours. The LC_{50} was lower in the

irradiated Protecto than the untreated. The toxicity index of the tested biocide was 100 according to LC_{50} and LC_{90} of Protecto + 350 Gy that considered the most effective treatment, followed by Protecto + 250 Gy (74.3 and 47.03%), Protecto + 150 Gy (17.9 and 21.01%), then unexposed Protecto (11.6 and 8.38%) that considered the least effective treatment. The LC_{50} was decreased at 72 hours after treatment. The LC_{50}, were 0.25, 0.06, 0.04 and 0.001 gm/L when the newly hatched larvae treated by Protecto, Protecto +150 Gy, Protecto + 250 Gy and Protecto + 350 Gy, respectively.

2.1.2. Fourth instars larvae:

Data in Table (4) indicated that Protecto + 350 Gy was the most potent compound after one hour from exposure, the LC_{50} was 89.62 gm/L, followed by Protecto + 250 Gy (111.1 gm/L), Protecto + 150 Gy (123.1 gm/L) and unexposed Protecto (164.1 gm/L). The toxicity index of the biocide treatments based on LC_{50} and LC_{90} was 100 for Protecto + 350 Gy against the 4th instar larvae of the pink bollworm, followed by Protecto + 250 Gy (toxicity index = 80.7 and 75.3%), Protecto + 150 Gy (toxicity index= 72.8 and 63.7%) and unexposed Protecto biocide (toxicity index= 54.6 and 57.7%). It was noticed that gamma irradiation doses were potentiated biocide the *B. thuringiensis* efficacy.

The LC_{50} value was decreased at 72 hours after treatment. The LC_{50} were 96.6, 22.49, 12.19 and 11.59 gm/L when the 4th instar larvae treated by Protecto, Protecto +150 Gy, Protecto +250 Gy and Protecto +350 Gy, respectively.

2.2. Cotton leafworm, *S. littoralis*:

The 4th instar larvae of the cotton leafworm treated by Protecto recorded, the LC_{50} of 190.8 gm/L, but the Protecto exposed to gamma irradiation doses of 150, 250 and 350 Gy had potentiated effects, LC_{50}'s were 75.31, 118.2 and 156.2 gm/L for Protecto +150 Gy, Protecto +250 Gy and Protecto +350 Gy, respectively (Table 5). Protecto+150 Gy was the most potent compound (toxicity index= 100%) according to LC_{50} and LC_{90}). While, the Protecto exposed to gamma dose of 250 Gy had decreased effect (toxicity index= 63.7 and 50.6%) according to LC_{50} and LC_{90}, followed by Protecto + 350 Gy (toxicity index= 48.2 and 36.04%) compared with Protecto +150 Gy.

2.3. Cowpea aphid, *A. crassivora*:

The adults and nymphs of cowpea aphid were treated by Protecto, Protecto +150 Gy, Protecto + 250 Gy and Protecto + 350 Gy (Table 5). Gamma irradiation doses caused potentiating effect on the Protecto efficiency especially dose of 350 Gy, followed by Protecto +250 Gy and Protecto +150 Gy (LC_{50}= 16.40, 41.17 and 49.04 gm/L) compared with unexposed Protecto, (101.5 gm/L).

Table 4. Efficacy of the tested biocide exposed to gamma doses against pink bollworm larvae.

Treatments	LC_{50} (gm/L) 95%Confidence limits	LC_{90} (gm/L) 95%Confidence limits	Toxicity index	
			LC_{50}	LC_{90}
Newly hatched larvae after 6 hours				
Protecto	0.45 0.19 ± 0.68	9.65 5.08 ± 12.8	11.6	8.38
Protecto+150 Gy	0.29 0.11 ± 0.46	3.85 2.57 ± 8.52	17.9	21.01
Protecto+250 Gy	0.07 0.0004 ± 0.184	1.72 1.11 ± 4.09	74.3	47.03
Protecto+350 Gy	0.052 0.0006 ± 0.174	0.809 0.476 ± 1.184	100	100
Newly hatched larvae after 72 hours				
Protecto	0.25 0.19 ± 0.48	7.11 3.08 ± 16.8	4.0	8.54
Protecto+150 Gy	0.06 0.01 ± 0.33	2.23 0.57 ± 4.22	16.7	27.2
Protecto+250 Gy	0.04 0.0002 ± 0.127	1.24 1.01 ± 3.05	25.0	48.9
Protecto+350 Gy	0.01 0.0004 ± 0.198	0.607 0.356 ± 1.081	100	100
4^{th} instars larvae after one hour				
Protecto	164.1 115.4 ± 346.5	555.1 166.2 ± 987.5	54.6	57.7
Protecto+150 Gy	123.1 118.7 ± 416.3	502.3 136.9 ± 839.0	72.8	63.7
Protecto+250 Gy	111.1 75.93 ± 389.2	425.1 126.9 ± 652.3	80.7	75.3
Protecto+350 Gy	89.62 41.15 ± 272.1	320.1 102.9 ± 635.5	100	100
4^{th} instars larvae after 72 hour				
Protecto	96.6 231.4 ± 626.8	368.2 166.2 ± 582.5	11.9	30.3
Protecto+150 Gy	22.49 15.38 ± 32.56	343.6 355.9 ± 1139	51.5	32.5
Protecto+250 Gy	12.19 5.853 ± 29.51	217.6 259.9 ± 952.3	95.1	51.3
Protecto+350 Gy	11.59 4.562 ± 22.13	111.7 96.9 ± 535.5	100	100

$$\text{Toxicity index} = \frac{LC_{50}\ (LC_{90}) \text{ of the most efficacy compound}}{LC_{50}\ (LC_{90}) \text{ of each tested compound}} \times 100$$

for example, $\text{Toxicity index} = \frac{0.052}{0.45} \times 100 = 11.6\%$

Reviewing the above mentioned results, it could be concluded in general that Protecto compound (*B. thuringiences*) can be succefully used against the tested insect pests. Also, gamma irradiation was potentiated the efficacy of the biocide, Protecto and improved its potency when exposed to the doses of 150, 250 and 350 Gy.

Thus, Protecto +350 Gy proved the best treatment used to decrease the LC_{50} on the pink bollworm larvae and cowpea aphid adults & nymphs. While, Protecto +150 Gy, followed by Protecto +250 Gy and Protecto +350 Gy achieved the best potencies than unexposed Protecto on the cotton leafworm.

Amer (2006) reported that the combination of gamma irradiation with Dipel 2x (*Bacillus thuringiences,* Kurstaki) activated the spores of biocide compound and caused a potentiating effect when Dipel-2x exposed to gamma irradiation doses of 5, 10, 20, 40 & 80 Gy against the newly hatched larvae and eggs of the pink bollworm in both laboratory and field experiments during 2004 and 2005 cotton season. All treatments increased fiber and seed weights of the cotton crop.

Table 5. Efficacy of the biocide compound exposed to gamma doses against cotton leafworm larvae and cowpea aphid adults and nymphs.

Treatments	LC_{50} (gm/L) 95%Confidence limits	LC_{90} (gm/L) 95%Confidence limits	Toxicity index	
			LC_{50}	LC_{90}
4^{th} instars larvae of the cotton leafworm				
Protecto	190.8 179.43 ± 247.7	940.4 145.6 ± 1355	39.5	27.02
Protecto+150 Gy	75.31 52.64 ± 95.12	254.1 180.1 ± 300.7	100	100
Protecto+250 Gy	118.2 108.2 ± 146.5	502.2 246.4 ± 777.5	63.7	50.6
Protecto+350 Gy	156.2 128.7 ± 198.3	705.1 378.1 ± 999.7	48.2	36.04
Adults and nymphs of the cowpea aphids				
Protecto	101.5 63.9 ± 201.1	269.9 183.4 ± 935.1	16.2	10.6
Protecto+150 Gy	49.04 32.41 ± 104.6	245.8 104.5 ± 366.8	33.4	11.6
Protecto+250 Gy	41.17 23.47 ± 62.54	56.1 42.94 ± 94.62	39.8	50.8
Protecto+350 Gy	16.40 10.3 ± 29.8	28.48 15.5 ± 42.3	100	100

$$\text{Toxicity index} = \frac{LC_{50}\ (LC_{90}) \text{ of the most efficacy compound}}{LC_{50}\ (LC_{90}) \text{ of each tested compound}} \times 100$$

REFERENCES

1. Abbott, W.S. 1925. A method of computing the effectiveness of an insecticide. *J. Econ. Entomol.* 18: 265-267.
2. Amer, R.A. 2006. Combination of gamma irradiation with *Bacillus thuringiensis* (Kurs.) and the synergistic effect of two bioinsecticid mixture for controlling the pink bollworm, *Pectinophora gossypiella* (Saund.) in cotton bolls. *J.Egypt.Ger.Soc.Zool.* 51: 1-13.
3. Amer, R., A. and I .H. El –Nemaky. 2008. Effect of Some Biocides on the Biological and Prediction Parameters of the Pink Bollworm, *Pectinophora gossypiella* (Saund.) (Order:Lepidoptera- Family:Gelechiidae). *Egyptian Journal of Biological Pest Control,* 18(1), 2008, 61-70. Proceeding of 2nd Arab Conference of Applied Biological Pest Control, Cairo, Egypt, 7-10 April 2008.
4. Chen, Z.H., L.J. Chen, Y.L. Zhang and Z.J. Wu. 2011. Microbial properties, enzyme activities and the persistence of exogenous proteins in soil under consecutive cultivation of transgenic cottons (*Gossypium hirsutum* L.). *Plant Soil Env.,* 57(2): 67-74.
5. Costat Statistical Software (1990): Microcomputer program analysis version 4.20, cohort Software, Berkeley, CA.
6. Dennehye, J.J., J. Grannett and T.F. Leigh. 1983. Relevance of slide-dip and residual bioassay comparisons to detection of resistance in spider mites. *J. Econ. Entomol.,* 76: 1225-1230.
7. Duncan, D.B. 1955. Multiple ranges and multiple F.test. *Biomerics.* 11:1-42.
8. El-Defrawi, M. E. , A. Toppozada, N. Mansour and M. Zeid. 1964. Toxicological studies on the Egyptian cotton leafworm, Prodenia litura I. Susceptibility of different larval instars to insecticides. *J. Econ. Entomol*. 57: 591-593.
9. Hatem, A. E., S. S. Abdel-Samad, H. A. Saleh, M. H. Soliman and A. I. Hussien. 2009.Toxicologyical and physiological activity of plant extracts against *Spodoptra littoralis* (Boisduval) (Lepidoptra: Noctuidae) larvae. *Bol. San. Veg. Plagas* 35: 517-531.
10. Moy, J.H., B. Chinnasri, B.S. Sipes, D.P. Schmit, R.T. Hamasaki, E.F. Mersino and R.M. Yamakawa. 1997. Radiation disinfection or disinfestations of nematodes, aphids, mites, thrips and other pests on food plant materials: Evaluation for effectiveness and product quality. *Proceeding of a final Research Co- ordination meeting 3-7 November.*p. 105-114.

11. Pawar, V. M. and P. S. Borikar. 2005. Microbial options for the management of *Helicoverpa armigera* (Hubner) *Indian Society of Pulses Research and Development*, IIPR, Kanpur 193-231.
12. Rabindra, R. J. and B. Ramanujam. 2007. Microbial control of sucking pests using entomopathogenic fungi. *Journal of Biological Control.,* 21: 21-28.
13. Rashad, M.A. and E.D. Ammar. 1985. Mass rearing of the the spiny bollworm, *Earias insulana* (Boisd.) on semi artificial diet. *Bull.Soc.Ent.Egypt,* 65: 239-244.
14. Sallam, H.A. and S.M. Ibrahim. 1993. Inherited sterility in progeny of gamma irradiated male cotton leafworm, *Spodoptera littoralis* (Boisd.). *Proceeding of the final research co-ordination meeting. Phonix, Arizona,* 9-13 september.
15. Saranya, S., R. Ushakumari, J. Sosamma and P. Babum. 2010. Efficacy of different entomopathogenic fungi against cow pea aphid, *Aphis crassivora* (Koch). Journal of Biopesticides, 3: 138-142.
16. Soon, L.G. 1986. Diamondback moth management (*Proc. 1st Int. Workshop)*, Asian Research and Development Center. *Taipei*: 159.
17. Sun, Y. P. 1950. Toxicity index on improved method of comparing the relative toxicity of insecticides. *J. Econ. Entomol.,* 43: 45-53.

تأثير معاملات أشعة جاما مع المبيد الحيوى باسيلس ثورينجينسيزعلى بعض الآفات الحشرية فى المعمل

رضا عبد الجليل محمد عامر ، مجدى عبد العظيم أحمد ، عادل السيد حاتم

معهد بحوث وقاية النباتات – مركز البحوث الزراعية - دقى - جيزة – ج.م.ع

أجريت هذه التجربة معمليا عام 2010 بمعهد بحوث وقاية النباتات حيث تم تعريض الآفات المختبرة والمركب الحيوى البروتكتو لجرعات مختلفة من أشعة جاما. تم تعريض يرقات الفقس الحديث والعمر الرابع لدودة اللوز القرنفلية ويرقات العمر الرابع لدودة ورق القطن وكذلك الأطوار البالغة والحوريات لمن اللوبيا لجرعات آشعة جاما 150– 250– 350 جراى. بالإضافة إلى تعريض المركب الحيوى بروتكتو إلى نفس الجرعات من أشعة جاما. تم تقدير الفعل الابادى للمعاملات: البروتكتو – بروتكتو +150 جراى – بروتكتو +250 جراى – بروتكتو +350 جراى ضد نفس الآفات.

أدت جرعات آشعة جاما 150– 250– 350 جراى إلى زيادة النسبة المئوية لموت يرقات الفقس الحديث لدودة اللوز القرنفلية الى 52 – 56 – 58% على التوالى فى نفس يوم التعريض ووصلت نسبة الموت إلى 100% فى اليوم الثالث بعد التعريض للجرعة 350 جراى وفى اليوم الخامس بعد التعريض للجرعات 250 و150 جراى. كما وصلت النسبة المئوية للموت فى الطور اليرقى الرابع لدودة اللوز القرنفلية إلى 100% فى اليوم الثامن و العاشر بعد التعريض. بينما وصلت نسبة الموت 100% فى يرقات دودة ورق القطن فى اليوم العاشر و الثانى عشر بعد التعريض. أما الأطوار البالغة وحوريات من اللوبيا فقد حدث لها 100% موت فى نفس يوم التعريض.

عندما تم تعريض المركب الحيوى البروتكتو لجرعات آشعة جاما150– 250– 350 جراى حدثت تقوية فى فعالية المركب الحيوى على يرقات الفقس الحديث والعمر الرابع لدودة اللوز القرنفلية حيث انخفض التركيز النصفى المميت عن المركب الحيوى الغير معرض للإشعاع. كذلك حقق المركب المعرض للإشعاع كفاءة إبادية عالية فى حالة معاملة الأطوار البالغة وحوريات المن خاصة معاملة البروتكتو + 350 جراى يليه فى ذلك البروتكتو + 250 جراى ثم البروتكتو + 150 جراى عن المعاملة بمركب البروتكتو بمفرده. على العكس أظهر المركب الحيوى المعرض لجرعات آشعة جاما (البروتكتو +150 جراى – البروتكتو +250 جراى – البروتكتو +350 جراى) والمستخدمة ضد يرقات دودة ورق القطن إلى زيادة فى قيم التركيزالنصفى المميت كلما زادت جرعة آشعة جاما المعرض لها المركب الحيوى ولكنها أعطت جرعات نصفية مميتة أقل مقارنة بالمركب الحيوى بمفرده دون التعرض للإشعاع.