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Effect of *Bacillus thuringiensis* (Kurs.) Exposed to Gamma-Ray on Certain Biological Assays of *Pectinophora gossypiella* (Saund.) (Gelechiidae: Lepidoptera)

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ABSTRACT

The current study was conducted to evaluate the toxicity and certain biological assays of the pink bollworm, *Pectinophora gossypiella* (Saund.) treated with a bio-insecticide compound, *Bacillus thuringiensis* (Kurs.) alone and its exposure to gamma-ray doses (5, 10, 20, 40 & 80 Gy) under laboratory conditions.

Gamma-ray can potentiate *B. thuringiensis* toxicity gradually from *B. thuringiensis* + 5 Gy until *B. thuringiensis* + 80 Gy to become more toxic than the same compound without exposing to gamma doses against *P. gossypiella* newly hatched larvae.

Certain biological assays of *P. gossypiella* treated as newly hatched larvae were affected by *B. thuringiensis* exposed to gamma-ray treatments (5 up to 80 Gy). *B. thuringiensis* + 80 Gy were considered the best treatment compared with other treatment or the same compound without exposing to gamma-ray. Treatments caused an increase in the most biological assays during larval, pupal and adult stages (larval, pupal & adult period and mortalities; also, sterility was increased) in compared to the untreated one. Meanwhile, other biological assays of *P. gossypiella* were decreased (egg-laying rate, hatchability, control of hatchability & fecundity) as affected by *B. thuringiensis* exposed to gamma rays compared with untreated.

So, gamma doses used can potentiate *B. thuringiensis* to become its efficacy higher than it's used alone against *P. gossypiella* treated as newly hatched larvae.

INTRODUCTION

The pink bollworm, *Pectinophora gossypiella* (Saund.) (Gelechiidae: Lepidoptera) was described by W.W. Saunders in 1843 as *Depressaria gossypiella* from specimens found to be damaging cotton in India. At present, the pink bollworm has been recorded in nearly all cotton-growing countries of the world and it is a key pest in many of these areas (Ingram, 1994). The larvae bore into the developing cotton bolls, where they feed on the cotton lint and seeds. The pink bollworm spends the destructive larval phase inside the cotton bolls where it is well protected from control measures, so the control of this insect depends upon the time before cotton boll penetration.

Larvae of lepidopterious pests are effectively controlled by bio-insecticides containing spores and toxic protein crystals of *Bacillus thuringiensis* (Kurs.). However, the

bollworms are not controlled by this strain (Tantawy *et al.*, 2002). Therefore, a combined treatment with gamma irradiation with a biocide, *B. thuringiensis* against the pink bollworm is suggested.

Gamma irradiation had a drastic effect on many biological aspects of the bollworms such as the reduction in fecundity, egg viability, larval & pupal mortality, male & female adult longevity when adult moth of *E. insulana* exposed to different gamma doses ranged between 80-600 Gy (Mohamed, 2002). Also, Amer, *et al.* (2012) can potentiate *B. thuringiensis* by exposing to gamma doses of 150, 250 & 350 Gy against *P. gossypiella* newly hatched larvae and 4th instars larvae; also, *S. littoralis* 4th instars larvae were affected by the treatments used. In addition, Amer, *et al.* (2020) applied *B. thuringiensis* exposed to gamma doses of 160, 320 & 460 Gy to control three cotton pests of *P. gossypiella, E. insulana* and *O. hyalinipennis* at 2018 &2019 cotton seasons. *B. thuringiensis* + 460 Gy was the best treatment compared with other treatments used for controlling the three pests.

So, the aim of the current work to potentiate the biocide compound of *Bacillus thuringiensis* (Kurs.) by using gamma-ray doses (5, 10, 20, 40 & 80 Gy) against the newly hatched larvae of the pink bollworm, *Pectinophora gossypiella* (Saund.). In addition, some biological assays of *P. gossypiella* were studied.

MATERIALS AND METHODS

Insect:

A laboratory strain of the pink bollworm, *Pectinophora gossypiella* (Saund.) was reared at the Bollworms department, Plant Protection Research Institute, A.R.C. on a semi-artificial diet as described by Rashad and Ammar (1985). Rearing conditions were controlled at 27±2 ºC and 65-75% RH.

Compound:

Dipel-2x is a commercial formulation of *Bacillus thuringiensis* (Kurs.). It is a product of vailent Bioscience Corporation, USA, obtained from May trade Company, Giza, Egypt. It contains about 3200 International units potency per mg spores and protein crystals. Active ingredient constituted 6.4% of the formulation and the dose rate was 200 gm/feddan.

Dipel-2x was exposed to gamma rays at doses of 5, 10, 20, 40 & 80 Gy. All irradiation was done by a Co^{60} Canada Cell research, National Center for Radiation Research and Technology, delivered at a dose rate of 1.3 Rad/sec.

Bioassay:

Two gm of semi-artificial diet/Petri-dish (7 cm diameter) were mixed with 1 cm of *B. thuringiensis* prepared concentrations. Twenty-five of newly hatched larvae of *P. gossypiella* to each four replicates/ concentrate/ tested compound was exposed to the compound alone or exposed to gamma doses of 5, 10, 20, 40 & 80 Gy. The petri- dish used as untreated was prepared with 1 cm distilled water mixed with 2 gm artificial diet and kept at 27±1ºC and 65-75% R.H. Then the larvae were investigated (alive and dead larvae) at 3 days post-treatment.

LC_{50} & LC_{90} for each compound were determined by using Ldp-line software (www.Ehabbakr software/Ldp line) with using Abbott's (1925) and Finney (1971).

The comparing among treatments efficacy were estimated by using Sun's equation (1950).

Toxicity index = LC_{50} (LC_{90}) of the compound A/ LC_{50} (LC_{90}) of the compound B X 100

Where A: The most effective compound and B: The other tested compound.

Biological Assays:

The biological assays of *P. gossypiella* treated as newly hatched larvae with LC_{50} of *B. thuringiensis* alone or exposed to gamma doses (5, 10, 20, 40 & 80 Gy) were described as

following: Larvae or pupal duration & mortalities were investigated. In addition, adult stage assays were done as follows:

Male and female adult longevity, pre-oviposition, oviposition & post-oviposition periods, life cycle, egg-laying (no. egg/female), hatchability, fecundity and sterility as follows:

Egg hatchability % = No. hatched eggs/ No. deposited eggs X 100

Control of hatchability % = No. egg hatchability in untreated- No. egg hatchability in treatment/ No. egg hatchability in untreated X 100 (Zidan & Abdel-Megeed, 1987).

Fecundity % = No. egg per treated female/ No. egg per untreated female (crystal & Lachance, 1963).

Sterility observed% = 100- Egg hatchability % (Zidan & Abdel-Megeed, 1987).

Corrected sterility % = Sterility observed%- untreated/ 100-untreated (Zidan & Abdel-Megeed, 1987).

Statistically Analysis:

All data of biological assays of *P. gossypiella* were analyzed by using Costat Statistical Software (1990) and Duncan's multiple range tests (1955) at 5% probability level to compare the differences among time means.

RESULTS AND DISCUSSION

Bioassay:

Combination of gamma-ray treatments with *B. thuringiensis* (Table, 1) clearly shows that activated the spores of the biocide compound and caused a potentiation effect. Regarding the LC_{50} values in Table (1), a gradual increase in the efficacy of Dipel-2x, followed by Dipel-2x with gamma irradiation may be noted. The LC_{50}'s were; 0.1241 µg/cm^3 (*B. thuringiensis*), 0.1043 µg/cm^3 (*B. thuringiensis* +5 Gy), 0.0799 µg/cm^3 (*B. thuringiensis* + 10 Gy), 0.0664 µg/cm^3 (*B. thuringiensis* + 20 Gy), 0.04971 µg/cm^3 (*B. thuringiensis* + 40 Gy) and 0.02065 µg/cm^3 (*B. thuringiensis* + 80 Gy).

Table 1: Efficacy of *B. thuringiensis* exposed to gamma-ray against *P. gossypiella* newly hatched larvae

Treatments	LC_{50} (µg/cm^3)	LC_{90} (µg/cm^3)	Toxicity index	
			LC_{50}	LC_{90}
B. thuringiensis	0.1241	10210	16.64	27.15
B. thuringiensis +5 Gy	0.1043	10103	19.80	27.44
B. thuringiensis +10 Gy	0.0799	3859.6	25.84	71.83
B. thuringiensis +20 Gy	0.0664	3466.9	31.09	79.97
B. thuringiensis +40 Gy	0.04971	3193.2	41.54	86.82
B. thuringiensis +80 Gy	0.02065	2772.4	100	100

Biological Assays:

P. gossypiella treated as newly hatched larvae with LC_{50}'s of *B. thuringiensis* alone or exposed to gamma doses of 5, 10, 20, 40 & 80 Gy. The following biological assays were investigated.

Larval Duration:

Data in Table (2) observed that LC_{50} value of *B. thuringiensis* +80 Gy caused a drastic decrease in larval duration (17.5 days), followed by *B. thuringiensis* + 40 Gy (19.89 days) that had a moderate effect on the larval duration as shown in Table (2). While other treatments had values near from untreated (22.2 days) about 1 day.

Larval Mortality %:

As indicated in Table (2) when *P. gossypiella* treated as newly hatched larvae with LC_{50}'s of *B. thuringiensis* and its exposure to 20, 40 &80 Gy of gamma irradiation had a moderate latent effect on the larval mortality (between 18.3 to 28.2%). Also, *B. thuringiensis* (14.4%) and its exposure with gamma-ray of 5 Gy (15.1%) and 10 Gy (15.8%), respectively compared with untreated larval mortality value (13.7%).

Pupal Duration:

The pupal duration values ranged between 11.4 to 14.85 days when the newly hatched larvae were treated with LC_{50}'s of *B. thuringiensis* and its exposure to gamma-ray doses (5, 10, 20, 40 &80 Gy). The untreated value was 7.8 days (Table, 2).

Pupal Mortality %:

B. thuringiensis + 80 Gy caused the highly pupal mortality (39%) of *P. gossypiella* treated as newly hatched larvae compared with untreated value (12.5%). On the contrary, *B. thuringiensis* treatment and its exposure to gamma doses of 5 & 10 Gy gave the lowest pupal mortality percentages, were ranged between 17.82 to 19.21% compared with the previous compounds which gave the highest pupal mortalities. Other treatments of *B. thuringiensis* + 20 Gy and *B. thuringiensis* + 40 Gy had 21.4 & 25.9% pupal mortality of *P. gossypiella* when treated as newly hatched larvae as in Table (2).

Table 2: Biological assays of *P. gossypiella* treated as newly hatched larvae by *B. thuringiensis* exposed to gamma rays.

Treatments	Larval duration	Larval mortality%	Pupal duration	Pupal mortality%	Adult longevity		Adult mortality%
					♂	♀	
B. thuringiensis	22^{a}	14.4^{ab}	14.85^{d}	17.82^{ab}	30.3^{c}	28^{c}	6.12^{a}
B. thuringiensis +5 Gy	21.98^{ab}	15.1^{b}	14.82^{d}	18.11^{b}	29.5^{bc}	25.01^{bc}	11.35^{b}
B. thuringiensis +10 Gy	21.8^{ab}	15.8^{b}	13.42^{c}	19.21^{b}	21.5^{b}	20^{b}	12.12^{bc}
B. thuringiensis +20 Gy	21^{ab}	18.3^{c}	13.25^{c}	21.4^{c}	18.3^{ab}	19.9^{ab}	13.83^{c}
B. thuringiensis +40 Gy	19.89^{b}	22.5^{d}	12.33^{bc}	25.9^{d}	16.7^{ab}	15.5^{a}	15.74^{d}
B. thuringiensis +80 Gy	17.5^{c}	28.2^{e}	11.14^{b}	39^{e}	11.6^{a}	14.2^{a}	18^{e}
Untreated	22.2^{a}	13.7^{a}	7.8^{a}	12.5^{a}	10.5^{a}	13^{a}	6^{a}
L.S. $D_{0.05}$	1.673	1.699	1.737	1.812	1.531	1.612	1.456

Adult Longevity:

a. Male Adult Longevity:

All the treatments used increased the male adult longevity of *P. gossypiella* treated as newly hatched larvae (Table, 2) that ranged from 11.6 to 18.3 days in *B. thuringiensis*+20 Gy, *B. thuringiensis*+ 40 Gy & *B. thuringiensis* + 80 Gy compared with the untreated (10.5 days). On the other hand, adult longevity was noticed in the treatment of *B. thuringiensis, B. thuringiensis* + 5 Gy & *B. thuringiensis* + 10 Gy (21.5- 30.3 days).

b. Female Adult Longevity:

When *P. gossypiella* treated as newly hatched larvae with LC_{50}'s of *B. thuringiensis* and its exposure to gamma doses of 5, 10, 20, 40 & 80 Gy decrease the female adult longevity gradually from *B. thuringiensis* treatment (28 days) up to *B. thuringiensis* + 80 Gy (14.2 days) that had the near value from untreated one (13 days) as shown in Table (2).

Adult mortality %:

Resulted in Table (2) showed that all the treatments increased the *P. gossypiella* adult mortality% treated as newly hatched larvae except for *B. thuringiensis* treatment that had the low adult mortality (6.12%) that was near from untreated (6%).

Table (3) illustrated the biological assays of pre-oviposition, oviposition and post-oviposition periods of *P. gossypiella* treated as newly hatched larvae as follows:

Pre-Oviposition Period:

This period increased to 2.18 days in *B. thuringiensis* + 80 Gy treatment, followed by *B. thuringiensis* + 40 Gy (2.1 days) for *P. gossypiella* treated as newly hatched larvae with LC_{50}'s of tested compounds compared with untreated as well as the effect of *B. thuringiensis* with gamma doses of 5, 10 & 20 Gy where the pre-oviposition period exhibited 2 days (Table, 3).

Oviposition Period:

B. thuringiensis exposed to gamma doses treatments caused an increasing effect on oviposition period of *P. gossypiella* treated as newly hatched larvae with LC_{50}'s of tested compounds, especially with *B. thuringiensis* alone, followed by *B. thuringiensis* + 5 Gy. Meanwhile, *B. thuringiensis* + 10 Gy had twice increased nearly (10 days) as compared with untreated value (5.5 days). While *B. thuringiensis* + 20 Gy had the same value (8.1 days) as well as *B. thuringiensis* + 80 Gy treatments. On the other hand, *B. thuringiensis* + 40 Gy had increased about 1-day of untreated oviposition value (Table, 3).

Post-oviposition Period:

The untreated post-oviposition period was 5.5 days, that period was increasing in all the treatments used except in *B. thuringiensis* + 80 Gy that was the shortest period (3.92 days) post-oviposition period of *P. gossypiella* treated as newly hatched larvae with LC_{50}'s of the treatment. Treatments of *B. thuringiensis* alone and its exposed to 5 or 10 Gy had the same post-oviposition period nearly and had a slightly increased to 6.9 & 9.8 days in *B. thuringiensis* + 40 Gy & *B. thuringiensis* + 20 Gy compared with untreated one value that was 5.5 days (Table, 3).

Table 3: Biological assays of *P. gossypiella* treated as newly hatched larvae by *B. thuringiensis* exposed to gamma rays.

Treatments	Female adult longevity			Life cycle	Egg laying rate	Hatching rate
	Pre-oviposition	Oviposition	Post-oviposition			
B. thuringiensis	1.98^{a}	18^{a}	8.02^{b}	40.85^{a}	180.2^{ab}	158^{ab}
B. thuringiensis +5 Gy	2^{a}	14.99^{ab}	8.01^{b}	40.8^{a}	171.1^{b}	140.1^{b}
B. thuringiensis +10 Gy	2^{a}	10^{b}	8^{b}	39.22^{b}	155.8^{c}	120.1^{c}
B. thuringiensis +20 Gy	2^{a}	8.1^{c}	9.8^{a}	38.25^{bc}	153.4^{c}	115^{d}
B. thuringiensis +40 Gy	2.1^{a}	6.5^{cd}	6.9^{c}	36.22^{c}	127.3^{d}	85^{e}
B. thuringiensis +80 Gy	2.18^{a}	8.1^{c}	3.92^{e}	32.64^{e}	114.1^{e}	70.2^{f}
Untreated	2^{a}	5.5^{d}	5.5^{d}	34^{d}	188.2^{a}	167^{a}
L.S. $D_{0.05}$	0.637	1.612	1.523	2.345	5.365	3.325

Life Cycle:

All the treatments estimated used elongated the life cycle of *P. gossypiella* treated as newly hatched larvae (this cycle estimate from egg stage until adult emergence) especially with *B. thuringiensis* alone or exposed to 5 Gy as shown in Table (3) compared with the untreated (34 days) except for treatment of *B. thuringiensis* + 80 Gy decreased from this period about 2-days than untreated.

Egg-Laying Rate:

Untreated females deposited 188.2 eggs/female (egg-laying rate) as shown in Table (3). This value decreased with all treatments used treated as newly hatched larvae with LC_{50} 's of different treatments.

Egg hatching Rate:

Table (3) illustrated that all the treatments decreased the number of hatched egg/female (egg hatching rate) compared with untreated value (167 hatched egg). This result confirmed by sallam and Mohamed (2004) who showed that in adult females of *E. insulana* at 24 hours from exposure with 80 & 100 Gy, the egg hatching was significantly reduced than untreated.

Egg Hatchability%:

Percent of egg hatchability was 88.7% for untreated. This value near from egg hatchability percentage by *B. thuringiensis* treatment (87.7%) (Table, 4). On the other hand, other treatments decreased the egg hatchability percentage of *P. gossypiella* treated as newly hatched larvae with LC_{50} 's of different compounds, especially with *B. thuringiensis* + 80 Gy treatment that reach 61.3% egg hatchability.

Control of Hatchability %:

B. thuringiensis had the lowest value (5.389%) control of hatchability. Other treatments had gradually control of egg hatchability percentage of *P. gossypiella* treated as newly hatched larvae with LC_{50} 's of different treatments ranged between 16.17 to 58.08% (Table, 4).

Fecundity%.

Table (4) showed that *B. thuringiensis* gave the fecundity percentage of adult females (95.7 %) of *P. gossypiella* treated as newly hatched larvae. The fecundity decreased gradually by *B. thuringiensis* exposing to gamma doses until reached 60.6 % in *P. gossypiella* treated as newly hatched larvae with *B. thuringiensis* + 80 Gy (Table, 4). These results could be confirmed by Sallam and Mohamed (2004) who showed that female fecundity of *E. insulana* at 24 hours after irradiation with 80 & 100 Gy was significantly reduced.

Observed Sterility %:

As shown in Table (4), the untreated had 11.3% observed sterility, this value near from *B. thuringiensis* treatment which had the lowest observed sterility of *P. gossypiella* treated as newly hatched larvae with different compounds compared with other treatments that had values ranged between 18.2 to 38.7%.

Table 4: Biological assays of *P. gossypiella* treated as newly hatched larvae by *B. thuringiensis* exposed to gamma rays.

Treatments	Egg hatchability%	Control of hatchability%	Fecundity%	Sterility	
				Observed	Corrected
B. thuringiensis	87.7^{a}	5.389^{f}	95.7^{a}	12.3^{e}	1.127^{e}
B. thuringiensis +5 Gy	81.8^{b}	16.17^{e}	90.9^{b}	18.2^{d}	7.779^{d}
B. thuringiensis +10 Gy	77^{c}	28.14^{d}	82.8^{c}	23^{c}	13.19^{c}
B. thuringiensis +20 Gy	74.9^{d}	31.14^{c}	81.5^{c}	25.1^{b}	15.56^{c}
B. thuringiensis +40 Gy	66.8^{e}	49.1^{b}	67.6^{d}	33.2^{a}	24.69^{b}
B. thuringiensis +80 Gy	61.3^{f}	58.08^{a}	60.6^{e}	3.7^{f}	30.89^{a}
Untreated	88.7^{a}	0	0	11.3^{e}	0
L.S. $D_{0.05}$	1.612	1.549	1.985	1.865	1.562

Corrected Sterility %:

Treatment of *P. gossypiella* treated as newly hatched larvae with *B. thuringiensis* alone had the lowest percentage of corrected sterility (1.127 %) when *B. thuringiensis* exposed to gamma doses (5 up to 80 Gy) caused a gradually corrected sterility increasing from 7.779 % in *B. thuringiensis* + 5 Gy until reach to 30.89 % in *B. thuringiensis* + 80 Gy treatment of *P. gossypiella* treated as newly hatched larvae (Table, 4).

Generally, the tested bio-insecticides, *B. thuringiensis* alone and its exposure to gamma doses of 5, 10, 20, 40 & 80 Gy could be classified into four categories depending on their toxicity and latent effect on the most biological assays of the pink bollworm, *P. gossypiella* treated as newly hatched larvae as follows:

1. *B. thuringiensis* when used alone had the lowest toxicity and latent effect on some biological assays of *P. gossypiella.*
2. *B. thuringiensis* exposed to gamma doses of 5 & 10 Gy had a moderate effect on both toxicity and biological assays of *P. gossypiella.*
3. *B. thuringiensis* + 20 Gy or 40 Gy had a highly toxic and latent effect on *P. gossypiella* comparing with previous categories.
4. *B. thuringiensis* + 80 Gy had the most potent or biological effect on *P. gossypiella* comparing with other treatments or categories used.

So, gamma-ray can potentiate *B. thuringiensis* to become the most potent and effective on *P. gossypiella* than *B. thuringiensis* when used alone.

Previous searches ensured our current search as Amer, (2006) showed that the combination of gamma irradiation with Dipel2x activated the spores of the biocide compound and caused a potentiation effect from 5 to 80 Gy during the two cotton seasons 2004 and 2005; also, the treatments increased lint and seed weights (gm/100bolls). Whereas, Amer, *et al*. (2012) mentioned that LC_{50}'s of *B. thuringiensis* when exposed to gamma doses (150, 250 & 350 Gy) was lower than un-exposing *B. thuringiensis* on subjected insects (*P. gossypiella, S. littoralis* and *A. craccivora*). Also, Amer, *et al.* (2015) exposed *B. thuringiensis, M. anisopliae* and biopolymer compound (chitosan) to gamma doses of 15, 30 & 60 Gy for potentiating effect. It showed a potentiated effect especially with a dose of 60 Gy than other doses used against *S. littoralis* treated as 4^{th} instar larvae at different efficiency tests. While, Ali, *et al.* (2017) showed that radiation technology is widely used to produce changes in Biosystems of *Pectinophora gossypiella* males with gamma-irradiated as pupae using 50Gy and 150Gy. Comparing elements composition and DNA (using RAPD-PCR) between substerile 50Gy and the sterile dose 150Gy in *P. gossypiella* showed variation between them. Potassium (K) was the most abundant element in unirradiated and irradiated males followed by magnesium (Mg). The percentage of heavy metals as copper, zinc, and cadmium concurrent with K was directly proportional to the radiation dose. While the percentage of Mg, Phosphorous and calcium decreased as the radiation dose increased. The results also revealed that some extra bands appeared and others disappeared, as a result of irradiation. The appearance of extra bands may be due to the repair mechanism of the irradiation damaged DNA. The banding patterns obtained and the dendrograms drawn on the basis of presence and absence of bands revealed that 150Gy irradiated pupae are more different from the unirradiated pupae than the 50Gy irradiated pupae. It was concluded that the sterile male technique could be used as a beneficial tool in controlling *P. gossypiella*. Meanwhile, Amer, *et al.* (2020) observed that gamma radiation doses contribute to enhancement from efficacies of *B. thuringiensis* when exposed to 160, 320 & 640 Gy against three cotton boll pests of *P. gossypiella, E. insulana* and *O.hyalinipennis.*

REFERENCES

Abbott, W.W. (1925). A method of computing the effectiveness of an insecticide. *Journal of Economic Entomology*, 18:265-267.

Ali, H.M.; Moustafa, H.Z. and Sayed, R. M. (2017). Alterations in biomarkers associated with sterility in *Pectinophora gossypiella* (Saunders) induced by gamma irradiation. *Brazilian archieves of biological & technology*, 60:1-11.

Amer, R.A. (2006). Combination of gamma irradiation with *Bacillus thuringiensis* (Kurs.) and the synergistic effect of two bioinsecticide mixture for controlling the pink bollworm, *Pectinophora gossypiella* (Saund.) in cotton bolls. *Journal of Egyptian German Society & Zoology*, 51: 1-13.

Amer, R.A.; Ahmed, M.A. and Hatem, A.E. (2012). Effect of gamma irradiation combined with *B.T.* biocide treatments on some insect pests in laboratory. *Egyptian Journal of Agricultural Research*, 90 (3): 1041-1053.

Amer, R.A.; Yacoub, Sh.S.; Nouh, G.M. and Hatem, A.E. (2015). Gamma irradiation to potentiate some bio-agents compounds against the cotton leaf worm, *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae). *Egyptian Journal Biological Pest Control*, 25(2): 445-455.

Amer, R.A.; Salem, M.S.; Dar, R.A.; Hassan, N.N.; Abdel-Salam, D.A. (2020). Combination effects between gamma radiation and spraying equipment for three cotton boll pests controlling. *Journal of Entomology and Zoology Studies*, 8(2):633-644.

Costat Statistical Software (1990). Microcomputer program analysis version 4.20, cohort Software, Berkeley, CA.

Crystal, M.M. and Lachance, L.E. (1963). The modification of reproduction in insects treated with alkylating agents. Inhibition of ovarian growth and egg reproduction and hatchability. *Biological Bulletin*, 25:270-279.

Duncan, D.B. (1955). Multiple ranges and multiple F.test. *Biomerics.* 11:1-42.Sun, Y.P. (1950). Toxicity index on improved method of comparing the relative toxicity of insecticides. *Journal of Economic Entomology*, 43:45-53.

Finney, D.J. (1971). Probit analysis: A statistical treatment of the sigmoid response curve; Cambridge university press. London, New York: Melbourne, 333.

Ingram, W.R. (1994). *Pectinophora* (Lepidoptera: Gelechiidae). Eds., Insect pest of cotton, pp. 107-149, Wallingford, U.K.: CAB International.

Mohamed, H.F. (2002). Further studies on the effects of gamma irradiation on the spiny bollworm, *Earias insulana* (Boisd.). *Ph.D. Thesis, Ain Shams Univ., Plant protect. Dep.*

Rashad, A.M. and Ammar, E.D. (1985). Mass rearing of the spiny bollworm, *Earias insulana* (Boisd.) on semi artificial diet. *Bulletin of Society Entomolgy in Egypte*, 65: 239-244.

Sallam, H.A. and Mohamed H.F. (2004). Inherited sterility induced in progeny of gamma irradiation males and females of spiny bollworm, *Earias insulana* (Boisd.), effect on fecundity, fertility and mating. *Proceedings of the Eighth Conference of Nuclear Sciences and Applications*, Vol II: 712-723.

Tantawy, M.A.; Rashad, A.M.; Ragheb, D.A. and sabry, K.A. (2002). Resistence of the pink bollworm, *Pectinophora gossypiella* (Saund.) to the microbial pesticide *Bacillus thuringiensis*. *Egyptian Journal of Biological Pest Control*, 12 (2):119-123.

Zidan, H. and Abdel-Megeed, M.I. (1987). New Trends in pesticides and pest control - Part II Al-Dar Al-Arabia for publishing and distribution, Cairo, Egypt.

ARABIC SUMMARY

تأثير بكتيريا الباسيلس ثورينجينسيز المعرضة لأشعة جاما على بعض الصفات البيولوجية لدودة اللوز القرنفلية

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تهدف الدراسة الحالية إلى تقييم كلا من السمية وبعض الصفات البيولوجية لدودة اللوز القرنفلية المعاملة بالمركب الحيوى (*Bacillus thuringiensis*, Kurs.) بمفرده ومعرضا لجرعات أشعة جاما (5، 10، 20، 40، 80 جراى) تحت الظروف المعملية.

أدت أشعة جاما إلى تقوية مركب بكتيريا الباسيلس ثورينجينسيز بزيادة سميته تدريجيا من بكتيريا + 5 جراى حتى بكتيريا + 80 جراى لتصبح أكثر سمية بالمقارنة بنفس المركب الغير معرض لأشعة جاما.

تأثرت بعض الصفات البيولوجية لدودة اللوز القرنفلية المعاملة فى طور الفقس الحديث بالمعاملة ببكتيريا الباسيلس ثورينجينسيز المعرضة لأشعة جاما (من 5 جراى حتى 80 جراى). كما تعتبر معاملة بكتيريا الباسيلس + 80 جراى أفضل معاملة بالمقارنة بالمعاملات الأخرى سواء البكتيريا المعرضة لاشعة جاما او منفردة. أدت المعاملات الى زيادة ملحوظة فى معظم الصفات البيولوجية خلال مراحل الأطوار اليرقية والعذرية والبالغة (فترة الحياة والنسبة المئوية لكلا من الأطوار اليرقية والعذرية والبالغة كما زاد العقم زيادة ملحوظة مقارنة بالكونترول) وعلى العكس حدث نقص فى بعض الصفات البيولوجية الاخرى (معدل وضع البيض – الفقس – التحكم فى الفقس – الخصوبة) للمركب الحيوى البكتيرى سواء منفردا او معرضا للجرعات المختلفة لاشعة جاما. لذلك استطاعت اشعة جاما على تقوية بكتيريا الباسيلس ثورينجينسيز ليصبح تاثيرها أعلى من استخدام المركب منفردا على دودة اللوز القرنفلية المعاملة فى طور يرقات الفقس الحديث.