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RADIATION DOSE OPTIMIZATION FOR IMPROVING THE STERILE INSECT TECHNIQUE OF THE COTTON LEAF WORM, *SPODOPTERA LITTORALIS* (LEPIDOPTERA: NOCTUIDAE)

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ABSTRACT: Sterile Insect Technique (SIT)/Inherited Sterilely (IS) is considered a promising tactic against Lepidopteran pests using sub-sterilizing doses of ionizing radiation rather than sterile doses. Optimization of irradiation doses is important for developing the SIT/IS operational for an efficacious programme. The present study aimed to evaluate the effective dose which induce sterility for improving SIT/IS against *Spodoptera littoralis* with particular emphasis on mating ability and competitiveness. Eight gamma radiation doses (0, 100, 125, 150, 175, 200, 225 and 250 Gy) were used to irradiate full-grown male and female pupae of *S. littoralis*. Results indicated that the female moths were more radiosensitive than male moths, the dose of 175 and 250 Gy exhibited (0.0 %) egg hatch of irradiated female and male moth, respectively. Moreover, the sperm transfer by irradiated male was drastically reduced by increasing the dose level, however, the percentages of spermatophore were increased among the first generation (F_1) of male as compared to their Parent (P_1) at the same dose level. Full competitiveness was attained in the ratio of 3 irradiated: 1un-irradiated male moths at the doses 225 and 250 Gy. Field cage tests revealed that high levels of mating competitiveness were attained between irradiated and non-irradiated moths at all tested doses. Moreover, the copula duration showed insignificant differences among irradiation doses, however the duration was shorter in irradiated category that un-irradiated ones. The dose of 225 Gy caused a full sterility of P_1 female and F_1 male with high competeveness and can be used effectively in SIT/IS for *S. littoralis* management.

Key words: Inherited sterility, gamma radiation, mating ability, mating competitiveness, sexual compatibility

INTRODUCTION

The cotton leaf worm, *Spodoptera littoralis* (Boisduval, 1833) (Lepidoptera: Noctuidae) is considered one of the important lepidopteran pests in many regions worldwide, attacking many cultivated crop and vegetable species (Sayed and El-Helaly, 2018) . Over the last decades, the intensive uses of pesticides to control the cotton leaf worm and other Lepidopteran species have been created many adverse effects on the environment problems and developed resistance to this insect (Sayed *et al.*, 2020). Many attempts have been done to substitute the chemical control methods with environment-friendly tactics against those harmful pests (Sayed *et al.*, 2022). Ionizing radiation is considered as a modern promising technology for insect population suppression as an autocidal control methods using sterile insect technique (SIT), which provide safe, sustainable and successful alternative methods in insect pest management (Robinson *et al.*, 2005). SIT is based on the systemic release of sterile males in area-wide after being irradiated to ionizing radiation to mate and inseminate wild females, and through sequential releases the target population is suppressed (Dyck *et al.*, 2021). Evidently SIT programs have been particularly effective against tephritidae and mosquito species (Klassen *et al.*, 2021), while, a handful of Lepidoptera species have been successfully managed, for instance, corn earworm, *Helicoverpa zea* (Carpenter and Gross, 1993), gypsy moth, *Lymantria dispar* (Mastro, 1993), pink bollworm, *Pectinophora gossypiella* (Vreysen *et al.*, 2007) and codling moth, *Cydia*

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pomonella (Bloem *et al.*, 2001) However, there were challenges in implementing SIT against lepidopteran pests emerged because of their high resistance to ionizing radiation (Marec and Vreysen, 2019). This radio-resistance is due to the unique genetic structure of Lepidoptera, resulting high doses were required to induce full sterility in adult moths (Carpenter *et al.*, 2009), those doses may cause deleterious effect of irradiated insect that reduce the efficacy of sterile moths to compete the wild type in nature. Consequently, the sterility index is one of the main quality control procedures that should be in place to ensure the perfect use of SIT for Lepidoptera population suppression (Parker and Mehta, 2007; Bakri *et al.*, 2005). Inherited sterility (IS) or F_1 sterility offers a greater promise for lepidopteran pests than traditional sterility; full sterility in the first generation (F_1) can be accomplished by irradiating the parents (P_1) with sub-sterilizing doses, which render them partially sterile (North, 1975; Carpenter *et al.*, 2005). Sterility-fitness interaction needs a trade-off between producing competitive male moths against increasing residual fertility of irradiated insects being release, whereas the biological fitness of sterile moths is a key factor in the success of SIT/IS programs (Cáceres *et al.*, 2007; Bloem *et al.*, 2003). Generally, irradiation treatment renders insect lower competitive than wild ones (Helinski *et al.*, 2009), thus, considering sterility index, mating compatibility, mating propensity and survival are fundamental tasks for increasing the SIT/IS cost (Carpenter *et al.*, 1989). Mating competitiveness refers to the ability of irradiated male to compete with wild one for mating with wild female, and can be evaluated by readily females accept irradiated males rather than wild males (Woods *et al.*, 2016). Attempts have been conducted to quantify the mating competitiveness of sterile insect through mathematic methods (Fried, 1971; Pagendam *et al.*, 2018) and behavior-based model (Cayol *et al.*, 1999). Additionally, sexual compatibility parameter is an important to indicate the mating randomly or selectively in between the two groups, sterile and wild type insect (Lux *et al.*, 2002; Mudavanhu *et al.*, 2016). The present study aimed to provide assessment of biological fitness and mating performance of different levels of gamma irradiation doses for improving the SIT/IS of *S. littoralis*.

MATERIALS AND METHODS

1. Insect rearing

The cotton leaf worm, *S. littoralis* colony was reared and maintained for several generations under the laboratory conditions, 25 ± 2 ^{0}C and 65% R.H. Larvae were fed on semi artificial diet that developed by (Sayed *et al.*, 2021) (kidney bean 1000 g, agar 30 g, starch 35 g, gelatin 35 g, brewer yeast 150 g, ascorbic acid 15 g , sorbic acid 5 g, methyl benzoate 9.5g , formaldehyde 10 ml and distilled water 2000 ml) in rounded plastic bowls (15 x 70 cm) covered with muslin cloths until pupating. Resulted pupae were daily collected, sexed and kept in waxed paper cups on moistened saw dust. The full formed pupae were transferred in the adult rearing cage (50 x 50 x 50 cm) supplied with small cups containing pieces of cotton wool soaked with 10% sugar cane solution for moths feeding.

2. Irradiation Technique

Full-grown male and female pupae of *S. littoralis* were irradiated by different doses of gamma radiation 100, 125, 150, 175, 200, 225 and 250 Gy using ^{60}Co cell located in Nuclear Research Center, Atomic Energy Authority, Egypt. The dose rate of irradiation source was 7.0 Gray/min. Emerged parental moths (P_1) were allowed to mate with opposite unpredicted sex; the deposited eggs were collected to continue the F_1 generation.

3. Reproductive performance assay

Newly emerged males and females resulting from the irradiated pupae were paired with their untreated opposite sex. The daily deposited eggs of irradiated and un-irradiated females were collected, counted, recorded and kept to determine percent of egg hatching. Experimental time lasted for 7 days. To continue the F_1 generation for male line newly hatched larvae resulting from irradiated P_1 males were kept in groups in glass jars provided with the artificial diets. Freshly emerged moths were allowed to mate the opposite sexes and the females were observed for oviposition. The number of laid eggs was counted for each pair. The eggs were kept in Petri dish for observing their hatching whereas the percent of egg hatch was calculated. The ability of male to transfer the formed spermatophores into the bursa copulatrix of females indicates the mating success of moths, and was analyzed by dissection of female moths at the end of experiments. The number of mating was indicated by the number of spermatophores. Five replicates were conducted per each treatment and were repeated three times.

4. Mating competitiveness (C.V.) assay

Laboratory experiments were conducted to determine the male competitiveness of P_1 generations. Full-grown male pupae were irradiated at 175 and 200 and 225 and 250 Gy. Four combinations were conducted per each treatment. Mixed populations of un-irradiated (U ♂) and irradiated male (I ♂) moths were caged with virgin un-irradiated female (U ♀) moths in the ratios of 1: 0:1, 1:1:1 and 3:1:1, respectively alongside with the combination of U ♂ x U ♀. The eggs were collected and counted daily to determine fecundity and fertility. All tests were terminated 10 days after crossing. These trails were folded 20 times. Expected egg infertility and mating competitiveness were estimated by the following equations according to (Fried, 1971; Brower, 1979)

Expected egg infertility= I (F_I) + U (F_U)/ U + I

F_I = infertility of I ♂ x U ♀;

F_U = infertility of U ♂ x U ♀.

U = number of un-irradiated ♂; I = number of irradiated ♂

The competitiveness value (C.V.) =

Actual infertility% / Expected infertility%

Moreover, evaluation of the effectiveness of using tested doses in different ratios the biological efficiency index (BE) was calculated according (Makee and Saour, 2004) as follow

BE % = 1 - (R/T)* 100

Where R is the number of hatched eggs of irradiated moths that paired with untreated ones; T is the number of hatched eggs of the control treatment.

5. Sexual competitiveness test

Mating competitiveness assay were evaluated according to the method described by (USDA, 2003). Two large cages (2 X 2 X 2 m^3) made of white net material were set up in the laboratory of the insectaria building under 25 ± 2 ^{0}C and 65% R.H. Twenty virgin irradiated and un-irradiated female moths were released into each cage at 06.00 -08.00 pm (sunset time) in April to August 2021 and 2022. After two hours, twenty virgin irradiated and un-irradiated male moths were released into each cage. Two days before the experiments, newly emerged male and female moths carefully marked on the wings by color codes to identify the corresponding moths (irradiated or un-irradiated) and were separated in different laboratories. Low wattage led bulb (15 W) was used in the laboratory outside in each the cage. Each cage was monitored during 3-5 days after release to collect the mattings. The mating pairs were collected using a small plastic vial. Number of pairs along with the mating category [irradiated (I) or un-irradiated (U)], copulation duration (min) was recorded, this experiment was repeated 3 times. Male mating competitiveness was assessed by the relative sterility index (RSI) = I♂U♀ / I♂U♀ + U♂U♀; furthermore, sexual compatibility were estimated by the isolation sterility index (ISI) = (I♂I♀ + U♂U♀) - (I♂U♀+UI♀) / I♂I♀ + U♂U♀ + I♂U♀ + U♂I♀; mating competitiveness of male and female moths were evaluated through the relatively performance index of male (MRPI) and that of female (FRBI), in which MRPI = (I♂I♀ + I♂U♀) - (U♂I♀ + U♂U♀) / I♂I♀+ I♂U♀ + U♂I♀ + U♂U♀ and FRPI = (I♂I♀ + U♂I♀) - (I♂U♀ + U♂U♀) / I♂I♀ + I♂U♀ + U♂I♀ + U♂U♀.

Data Analysis

The statistical analysis of reproduction and mating competitiveness in laboratory and semi field cage studies were conducted using one-way of the analysis of variance (ANOVA) using SPSS, ver. 25 IBM Corp Released, (Meyers *et al.*,2013), the means were analyzed using

Tukey's multiple range test when the ANOVA statistics were significant ($P < 0.05$). Arcsine tables were used for transforming of the mortality percentages for data analysis, while the means and standard errors were from original data. The values of C.V. ranged from 0.0 -1.0, 1.0 or more indicate full competitiveness between un-radiated and irradiated male moths, while values close to 0.0 indicate superior competitiveness of the un-irradiated males. In sexual competitiveness test, RSI value can vary from 1.0 to 0.0, where 1.0 indicates that all female moths in the cage mated with irradiated male moths, 0.0 indicates that all female moths mated with un-irradiated male moths, and 0.5 indicates that half mated with irradiated male moths and half with un-irradiated male moths. ISI value (1.0 to 1.0), 1.0 indicates that a complete positive assortative mating indicating total mating isolation of the two groups (sterile and wild), -1 denote that all mating takes place of irradiated mated with un-irradiated and vice versa, this means complete negative assortative mating. MRPI or FRPI (1.0 to -0.1), 1.0 denotes that all mating is carried out by irradiated male or female moths, -1.0 indicates that all mating by un-irradiated male or female moths and 0.0 denotes that un-irradiated and irradiated male moths participate equally in mating.

RESULTS

1. Sterility index of irradiated male and female moths:

The impact of gamma irradiation on the fecundity of irradiated both male and female moths were presented in Fig (1). The average number of eggs per un-irradiated female moths paired with irradiate male moths (P_1) was significantly lower ($F_{(7, 119)} = 10.3$ $P = 0.0014$) at the doses 175, 200, 225 and 250 Gy than 0, 100 and 125 Gy (Fig 1, A). While, in the F_1 generation the Averages of eggs from un-irradiated female moths paired with F_1 male moths was insignificant ($F_{(7, 119)}= 3.3$ $P = 0.15$) at the tested doses compared to the control treatment (0 Gy).

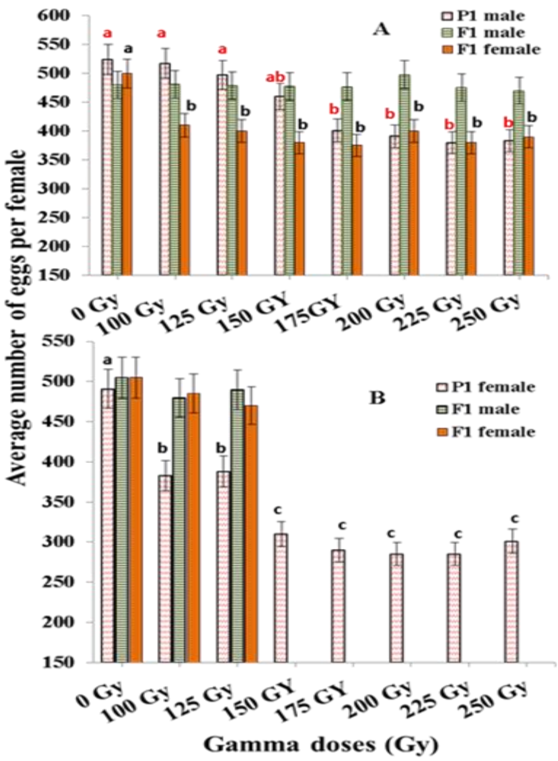

Fig (1). Average numbers of eggs per female produced from un-irradiate female paired with irradiated male moths (P_1 male) and their progeny (F_1 male and female of male line) (A), and, irradiated female moths paired with un-irradiated male moths (P_1 female) and their progeny (F_1 male and female of female line) (B).

In the same figure the averages of F1 female moths paired with un-irradiated male moths were significantly increased ($F_{(7,\ 119)}$ = 31.14 P < 0.0001) at all tested doses as compared to the control treatment (0 Gy). Data of (Fig 1, B) showed that the average number of eggs per irradiated female moths (P1) paired with un-irradiated male moths was significantly decreased ($F_{(7,\ 119)}$= 20.7 P < 0.0001) by increasing the dose levels, while, the averages in the next generation (F_1) of both male and female moths were relatively similar at the dose levels 0, 100 and 125 Gy. No data were recorded on the other doses whereas no F_1 progeny were produced.

The percentages of egg hatch were significantly and gradually reduced in a dose dependent manner in irradiated both male and female moths. The percentages of egg hatch in irradiated male (P_1 male) significantly decreased (93.7% to 61.7, 51.2, 17.5, 11.8, 9.2, 4.0 and 0.0 %) at 0, 100, 125, 150,175, 200, 225 and 250 Gy, respectively in case of irradiated males (Fig 2, A).

The percentages were reduced in the next generation of both male (F_1 male) and female (F_1 female). Data also showed obvious reduction in egg hatch to reach (0.0 %) at 175, 200, 225 and 250 Gy in case of irradiated female moths (P_1 female) (Fig 2, B), the percentages were significantly decreased to (37.7, 7.5 and 2.12 %) at 100, 125, 150 Gy as compared to 92.5 % of control treatment, while, at the same doses the percentages was increased in the F_1 male and F_1 female.

Irradiation doses significantly reduced the sperm transfer (spermatophore) by irradiated male moths paired with un-irradiated female moths as compared to the control (0 Gy) ($F_{(7,\ 119)}$= 44.7 P < 0.0001) (Fig 3, A). In the same figure, the average numbers of spermatophore were higher among the F_1 of male and female than the P_1 at the same dose level. The same trend was recorded in case of female line (Fig 3, B) where the average numbers of spermatophore of irradiated female (P_1 female) were significantly lower at (0 and 100 Gy) as compared to (125, 150, 175, 200, 225 and 250 Gy) ($F_{(7,\ 119)}$= 57.1 P < 0.0001), while the sperm transfer not recorded in the F_1 generation of both male and female .

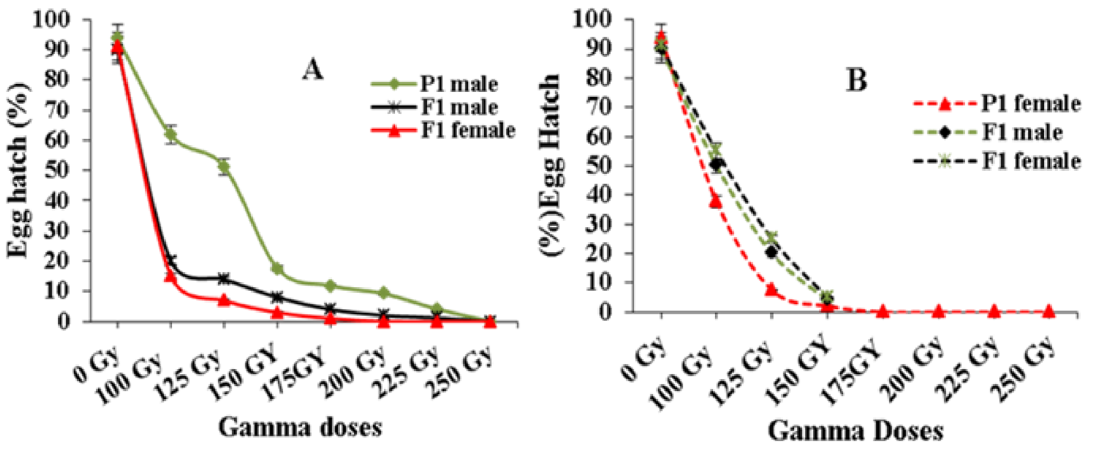

Fig (2). Percentages of *Spodoptera littoralis* hatched eggs from un-irradiate female paired with irradiated male moths (P_1 male) and their progeny (F_1 male and female of male line) (A), and also from irradiated female moths paired with un-irradiated male moths (P1 female) and their progeny (F1 male and female of female line) (B).

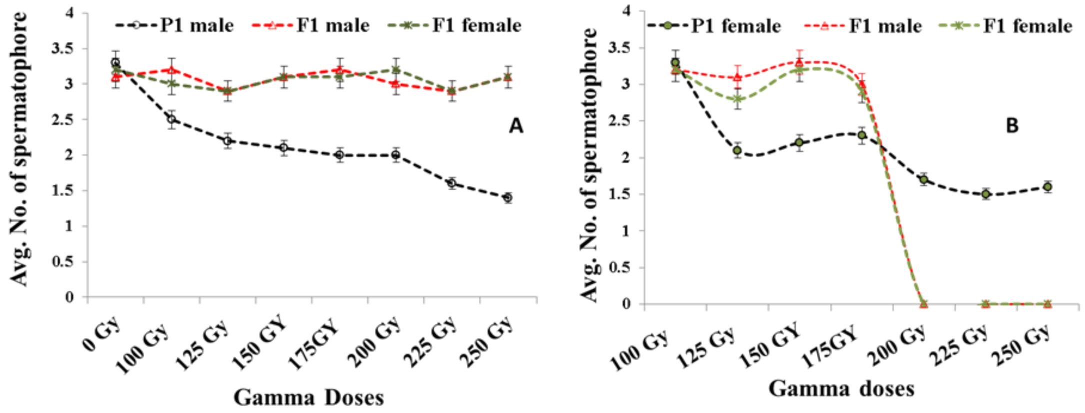

Fig (3). Averages of spermatophore in un-irradiate female paired with irradiated male moths (P1 male) and their progeny (F1 male and female of male line) (A), and, irradiated female moths paired with un-irradiated male moths (P1 female) and their progeny (F1 male and female of female line) (B).

2. Mating Competitiveness (C.V.)

The present data of reproductive biology of *S. littoralis* revealed that the doses of 175 to 250 Gy were full sterilizing of female moths and partial sterile of male moths. Consequence, our study on mating competitiveness was focused on the effects of these doses on mating competitiveness of the parental male moths of *S. littoralis*. Data in Table (1) present the mating competitiveness (C.V.) of irradiated male parents against untreated ones for mating with un-irradiated female moths, and show the observed & expected infertility of eggs beside the biological efficiency index. The data indicated that increasing the ratio of irradiated male moths against un-irradiated ones from 1:1 to 3:1 increased the percentage of observed infertile eggs at the tested doses.

Table (1): Percentages of observed and expected infertile eggs, averages of competitiveness value (C.V.) and biological efficiency index (BE) (%) of irradiated male moths paired with un-irradiated female moths at different ratios.

Dose (Gy)	**Cross ratio I♂ : U♂ : U♀**	**Infertile eggs% Observed**	**Expected**	**C.V.**	**% BE**
0	0 : 1 : 1	5.3		-	
175					
	1 : 0 : 1	82.7		-	
	1 : 1 : 1	64.7	44.0	0.80	63.0
	3 : 1 : 1	84.4	36.4	0.24	83.6
200					
	1 : 0 : 1	96.9		-	
	1 : 1 : 1	77.7	51.1	0.43	76.6
	3 : 1 : 1	89.4	74.0	0.14	88.9
225					
	1 : 0 : 1	99.7		-	
	1 : 1 : 1	94.5	52.5	0.11	94.2
	3 : 1 : 1	100	76.1	1.0	100
250					
	1 : 0 : 1	100		-	
	1 : 1 : 1	93.5	52.6	0.32	93.2
	3 : 1 : 1	100	76.3	1.0	100

Results of C.V. indicated that the value was not affected much, either by increasing the doses from 175 to 200 Gy or by increasing the ratio from 1: 1 to 1: 3. While the C. V. of the ratio 3:1 was significantly higher than 1:1 of the both doses 225 and 250 Gy.

3. Sexual competitiveness studies

The aim of this study is to determine the mating performance, mating competitiveness and sexual compatibility of irradiated male moths compared with un-irradiated ones. Data in Fig (4, A) show that the ISI of the tested dose was low values from -0.1 to 0.2 ($F_{(3,\ 23)}$= 958.2 P < 0.0001), however, the value of 200 Gy was the lowest (more compatible), while the value of 225 Gy was the highest (less compatible) compared to 175 and 250 Gy, these data indicated that the irradiated individuals mated satisfactorily with the un-irradiated moths. In the same figure the value of MRPI were ranged from -0.2 to 0.0 ($F_{(3,\ 23)}$= 425.2 P < 0.0001), the value was higher (0.0) for 175 Gy than those recorded for 200, 225 and 250 Gy, indicating that the male moths exposed to 175 Gy was more efficient in copulation with un-irradiated females. In the same figure the FRPI value was ranged from -0.2 to 0.0 (F (3, 23)= 125.2 P < 0.0001), the value was lower (- 0.2) for 175 Gy than those recorded for 200, 225 and 250 Gy, in which reflected tendency to copulate in greater proportion with un-irradiated male moths than irradiated ones.

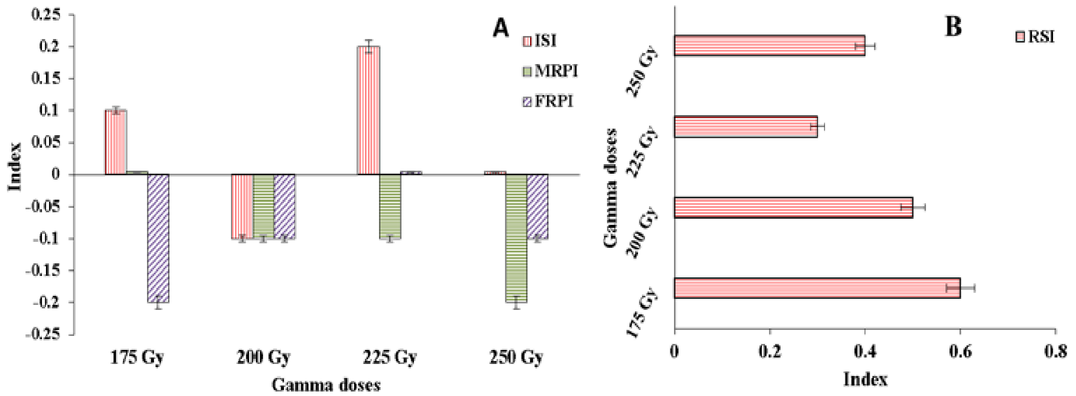

Fig 4. Averages of mating competitiveness (A) and sexual compatibility (B) parameters of *S. littoralis* male and female moths irradiated as full grown pupae.

The values of ISI, MRPI and FRPI which were not lower than -02 and not more than 0.2 revealed that there was no sexual isolation between irradiated and un-irradiated moth among all irradiation doses. Fig (4, B) presents that the RSI values were significantly different between tested doses ($F_{(3,\ 23)}$= 88.2 P < 0.0001), the value of 175 Gy was higher (successfully compete) than the 200, 225 and 250 Gy. The obtained results indicated that the category moths of U♂U♀ had longer duration of mating than those recorded in other mating in the all tested irradiation levels. Generally, the category of I♂U♀ moths was (59.2, 58.2, 76.0 and 50 min.), while the copulation time of U♂I♀ was (60.0, 72.0, 56.6 and 70.2 min.), moreover, the copulation time of I♂I♀ was (49.3, 86.6, 63.2 and 82.4 min) at 175, 200, 225 and 250 Gy, respectively (Fig 5) .

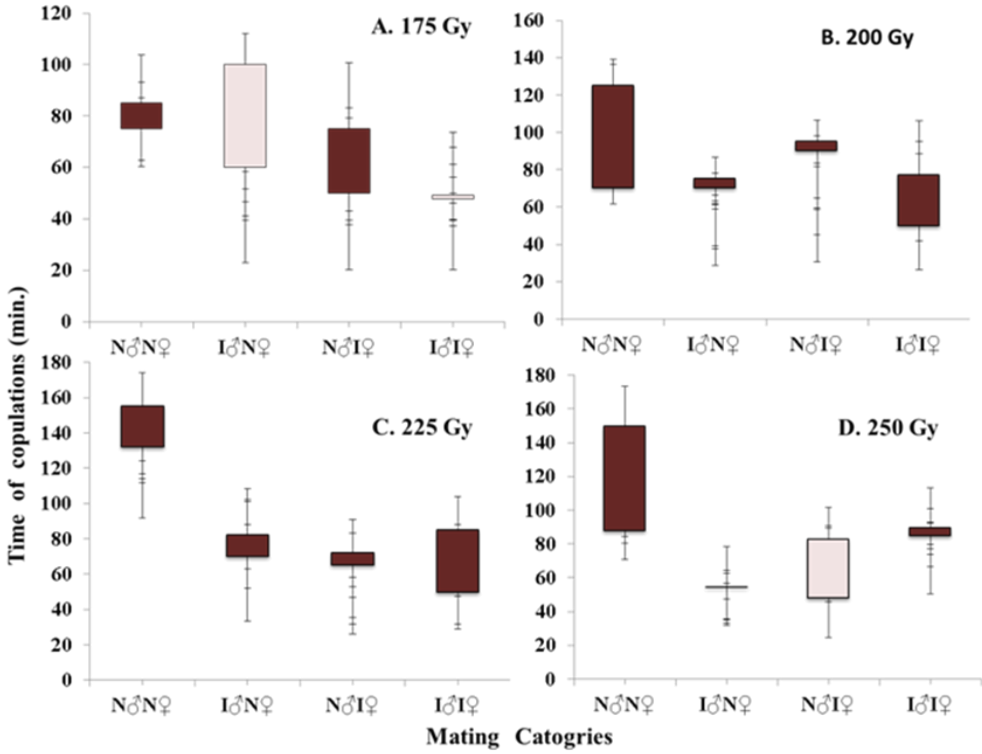

Fig 5. Average values of copulation times for different mating categories of the *S. littoralis* male and female moths irradiated as full grown pupae.

DISCUSSION

The obtained results revealed that the fecundity of *S. littoralis* female moth was significantly affected among both P_1 and F_1 male line, while in female line the reduction of fecundity was recorded only in P1. In both male and female lines males irradiated by doses of 175, 200, 225 and 250 Gy were fully sterile of female moths, while 250 is full sterile of both male and female moth. Moreover, the doses 200 and 225 Gy induce full sterility in F_1 male. The obtained results are in agreement with (Marec and Vreysen, 2019) who reported that the developing genetic sexing strain in Lepidoptera is one of currently SIT/IS challenges whereas release of sterile male and female moths was less efficiency than only male-only release. In contrast, according to laboratory studies, the release of both sexes might more promising than release only male moth (Saour *et al.*, 2022; Hight *et al.*, 2005). Evidently, release of sterile female moths hasn't negative impact on the plant and livestock as compared with other insect orders, and female moths have been shown to be more sensitive to radiation than male moths, therefore the doses of partial sterility in male moths could be a full sterility in female moths. (Vreysen *et al.*, 2010). In the present study most reduction of egg hatch (0.0 hatches) was recorded in 175 and 250 Gy of female and male moths, respectively, where in other Lepidoptera species the sterilizing dose was 400 and 200 Gy of male and female moths, respectively of false codling moth, *Cryptophlebia leucotreta* (Bloem *et al.*, 2003), and 400 Gy of the wax moth *galleria mellonella* (Jafari *et al.*, 2010). The averages number of spermatophore per mated female moths was decreased by increasing the dose level to parent, while, the mating ability through F_1 generations not clearly influenced. In general the female and male moths are polygamy, irradiation treatment has negative impact of the male mating ability of *S. littoralis* (Sayed *et al.*, 2022), *Spodoptera litura* (Sengupta *et al.*, 2022) and *Epiphyas postvittana* (Stringer *et al.*, 2013). The present results indicated that high doses of radiation 200 to 250 Gy exhibited lower in sperm transfer (spermatophore) in the P_1 generations compared to un-irradiated ones, however, in F_1 generation the mating ability was improved by increasing the spermatophore numbers of irradiated moths. These results are in harmony with a (Carpenter *et al.*, 2009; Wee *et al.*, 2011) who confirmed an improvement of the sperm bundle of F_1 generation of irradiated Lepidoptera. Results for increasing the ratio of irradiated males: un-irradiated ones in the competing population from 1:1 to 3:1 had increased the percentage of infertile eggs as well as the C.V values at the tested doses. This was in accordance of with (Brower, 1982) on *Ephestia elutella*, (Ocampo, 2001; Osouli *et al.*, 2021) on *Helicoverpa armigera*, (Fu *et al.*, 2016) on *Conopomorpha sinensis* and (Seth *et al.*, 2016)on *Spodoptera litura*. Result of field cage revealed that the RSI values of the tested doses were varied around to 0.5, referring that irradiated and un-irradiated male moths were competed equally. Also, a high competitiveness in the tested doses may be an advantage for using higher infertile eggs of sub-sterilizing doses. In this line, a high mating competitiveness was given of irradiated *S. frugiperda* males by 250 Gy (Jiang *et al.*, 2023) and 300 Gy of *E. postvittana* (Woods *et al.*, 2016). On the contrary, lower doses caused lower deleterious effect on insect quality (Lux *et al.*, 2002; Bakri *et al.*, 2005), higher in competitiveness (Bond *et al.*, 2019). The obtained values of ISI at tested doses, indicating the irradiated moths mated satisfactory with un-irradiated opposite sex and vice versa, similar results of the mating compatibility was reported by (Allinghi *et al.*, 2007) Moreover, data from MRPI and FRPI values were lower than 0.0 at the tested doses, indicating that both irradiated and un-irradiated moth mated in the field cage equally. While, FRPI values indicted that all tested doses reflected tendency for the irradiated female moths to copulate in lower proportion than un-irradiated ones. Combined data of ISI, MRPI and FRPI perfectly complement each other and well demonstrate mating competitiveness and sexual compatibility between irradiated and un-irradiated insect (Mudavanhu *et al.*, 2016; Simmons *et al.*, 2010). We found that Irradiation treatment reduced the copulation duration compared to un-irradiated ones, these findings are accordance with (Sayed, 2013; Krüger *et al.*, 2019). Conversely, irradiated male had a tendency to have longer copulation periods than untreated control (Holt and North, 1970; Koudelová and Cook, 2001). Discrepancy, there is no evidence of relationship between copulation duration and the fitness of sterile males in Lepidoptera (Suckling *et al.*, 2004). The obtained results suggested that the irradiation treatment of 225 Gy had a low impact on male performance, full sterility of irradiated female, full sterility in F_1 male, indicating a promising irradiated dose for successful application of SIT/IS against *S. littoralis*.

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الجرعة الإشعاعية المثلى لتحسين تقنية إطلاق الحشرات العقيمة لمكافحة دودة ورق القطن سبودبترا ليتورالز

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الملخص

تعد تقنية اطلاق العقم الموروث باستخدام جرعات تحت معقمة من الاشعة المؤينة طريقة واعدًة ضد افات حرشفية الأجنحة. ويعد تقدير جرعات التشعيع المثلي أمرًا هاما لتطوير هذه التقنية. وقد صممت التجربة الحالية لتحديد الجرعة الفعالة لتحسين تقنية العقم الموروث ضد افة دودوة ورق القطن مع الحفاظ على القدرة على التزاوج والتنافس مع الحشرات غير المشععة. لقد تم استخدام ثماني جرعات من أشعة جاما (٠، ١٠٠، ١٢٥، ١٥٠، ١٧٥، ٢٠٠، ٢٢٥ و ٢٥٠ جراي) لتشعيع العذارى الذكور والإناث لدودة ورق القطن . وأوضحت النتائج أن الاناث كانت أكثر حساسية للإشعاع من الذكور . كما أظهرت النتائج عدم قدرة البيض على الفقس (٠.٠) عند تشعيع كلا من اناث الاباء وذكور الجيل الاول عند للجرعات الاشعاعية من ١٧٥ الي ٢٥٠ جراي. كما أدت الجرعات تحت المعقمة أيضا الى انخفاض نقل الحيوانات المنوية بواسطة الذكور المشععة والتي زادت بزيادة الجرعة، وقد اظهرت النتائج زيادة النسبة المئوية في الحيوانات المنوية المنقولة للاناث خلال ذكور الجيل الأول مقارنة بذكور جيل الأباء عند نفس الجرعة الاشعاعية. هذا وبينت النتائج ان أفضل قدرة تنافسية للذكور عند نسبة ٣ مشعع : ١ غير مشعع وذلك عند الجرعات ٢٢٥ و ٢٥٠ جراي. وقد أظهرت التجارب في الأقفاص الحقلية مستويات عالية من القدرة التنافسية للتزاوج بين الفراشات المشععة وغير المشععة عند جميع الجرعات المختبرة. علاوة على ذلك، أظهرت فترة التزاوج فروق غير معنوية خلال جرعات التشعيع، علي الرغم أن فنرة التزاوج كانت أقصر في الحشرات المشععة مقارنة بغير المشععة. وقد اشارت نتائج الدراسة ان الجرعة ٢٢٥ جراي تسببت في عقم كامل لفراشات ذكور الجيل الاول وإناث الاباء مع الحفاظ على قدرتها التنافسية العالية لذلك يمكن استخدامها بفعالية في تقنية العقم الموروث ادارة افة دودة ورق القطن.