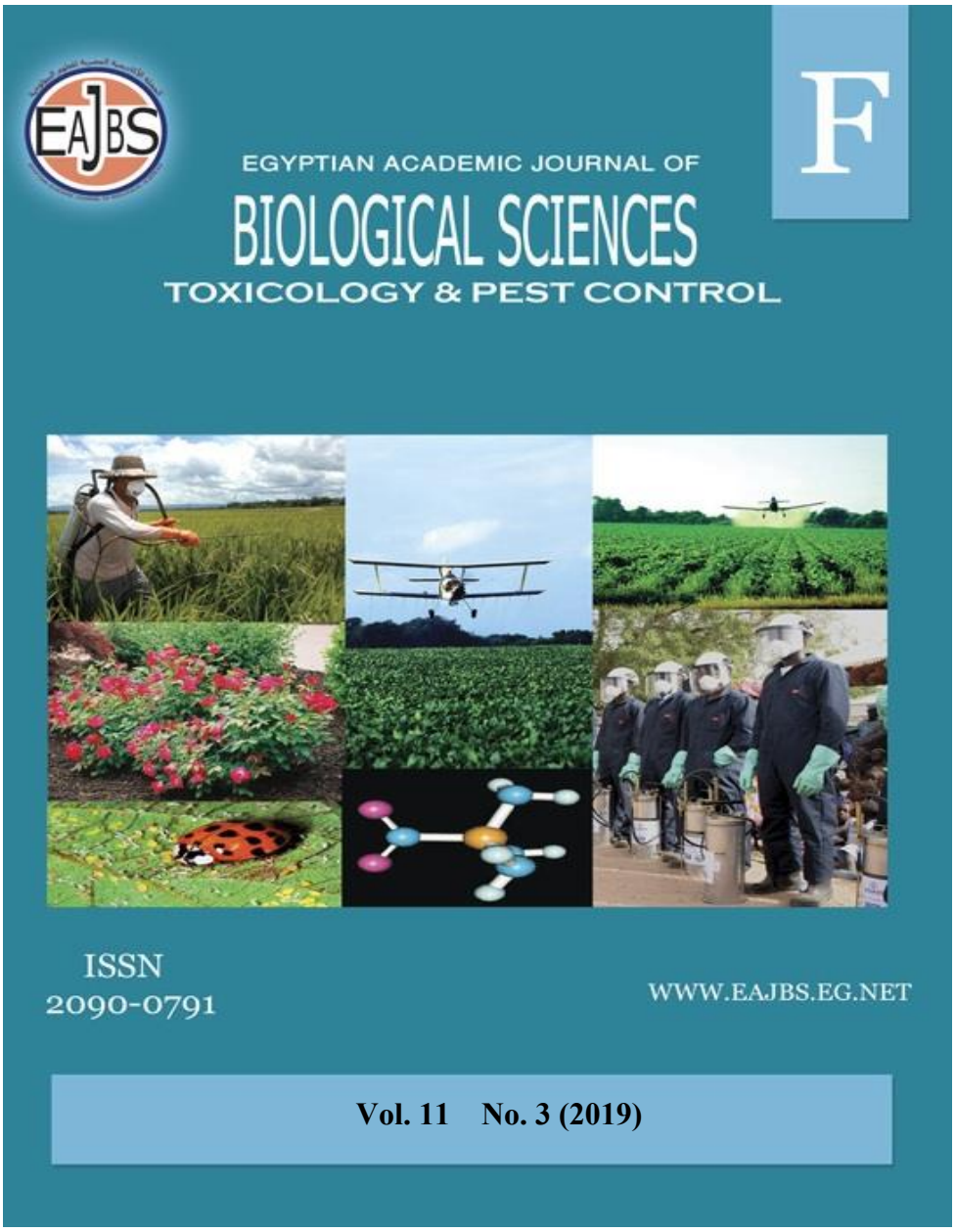

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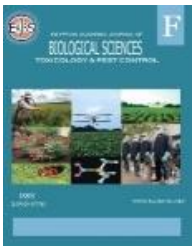

Gamma Radiation Potency to Potentiate Some Compounds For Controlling Three Cotton Boll Pests

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ABSTRACT

A Field experiment was done at Plant Protection Research Institute Experimental Station, Qaha district, Qalubeiah governorate during 2018 & 2019 two cotton seasons. Thirteen compounds related to different groups were used; three of them were exposed to gamma radiation doses of 400 & 700 Gy for potentiating purpose. The treatments were *Bacillus thuringiensis* (Kurstaki), *Beauvaria bassiana* (Balsamo), *B. thuringiensis* +*B. bassiana*, *B. bassiana*+400 Gy, *B. bassiana*+700 Gy, azadirachtin, azadirachtin+400 Gy, azadirachtin+700 Gy, fertacho, fertacho+400 Gy, fertacho+700 Gy, profenofos and profenofos+amadene. The treatments aforementioned were evaluated against three pests of cotton bolls that were pink bollworm, *Pectinophora gossypiella* (Saund); spiny bollworm, *Earias insulana* (Boisd.) and Cottonseed bug, *Oxycarenus hyalinipennis* (Costa) population and infestation reduction percentages.

Profenofos+Amadene was considered the best treatments caused reduction percentages in population and infestations against three pests used, followed by profenofos as well as fertacho+ 700 Gy nearly, azadirachtin +700 Gy, fertacho + 400 Gy, azadirachtin + 400 Gy, fertacho, azadirachtin, *B. bassiana*+700 Gy, *B. bassiana* + 400 Gy, *B. thuringiensis* +*B. bassiana*, *B. thuringiensis* and *B. bassiana*. In addition, the compounds used enhance the most cotton crop parameters acts in seed numbers, lint and seed weights during the two cotton seasons 2018 & 2019.

So, gamma radiation can potentiate the three compounds of *B. bassiana*, azadirachtin and fertacho to become the most effective compounds on aforementioned three pests and cotton crop parameters compared with the same compounds without exposing to gamma radiation.

INTRODUCTION

Cotton (*Gossypium* barbadense, L.) infested by many economic pests. From these pests were three cotton bolls destructive of pink bollworm, *Pectinophora gossypiella* (Saund); spiny bollworm, *Earias insulana* (Boisd.) and Cottonseed bug, *Oxycarenus hyalinipennis* (Costa) were the most destructive insect pests that cause terrible damage to cotton bolls. *P. gossypiella* is the destructive pest infesting cotton bolls; the neonate penetrates squares, flower buds, flowers, and bolls shortly after hatching and then

penetrates the lint and seeds of fully mature bolls, thus decreasing the quantity and quality of lint and seeds (Noble, 1969). Also, *E. insulana* is a serious insect pest, it causes a threat to cotton bolls, the larvae mainly feed on fruiting parts of many crops and vegetables causes top boring for the soft and growing tissues especially the terminal buds and later it attack the flower buds and bolls that ultimately shed (Khan, *et al.* 2007), resulting considerable losses in quantity and quality of crops. Sucking behavior of *O. hyalinipennis* (adult and nymphs) disturb the cotton crop at early (squares and flowers) as well as the late stages (open bolls) but most economic losses are caused in the late stage. It extracts the sap from the reproductive parts of plants and can also deteriorate the seed quality. Besides damaging the seeds and the reproductive parts, it worsens the lint quality resulting in poor ginning of cotton fibers (Ananthakrishan *et al.*, 1982).

A huge number of synthetic pesticides are used annually for insect pest control. No doubt agrochemicals have a major role in improving yields in food production; however, concern has arisen about the negative impact of such chemicals on human health and the environment (Dinham, 1993). Indiscriminate use of insecticides has not only caused the resistance problem in these pests but it has also polluted the environment.

Gamma irradiation as a genetic control method is unique among biological methods; it involves the release of genetically modified insects to control the same species (Soon, 1986). Inherited effects of gamma irradiation doses were studied by many authors as Sallam and Ibrahim (1993), Amer (2006), Amer, *et al.* (2011 and 2012).

Many searches trended to use bioagent compounds for controlling the cotton bollworms to try being successful steps in removing chemical pesticides from the environment. Amer and El-Nemaky (2008) mentioned that combination of Protecto and Biover had potentiating effects in relation to most biological and prediction parameters of the pink bollworm than when the two biocides were used singly. Amer, *et al.* (2011) mentioned that biover (*B. bassiana*)+ 300 Gy, followed by biover + 200 Gy and biover + 100 Gy had the potentiating effect on *P. gossypiella* newly hatched and fourth instar larvae than biover without exposing to gamma ray. Rafique *et al.* (2012) and Abedi, *et al* (2014) evaluated *Azadirachta indica* against *P. gossypilla and H. armigera* and stated that the compound has insecticidal potential showed significant mortality response.

Aim of a current field trial is to potentiate three compounds (*B. bassiana,* Azadirachtin and fertacho) by exposing to gamma radiation doses of 400 & 700 Gy compared to a bioagent additive compound (*B. thuringiensis +B. bassiana*) and chemical compound of organophosphorus (Profenofos) and Profenofos + Amadene. Thirteen treatments used to control the three insect pests of *P. gossypiella, E. insulana* and *O. hyalinipennis* on cotton bolls at 2018 and 2019 cotton seasons.

MATERIALS AND METHODS

A field experiment of cotton (Giza 86 variety, 2017 strain) was done to evaluate the efficacy of thirteen treatments against *P. gossypiella, E. insulana* and *O. hyalinipennis* that infesting cotton bolls at 2018 & 2019 growing cotton seasons at Plant Protection Research Institute Station, Qaha district, Qaluobeiah governorate. The experimental area was divided according to the complete randomized block design including four replicates for each treatment; each replicate was 6x7 m (1/100 feddan).

The tested compounds were applied three times at 15 days intervals. The first spray was applied at 21th and 27th July in 2018 and 2019 cotton seasons, respectively. Boll samples were collected at random before applying the compounds and then weekly after application. One hundred bolls (25 bolls x 4 replicates) were collected from each treatment and examined.

Insects:

Three pests were investigated on green cotton bolls were mentioned in Table (1).

Table (1). Insects infested the cotton bolls

English name	Bionomial name	Family	Order
Pink Bollworm	*Pectinophora gossypiella* (Saunders)	Gelechiidae	Lepidoptera
Spiny Bollworm	*Earias insulana* (Boisduval)	Noctuidae	Lepidoptera
Cotton Seed Bug	*Oxycarenus hyalinipennis* (Costa)	Lygaeidae	Hemiptera

Compounds:

Thirteen treatments belong to six compounds as in Table (2).

Table (2). Compounds used common name and application rate.

Trade name	Common name	Application rate	Product Co.	Imported Co.
Biotect 9.4% W.P	*Bacillus thuringiensis* (Kurstaki)	300g/ feddan	Organic for biotechnology co. Beheira Governorate, Egypt.	
Biover 10% W.P	*Beauvaria bassiana* (Balsamo)	200gm per 100 liter water/ feddan	Special Unit of Producing Bio-insecticides, Plant Protection Research Institute, Agriculture Research Center, Egypt.	
Achook 0.15% EC.	Azadirachtin, *Azadirachta indica*	750 cm3/ feddan	Bahar agrochem & feeds, India	Al- Masrya for agriculture development, Beheira Governorate, Egypt.
Fertacho 40% W.P	Thiamethoxam 20% + chlorantranelebrol 20%	35 gm/ feddan	Syngenta Agro Swetherland, Qalubeiah Governorate, Egypt.	
Ictacron 72% EC	Profenofos	750 cm3/feddan		International company for chemical & Agency trade (ACTA), Giza Governorate, Egypt.
Amadene 36%	Hydrolyzid protein 36%	(1L amadene + 20L water + 750 cm3 Ictacron)/ feddan	Diachem S.P.A., Italy	Oasis for importing & exporting company, Cairo Governorate, Egypt.

Knapsack-motor sprayer, Cifarilli (20 L) was used in applying the compounds as foliar treatment. The compounds application started when the percent infestation of green bolls reached about 3%.

Gamma Radiation:

B. bassiana, Azadirachrtin and Fertacho compounds were exposing to gamma radiation doses of 400 and 700 Gy at a dose rate of 1.084 KGy/h by a Cesium^{137} Hendy Gamma Cell Research at National Center for Radiation Researches & Technology. **Thirteen treatments were used as follows: 1.** *B. thuringiensis,* **2.** *B. bassiana*, **3.** *B. thuringiensis* + *B. bassiana,* **4.** *B. bassiana* + 400 Gy, **5.** *B. bassiana* + 700 Gy, **6.**

Azadirachtin, **7.** Azadirachtin + 400 Gy, **8.** Azadirachtin + 700 Gy, **9.** Fertacho, **10.** Fertacho + 400 Gy, **11.** Fertacho + 700 Gy, **12.** Profenofos, **13.** Profenofos + Amadene.

The percent reduction in population and infestation were calculated according to Handerson and Telton formula (1955):

% Reduction = 100 (1- (Ta x Cb / Tb x Ca)).

Where Ta = number of infested bolls from the treatment after application.

Tb = number of infested bolls from the treatment before application.

Ca = number of infested bolls from the control after application.

Cb = number of infested bolls from the control before application.

Cotton Crop Parameters:

The number of seeds and weights of lint and seeds (g) cotton crop were assessed as compared to the control. The samples were collected per 100 open cotton bolls.

Statistical Analysis:

All investigated data were analyzed by using Costat statistical program software, 1990 and Duncan multiple range tests (Duncan, 1955) at 5% probability level to compare the differences among time means.

RESULTS AND DISCUSSION

A field trial was done at Plant Protection Research Institute Station, Qaha district, Qalubeiah governorate during two cotton seasons (2018 & 2019). The purpose of trial is potentiating three compounds efficacy (*B. bassiana*, Azadirachtin and fertacho) by exposing to gamma radiation doses (400 & 700 Gy); also, compared its efficacy with the same compounds without radiation; in addition to compare with additive biocides (*B. thuringiensis* + *B. bassiana*) and organophosphorus compound (Profenofos or Profenofos + Amadene).

The controlling target pests were pink bollworm, *P. gossypiella*; spiny bollworm, *E. insulana* and cotton seed bug, *O.hyalinipennis*; also, investigate the reduction percentages of larval population and infestation for three pests mentioned. Moreover, determined the cotton crop acts in seed number, lint & seed weight/100 opened cotton boll during two cotton seasons trials (2018 & 2019).

Pink and Spiny Bollworms:

a. Larval Population Reductions:

Thirteen compounds were applied on cotton green bolls when larval population and infestation was 3% of *P. gossypiella* or *E. insulana* or both of them.

The pink and spiny larval population reductions had slightly increased in 2019 than 2018 cotton seasons as shown in Table (3). The organophosphorus compound (Profenofos) + amadene (hydrolyzide protein) was the best treatment caused bollworms larval population reduction during two cotton seasons (83.1 & 77.7% for 2018 & 2019 cotton seasons, respectively). It may be amadene compound caused insect attracting, and then kill by using profenofos compound. The second efficacy compound was Profenofos 79.8 & 73.3% reduction in bollworms population. Gamma radiation dose of 700 Gy potentiate the compound of fertacho + 700 Gy and azadirachtin + 700 Gy, followed by the same two compounds exposing to dose of 400 Gy comparing with the same compounds without exposing to gamma radiation as illustrated in Table (3). In addition, *B. bassiana*+ 700 Gy, followed by *B. bassiana* + 400 Gy had potentiating action in bollworms reduction comparing with *B. bassiana* without exposing to gamma doses. Moreover, *B. thuringiensis* + *B. bassiana* had potentiating effect in efficacy on larval reduction comparing with each of them when using singly.

b. Infestation Reduction:

The same trend in larval population reduction was also cleared in bollworms infestation reduction (Table 4); but the infestation reduction was higher than population.

Profenofos + amadene was the highest reduction in bollworms infestation at two cotton seasons 2018 & 2019, followed by profenofos, fertacho + 700 Gy, azadirachtin + 700 Gy, fertacho + 400 Gy, azadirachtin + 400 Gy, fertacho, Azadirachtin, *B. bassiana* +700 Gy, *B. bassiana* + 400 Gy, *B. thuringiensis* + *B. bassiana* , *B. thuringiensis* and *B. bassiana*.

Table (3): Percent reduction in larval populations of the pink and spiny bollworms during application with some compounds at 2018 & 2019 cotton seasons.

Compounds	% Larval population reductions during application									Seasonal Average
	1st spray			2nd spray			3rd spray			
	7	14	Aver.	7	14	Aver.	7	14	Aver.	
2018 season										
B. thuringiensis	9.33^{e}	10.7^{g}	**10**^{e}	12.6^{g}	11.1^{f}	**11.9**^{g}	14.3^{h}	15.2^{h}	**14.8**^{g}	**12.2**^{f}
B. bassiana	8.8^{e}	7.7^{g}	**8.25**^{e}	9^{g}	11.1^{f}	**10.**^{g}	12^{h}	14^{h}	**13**^{g}	**10.5**^{f}
B. thuringiensis +*B. bassiana*	28^{d}	33.3^{f}	**30.7**^{e}	35.3^{f}	38.3^{e}	**36.8**^{f}	40^{g}	39.1^{g}	**39.6**^{f}	**35.7**^{e}
B. bassiana +400 Gy	49^{c}	52.2^{e}	**50.6**^{c}	54.5^{e}	58^{e}	**56.3**^{e}	62^{ef}	60.2^{de}	**61.1**^{d}	**56**^{d}
B. bassiana +700 Gy	48.2^{c}	52.2^{e}	**50.2**^{c}	59.8^{de}	60^{c}	**59.9**^{de}	62.5^{ef}	60de	**61.3**^{d}	**57.1**^{cd}
Azadirachtin	48.8^{c}	54.7^{de}	**51.8**^{c}	57^{e}	59.9^{c}	**58.5**^{e}	67.1^{cde}	62.2^{cd}	**64.7**^{cd}	**58.3**^{cd}
Azadirachtin +400 Gy	50^{c}	60^{cd}	**55**^{bc}	64^{cd}	66.3^{b}	**65.2**^{cd}	69.1^{cd}	66.5^{bc}	**67.8**^{bc}	**62.7**^{bc}
Azadirachtin +700 Gy	58.8^{b}	62.3^{c}	**60.6**^{b}	66.1^{c}	68.8^{b}	**67.5**^{c}	72.2^{c}	70^{b}	**71.1**^{b}	**66.4**^{b}
Fertacho	72.5^{a}	69.1^{b}	**70.8**^{a}	63.9^{cd}	44.8^{d}	**54.4**^{e}	57.5^{f}	50^{f}	**53.8**^{e}	**59.7**^{cd}
Fertacho + 400 Gy	50^{c}	60^{cd}	**55**^{bc}	63.3^{cd}	67^{b}	**65.2**^{cd}	70^{cd}	68.6^{b}	**69.3**^{bc}	**63.2**^{bc}
Fertacho + 700 Gy	72.5^{a}	69.1^{b}	**70.8**^{a}	75.4^{b}	72.5^{b}	**73.9**^{b}	65de	56^{e}	**60.5**^{d}	**68.4**^{b}
Profenofos	70^{a}	74^{ab}	**72**^{a}	79^{ab}	82.5^{a}	**80.8**^{a}	84.1^{b}	88.8^{a}	**86.5**^{a}	**79.8**^{a}
Profenofos+ Amadene	72.2^{a}	75.5^{a}	**73.9**^{a}	82.5^{a}	87.4^{a}	**84.9**^{a}	90.8^{a}	89.9^{a}	**90.4**^{a}	**83.1**^{a}
L.S.D$_{0.05}$	2.95	3.25	2.61	2.32	2.42	2.37	4.32	3.62	3.97	2.98
2019 season										
B. thuringiensis	12.6^{e}	12^{f}	**12.3**^{g}	14.2^{g}	16.9^{e}	**15.6**^{f}	20.7^{f}	20.7^{g}	**20.7**^{h}	**16.2**^{g}
B. bassiana	10.2^{e}	9.33^{f}	**9.77**^{g}	12.2^{g}	14^{e}	**13.1**^{f}	16.7^{f}	18^{g}	**17.4**	**13.4**^{g}
B. thuringiensis+ *B. bassiana*	33.3^{d}	35.5^{e}	**34.4**^{f}	38.3^{f}	42.2^{d}	**40.3**^{e}	49.8^{e}	46.6^{f}	**48.2**^{g}	**40.9**^{f}
B. bassiana + 400 Gy	52.2^{c}	54.4^{d}	**53.3**^{e}	58.2^{e}	60^{c}	**59.1**^{d}	68.2^{c}	64de	**66.1**^{e}	**59.5**^{e}
B. bassiana + 700 Gy	50^{c}	55.5^{d}	**52.8**^{e}	58.2^{e}	60^{c}	**59.1**^{d}	70^{bc}	64de	**67**^{de}	**59.6**^{e}
Azadirachtin	52.2^{c}	54.4^{d}	**53.3**^{e}	62.2^{de}	68.9^{b}	**65.6**^{c}	72.2^{bc}	68.9^{cd}	**70.6**^{cde}	**63.2**^{de}
Azadirachtin + 400 Gy	72.5^{a}	70^{ab}	**71.3**^{ab}	65^{cd}	68.9^{b}	**66.9**^{c}	60^{d}	58.2^{e}	**59.1**^{f}	**65.8**^{cde}
Azadirachtin + 700 Gy	60^{b}	65^{bc}	**62.5**^{cd}	68.2^{bcd}	72.5^{b}	**70.4**^{bc}	75.6^{ab}	72.2^{bc}	**73.9**^{bcd}	**69.9**^{bc}
Fertacho	52.2^{c}	62.2^{c}	**57.2**^{de}	65.5^{cd}	70^{b}	**67.8**^{bc}	72.2^{bc}	70^{cd}	**71.1**^{de}	**65.4**^{ce}
Fertacho + 400 Gy	52.2^{c}	62.2^{c}	**57.2**^{de}	69.1^{bc}	70^{b}	**69.6**^{bc}	72.2^{bc}	72.2^{bc}	**72.2**^{cde}	**66.3**^{cd}
Fertacho + 700 Gy	62.2^{b}	65^{bc}	**63.6**^{cd}	72.2^{ab}	72.2^{b}	**72.2**^{abc}	76.6^{ab}	75^{abc}	**75.8**^{abc}	**70.5**^{bc}
Profenofos	64^{b}	68.8^{abc}	**66.4**^{bc}	72.5^{ab}	75.1^{ab}	**73.8**^{ab}	80.8^{a}	78.8^{ab}	**79.8**^{ab}	**73.3**^{ab}
Profenofos+ Amadene	74^{a}	74^{a}	**74**^{a}	77.3^{a}	78.8^{a}	**78.1**^{a}	82^{a}	80^{a}	**81**^{a}	**77.7**^{a}
L.S.D$_{0.05}$	2.31	3.54	2.93	3.22	2.32	2.27	4.12	3.22	3.17	2.79

Table (4): Percent reduction in infestations of the pink and spiny bollworms during application with some compounds in 2018 & 2019 cotton seasons.

Compounds	% Infestation reductions during application									Seasonal Average
	1st spray			2nd spray			3rd spray			
	7	14	Aver.	7	14	Aver.	7	14	Aver.	
2018 season										
B. thuringiensis	7.32^{e}	8.08^{f}	**7.7^{f}**	13.6^{g}	17.1^{h}	**15.4^{f}**	20.2^{e}	20.2^{g}	**20.2^{g}**	**14.4^{g}**
B. bassiana	5.4^{e}	7.7^{f}	**6.55^{g}**	12.6^{g}	15.8^{h}	**14.2^{f}**	18^{e}	16.2^{g}	**17.1^{g}**	**12.6^{g}**
B. thuringiensis +B. bassiana	38.8^{d}	40^{e}	**39.4^{e}**	42.2^{f}	42.2^{g}	**42.2^{e}**	46.5^{d}	44^{f}	**45.3^{f}**	**42.3^{f}**
B. bassiana + 400 Gy	44.4^{cd}	48.8^{d}	**46.6^{d}**	50^{e}	52.2^{f}	**51.1^{d}**	62.2^{c}	58.8^{e}	**60.5^{de}**	**52.7^{e}**
B. bassiana + 700 Gy	50^{bc}	52.2^{cd}	**51.1^{cd}**	52.2^{e}	54^{ef}	**53.1^{d}**	62.8^{c}	58.8^{e}	**60.8^{cde}**	**55de**
Azadirachtin	50^{bc}	52.2^{cd}	**51.1^{cd}**	54de	56^{def}	**55^{cd}**	60^{c}	58.8^{e}	**59.4^{e}**	**55.2^{de}**
Azadirachtin + 400 Gy	52.2^{bc}	56^{bc}	**54.1^{bc}**	60^{bc}	60^{bcd}	**60^{bc}**	62.8^{c}	68^{c}	**65^{bc}**	**59.7^{bcd}**
Azadirachtin + 700 Gy	54^{bc}	58.8^{b}	**56.4^{bc}**	60^{bc}	60^{bcd}	**60^{bc}**	62.2^{c}	68^{c}	**65.1^{bc}**	**60.5^{bc}**
Fertacho	50^{bc}	52.2^{cd}	**51.1^{cd}**	54.4^{de}	58.8^{cde}	**56.6^{cd}**	64^{bc}	60de	**62^{bcde}**	**56.6^{cde}**
Fertacho + 400 Gy	54^{bc}	55^{bc}	**54.5^{bc}**	58.8^{cd}	62.2^{bc}	**60.5^{bc}**	64.4^{bc}	64.4^{cd}	**64.4^{bcd}**	**59.8^{b}**
Fertacho + 700 Gy	58.8^{b}	58.8^{b}	**58.8^{b}**	64^{b}	65^{b}	**64.5^{b}**	68.8^{b}	64^{cd}	**66.4^{b}**	**63.2^{b}**
Profenofos	75^{a}	78.8^{a}	**76.9^{a}**	80^{a}	82^{a}	**81^{a}**	85^{a}	80^{b}	**82.5^{a}**	**80.1^{a}**
Profenofos + Amadene	78.8^{a}	78.8^{a}	**78.8^{a}**	80^{a}	85^{a}	**82.5^{a}**	85^{a}	85^{a}	**85^{a}**	**82.1^{a}**
L.S.D$_{0.05}$	3.69	2.12	2.91	2.58	3.65	3.12	4.35	5.32	4.54	3.62
2019 season										
B. thuringiensis	10^{f}	12^{e}	**11^{e}**	20.2^{g}	23.9^{g}	**22.1^{f}**	33.3^{i}	24.4^{f}	**28.9^{h}**	**20.7^{f}**
B. bassiana	8.8^{f}	9.7^{e}	**9.25^{e}**	14^{h}	17.4^{g}	**15.7^{g}**	24.4^{j}	20.2^{f}	**22.3^{i}**	**15.8^{f}**
B. thuringiensis +B. bassiana	35^{e}	38^{d}	**36.5^{d}**	42.2^{f}	45^{f}	**43.6^{e}**	52.2^{h}	50^{e}	**51.1^{g}**	**43.7^{e}**
B. bassiana + 400 Gy	50^{d}	52.2^{c}	**51.1^{c}**	55^{e}	58^{e}	**56.5^{d}**	60^{g}	60^{d}	**60^{f}**	**55.9^{d}**
B. bassiana + 700 Gy	55^{bcd}	58.8^{bc}	**56.9^{bc}**	56^{e}	58.8^{de}	**57.4^{d}**	62.8^{fg}	60^{d}	**61.4^{f}**	**58.6^{cd}**
Azadirachtin	52.2^{bcd}	56^{bc}	**54.1^{bc}**	60^{cde}	60^{cde}	**60^{cd}**	64^{efg}	62.8^{cd}	**63.4^{ef}**	**59.2^{cd}**
Azadirachtin + 400 Gy	54^{bcd}	58.8^{bc}	**56.4^{bc}**	62.8^{bcd}	66^{bcd}	**64.4^{bc}**	69.9^{cde}	68^{bc}	**68.9^{cde}**	**63.2^{cd}**
Azadirachtin + 700 Gy	56^{bcd}	62.8^{b}	**59.4^{b}**	66^{b}	68^{b}	**67^{b}**	72.2^{cd}	72.2^{b}	**72.2^{cd}**	**66.2^{bc}**
Fertacho	54^{bcd}	56^{bc}	**55^{bc}**	58.8^{de}	58.8^{de}	**58.8^{d}**	64^{efg}	64^{cd}	**64^{ef}**	**59.3^{b}**
Fertacho + 400 Gy	58.8^{bc}	62.8^{b}	**60.8^{b}**	65^{bc}	67^{bc}	**66^{b}**	68.8^{def}	64^{cd}	**66.4^{def}**	**64.4^{cd}**
Fertacho + 700 Gy	60^{b}	60^{bc}	**60^{b}**	65^{bc}	70^{b}	**67.5^{b}**	76^{bc}	72.2^{b}	**74.1^{bc}**	**67.2^{b}**
Profenofos	80^{a}	80^{a}	**80^{a}**	85^{a}	82^{a}	**83.5^{a}**	80^{b}	80^{a}	**80^{ab}**	**81.2^{a}**
Profenofos + Amadene	80^{a}	85^{a}	**82.5^{a}**	85^{a}	88^{a}	**86.5^{a}**	90^{a}	80^{a}	**85^{a}**	**84.7^{a}**
L.S.D$_{0.05}$	1.12	2.21	1.67	2.23	3.54	2.89	3.65	4.45	4.05	2.87

Cottonseed Bug:

a. Population.

Table (5) showed that profenofos + amadene compound was considered the best treatments caused a reduction in seed bug population, followed by profenofos. fertacho + 700 Gy, followed by azadirachtin + 700 Gy, fertacho + 400 Gy and azadirachtin + 400 Gy had potentiating efficacy on cottonseed bug population than its reduction on cottonseed bug without exposing to gamma doses.

The fungicide, *B. bassiana* when exposing to gamma doses of 700 and 400 Gy had potentiating effect on cottonseed efficacy compared to the same compound when used singly. Moreover, *B. thuringiensis* + *B. bassiana* had best efficacy compared to use each of them singly.

b. Infestation:

The previous trend was also appeared in cottonseed bug infestation reduction as in Table (6).

Both nymphes and adults of cotton seed bug (*O.hyalinipennis*) feed on immature seeds causing multiple types of injuries to the cotton crop including a reduction in yield, seed weight and oil contents (Srinivas and Patil, 2004). Cottonseed bug may also feed on the leaves and young stems of the host plants to obtain moisture (Ananthakrishan *et al.* 1982). It causes severe of embryo, reduced seed viability (Srinivas and Patil, 2004) and deteriorates the quality of cotton by staining lint and oil content (Sweet, 2000).

Shah, *et al.* (2016) assess the efficacy of 12 insecticides against dusky cotton bug (*Oxycarenus laetus*) in field conditions, the insecticides were belonging to five different groups viz. organophosphate, pyrethroid, neo-nicotinoid, naturalize and insect growth regulator (IGRs). All tested insecticides were significantly different in relation to pest mortality than the untreated check. Among the insecticides, organophosphates proved the most effective and gave 79.3% pest mortality followed by pyrethroids (53.6%) and neo-nicotinoids (53.4%) while naturalize proved least effective and gave 14.6% mortality followed by insect growth regulator (IGRs) (25.0%).

Table (5): Percent reduction in cottonseed bug populations during application with some compounds in 2018 & 2019 cotton seasons.

Compounds	% Reduction of cotton seed bug populations during application									Seasonal Average
	1st spray			2nd spray			3rd spray			
	7	14	Aver.	7	14	Aver.	7	14	Aver.	
2018 season										
B. thuringiensis	20^{g}	25^{e}	**22.5**^{g}	25^{g}	35^{e}	**30**^{ef}	11.8^{g}	10^{f}	**10.9**^{g}	**21.1**^{f}
B. bassiana	18^{g}	25^{e}	**21.5**^{g}	25^{g}	25^{f}	**25**^{f}	10^{g}	10^{f}	**10**^{g}	**18.8**^{f}
B. thuringiensis +*B. bassiana*	20^{g}	30^{e}	**25**^{fg}	35^{f}	35^{e}	**35**^{e}	11.8^{g}	10^{f}	**10.9**^{g}	**23.6**^{f}
B. bassiana + 400 Gy	35^{f}	40^{d}	**37.5**^{e}	45^{e}	45^{d}	**45**^{d}	21.8^{f}	20^{e}	**20.9**^{f}	**34.5**^{e}
B. bassiana + 700 Gy	35^{f}	45^{d}	**40**^{e}	45^{e}	45^{d}	**45**^{d}	39.4^{d}	35^{d}	**37.2**^{e}	**40.7**^{de}
Azadirachtin	25^{g}	45^{d}	**35**^{ef}	52.5^{d}	62.5^{c}	**57.5**^{c}	47.1^{c}	47.5^{c}	**47.3**^{d}	**46.6**^{cd}
Azadirachtin + 400 Gy	55^{c}	60^{c}	**57.5**^{c}	65^{c}	50^{d}	**57.5**^{c}	47.1^{c}	25^{e}	**36.1**^{e}	**50.4**^{b}
Azadirachtin + 700 Gy	40^{ef}	43.3^{d}	**41.7**^{de}	55^{d}	65^{c}	**60**^{c}	70.6^{a}	55^{b}	**62.8**^{bc}	**54.8**^{b}
Fertacho	50^{cd}	55^{c}	**52.5**^{cd}	43.8^{e}	62.5^{c}	**53.2**^{c}	55.9^{b}	32.5^{d}	**44.2**^{d}	**49.9**^{bc}
Fertacho + 400 Gy	45^{de}	45^{d}	**45**^{de}	55^{d}	60^{c}	**57.5**^{c}	73.3^{a}	45^{c}	**59.2**^{c}	**53.9**^{b}
Fertacho + 700 Gy	68^{b}	75^{b}	**71.5**^{b}	75^{b}	60^{c}	**67.5**^{b}	29.4^{f}	25^{e}	**27.2**^{f}	**55.4**^{b}
Profenofos	70^{b}	75^{b}	**72.5**^{b}	82.5^{a}	95^{a}	**88.8**^{a}	75.9^{a}	67.5^{a}	**71.7**^{a}	**77.7**^{a}
Profenofos + Amadene	82.5^{e}	95^{a}	**88.8**^{a}	82.5^{a}	82.5^{b}	**82.5**^{a}	75.9^{a}	60^{b}	**67.9**^{ab}	**79.7**^{a}
L.S.D$_{0.05}$	3.25	4.52	3.89	4.11	4.32	4.22	4.36	5.12	4.74	4.28
2019 season										
B. thuringiensis	25^{ij}	30^{i}	**27.5**^{fg}	35^{gh}	40^{g}	**37.5**^{g}	14^{f}	12^{d}	**13**^{f}	**26**^{f}
B. bassiana	20^{j}	25^{i}	**22.5**^{g}	30^{h}	35^{g}	**32.5**^{g}	15^{f}	12^{d}	**13.5**^{f}	**22.8**^{f}
B. thuringiensis +*B. bassiana*	28^{hi}	30^{i}	**29**^{f}	32^{h}	35^{g}	**33.5**^{g}	20^{e}	12^{d}	**16**^{f}	**26.2**^{f}
B. bassiana + 400 Gy	32^{gh}	38^{h}	**35**^{e}	40^{fg}	48^{f}	**44**^{f}	45^{d}	25^{e}	**35**^{e}	**38**^{e}
B. bassiana + 700 Gy	40^{ef}	40^{gh}	**40**^{e}	50^{de}	55^{e}	**52.5**^{e}	45^{d}	40^{b}	**42.5**^{d}	**45**^{d}
Azadirachtin	35^{fg}	45^{fg}	**40**^{e}	55^{cd}	58^{de}	**56.5**^{de}	62.2^{b}	45^{ab}	**53.6**^{bc}	**50**^{c}
Azadirachtin + 400 Gy	48^{d}	52^{de}	**50**^{cd}	58^{c}	65^{bc}	**61.5**^{cd}	60^{bc}	45^{ab}	**52.5**^{bc}	**54.7**^{bc}
Azadirachtin + 700 Gy	50^{cd}	58^{bc}	**54**^{c}	45^{ef}	62.5^{cd}	**53.8**^{e}	68.8^{a}	50^{a}	**59.4**^{a}	**55.7**^{b}
Fertacho	45^{de}	48^{ef}	**46.5**^{d}	60^{b}	65^{bc}	**62.5**^{c}	55^{c}	50^{a}	**52.5**^{bc}	**53.8**^{bc}
Fertacho + 400 Gy	58^{b}	62.5^{b}	**60.3**^{b}	65^{b}	55^{e}	**60**^{cd}	50^{d}	40^{b}	**45**^{d}	**55.1**^{bc}
Fertacho + 700 Gy	54^{bc}	55^{cd}	**54.5**^{c}	65^{b}	70^{b}	**67.5**^{b}	58.8^{bc}	48^{a}	**53.4**^{bc}	**58.5**^{b}
Profenofos	75^{a}	85^{a}	**80**^{a}	80^{a}	82^{a}	**81**^{a}	70^{a}	45^{ab}	**57.5**^{ab}	**72.8**^{a}
Profenofos + Amadene	80^{a}	88^{a}	**84**^{a}	85^{a}	85^{a}	**85**^{a}	60^{bc}	40^{b}	**50**^{c}	**73**^{a}
L.S.D$_{0.05}$	3.65	4.89	4.27	4.56	3.25	3.91	5.12	5.63	5.38	4.52

Table (6): Percent reduction in cottonseed bug infestations during application with some compounds at 2018 & 2019 cotton seasons.

Compounds	% Reduction of cotton seed bug infestations during application									Seasonal Average
	1st spray			2nd spray			3rd spray			
	7	14	Aver.	7	14	Aver.	7	14	Aver.	
2018 season										
B. thuringiensis	25^{f}	40^{d}	**32.5**^{e}	50^{ef}	25^{g}	**37.5**^{h}	20^{e}	7.7^{g}	**13.9**^{f}	**27.9**^{f}
B. bassiana	25^{f}	40^{d}	**32.5**^{e}	50^{ef}	25^{g}	**37.5**^{h}	20^{e}	7.7^{g}	**13.9**^{f}	**27.9**^{f}
B. thuringiensis +*B. bassiana*	30^{ef}	35^{d}	**32.5**^{e}	45^{f}	50^{f}	**47.5**^{g}	40.8^{d}	30^{e}	**35.4**^{e}	**38.5**^{e}
B. bassiana + 400 Gy	35de	40^{d}	**37.5**^{de}	50^{ef}	55^{ef}	**52.5**^{fg}	50^{c}	40.8^{d}	**45.4**^{c}	**45.1**^{de}
B. bassiana + 700 Gy	35de	50^{c}	**42.5**^{cd}	60^{cd}	72.5^{bc}	**66.3**^{bc}	40.8^{d}	30^{e}	**35.4**^{e}	**48.1**^{d}
Azadirachtin	25^{f}	50^{c}	**37.5**^{de}	50^{ef}	61.3^{de}	**55.7**^{ef}	65.4^{b}	50^{c}	**57.7**^{b}	**50.3**^{cd}
Azadirachtin + 400 Gy	45^{c}	55^{c}	**50**^{c}	68.8^{b}	52.2^{f}	**60.5**^{bcde}	53.9^{c}	40^{d}	**46.9**^{c}	**52.5**^{bcd}
Azadirachtin + 700 Gy	65^{b}	70^{b}	**67.5**^{b}	70^{b}	65^{cd}	**67.5**^{b}	53.9^{c}	20^{f}	**36.9**^{de}	**57.3**^{bc}
Fertacho	40^{cd}	50^{c}	**45**^{cd}	66.7^{bc}	62.5^{de}	**64.6**^{bcd}	50.9^{c}	36.7^{de}	**43.8**^{cd}	**51.1**^{bcd}
Fertacho + 400 Gy	62.5^{b}	70^{b}	**66.3**^{b}	65.4^{bc}	50^{f}	**57.7**^{def}	50^{c}	43.8^{cd}	**46.9**^{c}	**56.9**^{bc}
Fertacho + 700 Gy	42.5^{cd}	55^{c}	**48.8**^{c}	55de	62.5^{de}	**58.8**^{cdef}	76.9^{a}	60^{b}	**68.5**^{a}	**58.7**^{b}
Profenofos	85^{a}	95^{a}	**90**^{a}	85^{a}	75^{b}	**80**^{a}	75^{a}	60^{b}	**67.5**^{a}	**79.2**^{a}
Profenofos + Amadene	82.5^{a}	90^{a}	**86.3**^{a}	85^{a}	83.8^{a}	**84.4**^{a}	76.9^{a}	70^{a}	**73.5**^{a}	**81.4**^{a}
L.S.D$_{0.05}$	2.89	2.12	2.51	3.21	3.21	3.21	4.12	3.12	3.62	3.11
2019 season										
B. thuringiensis	25^{f}	30^{h}	**27.5**^{g}	40^{e}	45^{f}	**42.5**^{h}	40^{g}	30^{e}	**35**^{e}	**35**^{f}
B. bassiana	30^{ef}	40^{g}	**35**^{f}	45de	35^{g}	**40**^{h}	20^{h}	15^{f}	**17.5**^{f}	**30.8**^{f}
B. thuringiensis +*B. bassiana*	40^{cd}	50^{ef}	**45**^{de}	65^{b}	65^{cd}	**65**^{bcd}	40^{g}	30^{e}	**35**^{e}	**48.3**^{e}
B. bassiana + 400 Gy	40^{cd}	45^{fg}	**42.5**^{e}	54^{c}	60de	**57**^{ef}	55de	45^{c}	**50**^{c}	**49.8**^{de}
B. bassiana + 700 Gy	43.3^{c}	52^{e}	**47.7**^{cde}	65^{b}	75^{b}	**70**^{b}	48^{f}	35de	**41.5**^{de}	**53.1**^{cde}
Azadirachtin	45^{c}	55de	**50**^{cd}	65^{b}	60de	**62.5**^{cde}	55de	35de	**45**^{cd}	**52.5**^{cde}
Azadirachtin + 400 Gy	45^{c}	60^{d}	**52.5**^{c}	70^{b}	65^{cd}	**67.5**^{bc}	60^{d}	40^{cd}	**50**^{c}	**56.7**^{bcd}
Azadirachtin + 700 Gy	65^{b}	70^{c}	**67.5**^{b}	65^{b}	55^{f}	**60**^{def}	50^{ef}	45^{c}	**47.5**^{cd}	**58.3**^{bc}
Fertacho	35de	55de	**45**^{de}	50^{cd}	60de	**55**^{fg}	68^{c}	58^{b}	**63**^{b}	**54.3**^{bcde}
Fertacho + 400 Gy	45^{c}	60^{d}	**52.5**^{c}	55^{c}	45^{f}	**50**^{g}	70^{bc}	70^{a}	**70**^{a}	**57.5**^{bc}
Fertacho + 700 Gy	65^{b}	70^{c}	**67.5**^{b}	70^{b}	70^{bc}	**70**^{b}	60^{d}	30^{e}	**45**^{cd}	**60.8**^{b}
Profenofos	85^{a}	90^{b}	**87.5**^{a}	86^{a}	88^{a}	**87**^{a}	80^{a}	65^{a}	**72.5**^{a}	**82.3**^{a}
Profenofos + Amadene	88^{a}	98^{a}	**93**^{a}	85^{a}	85^{a}	**85**^{a}	75^{ab}	65^{a}	**70**^{a}	**82.7**^{a}
L.S.D$_{0.05}$	2.69	1.58	2.14	3.36	3.33	3.35	4.32	5.12	4.72	3.40

Cotton Crop Parameters:

The parameters of cotton crop (seed numbers, lint and seed weights) for each 100 opened cotton bolls is an important step to clear the effective of thirteen treatments used on the quality of cotton crop as illustrated in Table (7) that mentioned the role of gamma radiation treatments for potentiating compounds used to purpose of crop quality enhancement.

a. Seed Numbers:

Profenofos + amadene treatment caused increasing in cottonseed numbers to 1633 & 1490 seeds/ opened 100 bolls compared to untreated 989 & 954.5 seeds/ 100 opened boll at 2018 & 2019 cotton seasons, respectively. Also, profenofos had increased the cotton seed compared to untreated, followed by compounds that exposed to gamma radiation doses (400 & 700 Gy) as follows: fertacho + 700 Gy, fertacho + 400 Gy, azadirachtin + 700 Gy, azadirachtin + 400 Gy, *B. bassiana* + 700 Gy, *B. bassiana* + 400 Gy, fertacho, azadirachtin, *B. thuringiensis* + *B. bassiana, B. thuringiensis* and *B. bassiana* (Table 7).

b. Lint Weight (g):

Azadirachtin + 700 Gy had the highest lint weight/100 opened boll, it was 90 & 70 g/100 opened boll compared with untreated (50.2 & 46.4 g) for 2018 & 2019 cotton seasons; followed by azadirachtin + 400 Gy, *B. bassiana* + 700 Gy, *B. bassiana* + 400 Gy, fertacho + 700 Gy, fertacho + 400 Gy, profenofos + amadene, profenofos, fertacho, azadirachtin *B. thuringiensis* + *B. bassiana*, *B. thuringiensis* and *B. bassiana* (Table 7).

c. Seed Weight (g):

Fertacho + 700 Gy had 130 & 140 g cottonseed weights comparing with 86.6 &755 g for untreated cottonseed at 2018 and 2019 cotton seasons (Table 7). Fertacho + 400 Gy increased the seed weight at two seasons, followed by profenofos + amadene, profenofos, azadirachtin + 700 Gy, azadirachtin + 400 Gy, *B. bassiana* + 700 Gy, *B bassiana* + 400 Gy, azadirachtin, fertacho, *B. thuringiensis* + *B. bassiana*, *B. thuringiensis* and *B. bassiana.*

Table (7): Cotton crop parameters as affected by some compounds applications at 2018 & 2019 cotton seasons.

Compounds	Average weights (gm/100boll)					
	Seed numbers	Comparison With untreated	Lint weights	Comparison With untreated	Seed weights	Comparison With untreated
Season 2018						
Untreated	989^{h}	$-^{n}$	50.2^{h}	$-^{h}$	86.6^{e}	$-^{h}$
B. thuringiensis	1100^{g}	$+111^{l}$	65^{g}	$+14.8^{g}$	95^{cde}	$+8.4^{fg}$
B. bassiana	1000^{h}	$+11^{m}$	50.9^{h}	$+0.7^{h}$	92^{de}	$+5.4^{g}$
B. thuringiensis+ *B. bassiana*	1112^{fg}	$+123^{k}$	68.9^{fg}	$+18.7^{fg}$	95^{cde}	$+8.4^{fg}$
B. bassiana + 400 Gy	1212^{de}	$+223^{i}$	82^{bcd}	$+31.8^{bc}$	98^{cde}	$+11.4^{ef}$
B. bassiana + 700 Gy	1240^{de}	$+251^{g}$	83.3^{abc}	$+33.1^{bc}$	103^{bcd}	$+16.4^{de}$
Azadirachtin	1220^{de}	$+231^{h}$	70^{fg}	$+19.8^{efg}$	97^{cde}	$+10.4^{fg}$
Azadirachtin+ 400 Gy	1280^{cd}	$+291^{f}$	86.6^{ab}	$+36.4^{ab}$	105^{bc}	$+18.4^{cd}$
Azadirachtin+ 700 Gy	1320^{c}	$+331^{e}$	90^{a}	$+39.8^{a}$	110^{b}	$+23.4^{bc}$
Fertacho	1180^{ef}	$+191^{j}$	72^{efg}	$+21.8^{ef}$	96^{cde}	$+9.4^{fg}$
Fertacho+ 400 Gy	1415^{b}	$+426^{d}$	76^{def}	$+25.8^{de}$	130^{a}	$+43.4^{a}$
Fertacho+ 700 Gy	1570^{a}	$+581^{c}$	78.8^{cde}	$+28.6^{cd}$	135^{a}	$+48.4^{a}$
Profenofos	1580^{a}	$+591^{b}$	75^{def}	$+24.8^{def}$	112^{b}	$+25.4^{b}$
Profenofos+ Amadene	1633^{a}	$+644^{a}$	75^{def}	$+24.8^{def}$	115^{b}	$+28.4^{b}$
$L.S.D_{0.05}$	7.06	7.01	6.21	5.22	10.2	5.67
Season 2019						
Untreated	954.5^{g}	$-^{n}$	46.4^{g}	$-^{f}$	75.5^{f}	$-^{f}$
B. thuringiensis	990^{fg}	$+35.5^{l}$	51^{efg}	$+4.6^{def}$	82^{ef}	$+6.5^{e}$
B. bassiana	980^{fg}	$+25.5^{m}$	49.5^{fg}	$+3.1^{ef}$	79^{f}	$+3.5^{ef}$
B. thuringiensis+ *B. bassiana*	1000^{fg}	$+45.5^{k}$	53.8^{def}	$+7.4^{cde}$	82.5^{ef}	$+7^{de}$
B. bassiana + 400 Gy	1150^{de}	$+195.5^{h}$	63.3^{bc}	$+16.9^{b}$	88^{de}	$+12.5^{d}$
B. bassiana + 700 Gy	1166^{de}	$+211.5^{g}$	66^{ab}	$+19.6^{ab}$	88^{de}	$+12.5^{d}$
Azadirachtin	1030^{f}	$+75.5^{j}$	55^{def}	$+8.6^{cd}$	84^{ef}	$+8.5^{de}$
Azadirachtin+ 400 Gy	1200^{cd}	$+245.5^{f}$	66.6^{ab}	$+20.2^{ab}$	93.8^{cd}	$+18.3^{c}$
Azadirachtin+ 700 Gy	1250^{c}	$+295.5^{e}$	70^{a}	$+23.6^{a}$	94^{cd}	$+18.5^{c}$
Fertacho	1100^{e}	$+145.5^{i}$	56^{def}	$+9.6^{c}$	83^{ef}	$+7.5^{de}$
Fertacho+ 400 Gy	1340^{b}	$+385.5^{d}$	58^{cd}	$+11.6^{c}$	110^{b}	$+34.5^{b}$
Fertacho+ 700 Gy	1350^{b}	$+395.5^{c}$	58.3^{cd}	$+11.9^{c}$	140^{a}	$+64.5^{a}$
Profenofos	1467^{a}	$+512.5^{b}$	56^{def}	$+9.6^{c}$	95^{cd}	$+19.5^{c}$
Profenofos+ Amadene	1490^{a}	$+535.5^{a}$	56.3^{de}	$+9.9^{c}$	99^{c}	$+23.5^{c}$
$L.S.D_{0.05}$	8.11	7.65	4.45	4.96	6.53	5.47

It can be classified the thirteen treatments used efficacy against three cotton boll pests (*P. gossypiella, E. insulana,* and *O.hyalinipennis*) on the field application to four categories as follows:

1. The first category that had high efficacy on tested pests than other treatments. It's were profenofos + amadene and profenofos.
2. Second category that had a high efficacy on tested pests but slightly decreased comparing with first category. It's were fertacho + 700 Gy, azadirachtin + 700 Gy, fertacho + 400 Gy, azadirachtin + 400 Gy, fertacho and azadirachtin.
3. Third category that had intermediate efficacy on tested pests. It's were *B. bassiana* + 700 Gy, *B. bassiana* + 400 Gy and *B. thuringiensis* + *B. bassiana*.
4. Fourth category that had lower efficacy on tested pests. It's were *B. thuringiensis* and *B. bassiana* when used singly.

From all, we deduced that profenofos + amadene, followed by rofenofos singly were considered the best control for the three cotton boll pests (*P. gossypiella, E. insulana* and *O.hyalinipennis*). Abd-El Rahman, *et al.* (2015) showed that profenofos had sufficient reduction in *Earias insulana* on the cotton crop. In addition to the mode of action, the profenofos compound on acetyle cholinesterase in insect; Osman and Abou-Zaid (2015) found that destruction of some cells in midgut and cuticle layers of *S. littoralis* that treated with profenofos. Hassan, *et al.* (2016) found the toxicity and ultra-structural studies cleared that tested compound of cypermethrin, esfenvalerate, chlorpyrifos and *B. thuringiensis* had destroyed influence on alive and dead *S. littoralis* larvae in integument, muscle, fat body and midgut when the larvae treated as fourth instar larvae as compared with control. Meanwhile, chlorpyrifos was the most neurotoxicity agent than other tested compounds. A compound of amadene in current work when added to profenofos makes attracting the insect by hydrolyzed protein (active ingredient of amadene) to the place of killing by profenofos.

Gamma doses contribute to enhancement from efficacies of the three compounds (*B. bassiana,* azadirachtin, and fertacho) when they are exposed to gamma radiation doses of 400 & 700 Gy. Previous works agree with current study as Amer (2006) showed that the combination of gamma irradiation with Dipel2x activated the spores of the biocide compound and caused a potentiation effect. Also, Amer (2006) carried out the field experiments during the two cotton seasons 2004 and 2005. The results showed that the efficiency of Dipel-2x increased gradually with gamma irradiation from 5 to 80 Gy. Also, the treatments increased lint and seed weights (gm/100bolls). Amer, *et al.* (2011) showed that newly hatched and fourth instars larvae of the pink bollworm, *P. gossypiella* treated by the biocide compound, biover (*B. bassiana*) exposed to 100, 200 & 300 Gy of gamma radiation doses had potentiated effect on the biover efficiency against the newly hatched and fourth instars larvae of the pink bollworm. Amer, *et al.* (2015a) exposed *B. thuringiensis, M. anisopliae* and biopolymer compound (chitosan) to gamma doses of 15, 30 & 60 Gy for potentiating effect. It showed potentiated effect especially with dose of 60 Gy than other doses used against *S. littoralis* treated as 4th instar larvae at different efficiency tests. Amer, *et al.* (2015b) mentioned that *B. thuringiensis* + 60 Gy lead to swelling of outer cuticle fibrous layer of *S. littoralis* larvae integument. Furthermore, hypodermis layer had distention and damage in *S. littoralis* larvae. Also, it occurrence of split and destruction of muscles into small portions and remarkable suffered on the fat body cells as vacuolization and destroyed the fat body membranous sheath; in addition to alterations influences in the midgut of *S. littoralis* as destroyed of columnar or hyperphesia cells padding midgut, damage of brush border with excess of goblet cells.

Furthermore, Amer, *et al.* (2018) reported that a heavily % DNA of *S. littoralis* had destruction rang: 40-92% caused by Chitosan + 60 Gy that had the highly % DNA destruction (8.399%), followed by chitosan + 30Gy (7.829%), *M. anisopliae* + 15 Gy (5.681%), chitosan (3.991%), *B. thuringiensis* + 30 Gy (3.902%), *M. anisopliae*+ 60 Gy (2.604 %) and chitosan + 15 Gy (1.868%). Amer, *et al.* (2019) stated that gamma-ray doses (50&500 Gy) treatments were the most efficacy against *E. insulana* egg stage than magnetic flux treatments (20& 180 mlt)

At current work, the additive compound of *B. thuringiensis* + *B. bassiana* had potentiating effect than *B. thuringiensis* or *B. bassiana* singly. Amer and El-Nemaky (2012) showed that Lysozyme and phenoloxidase activity decreased in *P. gossypiella* 4th instars larvae treated as newly hatched by Protecto + Biover treatment as protector or Biover singly. Meanwhile, Rafiq, *et al.* (2012) conducted that neem extracts in different parts of plants showed significant mortality response against 3rd instar larvae of cotton *P. gossypiella*, *S. litura* and *H. armigera*. The surviving insects showed the behavior with decrease in insect weight and slower feeding activity as compared to the control. The efficacy of these extracts may be further enhanced by using 1st and 2nd instar larvae of these insects in bioassays as well as optimizing dose concentration and treatment time. Also, Dawkar, *et al.* (2019) suggested that azadrachtin targets more than one protein in *H. armigera* and hence could be a potent biopesticide.

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ARABIC SUMMARY

كفائة آشعة جاما فى تقوية بعض المركبات لمكافحة ثلاثة آفات على لوز القطن

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أجريت تجربة حقلية فى محطة بحوث وقاية النباتات – قها – محافظة القليوبية خلال موسمى قطن ٢٠١٨ و٢٠١٩. طبقت فيها ١٣ معاملة تتبع مجاميع مبيدات آفات مختلفة، ثلاثة مركبات من بينهم تم تعريضهم لجرعتين من آشعة جاما (٤٠٠- ٧٠٠ جراى) بغرض تقوية لفعلهم الإبادى.

المعاملات المستخدمة كانت كالتالى: بكتيريا *Bacillus thuringiensis* - فطر *Beauvaria bassiana* - بكتيريا + فطر *B. thuringiensis* +*B. bassiana* - فطر +٤٠٠ جراى – فطر + ٧٠٠ جراى- مستخلص الأزدراكتين Azadirachtin - الأزدراكتين +٤٠٠ جراى - الأزدراكتين + ٧٠٠ جراى - فيرتاكو fertacho - فيرتاكو + ٤٠٠ جراى - فيرتاكو + ٧٠٠ جراى - بروفينوفوس profenofos - بروفينوفوس + أمادين .

تم تقييم المعاملات السابقة حقليا لخفض التعداد والاصابة لثلاثة آفات تصيب لوز القطن وهى دودة اللوز القرنفلية *Pectinophora gossypiella* ودودة اللوز الشوكية *Earias insulana* وبقة بذرة القطن *Oxycarenus hyalinipennis* .

يعتبر البروفينوفوس + أمادين أفضل المعاملات خفضا للنسبة المئوية للتعداد والاصابة للآفات الثلاثة يليه فى ذلك البروفينوفوس الذى تشابه فعله الابادى مع مركب الفيرتاكو + ٧٠٠ جراى ثم الأزدراكتين + ٧٠٠ جراى – فيرتاكو + ٤٠٠ جراى- الأزدراكتين + ٤٠٠ جراى – فيرتاكو منفردا – الأزدراكتين منفردا – فطر+ ٧٠٠ جراى – فطر + ٤٠٠ جراى – بكتيريا + فطر – بكتيريا منفردة – فطر منفردا.

بالاضافة الى ما سبق ساهمت المركبات المستخدمة فى تحسين صفات محصول القطن من عدد البذور ووزن الشعر والبذرة/ ١٠٠ لوزة متفتحة خلال موسمى الاختبار ٢٠١٨ و ٢٠١٩.

ولذلك اتضح ان أشعة جاما لها فعل تقوية للثلاثة مركبات (فطر- الأزدراكتين - فيرتاكو) ليصبح تأثيرهم اكثر فاعلية بالمقارنة باستخدام المركب منفردا دون التعريض للاشعاع.