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Biological Control of Certain Insect Pests Attacking Cotton Plants in Sohag Governorate

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ABSTRACT

The present investigations were carried out to study the efficiency of releasing the egg parasitoid, *Trichogramma evanescens* (West.) only or with *Chrysoperla carnea* Stephens., *Coccinella undecimpunctata* L. and *Coccinella septempunctata* L. against the pink bollworm, *Pectinophora gossypiella* (Saund.), and the spiny bollworm, *Earias insulana* (Boisd.), Also the effect on cotton yield was determined. Data revealed that all biological control treatments decreased significantly the population of both pink and spiny bollworms, All treatments induced significant increase in cotton yield compared with the untreated check. Also, numbers of diapausing larvae were significantly reduced by all treatments in both years. and investigations the efficiency of releasing *Ch. carnea*, *C. undecimpunctata* and *C. septempunctata* against the cotton aphid, *Aphis gossypii* Glover in cotton fields during 2010 and 2011 seasons, cotton aphid in treated plots compared with the untreated check.

Key words: Biological control, *Pectinophora gossypiella*, *Earias insulana*, *Aphis gossypii*, cotton.

Introduction

Cotton, *Gossypium barbadence* L. is one of the most important economical crops in Egypt and all over the world where it is employed in several industrial productions i.e. ginning, textile, Food oil, soap, furniture and many other industries, as well as a source of foreign coin when exported to another countries, (Al-Shannaf, 2010). In almost all cotton producing countries of the world, insect pests and crop diseases are considered the major factors contribute to decrease in cotton production, (Masooad *et al.*, 2011). Cotton plants are attacked by several insect pests starting from germination of seedlings till harvest, causing different levels of damages to the vegetation, flowers, fibers, and, (Afzal *et al.*, 2003). Biological Control is a method used worldwide in pest management. It has been considered as a sustainable, economical and environmental attractive alternative for chemical pest control. Several studies have attention on biological control of aphids and cotton boll worms infesting cotton plants (Malik, 2001; Khider *et al.*, 2003; Pervez and Omkar, 2005 and Abd El-Gawad and El-Zoghbey, 2009). So the present work aimed to study the effect of releasing predators larvae and *T. evanescens* parasitoid on certain cotton pests at Sohag Governorate.

Material and Methods

(1): Biological control of P. gossypiella and E. insulana:

These set of field experiments were carried out in cotton plantation in an area of about one feddan, during the two successive growing seasons of (2010 and 2011) to evaluate the effect of releasing the egg parasitoids, *T. evanescence* and the predators, *Ch. carnea*, *C. undecimpunctata* and *C. septempunctata* on the population density of the pink bollworm, *P. gossypiella* and the spiny bollworm *E. insulana* infesting cotton plants (Giza 90), in comparison with control (non treated) which separated by 1000 m from the treated blocks.

The experimental area was divided into plots of 3 χ 3.5 m. The treatments were arranged in randomized complete blocks design with 4 replicates each. Four treatments were used, *T. evanesces* only, *T. evanesces + Ch. carnea*, *T. evanesces + C. undecimpunctata* and *T. evanesces + C. septempunctata*, in addition to control. Five releases with two weeks intervals were applied to cover the cotton season. The release started at 1/ July and 4/ July at 2010 and 2011 seasons, respectively, depending on the first appearance of a male moth in the pheromone traps and onset of square formation on cotton plants.

(a): Parasitoid:

The cards containing the eggs of *Sitotroga cerealella* Olivier parasitized by *T. evanesces* were supplied from the mass-rearing laboratory of Biological control Research Department, Agricultural Research Center, Giza, Egypt.

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Releases were applied into the field inside thick paper envelops (8×12 cm.), 22 envelops were needed per feddan. Each envelop (card) contained two ages of parasitized eggs (1 and 3 days before adult emergence) to produce two waves each of 400 adult female wasps. That produced 17400 adult females / feddan release. Envelops were hanged manually before sunset on cotton plants at about 50 cm. above the ground (Abd El-Rahman *et al.*, 2008).

(b): Predators:

Ch. carnea and *C. septempunctata* were obtained from the Center of Bio-organic Agricultural Service (CBAS) Aswan, Egypt. For *C. undecimpunctata*, adults were collected from crops planted in the Farm of Shandaweel Agricultural Research Station, then held in tube containers that were with moistened cotton pads and ventilated with fine polyester mesh and provided with cotton leafs infested with *A. gossypii*. Adults lay eggs on paper that covered inside surface of the tube. The eggs were collected were kept in Petri dishes for hatching. The three predators were released at the 2nd larval instar by 12000 larvae/ feddan.

(c): Estimation:

After one week of release, samples of 10 random green bolls per each plot were examined weekly for the evidence of *P. gossypiella* and *E. insulana* larvae in all treatments and continued till the end of season.

At harvest all the remainder bolls on the cotton plants were collected from plots of each treatment, dissected, number of larvae counted, and the numbers of diapausing pink bollworm larvae per plot were determined as all the living larvae at the time were considered in diapause (Kittock *et al.*, 1975). At the harvest time, the cotton yield at plots of 1/24 feddan from the inner square area of each experimental block (one feddan) was counted in all treatments.

(2): Biological control of Aphis gossypii:

These experiments were carried out at Shandaweel Research Station in an area of about half feddan, during the two successive growing seasons of (2010 and 2011) in order to compare and evaluate the effect of releasing the predators of *Ch. carnea, C. undecimpunctata* and *C. septempunctata* separately in the second instar larvae by the rate of 12000 larvae / feddan on the population density of the cotton aphid *A. gossypii* infesting cotton plants (Giza 90), in comparison with control (non treated). The experimental area was divided into plots of 3 X 3.5 m. The treatments were arranged in randomized complete blocks with 4 replicates each. Three releases with two weeks intervals were started at 15/ July in the two seasons. After one week from release, samples of 10 leafs were taken randomly, then transferred to laboratory for aphid estimation. The samples continued to the end of the season.

(3): Statistical analysis of the data:

Data were analyzed by analysis of variance. When the resulted (F) was significant, Duncan's multiple range test was used to partition the means into significant ranges.

Results and Discussions

(1): Biological control of P. gossypiella and E. insulana populations:

(a): Effect of biological control treatments on Pectinophora gossypiella and Earias insulana populations:

2010 season:

Data presented in Table (1) revealed that all biological control treatments decreased significantly the population of both pink and spiny bollworms compared with the untreated check.

The mean number of pink bollworm (PBW) larvae per 100 bolls in treated plots ranged between 4.64 and 9.51 larvae, whereas it reached 20.44 larvae in untreated fields. The 4th treatment (T. + C7), 5 release of *T. evanescens* with 5 release of *C. septempunctata* induce the highest reductions in larval population (77.30%) followed by the 3rd treatments (T. + C11) 5 release of *T. evanescens* with 5 release of *C. undecimpunctata* (67.61) followed by The 2nd treatment (T.+ Ch.) 5 release of *T. evanescens* with 5 release of *Ch. carnea* (59.83 % reduction) respectively. Meanwhile, the lowest effect (53.47% reduction) was recorded for the first treatment (T.) 5 release of *T. evanescens* alone.

Also the results in Table (1) demonstrated that the mean number of spiny bollworm (SBW) larvae per 100 bolls in treated plots ranged between 3.10 and 7.17 whereas it reached 14.80 larvae in untreated plots, recording high percentages of reduction (81.71, 72.30 and 55.41 %) in (T.+ C7), 5 release of *T. evanescens* with 5 release of *C. septempunctata*, (T. + C11) 5 release of *T. evanescens* with 5 release of *C. undecimpunctata* and (T.+ Ch.) 5 release of *T. evanescens* with 5 release of *Ch. carnea* respectively. The lowest effect on SBW larval population was observed when the parasitoid was treated alone, recording to 51.55%.

Regarding the effect of different treatments on the PBW and SBW together, the results in Table (1) showed that the highest levels of reduction in 2010 season were recorded for T.+ C7 (75.37 %) and T.+ C11 (69.58) followed by T.+ Ch. (57.97% reduction). The parasitoid release induced the lowest effect when treated singly against the two bollworms, recording 52.67% reduction in larval population.

Table 1: Effect of Biological control on larval population of *P. gossypiella* and *E. insulana* during 2010 season.

Treatment	*P. gossypiella*		*E. insulana*		*P. gossypiella* and *E. insulana*	
	Mean No. of larvae/100 bolls	% Reduction	Mean No. of larvae/100 bolls	% Reduction	Mean No. of larvae/100 bolls	% Reduction
T.	9.51 B	53.47	7.17 B	51.55	16.68 B	52.67
T. + Ch.	8.21 B	59.83	6.60 B	55.41	14.81 B	57.97
T. + C11	6.62 C	67.61	4.10 C	72.30	10.72 C	69.58
T. + C7	4.64 D	77.30	3.10 C	81.71	8.74 C	75.37
Untreated check	20.44 A	--	14.80 A	--	35.24 A	--

T.= *T. evanesces*, Ch.= *Ch. carnea*, C11=*C. undecimpunctata*, C7= *C. septempunctata*
Means followed by the same letter do not significantly at 0.05 level of probability.
* Numbers in table are average of 12 inspection

2011 season:

Data in Table (2) show that all treatments induced significantly effects on the larval population of both pink and spiny bollworms compared with the untreated check.

It is obvious that the mean number of pink bollworm (PBW) larvae per 100 bolls in treated fields ranged between 4.11 and 8.76 larvae, whereas it reached 17.03 larvae in untreated fields. The 4th treatment (T. + C7), 5 release of *T. evanescens* with 5 release of *C. septempunctata* induce the highest reductions in larval population (75.78%) followed by the 3rd treatments (T. + C11) 5 release of *T. evanescens* with 5 release of *C. undecimpunctata* (63.89) followed by The 2nd treatment (T.+ Ch.) 5 release of *T. evanescens* with 5 release of *Ch. carnea* (58.19 reduction) respectively. Meanwhile, the lowest effect (48.56 % reduction) was recorded for the first treatment (T.) 5 release of *T. evanescens* alone.

On the other hand, the effect of the parasitoid treated alone against the SBW population were slight, recording 48.43% reduction. Meanwhile, higher percentages of larval reduction were observed at (T. + C7) 5 release of *T. evanescens* with 5 release of *C. septempunctata* with 81.71 reduction, followed by (T. + C11) 5 release of *T. evanescens* with 5 release of *C. undecimpunctata* and (T.+ Ch.) 5 release of *T. evanescens* with 5 release of *Ch. carnea* with 65.84 and 57.79 % reduction respectively.

Concerning the effect of different treatments on both the PBW and SBW during 2011 season, the results in Table (2) indicate that the superior effect of T.+ C7 recorded (75.37 %) and T.+ C11 (64.74%) reduction in larval population followed by T.+ Ch. (58.06% reduction). Lower percentages of reduction (48.48%) were recorded for the parasitoid release singly.

Table 2: Effect of Biological control on larval population of *P. gossypiella* and *E. insulana* during 2011 season.

Treatment	*P. gossypiella*		*E. insulana*		*P. gossypiella* and *E. insulana*	
	Mean No. of larvae/100 bolls	% Reduction	Mean No. of larvae/100 bolls	% Reduction	Mean No. of larvae/100 bolls	% Reduction
T.	8.76 B	48.56	7.05 B	48.43	15.81 B	48.48
T. + Ch.	7.12 C	58.19	5.77 C	57.79	12.87 C	58.06
T. + C11	6.15 D	63.89	4.67 D	65.84	10.82 D	64.74
T. + C7	4.11 E	75.78	2.50 E	81.71	6.61.56 E	75.37
Untreated check	17.03 A	--	13.67 A	--	30.69 A	--

T.= *T. evanesces*, Ch.= *Ch. carnea*, C11=*C. undecimpunctata*, C7= *C. septempunctata*
Means followed by the same letter do not significantly at 0.05 level of probability.
* Numbers in table are average of 12 inspection

(b): Effect of biological control treatment on diapausing P. gossypiella larvae:

Mean number of diapausing larvae and the percentages of reduction in larval population in the treated plots during two successive seasons are listed in table (3).

Numbers of diapausing larvae were significantly reduced by all treatments in both years. *T. evanesces* (5 release) + *C. septempunctata* (5 release) gave the lowest mean numbers of diapausing larvae (6.47 and 7.33)

causing the highest effect (89.03 and 89.33% reduction) in larval population during 2010 and 2011 seasons, respectively. The mean number of diapausing larvae in the untreated fields were 59 larvae in 2010 and 68.67 larvae in 2011.

The mean number of diapausing larvae in the rest treatments during the two seasons, 2010 and 2011 were (24.30 and 27.70), (15.43 and 17.20) and (10.63 and 11.93) for *T. evanesces* (5 release) alone, *T. evanesces* (5 release) + *Ch. carnea* (5 release) and *T. evanesces* (5 release) + *C. undecimpunctata* (5 release), respectively. The corresponding values of the percent reduction in diapausing larval populations were (58.81 and 59.66), (73.85 and 74.95) and (81.98 and 82.63) during the 2010 and 2011 seasons for T. , T.+ Ch and T.+C11 respectively. Data revealed that the highest average percentage of reduction in pink bollworms diapausing larval population during the two seasons of the study was 89.18 for T.+C7. The rest treatments induced 59.24 to 82.31 % average reduction and could be arranged designingly as follows: T. (59.24%), T.+ Ch. (74.40%) and T.+C11 (82.31 % reduction)

Our results agree partially with the results obtained by Bariola *et al.* (1984) who found that the numbers of pink bollworm diapausing larvae were significantly reduced by late-season insecticide treatments. He stated that percentage reduction in the larval population increased by increasing the number of insecticide application. El-Nagar (2007) found the highest average reduction percentage in pink bollworm diapausing larvae during the two experimental seasons was 64.09% for the treatment of one insecticidal spray one week before harvest followed by another spray one week after harvest. The rest treatment could be arranged descentingly as follows: one spray of insecticide before harvest followed by one spray of the oil after harvest (57.53%), one spray of the insecticide before harvest (43.72%), and one spray of the oil after harvest (28.7%) average reduction on diapausing pink bollworm larval population.

Table 3: Mean numbers of diapausing pink bollworm larvae in treated and untreated cotton fields during 2010 and 2011 seasons.

Treatment	Mean No. of diapausing larvae/100 Boll		% reduction		
	2010	2011	2010	2011	Average
T.	24.30 B	27.70 B	58.81	59.66	59.24
T. + *Ch.*	15.43 C	17.20 BC	73.85	74.95	74.40
T. + C11	10.63 CD	11.93 C	81.98	82.63	82.31
T. + C7	6.47 D	7.33 C	89.03	89.33	89.18
Untreated check	59.00 A	68.67 A	-	-	-

T.= *T. evanesces*, Ch.= *Ch. carnea*, C11=*C. undecimpunctata*, C7= *C. septempunctata*
Means followed by the same letter do not significantly at 0.05 level of probability.

(c): Effect of biological control treatment of bollworms on cotton yield:

The efficacy of different treatments on cotton yield was determined at the end of the two seasons of experiments, 2010 and 2011 (Table 4)

2010 season:

The results show that all treatments induced significant increase in cotton yield compared with the untreated check. According to Duncan's multiple range test, the different between the yields of the four treatments of the parasitoids alone and with the predators significant, ranged between 33.83 and 58.20 Kg/plot, whereas the mean yield in the control fields was 23.48 Kg/plot.

Data showed that the highest percentages of increases in cotton yield were recorded when 5 release of *Trichogramma* and *C. septempunctata* (147.87 % increases) followed by 5 release of *T. evanescens* with 5 release of *C. undecimpunctata* (112.10 % increases) followed by 5 release of *T. evanescens* with 5 release of *Ch. carnea* (69.38% increases), The lowest increases was 44.08 % by *T. evanescens* alone.

2011 season:

Approximately, the results of 2011 were similar to those of 2010 season. All treatments caused significant increase in cotton yield. The data in table (4) show low yield in the untreated fields (24.97 Kg/plot), whereas it ranged between 31.63 and 56.30 Kg/plot for the treated fields. Also the data represented low increase in the yield (26.67%) in T. (5 release of *T. evanescens* alone, whereas the highest increases were achieved during 2011 season for the treatment of 5 release of *Trichogramma* and *C. septempunctata* 125.47% increase. In this respect, 5 release of *T. evanescens* with 5 release of *C. undecimpunctata* and 5 release of *T. evanescens* with 5 release of *Ch. carnea* gave moderate increase in cotton yield (47.66 and 95.03% respectively).

It is to be mentioned that the increases in cotton yield for all treatments were higher in 2010 than in 2011 season (Table 4). With regard to the average percentage of increases in cotton yield during the two experimental seasons, excessively, the results are in harmony with those obtained for the effect of different treatment on reducing the bollworms infestation in treated cotton fields (Table 4).

In general, it could be concluded that treated the cotton fields with the egg parasitoid *Trichogramma* at individual release was not sufficient to suppress the bollworms infestation, whereas, satisfactory results were obtained when the parasitoid releases were integrated with predators release. Hence, higher reduction in bollworms population and greater cotton yields were achieved.

Table 4: Effect of Biological control of *P. gossypiella* and *E. insulana* on cotton yield during 2010 and 2011 seasons.

Treatment	Yield in Kg/ plot			% increases		
	2010	2011	Average	2010	2011	Average
T.	33.83 D	31.63 D	32.73	44.08	26.67	35.38
T. + Ch.	39.77 C	36.87 C	38.32	69.38	47.66	58.52
T. + C11	49.80 B	48.70 B	49.25	112.10	95.03	103.56
T. + C7	58.20 A	56.30 A	57.25	147.87	125.47	136.67
Untreated check	23.48 E	24.97 E	24.23	-	-	-

T.= *T. evanesces*, Ch.= *Ch. carnea*, C11=*C. undecimpunctata*, C7= *C. septempunctata*
Means followed by the same letter do not significantly at 0.05 level of probability.

In this respect our finding agree with the results obtained by Ahmed et al (2003) who compared the biocontrol technique (*T. chilonis* parasitoid + *Ch. carnea* predator) with the conventional insecticides in suppression the infestation of pink bollworm and two *Earias* spp. and found that the least infestation of the three cotton bollworm was in the blocks treated with biocontrol technique followed by insecticide treatment. Mohamed (2007) who noticed that the parasitoid *T. evanescens* integrated with the predaceous insect *Ch. carnea* caused the highest reduction in pink bollworm, *P. gossypiella* and spiny bollworm, *E. insulana* infestation compared with insecticidal treatments. The reduction percentages in bollworms infestation in both treatments parasitoid alone and parasitoids + predator were 34.78 and 52.18 respectively.

Ahmad *et al.* (1996) observed that *T. chilonis* releases against cotton bollworms along with P.B. ropes (Pheromones) checked the bollworms infestation although pheromone and parasitoid treatments alone were effective. Romeis and Shanower (1996) and Ahmad *et al.* (1998) reported that *Trichogramma* species have the great potential to control bollworms in cotton integrated pest management (IPM). Malik (2001) carried out a field release of *T. bactrae* (about 72.000 adults) an effective biological agent of the pink bollworm, *P. gossypiella* in long staple, uplond 1517-88 cotton. He found that the total parasitization in *P. gossypiella* eggs in two replications was 19.56 and 26.84% , respectively. Khider *et al.* (2003) released the parasitoids *T. evanescens* in cotton field during the cotton seasons 2002 and 2003 and found that the higher reduction in infestation rates caused to pink and spiny bollworms during the flowering and boll formation stages. The reduction percentage ranged between 17.2 and 54.98% when the parasitoid was released early during the flowering stage, meanwhile it attained 16.83% when released later during the boll formation growth stage. Abdel-Rahman *et al.* (2007) found that five biweekly release of *T. evanescens*. Successfully declined the total larval populations of the spiny bollworm *E. insulana*.

Abd El-Rahman *et al*. (2008) released *T. evanescens* to evaluated its efficacy in suppression spiny bollworm, *E. insulana* infestation in El-Farafra, New valley Governorate, Egypt, and found that five release (17600 adult females in 2 waves / feddan / release) in two weeks intervals successfully suppressed cotton bollworm infestation to be one fourth to one third of that of the untreated cotton fields. Baraka *et al.* (2008) evaluated the number of release of the egg parasitoid, *T. evanescens* in suppressing the spiny bollworm, *E. insulana* infestation in El- Farafra cotton fields, New valley Governorate, Egypt and found that the five *Trichogramma* releases presented 76.29% final mean reduction in boll infestation compared with 83.97% resulted from the six release. Cotton yield loss was 13.17 % in the five release field compared with 12.05 % in the six release one.

(2): Biological control of cotton aphid, A. gossypii:

The present investigation was carried out to study the efficiency of releasing the predators, *Ch. carnea, C. undecimpunctata* and *C. septempunctata* against the cotton aphid, *A. gossypii*, in cotton fields during 2010 and 2011 seasons.

2010 season:

Data presented in Table (5) revealed that all biological control treatments decreased significantly the population of cotton aphid, *A. gossypii* compared with the untreated check. The mean number of *A. gossypii* per 10 leaves in treated plots ranged between 17.75 and 30.91 aphid, whereas it reached 95.36 aphid in untreated fields. The 3rd treatment (C7), 3 release of *C. septempunctata* induce the highest reductions in aphid population (81.39%) followed by the 2nd treatments (C11) 3 release of *C. undecimpunctata* 78.13% reduction . Meanwhile, the lowest effect (67.59% reduction) were recorded for the first treatment 3 release of *Ch. carnea* respectively.

2011season:

Data presented in Table (5) revealed that results at 2011 season was similar to that at 2010 season.

The mean number of *A. gossypii* per 10 leaves in treated plots ranged between 20.37 and 33.53 aphid, whereas it reached 116 aphid in untreated fields. The 3rd treatment (C7), 3 release of *C. septempunctata* induce the highest reductions in aphid population (82.44%) followed by the 2nd treatments (C11) 3 release of *C. undecimpunctata* 77.73% reduction . Meanwhile, the lowest effect (71.09% reduction) were recorded for the first treatment 3 release of *Ch. carnea* respectively.

Our results in agree with Pervez and Omkar, (2005) who reported that among ladybeetle group, seven spotted ladybird, *C. septempunctata* is one of the potential predators of aphids in India. Bahy El-Din (2006) mentioned that predators belong to family Coccinellidae, comprise one of the most active groups of predatory species, that feed on different sucking pests including aphids. This family gained the interest of many investigators as important group of predator in the biological control of insect pests attacking different crop plants

Abd-Rabou (2008) released *C. undecimpunctata* L. for control of aphids (including *A. gossypii* Glover on cotton) in Egypt. The results showed that the population of aphid decreased on cotton after releasing *C. undecimpunctata*. Abd El-Gawad and El-Zoghbey (2009) released three rates of *C. undecimpunctata* stages release in cucumber field for controlling *A. gossypii* and *M. persicae*. The tested rates were 12000 predator larvae/ feddan/releases, 6000 predator adults/feddan/releases and combination of 6000 larvae and 3000 adults/feddan/releases. This release indicated the potential use of this predator to control the targeted aphis on cucumber. Reduction in aphids' populations and subsequent yields were significant. Highest reduction and yield gain was observed when combination larvae and adults were released.

Table 5: Effect of Biological control treatments on the population of *Aphis gossypii* during 2010 and 2011 seasons.

Treatment	Mean No. of aphid/ 10 leaves			% reduction		
	2010	2011	Average	2010	2011	Average
Ch. carnea	30.91 B	33.53 B	32.22	67.59	71.09	69.34
C. undecimpunctata	20.86 C	25.83 C	23.35	78.13	77.73	77.93
C. septempunctata	17.75 C	20.37 C	19.06	81.39	82.44	81.91
Untreated check	95.36 A	116.0 A	105.68	--	--	--

Means followed by the same letter do not significantly at 0.05 level of probability.
* Numbers in table are average of 12 inspection

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