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Efficacy of the Egg Parasitoid, *Trichogramma evanescens* West. in Suppressing Spiny Bollworm, *Earias insulana* (Boisd.) Infestation in El-Farafra Cotton Fields, New Valley Governorate, Egypt

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ABSTRACT

During 2003 and 2004 cotton seasons, *Trichogramma evanescens* West. was released in an inundative manner to evaluate its efficacy in suppressing spiny bollworm, *Earias insulana* (Boisd.) infestation in El-Farafra, New Valley Governorate, Egypt, cotton fields. Five releases (17600 adult females in 2 waves / feddan / release) in two weeks intervals successfully suppressed cotton boll bollworm infestation to be one fourth to one third of that of the untreated cotton fields and produced an equilibrium status between the pest population and the released parasitoid. Releasing *Trichogramma* parasitoid successfully decreased the losses in cotton yield caused by the bollworm by about one fourth of its value in the untreated control treatment.

Key words: *Trichogramma evanescens*, *Earias insulana*, cotton, yield loss, Egypt.

INTRODUCTION

New Valley Governorate is considered as a clean and isolated area and to keep it chemical free, decision makers prevent the use of any conventional chemical pesticides in the governorate. Consequently, biological control strategies became one of the safe solutions to limit the harmful effect of plant pests. They strike only the target pest with no risk to other natural enemies, human health or environment. *Trichogramma* spp. were the most studied group of natural enemies worldwide due to their efficiency and easy maintenance under laboratory conditions and the vast diversity of their species in the majority of ecosystems (Morrison, 1985 and Oliveira *et al.*, 2003). Rice is the most important cash summer crop in the New Valley oases (El-Farafra, El-Dakhla and El-Kharga Oases). As a result of its high water requirement many efforts were made to replace it by other economic crops with moderate water supplement such as cotton, sunflower, maize, peanut...etc. *Aphis gossypii* Glovet, *Pectinophora gossypiella* Saunders, *Earias insulana* (Boisd.) *Nezara viridula* L., *Eusarcoris ventralis* West. and *Graptostethus servus* F. were recorded attacking cotton bolls in El-Farafra cotton plantations (Abdel-Rahman *et al.*, 2007).

On establishing a new *Tichogramma* release program, different methods including calendar date, plant development, pheromone or light traps, egg-laying, and developmental degree-days may be used to synchronize inundative releases of the parasitoid with the start of host oviposition (Kanour and Burbutis, 1984).The first appearance of a male moth within the relative estimate of pheromone traps gave an indication of the beginning of female ovipositional season, which must be urgently combined with the distribution of *Trichogramma* cards (Hassan, 1982). According to Thomas *et al.*, (2004), *Trichogramma* releasing cards must be distributed while the onset of square formation upon which bollworm moth invasion was firstly recorded.

This study aimed to evaluate the effectiveness of the egg parasitoid *Trichogramma evanescens* West. in suppressing the spiny bollworm (*E. insulana*) infestation in El-Farafra cotton fields.

MATERIALS AND METHODS

The present study was conducted in El-Amal village, 20 Km far from the south direction of El-Farafra Oasis center for two successive cotton growing seasons (2003 and 2004). Two fields, with about 3 Km separating distance in between, were sown with cotton (Giza 83 variety) on April 25th and April 20th in 2003 and 2004 cotton seasons, respectively. The first field was of three feddans (feddan = 4200 m^2) and used for *Trichogramma* releases and another one (two feddans), without *Trichogramma* releases was considered as untreated check area. Each field was divided into four plots representing four treatment replicates. The two fields were served by the same normal agriculture practices.

1- *Trichogramma* release.

T. evanescens was released in an inundative manner as pupae inside its factitious host,

angoumois grain moth, *Sitotroga cerealella*, eggs. Depending on the first appearance of a male moth in the pheromone traps and onset of square formation on cotton plants, *Trichogramma* release started from June 28th and 26th until August 28th and 24th in 2003 and 2004 cotton seasons, respectively. Five releases with two weeks intervals were needed to cover the cotton season. Releases were applied into the field inside thick paper envelops (8 x 12 cm.). Distances between releasing points were 14 m and started 7 m from the edges of the field. Accordingly, 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 17600 adult females/feddan/ release. Envelops were hanged manually before sunset on cotton plants at about 50 cm above the ground.

2- Efficacy of released parasitoid on suppressing spiny bollworm infestation

Sequential sampling method was used to evaluate infestation of green cotton bolls with the two bollworms. Four random samples each of 25 green bolls were weekly collected from each plot in the treated and untreated check (control) fields. Collected bolls were dissected and the number of obtained larvae was recorded. These larvae were categorized according to their size into small, medium and large larvae. The reduction in bollworm population was determined according to the following equation:

$$\text{Reduction \%} = \frac{C - T}{C} X\ 100$$

Where,

C: Number of bollworms in control.

T: Number of bollworms in treatment.

3- Crop yield loss assessment

The goal of this test was to evaluate the potential of released parasitoid on suppressing spiny and pink bollworm populations, which synchronized with the reduction in cotton crop losses. From the beginning of the season, 100 plants were randomly marked in both treated and untreated areas. Throughout the season no bolls were collected from these plants. At the end of the season all bolls of such marked plants were collected and losses were determined using El-Saadany *et al.* (1975) equations as follows:

$$\text{Losses \%} = \frac{(a - e) - (b + c + d)}{(a - e)} X\ 100$$

Where,

a- Number of total bolls in 100 plants.

b- Number of fully opened bolls.

c- Two thirds of bolls with two matured open locks (2/3 open boll).

d- One thirds of bolls with one matured open lock (1/3 open boll).

e- Number of non-opened bolls.

Number of green bolls expected to open, also counted and added to the number of fully opened bolls.

Or,

$$\text{Losses\%} = \frac{\text{Total No. of locks} - \text{No. of healthy locks}}{\text{Total No. of locks}} X\ 100$$

RESULTS AND DISCUSSION

During 2003 and 2004 cotton seasons, the spiny bollworm (SBW) *E. insulana* larvae were the major cotton pest with minor representation of the pink bollworm (PBW) *P. gossypiella* (Tables 1&2).. Accordingly, larval stage of *E. insulana* was considered at the subsequent results whereas such of *P. gossypiells* was stated upon its appearance.

1- Release of the egg parasitoid, *Trichogramma evanescens*

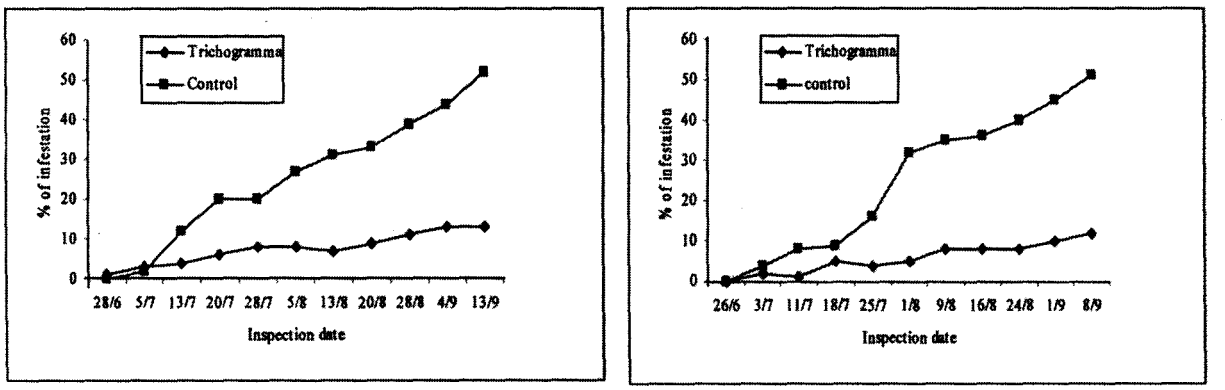
a- 2003 cotton season

As shown in Table (1), the first *Trichogramma* release was not enough to cause effective suppression in SBW as one and three small SBW larvae were found in the first and second inspection samples collected from *Trichogramma* plots compared with 0 and 2 small SBW larvae in the untreated field. At the third inspection sample (July 13th) when the 2nd *Trichogramma* release was carried out, 4 larvae (2 small and 2 medium) were counted in the treated samples opposed to 12 larvae (7 small, 4 medium and 1 large) in the untreated ones, indicating 66.67% reduction. Regarding the size of the recorded larvae in the previous inspection and the following ones, it could be noted that few numbers of small larvae were recorded in *Trichogramma* plots than in the control ones. This finding may be as a result of the efficacy of *Trichogramma* on parasitizing bollworms' eggs. Another week later, on July 20th, the SBW population increased greatly in the control samples reaching 20 larvae (10 small, 6 medium and 4 large) compared to 6 larvae (1 small, 2 medium and 3 large) in *Trichogramma* samples, achieving 70% reduction. The same trend was observed in the following inspection samples up to the end of the season (two weeks after the 5th *Trichogramma* release) the numbers of the spiny bollworm were suppressed by 60–74.51%, with an average of 70.14%. These results were illustrated graphically in Fig. (1).

In general, 83 SBW larvae were collected from *Trichogramma* treated samples throughout the

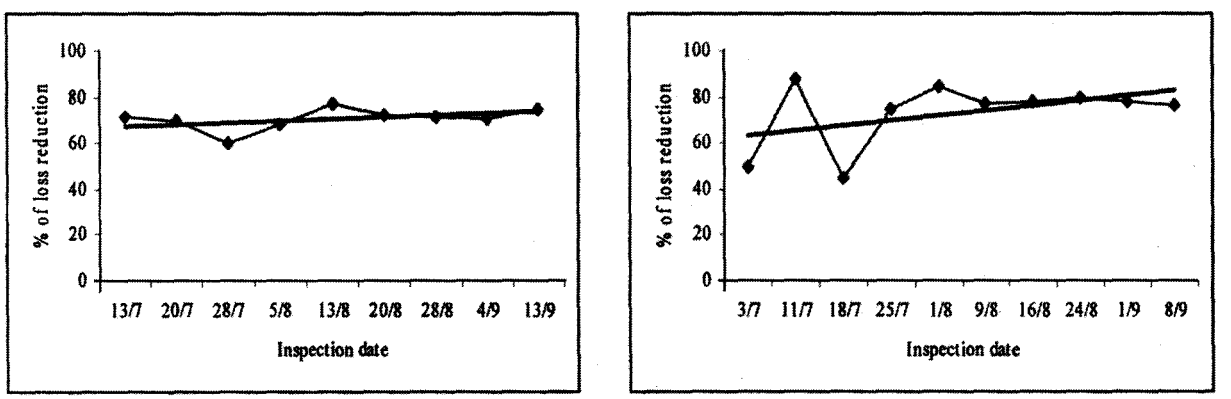
Table (1): Efficacy of releasing *Trichogramma evanescens* on suppressing *E. insulana* infestation on 2003 cotton season. (Larval content/ 100 cotton bolls).

No. of releases	Inspection date	Treated				Untreated				% Reduction
		Small	Medium	Large	Total	Small	Medium	Large	Total	
1st	28/6	1	0	0	1	0	0	0	0	---
	5/7	3	0	0	3	2	0	0	2	-50
2nd	13/7	2	2	0	4	7	4	1	12	66.67
	20/7	1	2	3	6	10	6	4	20	70.00
3rd	28/7	2	4	2	8	11	4	5	20	60.00
	5/8	2	3	3	8	8	6	13	27	70.37
4th	13/8	3	1	3	8	10	11	10	31	74.19
	20/8	3	2	4	9	10	11	12	33	72.73
5th	28/8	4	2	5	11	9	15	14	38	71.05
	4/9	3	5	5	13	12	12	20	44	70.45
	13/9	4	5	4	13	13	13	25	51	74.51
Total		28	26	29	83	92	82	104	278	70.14
Mean					7.55				25.27	



A – 2003 season B – 2004 season

Fig. (1): Efficacy of *T. evanescens* in suppressing infestation with spiny bollworm at El-Amal village, El-Farafra Oasis).



A – 2003 season B – 2004 season

Fig. (2): General trend of the efficacy of *T. evanescens* on the percent of crop losses at El-Amal village, El-Farafra Oasis.

Table (2): Efficacy of releasing *Trichogramma evanescens* on suppressing *E. insulana* infestation on 2004 cotton season (Larval content/ 100 cotton bolls).

No. of releases	Inspection date	Treated				Untreated				% Reduction
		Small	Medium	Large	Total	Small	Medium	Large	Total	
1st	26/6	0	0	0	0	0	0	0	0	---
	3/7	2	0	0	2	3	1	0	4	50.00
2nd	11/7	0	1	0	1	5	2	1	8	87.50
	18/7	3	1	1	5	4	3	2	9	44.44
3rd	25/7	2	2	0	4	9	4	3	16	75.00
	1/8	2	1	2	5	12	11	9	32	84.38
4th	9/8	3	2	3	8	10	13	12	35	77.14
	16/8	2	3	3	8	14	10	11	35	77.14
5th	24/8	3	3	2	8	12	12	15	39	79.49
	1/9	4	3	3	10	12	18	15	45	77.78
	8/9	5	3	4	12	14	17	19	50	76.00
Total		26	19	18	63	95	91	87	273	76.92
Mean					5.73				24.81	

season (eleven inspections) opposed to 278 SBW in the untreated plots. This means that *T. evanescens* was able to minimize the total spiny bollworm infestation to be less than one third of that of the untreated samples showing 70.14% whole mean reduction in infestation.

By considering the graphic representation of successive inspection dates versus the percent infestation reduction (Fig. 2), the general picture of this relation behaved more or less linear trend parallel to the x axis, which means that, released parasitoid successfully suppressed the percent of cotton boll infestation across the whole season producing an equilibrium status between pest population and its released parasitoid.

b- 2004 cotton season

Releasing *Trichogramma* wasps in cotton field during the second cotton season (2004) showed the same trend as in the first season (2003). Throughout the 2004 cotton season, 63 SBW larvae (26 small, 19 medium and 18 large) were detected in *Trichogramma* released field opposing to 273 larvae (95 small, 91 medium and 87 large) in the control one. This means that releasing *T. evanescens* was able to reduce the total infestation to be less than one fifth of that in the untreated control field showing 76.92% reduction in infestation.

To attain high degree of accuracy, evaluation of any biological control program based on an egg parasitoid candidate must be done either according to the fate of the lepidopterous eggs or the small sized emerged caterpillar if the lepidopterous egg was obscure. The fewer the small sized larval content, the more efficient the proposed program. Consequently, content of medium and large sized larvae were logically diminished. This was clear in the values represented in Tables 1 and 2, as by the end of the first season, 28, 26 and 29 small, medium and large larvae, respectively were found as total larvae in the treated field compared with 92, 82 and 104 larvae in the untreated control.

The inverse relationship between egg parasitism and larval population reflected its influence on the percent reduction of cotton infestation. Reduction trend in cotton boll infestation percentage was proportionally increased in time dependent manner. Such infestation reduction may be correlated with high bollworm egg pressure through the growing season, which may enhance *Trichogramma* egg parasitization rate. This is in accordance with other previous results as the first *Trichogramma* releases were not enough to cause significant suppression to the SBW while parasitism activity increased by time as the number of bollworms increased. Gross *et al.* (1984) suggested that parasitism rate of *Trichogramma* wasp was high only when host densities were high. In the contrary, King *et al.* (1985) stated that in a field study at North Carolina, bollworm and budworm egg densities between egg-laying cycles were too low to maintain reproduction of *Trichogramma* in cotton.

2- Loss assessment in crop yield

a- 2003 cotton season

This study was designed to confirm egg-parasitizing ability of the released parasitoid in suppressing bollworm populations and consequently reducing cotton crop losses. Total numbers of bolls in both treated and untreated samples (100 plants) were 1508 and 1542 bolls, respectively, from which 150 and 354 bolls were non opened bolls (Table, 3). As each boll has 3 locks, the total

Table (3): Loss assessment in El-Farafra cotton yield as affected by *T. evanescens* releases during 2003 and 2004 seasons (Total bolls/ 100 plants).

Parameter	2003 cotton season		2004 cotton season	
	Trichogramma	Control	*Trichogramma*	Control
Total number of bolls in sample	1508	1542	1546	1554
Number of full opened bolls	1012	464	1028	434
Number of bolls 1/3 opened	124	440	110	366
Number of bolls 2/3 opened	190	256	220	298
Number of non opened bolls	150	354	136	388
Number of green bolls	32	28	52	68
% of full opened bolls	67.11	30.10	66.49	27.93
The expected number of green bolls which will be opened	21.47	8.43	34.58	18.99
Total full opened bolls	1033.48	472.43	1062.58	452.99
Number of actually opened bolls	1201.48	789.76	1245.91	773.66
Total number of opened locks	4074	3564	4230	3498
Number of healthy locks	3604.42	2369.28	3737.73	2320.98
% of losses	13.03	50.43	13.17	50.71

* Total number of opened locks = (Total number of bolls – Number of non opened bolls) X 3.

numbers of opened locks were 4074 and 3564 locks, respectively. According to El-Saadany *et al.* (1975) equation, percentage of losses was estimated by 13.03 and 50.43% in *Trichogramma* treated and control fields, respectively, which meant that releasing *Trichogramma* parasitoid successfully decreased the crop losses by about one fourth of its value in the untreated control treatment.

b- 2004 cotton season

As shown in Table (3), the percent of cotton yield losses in *Trichogramma* release field was 13.17% opposing to 50.71 % in the untreated one which meant the ability of the egg parasitoid to reduce the loss in cotton yield by about one fourth of its value in the untreated control treatment.

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