

Control of the Tomato Fruit Worm, *Helicoverpa armigera* (Hübner) by Releasing the Egg Parasitoid, *Trichogramma evanescens* West. in Tomato Fields in Southern Egypt

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ABSTRACT

Tomato is a major vegetable crop in the region of Nasser Lake, southern of Aswan Governorate, Egypt. The tomato fruit worm, *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) is the most serious insect pest attacks tomato in the region. The egg parasitoid, *Trichogramma evanescens* Westwood (Hymenoptera: Trichogrammatidae) is the most common, native and widely distributed egg parasitoid species in Egypt. Efficacy of *T. evanescens* for controlling *H. armigera* in tomato fields in Nasser Lake region was studied. Field studies were carried out in three sites; Khor Abdel-Saied, Khor Elsuol and El-Daleel, Kalabsha district, Aswan Governorate, represented the largest tomato agricultural areas in the region, during the growing season 2005/06. Evaluation of *T. evanescens* releases against *H. armigera* in the tomato fields was estimated as rate of larval infestation by direct count. The evaluation was undertaken to test different release rates, timings and number of releases of the parasitoid. All data were statistically analyzed. Obtained results showed that the treatment of 40,000 parasitoids/ feddan, four times at interval of 10 to 15 days at the flowering growth stage gave the best result as the average of infestation was 1.5 % compared to 5.5 % in the control, the reduction reached 72.7 %. In the other treatments, the infestation rate ranged between (1.9 and 2.5 %), with a reduction of (65.45 and 54.5 %), at the flowering growth stage, while it ranged between (2.5 and 3 %), with a reduction of (54.5 and 45.5 %), at the fruiting stage compared with the control. Cost benefit of using the *T. evanescens* releases showed a saving of LE 852 (= 154.9 US \$)/ feddan (= 387.3 US \$/ hectare). Therefore, the release of 40,000 parasitoids/ release/ feddan, four times (12-15 days intervals) and starting by early tomato flowering growth stage is recommended for the using of *T. evanescens* against *H. armigera* in Nasser Lake region.

Key words: Tomato, *Helicoverpa armigera*, *Trichogramma evanescens*, Release, Evaluation, Egypt.

INTRODUCTION

Tomato is one of the essential vegetable crops in the region of Nasser Lake, southern of Aswan Governorate, Egypt. Its cultivated area is about 2000 feddans (= 800 hectares) (= 18.3 % of the total area), represented mainly by Nile and winter lugs. Tomato plants are subject to the infestation with several insect pests such as; whiteflies, aphids, leaf-miners and the tomato fruit worm, *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) which is the major insect pest in the tomato fields of the region (Abbas, 1998).

Talekara *et. al.*, (2005) stated that *H. armigera* is a highly polyphagous pest that attacks over 100 plant species including such widely grown and economically important crops as cotton, maize, tobacco, pigeon pea and chickpea, beside tomato.

Seasonal infestation with the tomato fruit worm, *H. armigera* usually lasts from April to September in the Nile valley, while, it extends from October to May, according to the lug, in Lake Nasser region. Larvae may attack tomato crops from transplanting until fruit maturity but the most sensitive growing period coincides with the most attractive phenological stages for ovipositing females, from early to last flowering stage. The predilection of this moth species for the harvestable fruiting parts, high

polyphagy, wide geographical range, mobility, migratory potential, facultative diapause, high fecundity and propensity to develop resistance to insecticides are the many factors that contribute strongly to its pest status. Larvae feed on the reproduction parts of the tomato plants such as; buds and flowers (Adashkevich and Rashidov, 1986).

Without the existence of natural enemies, crop losses by pests in agriculture and forestry would be catastrophic, and costs adverse effects of chemical pesticides, the concept of Integrated Pest Management (IPM) is being promoted world-wide in agricultural and health programs. Documentation over the last few decades of the harmful effects of many pesticides to human life has brought into focus the need for development of environmentally friendly methods of pest control.

Trichogramma species are the most widely used insect natural enemy in the world (Li-Ying, 1994), partly because they are easy to mass rear and they attack many important crop insect pests. Nine species of *Trichogramma* are reared in private or government owned insectaries around the world and released annually on an estimated 80 million acres of agricultural crops and forests in 30 countries (Li-Ying, 1994).

Trichogramma evanescens Westwood

(Hymenoptera: Trichogrammatidae) is the most common, native and widely distributed egg parasitoid species in several fields; vegetable and fruit crops in Egypt. Besides, it has been recorded in different Egyptian habitats. The parasitoid species has been used successfully for controlling; the lesser sugar-cane borer in sugar-cane fields (El-Heneidy *et al.*, 1991), the corn borers in maize fields (El-Mandarawy *et al.*, 2004), the lepidopterous pests on the fruit trees; olive, apricot and peach (Hegazi *et al.*, 2004) and the cotton bollworms in cotton fields (Khidr *et al.*, 2003).

The present study focused on evaluating the efficacy of releasing *T. evanescens*, as a non-chemical mean, for controlling *H. armigera* in tomato fields at Nasser Lake region, Kalabsha district, Aswan Governorate.

MATERIALS AND METHODS

Field studies were carried out in three sites; Khor Abdel-Saied, Khor Elsuol and El-Daleel, Kalabsha district, Aswan Governorate, represented the largest tomato agricultural areas in the region, during the growing season 2005/06.

Two fields/ site (2 feddans each = 0.8 hectare) were the experimental replicates. Sex pheromone traps for *H. armigera* moths were placed in the center of the fields. Fresh pheromone lures were exchanged every 6 weeks. The traps and the pheromones were purchased from the Plant Protection Research Institute, Giza, Egypt. Direct count technique (20 random tomato plants/ site/ date) was practiced to estimate total numbers of fruits and infested ones and consequently, the percentages of infestation (El-Awady, *et al.* 2008). Inspection of both the sex pheromone trap catches of *H. armigera* moths and the natural pest infestation rates was undertaken biweekly/ site/ date through the period lasted from November to April throughout the growing season 2005/06. Evaluation of *T. evanescens* releases against *H. armigera* in the tomato fields was estimated as rate of larval infestation. The parasitoid was mass reared under the laboratory conditions of 25±1°C and 70-75 % R.H. on *Sitotroga cerealella* eggs at the Center of Bio-organic Agricultural Services (CBAS) in Aswan. Field experiments were conducted to compare different releasing rates with varying time and number of application as follows:

At flowering stage:

Code A- A rate of 40,000 parasitoids/ feddan was released once.

Code B- A rate of 40,000 parasitoids/feddan was released four times.

Code C- A rate of 60,000 parasitoids/feddan was released once.

Code D- A rate of 60,000 parasitoids/feddan was released four times.

At fruiting stage:

Code E- A rate of 60,000 parasitoids/ feddan was released once.

Code F- A rate of 60,000 parasitoids/ feddan was released four times.

Code G- A rate of 100,000 parasitoids/ feddan was released once.

Code K- A rate of 100,000 parasitoids/ feddan was released four times.

Control: Control area without releases.

The parasitoid was released using releasing cards; each card (6x8 cm) was folded to form a pocket (4x6 cm). The cards included parasitized *Sitotroga's* eggs, were cut to small pieces (2x2 cm²) and placed inside the releasing pockets (1 piece per pocket). Two thousands parasitoids to emerge from each card, which means that the 40000 parasitoids (= 20 cards) etc.. (El-Dawwi, 2009). In case of the four releases, intervals between releases were 12 - 15 days. Each treatment was carried out only in one feddan of the experimental tomato field/ site. Four sex pheromone traps for *H. armigera* moths were placed in the experimental fields but each one served two treatments [(A + B), (C + D), (E + F) and (G + K)]. A fifth pheromone trap was placed to serve the control. Data were summarized and recorded.

Statistical Analysis

All data of the field experiments were statistically analyzed using Statistical Block of Social Science program SAS (Statistical Analysis System) and using Analyze (ANOVA).

RESULTS AND DISCUSSION

Rate of infestation with *H. armigera*

First infestation record of *H. armigera* larval infestation was found during the 3rd week of December 2005, about 60-65 days post planting date, with relatively high rates of infestation; 10 % at Khor Abdel-Seed, 12.9 % at Khor Elsuol and 5.2 % at El-Daleel and continued with such high rates during the 1st week of January, 2006 and afterwards decreased towards the end of the season to reach 4.2 – 5.8 % during March and April. General seasonal mean of infestation rate was 5.5 %. Statistical analysis showed significant differences among the three sites in the rate of *H. armigera* larval infestation.

Pheromone trap catches

H. armigera moths were captured early in the traps, during the 3rd week of November, 2005, with very low numbers (2-3 moths /trap), particularly at El-Daleel, and Khor Elsuol. Means at the two sites ranged between 0.6 and 0.9, while it reached 22.2 moths /trap at Khor Abdel-Seed. Seasonal mean of moths' number in the three sites was 7.9 moths /trap. Statistical analysis showed no significant differences among the three sites.

Outcome of releasing *T. evanescens* in tomato fields

Different rates, numbers and timing of releases of the parasitoid, *T. evanescens* against *H. armigera* in the three experimental fields of tomato were tested and evaluated by estimating the rates of the pest larval infestation. First release of the parasitoid was carried out at the flowering growth stage during the 3rd week of November 2005 in treatments coded (A & B & C & D) and at the fruiting growth stage during the 3rd week of December 2005 in the treatments coded (E & F & G & K).

In general, monthly rates of infestation with *H. armigera* larvae (direct counts) ranged between 0.3 – 8.9, 1.0 – 9.1 and 0.4 – 3.7 % in the eight treated fields with *T. evanescens* at Khor Abdelseed, Khor Elsuol and El-Daleel sites, Kalabsha district, respectively. Respective monthly rates in the control areas ranged between 4.2-12.3, 4.6–12.9 and 4.1–6.0 % at the same sites (Figures 1-3).

Trichogramma was more effective when released at the flowering stage of the tomato, the infestation averaged 2.5, 1.5, 2.2 and 1.9 % at the treatments A, B, C and D during the season, respectively compared to the percentages followed the releases at the fruiting stage when the percentages of infestation were 2.7, 2.5, 3.0 and 2.4 % at the treatments E, F, G and K, respectively. The four releases of *T. evanescens* gave the better results at all the treatments. Mean percentages were 1.5, 1.9, 2.5, 2.5 % at the treatments B, D, F and K, respectively compared with the one release when the respective mean percentages were 2.5, 2.1, 2.7 and 3.0 % at treatments A, C, E and G. Among the four release plots, the treatment (B) (40000 parasitoid individuals /feddan four times at two weeks intervals) was the best as the mean percentage of infestation was 1.5 % compared to the other treatments D, F, K and the control when the mean percentages were 1.9, 2.5, 2.5 and 5.5 %, respectively (Table 1).

Obtained results of releases also showed that the reduction percent reached 72.7 % at the treatment (B) (1.5 % infestation) compared to 5.5 % in the control. In the other treatments, the percentages of

infestation ranged between (1.9 and 2.5 %), with a reduction percent attained (65.45 and 54.5 %), at the flowering growth stage, while it ranged between (2.5 and 3 %), with a reduction percent of (54.5 and 45.5 %), at the fruiting stage compared with the control.

Efficacy of using *T. evanescens* to control the tomato fruit worm *H. armigera* in tomato fields were reported by different authors; in Switzerland, biological efficacy of *T. maidis* according to the attacked plants was 60-90% (Bigler, 1986). Yin and Chang (1987) reported that the rate of parasitism on the eggs of *H. zea* by *T. evanescens* reached 68.4 - 80.4% in field trials. In addition, Hassan (1988) studied the searching capacity of the egg parasitoids on a host plant. In a comparison among 12 *Trichogramma* species and/or strains parasitizing the pyralid, *Ostrinia nubilalis* (Hb) and the noctuid, *H. armigera* as hosts, it was concluded that a strain of *T. evanescens* from USSR was the most suitable for the control of *O. nubilalis*. *H. armigera* accepted a wider spectrum of *Trichogramma* species than *O. nubilalis*. Izquierdo *et al.* (1994) reported that the eggs of *H. armigera*, collected weekly from 27 commercial tomato crops in Spain during 1990-92, were found parasitized by *T. evanescens* and *Telenomus ullyetti*. Kovalenkov (1999) in Russia recorded the use of *Trichogramma* (widely used in integrated pest control during 1970-80s). Production and application of *T. evanescens* to control cotton bollworm [*H. armigera*] and other cutworms [Noctuidae] on tomato, cabbage and maize was mentioned. In this concern also, Catarina *et al.* (2006) stated that the minute egg parasitoids of the genus *Trichogramma* are promising candidates for biological control of lepidopteran pests in tomato in Portugal.

In the present study, treatment (B) attained 72.7 % reduction in the infestation. Almost similar results were achieved by Abbas (1998) who reported that when *T. evanescens* was released three times at two-week intervals at a rate of 50,000/ha (20,000 per feddan), percentage of injured tomato fruits (by *H. armigera* larvae) ranged between 0.9-3.5 % in the treated fields, with an average of 1.5%, while it ranged between 3.0-9.3%, with an average of 6.4% in the control field. An average of 76.5 % reduction in infestation (injured fruits) was achieved as a result of releasing the parasitoid. Agamy (2003) reported that releasing *T. evanescens* three times in potato fields moderately and highly infested with the potato tuber moth (PTM), *Phthorimaea operculella* decreased the infestation of potato tubers to 4.80% in moderately infested fields compared to 8.84 % in the highly infested fields.

Proper timing for releases of *T. evanescens* is

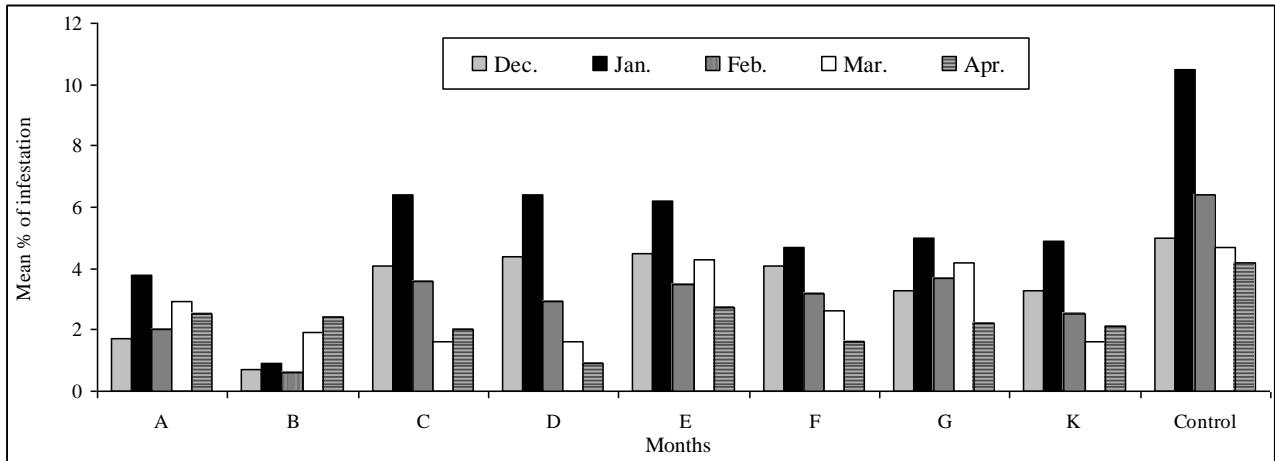


Fig. (1): Monthly mean percentages of infestation with *Helicoverpa armigera* larvae in tomato fields' post different releases of *T. evanescens* at Khor Abdelseed site, Kalabsha district, Aswan, Egypt, season 2005/06.

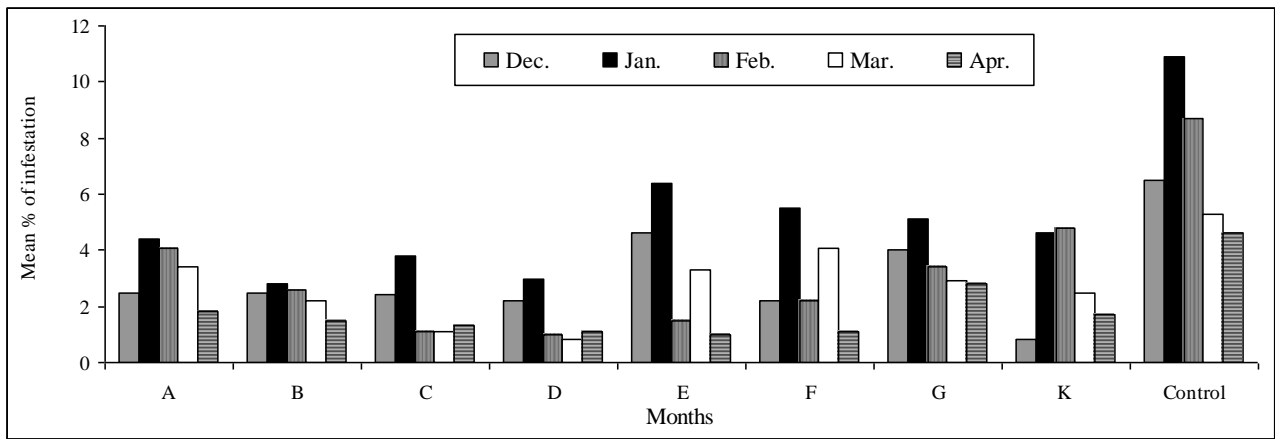


Fig. (2): Monthly means percentages of infestation with *Helicoverpa armigera* larvae in tomato fields' post different releases of *T. evanescens* at Khor Elsuol site, Kalabsha district, Aswan, Egypt, season 2005/06.

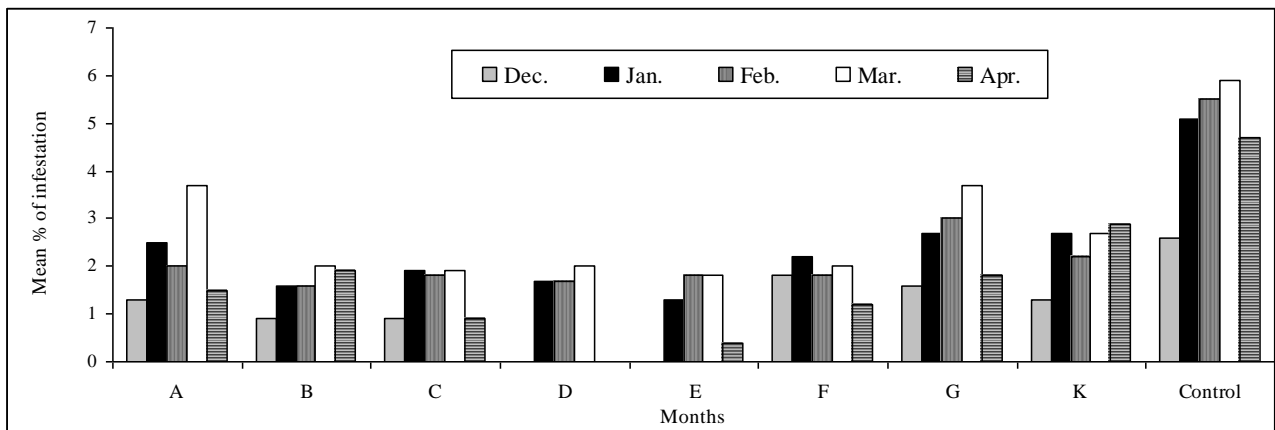


Fig. (3): Monthly mean percentages of infestation with *Helicoverpa armigera* larvae in tomato fields' post different releases of *T. evanescens* at El-Daleel site, Kalabsha district, Aswan, Egypt, season 2005/06.

Table (1): Infestation rate with *Helicoverpa armigera* larvae after releasing *Trichogramma evanescens* at Khour Abdel-Seed, Khour El-Suol and El-Daleel sites, Kalabsha district, Aswan Governorate, season 2005/06

Site	A	B	C	D	E	F	G	K	Control
Khour Abdel-Seed	2.5 ^c	1.0 ^d	3.3 ^{bc}	3.1 ^{bc}	4.0 ^b	3.1 ^{bc}	3.4 ^{bc}	2.6 ^c	5.7 ^a
Khour El-Suol	3.0 ^b	2.1 ^{cd}	1.8 ^d	1.5 ^d	3.2 ^b	2.8 ^{bc}	3.3 ^b	2.7 ^{bc}	6.7 ^a
El-Daleel	2.0 ^{bcd}	1.4 ^{cde}	1.4 ^{cde}	1.1 ^{de}	1.0 ^e	1.7 ^{cde}	2.4 ^b	2.0 ^{bc}	4.2 ^a
General Mean	2.5	1.5	2.2	1.9	2.7	2.5	3.0	2.4	5.5

Same letters in same row are not significant.

very important factor for success of the releases. Hassan *et al.* (1986) reported that the first application is recommended at the beginning of the first pest flight into the light traps and the second in 7-10 days later. The highest efficacy of 76.0-84.9% was denoted in Germany with two releases of 75 000 individuals of *T. evanescens* after the beginning of egg hatching (Hassan and Guo, 1991). Khidr *et al.* (2003) carried out experimental trials to compare the efficacy of *T. evanescens* with the insecticidal applications on the infestation with cotton bollworms; the pink bollworm, *Pectinophera gossypiella* (Saund.) and the spiny bollworm, *Earias insulana* (Boisd.) in cotton fields at Menoufia Governorate for two seasons 2002 and 2003. Three to four parasitoid releases were conducted during the growth flowering and boll formation stages. Reduction percentages of infestation 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. In the parasitoid release areas, number of insecticidal applications was reduced to almost half and consequently, the costs were dropped by 2-2.5 folds. El-Heneidy *et al.* (2004) carried out experimental trials to choose the proper timing and number of releases of the egg parasitoid, *T. evanescens* for controlling the cotton bollworms; *P. gossypiella* and *E. insulana* in Egyptian cotton fields at Menoufia and Sharkia Governorates during the cotton season 2003. Two to four parasitoid releases were conducted during the flowering and boll formation growth stages. The reduction ranged between 48.6 to 56.5 % and 16.4 to 21.7 % when the parasitoid was released early during the flowering stage and few weeks later during the boll formation growth stage, respectively. In the parasitoid release areas, number of insecticidal applications was reduced to almost one third and consequently, the costs were dropped by 29.3 to 36 %.

Cost benefits of using *T. evanescens* for controlling *H. armigera* in tomato fields at Lake Nasser region

Tomato fruit production in the experimental areas averaged 30.1 tons/ feddan (= about LE 22 500 = 4091 US \$). Seasonal percentage of infestation of the pest in the control field was 5.5 % (= 1.65 tons losses/ feddan = LE 1237.5 = 225 US \$). Costs of *T. evanescens*; production and releases reached LE 48 (= 8.7 US \$)/ feddan and achieved 72.7% reduction in the seasonal percentage of infestation in case of treatment (B) (= about 0.45 ton losses/ feddan = LE 337.5 = 61.4 US \$). Total costs reached LE 337.5 + 48 = LE 385.5 (= 70.1 US \$)/ feddan then LE 852 (= 154.9 US \$)/ feddan (= 387.3 US \$/ hectare) were saved by using *T. evanescens*, the safe

control method of the pest in Lake Nasser region.

Brad and Nathaniel (2004) stated that low release rates may be the most cost effective method as comparable net benefits was attained by using medium or high releasing rates. High rates do not always cause significant increase in egg mortality.

In conclusion, obtained results proved that *T. evanescens* is an efficient safe biocontrol agent for controlling the tomato fruit worm, *H. armigera* in tomato fields at Lake Nasser region, southern of Aswan. Recommended rate for using the *T. evanescens* against *H. armigera* in the region is 40,000 parasitoids/ release/ feddan, four times (12 - 15 days intervals) and starting by flowering growth stage.

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