Evaluation of the effect of integrated control of tomato leafminer *Tuta absoluta* with sex pheromone and insecticides.

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Abstract: An experiment was conducted toward the development of integrated control program for the tomato leafminer *Tuta absoluta* in the summer growing season of 2012 at Manwat village, Giza governorate. An integrated pest management (IPM) program which consisted of mass-trapping *T. absoluta* males in red plastic basin traps at a density of 8 traps / feddan, biweekly application of voliam flexi 40 % WG (20 % Thiamethoxam+ 20 % chlorantaniliprole) and Dan top 50 % WG (Clothianidin) in sequence during vegetative stage and weekly application of Dipel DF 6.4 % W G(*Bacillus thuringiensis*) during fruiting stage was compared with mass trapping only and farmers practice in which farmers sprayed several insecticides at their own discretion. The results showed that mean percent fruit damage was lower in the field treated with pheromone baited water traps only (37.44 %) than that in the farmers field (39.16 %), both being significantly higher than that in the field treated with such traps in combination with insecticide application. Therefore *T. absoluta* sex pheromone appears to be a valuable component in the integrated management of *T. absoluta*.
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1. Introduction

Tuta absoluta (Meyrick) (Lepidoptera: Gelechiidae) commonly known as tomato leafminer is an important pest that also feeds on other host plants from the Solanaceae family (Vargas, 1970). It was first recorded in Western Egypt in late 2009 (Temerak, 2011). Young larvae can mine leaves, stems, shoots, flowers and developing fruits. later instars can attack mature fruits (Vargas, 1970). In the absence of control strategies, larval feeding can result in up to 100 % crop losses (Apablaza, 1992 and Estay, 2000). Although various control measures have been practiced to reduce the damage caused by the tomato leafminer, insecticide applications remain the main control method (Siqueria *et al.*, 2001). The internal living and feeding habits of the larvae and its ability to produce several broods each year make it necessary for farmers to apply insecticide every 4 – 5 days / season with minimum and maximum numbers of sprays 8 to 25 sprays respectively(Temerak,2011).

Intensive use of insecticides results in environmental damage, build up of insecticides residues on tomato fruits (Walgenbach *et al.*, 1991), destruction of natural enemy populations (Campbell *et. al.*, 1991), and rapid development of insecticide resistance. In Argentina, *Tuta absoluta* was reported to be resistance to deltamethrin, and abamectin (lietti *et al*., 2005). Resistance to cartap, abamectin,permethrin and methamidophos (Siqueira *et. al*., 2000) and acephate and deltamethrin (Branco *et. al.*, 2001) has been reported in Brazil. The devastation of the tomato leafminer coupled with the fact that it has the capacity to develop resistance very rapidly to any control measure used singly has made this pest the focus of IPM research in many countries of the world. Among components of IPM programs, the use of sex pheromone – baited traps has given promising results against the tomato leafminer in Spain (Robredo-Juncoard cardensoso-Herrero, 2008) and Argentina (Botto, 1999) There have been few efforts on using of synthetic sex pheromone of tomato leafminer in Egypt. In this paper the effectiveness of mass-trapping only and mass-trapping together with insecticide applications in controlling the pest are reported.

2. Materials and Methods

The experimental area of two feddans (feddan = 4200 m^2) located at Manwat village in Giza governorate (Egypt) was subdivided into three fields (Figure 1). Field 1 (½ feddan) was treated with insecticides together with pheromone-bated water basin traps (IPM program) (Table 1). Field 2(½ feddan) used pheromone-bated water basin traps only. Field 1 and field 2 were separated from each other by about one feddan cabbage. Field 3 (one feddan) separated from other tomato fields by about 2 feddans lettuce was treated with pesticides commonly used by tomato farmers (farmers program) (Table 1) each experimental field was divided into three replicates. Thirty-day-old seedlings of tomato (*lycopersicon esculentum* Mill Cv. Supper strain B) were transplanted on 10 February 2012. Tillage, fertilizer application and irrigation followed the recommended cultivation practices. In pheromone treated fields four red plastic basin water traps (40 cm. dimeter, 21 cm. high) with water containing detergent (0.2 %), red traps appeared to be the most attractive color for monitoring *T. absoluta* moths (Taha *et al.,* 2012), were baited with a pheromone lure obtained from Chemtica, Heredia, Costa Rica) containing 0.5 mg of the synthetic pheromone (E3, Z8, Z11-tetradecatrienyl acetate).The traps were placed 30 cm above the ground for trapping male moths throughout the period from transplanting to harvest. Traps were visited weekly to remove moths and replenish water and detergent with pheromone Lures renewed every four weeks. The tomato leafminer infestation in each treatment was determined weekly by recording the numbers of eggs, live larvae and mines in a random sample of 60 leaflets from each treatment (20 leaflets / replicate).The fruits damaged caused by *Tuta absoluta* larvae were assessed at weekly intervals for 3 weeks starting May 17. At each date 60 plants / treatment (20plants / replicate) selected randomly were inspected carefully and the number of healthy and damaged fruits were recorded to calculate the percentage of damaged fruits. Data from treatments were subjected to analyzed and the difference between means was tested for significant at 5 % level by F. test according to Fisher (1944), Sendoecor (1956) and Sendecor and Cochron (1972).

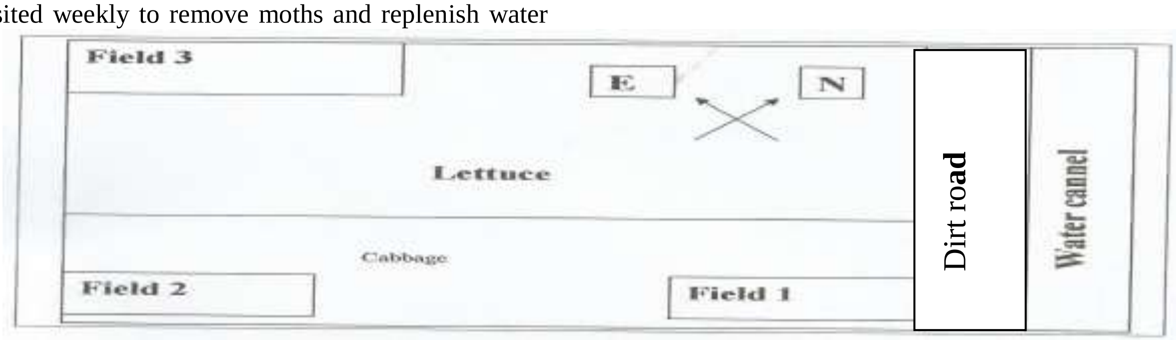

Figure (1): Diagram of the location of tomato fields in the experimental area field 1, 2 and 3 at Manwat village.

Table (1): insecticide treatment in tomato fields 1 and 3 (liters / feddan). Field 2 used pheromone – baited traps only.

date	Field 1			Field 3		
	Active ingredient	Commercial name	Rates / 100 L. of water	Active ingredient	Commercial name	Rates / 100 L. of water
18-2	20 %Thiamethoxam +20%chlorantaniliprole	Voliam flexi 40%WP	25g.	Methomyl	Lannat 90 % SP	75g.
22-2				Profenofois	Selecron 72 % EC	175cm.
26-2				Methomyl	Lannat 90 % SP	75g.
1-3	Clothianidin	Dan top	50g.		Karat 2.5 % EC	175g.
8-3				Methomyl	Lannat 90 % SP	75g.
15-3		Voliam flexi 40 % WP	25g		Dimethoat40% EC	150 cm
19-3				Lambda-cyhalothrin	Karat 2.5 % EC	175g.
24-3				Abamectin	Vertimic 1.8 EC	50 cm
29-3	Clothianidin	Dan top 50 % WG	50g.	Methomyl	Lannat 90 % SP	75g.
5-4				Dimethoate	Dimethoat40% EC	150 cm
12-4	20 %Thiamethoxam + 20 % chlorantaniliprole	Voliam flexi 40 % WP	25g	Lufeneron	Match 5% EC	40 cm
20-4				Methomyl	Lannat 90 % SP	75g.
28-4	Clothianidin	Dan top	50g.	Abamectin	Vertimic 1.8 EC	50 cm
5-5	Bacillus Thuringiensis	Dipele DF 6.4 %(DF) WG	100g.	Azadrachtin	Nimbecidin0.03%EC	500 cm
10-5	B.T.			Lambda-cyhalothrin	Karat 2.5 % EC	175g.
15-5	B.T.			Azadrachtin	Nimbecidin0.03%EC	500 cm

3. Results

The population level of the pest was slightly higher for the first 3 weeks as can be seen from the number of eggs, larvae and mines found per leaflet. The mean number of eggs was significantly lower in fields treated with pheromone-baited traps together with insecticide applications (IPM) (0.39 / leaflet) and field treated with pheromone-baited traps only (0.33 / leaflet) than in the field treated with insecticides (farmers field)(0.59 / leaflet) (Table 2). Similarly the mean number of surviving larvae was significantly lower in the field treated with pheromone–baited traps together with insecticide applications (0.09/ leaflet) and in the field treated with pheromone-baited traps only (0.12/ leaflet) than in the farmerόό s field (0.24/leaflet). (Table 2).

Table 2: The effect of different treatments on the control of *Tuta absoluta* in Manwat in 2012

Treatments	Mean number of eggs / leaflet	Mean number of larvae/ leaflet	Mean number of mines / leaflet
IPM program	0.39^{b} ±0.007	0.09^{b} ±0.050	0.19^{c} ±0.003
pheromone-baited traps only	0.33^{b} ±0.009	0.12^{b} ±0.00	0.45^{b} ±0.009
farmers field	0.59^{a} ±0.024	0.24^{a} ±0.006	0.67^{a} ±0.009
F. Test	* *	*	**

* = Significant different (0.05). ** = Highly significant different (0.01)
Means followed by the same letters are not significantly different at 0.05 level of probability.

The mean number of mined leaflets was vary significantly among different treatment methods. The mean number of mined leaflets was significantly lower in IPM field (0.19/ leaflet) than in the pheromone -baited traps field (0.45/leaflet) or in the farmerόό s field (0.67/leaflet). Nevertheless level of mined leaflets in the farmer's field was significantly higher than that of the field treated with pheromone. baited traps only (Table 2). Mean percent damaged fruit by *T. absoluta* larvae was significantly higher in the farmer's field (39.16 % damaged fruits) than in IPM field (4.65 % damaged fruit) but not significantly different than pheromone-baited traps field (37.44 % damaged fruits) (Fig. 2)

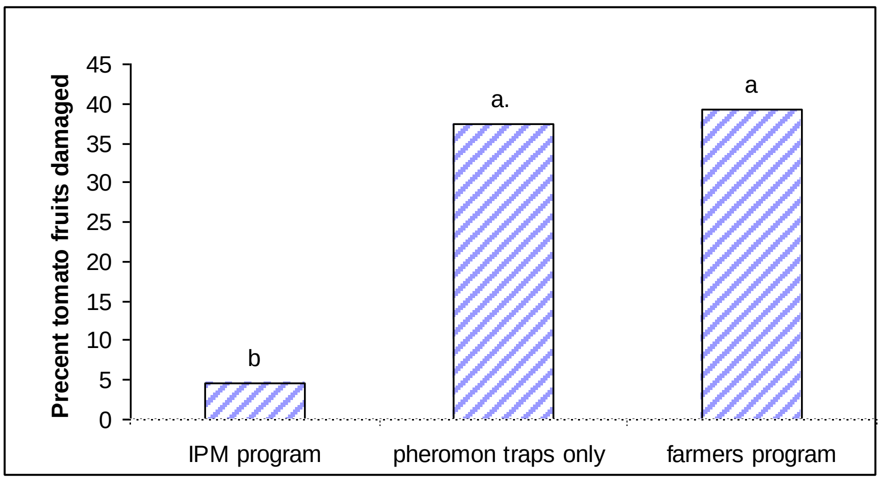

Fig: 2 Percent tomato fruits damage by Tuta absoluta larvae in Manwat in 2012 Percent damage for treatments with the same letters were not significantly different at p. 0.05 by F. test

4. Discussion

The tomato leafminer which have a short generation time and high biotic potential are at increased risk of developing resistance to insecticide use. Resistance to organophosphate and pyrathyroid insecticides has been reported in Chile (Salazer & Araya, 1994, 2001). Previous reports demonstrated the feasibility of using the tomato leafminer synthetic pheromone in monitoring (Balizan and Moonen, 2012) and mass trapping (Robredo-Juncoard cardensoso-Herrero, 2008). However, to our knowledge, this is the first report demonstrating the efficacy of the integrated application of pheromone-baited traps and insecticides to suppress the tomato leafminer infestation.

Our results indicated that mass trapping of male moths together with selected insecticide applications (IPM program) was effective in reducing damage below the economically acceptable limit (1 – 5 % damage fruits) reported for fresh-market and processing tomato (Gravena, 1991). Moreover, the IPM program used a lower total number of sprays (11) than the corresponding regular farmer' s practice sprays(16). In the farmer' s field, the tomato leafminer larval population densities still remained at high larval population densities during flowering and fruiting stages and caused damage to fruits above the economical acceptable level in spite of multiple insecticide applications. One reason may be that the farmer used non selective and effective insecticides, the other reason may be that the chemical insecticide was difficult for farmers to spray on the pest uniformly, particularly as vegetable grow large.

In the filed treated with pheromone bated traps only, the patterns of fruit damage did not differ significantly from that in the farmer' s field. Among the many possible reasons for the failure of mass trapping in the control of *T. absoluta* are that the trapping system employed did not capture all the available males and migration of gravid females from other places to the pheromone-treated area

Therefore, the sex pheromone of the tomato leafminer *T. absoluta* appears to be a valuable component in IPM programs against this pest. Integrating sex pheromone-baited water traps with alternative weekly applications using insecticides from different made of action groups offers even better control.

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