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Effects and Economics of Different Treatments against the Tomato Leaf Miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) at Harvesting Time

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ABSTRACT

Nine field treatments against the tomato leaf miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) infesting tomato plants were carried out in Fayoum governorate, Egypt in 2012 and 2013 seasons. In 2012, the best results were obtained by using a combination of the egg parasitoid *Trichogramma evanescens* West. and the chemical insecticide Coragen 20%. This treatment gave the least % infestation in tomato fruits and the highest yield/ feddan. The treatment of pheromone trap + Coragen ranked second, while the light trap + Coragen ranked third. In 2013, *T. evanescens* + the bio-insecticide Emamectin gave the best results, followed by the *Trichogramma* + Coragen and then the pheromone trap + Coragen. Economically, regarding the costs of application and obtained yield of tomato crop, *Trichogramma* + Coragen ranked first, followed by *Trichogramma* + Emamectin.

Key words: Tomato, *Tuta absoluta,* Infestation, Harvesting Time, Control, Economics.

INTRODUCTION

Tomato (*Lycopersicane sculentum* Mill) is one of the most important vegetable crops for fresh consumption and processing. In Egypt, tomatoes are grown all year round in three main plantations, winter, summer and autumn. The cultivated area of tomato has increased considerably in the last two decades and according to the reports of the Ministry of Agriculture, its area increased to 571844 feddan until 2008, yielding 9204097 tons, with an average of 16.10 tons/ feddan (Anonymous 2008).

Tomato plants are attacked with many insect pests; mainly *Spodoptera exigua* (Boisd.), *Helicoverpa armigera,* (Hübner), *Phthorimaea operculellea* (Zeller) and recently *Tuta absoluta* (Povolny). The tomato borer, *T. absoluta* (Meyrick) (Lepidoptera: Gelechiidae) has been responsible for most of the losses in tomato yield in both protected and open fields attacking all aerial parts of the plant (leaves, stems and fruits). The pest invaded Egypt in 2009 and has become well established in all Governorates by 2011.

Control of *T. absoluta* by application of chemical insecticides is a quick and easy step towards reduction of its population. However, use of pesticides is usually accompanied by many problems including toxic effects to human, animals as well as to beneficial insects.

Aim of the present work was mainly directed towards evaluating the effects of different control methods of *T. absoluta* in tomato fields.

MATERIALS AND METHODS

The study was conducted at a farm at Qarun district, Fayoum Governorate, Egypt. Tomato was planted on 5th of November in two successive seasons 2012 and 2013. Plot size was about 90 m^2. All plots received the recommended agricultural practices, except chemical insecticides. Ten treatments were tested to evaluate their effects in controlling the pest. Each treatment was separated by 300 meters from each other to avoid any interference among treatments. Randomized complete block design, with four replicates, was used.

Treatments were:

1. Twelve releases of *Trichogramma* evanescens at the rate of (120.000 parasitoid/ feddan) during the whole season.
2. UV light trap at the rate of one trap/ feddan.
3. *Tuta* pheromone trap at a rate of one trap/feddan.
4. Twelve applications of *Trichogramma* + Poraclim, a bio-insecticide Emamectin benzoate (wp) at a rate of 60gm/fed.
5. Twelve applications of *Trichogramma* + Coragen (chlorantraniliprole) 20% at rate of 50ml/fed.
6. Trap light + 12 applications of Poraclim.
7. Trap light + 12 applications of Coragen.
8. Pheromone trap + 12 applications of Poraclim.
9. Pheromone trap + 12 applications of Coragen.
10. Untreated control.

Assessment

The egg parasitoid *T. evanescens* was obtained from the International Company for Bio-agriculture, Alharram, Giza, Egypt. Parasitoid cards, each containing 1000 parasitized eggs of *Sitotroga cerealella* were used for releasing. The 1st application of Poraclim, Coragen and release of the wasp took place after occurrence of the 1st *T. absoluta* male moth in the pheromone trap and

continued weekly until 12 February.

The parasitoid cards were distributed at a rate of 120 cards/ fed. (120.000 parasitoids/ fed/ release). The cards were transported to the field in a cooling box to avoid harmful effect of heat during transportation. The releasing cards were hanged on the plant and at 10 meters distances among releasing points.

Mean numbers of (infested and healthy fruits), weights of (infested and healthy fruits); as well as losses in yield due to infestation (kg/ ton) and tomato fruit yield (ton/ fed), and economics of all the tested treatments were estimated.

$$\% \text{ Mean no. of infested fruits} = \frac{\text{No. of infested fruits}}{\text{Total no. of fruits.}} \times 100$$

$$\% \text{ Mean No. of healthy fruits} = \frac{\text{No. of non infested fruits}}{\text{Total no. of fruits.}} \times 100$$

$$\% \text{ Mean weight of infested fruits} = \frac{\text{Weight of infested fruits}}{\text{Total weight of fruits.}} \times 100$$

$$\% \text{ Mean weight of healthy fruits} = \frac{\text{Weight of healthy fruits}}{\text{Total weight of fruits.}} \times 100$$

RESULTS AND DISCUSSION

Effect of different treatments on *Tuta absoluta* damages at harvest time

Intensity of infestation represented by % mean numbers of infested and healthy fruits, weight of infested and healthy fruits as well as yield losses due to infestation (kg/ ton) and tomato fruit yield (ton/ fed) for all the tested treatments was represented in tables (1&2). Data indicated highly significant differences between the control and the other tested treatments concerning the tomato fruit infestation in both seasons.

Results in table (1) (2012) indicated that the 12th releases of *Trichogramma* at the 120,000 parasitoids/fed + Coragen had the best results and was the most effective for reducing *T. absoluta* damage as well increased the fruit yield. It recorded the lowest percentages of number and weight of infested fruits (7.66 & 8.88, respectively). On the other hand, this treatment gave the heaviest fruit yield of (13.45ton/ fed) with a lowest mean value of loss due to infestation (109.7kg/ton). Highest yield was recorded at this treatment may be due to early foliage protection by early releasing of the egg parasitoid and the treatment with coragen. The pheromone + Coragen ranked second in efficiency of decreasing the % of infested fruits sand the yield (9.90 ton/fed with losses of 115.1kg/ton).

The light trap + Coragen ranked third, based on the same criteria. The 12th *Trichogramma* releases comparing to the light trap and the pheromone, recorded the lowest % mean numbers of and weights of infested fruits (16.27 and 17.78, respectively) and the highest % mean numbers and weight of healthy fruits (83.73 and 82.22, respectively). On the other hand, this treatment gave the highest mean value of fruit yield (8.33ton/fed) and the lowest mean value of losses due to infestation (147.5kg/ton).The pheromone ranked second for protection due to the same criteria. While, the light trap was the lowest one for reducing *T. absoluta* infestation. It recorded relatively high % mean of numbers and weights of infested fruits and relatively low value of fruit yield (2.83ton/fed) and high value of yield loss due to infestation (333.3kg/ton).

Results revealed highly significant differences between control and all other treatments. Data in table (2) (2013 season) indicated that, the 12th*Trichogramma* releases + Emamectin was the most effective treatment compared to the other tested treatments. It gave lowest % mean numbers and weights of infested fruits (9.01 & 10.92, respectively) as well this treatment was the second considering the resultant yield (13.20ton/fed) and the lowest losses of infested fruits yield (124.43kg/ton). *Trichogramma* + Coragen ranked second of efficacy for decreasing the % mean numbers and weights of infested fruits as well increasing mean values of fruit yield and low means of losses due to infestation.

Obtained results agree with those of Mansour (2004) who studied the effect of the egg parasitoid *T. evanescens* alone, Agerin (*B. thuringiensis*), and their combination on the cotton bollworms in comparison with a chemical insecticide. The author found highly significant differences between control and the other four treatments and stated that *T. evanescens* combined with Agerin could be recommended to control the target pests. Cabello *et al.* (2009) released *Trichogramma achaeae* for controlling *T. absoluta* and claimed that this parasitoid can be a good weapon to control this pest in greenhouses. Cabello *et al.* (2012) reported that use of *T. achaeae* gave better results against *T. absoluta* on tomato compared to *T. urquijoi* in a greenhouse. Cocco *et al.* (2012) investigated the effectiveness of mass trapping by light and pheromone traps to control *T. absoluta* on tomato in Southwestern Sardinia. The pheromone traps at the tested densities were not effective for reducing leaf and fruit damage. On the other hand, light traps reduced significantly the leaf damage to low/ moderate *T. absoluta* population density during the summer–winter season. Taha *et al.* (2013) evaluated the effect of integrated control of *T. absoluta* with sex pheromone and insecticides and stated that sex pheromone appeared to be a valuable component in integrated management of *T. absoluta.*

Table (1): Effect of different treatments on *Tuta absoluta* damages at harvesting time in tomato season 2012

Treatments	% Mean no. of infested fruits	% Mean no. of healthy fruits	% Mean weight of infested fruits	% Mean weight of healthy fruits	Mean value of yield (tone / fed)	Losses due to infestation (kg/ton)
T1	7.66±0.97a	92.34±1.01ab	8.88±1.29a	91.12±1.69a	13.45±0.99a	109.7±1.98a
T2	9.51±0.97abc	90.49±1.01bc	11.32±1.29ab	88.68±1.69ab	11.18±0.99ab	112.6±1.98ab
T3	16.27±0.97d	83.73±1.01e	17.78±1.31c	82.22±1.69c	8.33±0.99c	147.5±1.98c
T4	8.97±0.97ab	91.03±1.01ab	10.04±1.29ab	89.96±1.69ab	6.26±0.99ab	150.3±1.98ab
T5	11.38±0.97bc	88.62±1.01cd	13.21±1.29bc	86.79±1.69bc	4.44±0.99bc	139±1.98bc
T6	27.61±0.97e	72.39±1.01g	29.59±1.29f	70.41±1.69f	2.83±0.99f	333.3±1.98f
T7	8.69±0.97ab	91.31±1.01a	8.25±1.29a	91.75±1.69a	9.90±0.99a	115.1±1.98a
T8	12.27±0.97c	87.73±1.01ef	15.14±1.29cd	84.86±1.69cd	8.46±0.99cd	116.3±1.98cd
T9	21.19±0.97f	78.81±1.01f	24.68±1.29e	75.32±1.69e	5.22±0.99e	162.3±1.98e
T10	43.80±0.97h	56.20±1.01h	41.28±1.29g	58.72±1.69g	1.29±0.99g	478.6±1.98g

T1= *Trichogramma* + Coragen, T2= *Trichogramma* + Emamectin, T3= *Trichogramma,* T4= Light trap + Coragen, T5= Light trap + Emamectin, T6= Light trap, T7= Pharmone + Coragen, T8= Pharmone + Emamectin, T9= Pharmone and T10= Control.

Table (2): Effect of different treatments on the *Tuta absoluta* damage at harvesting time during season 2013

Treatments	% Mean no. of infested fruits	% Mean no. of healthy fruits	% Mean weight of infested fruits	% Mean weight of healthy fruits	Mean value of yield (tone / fed)	Losses due to infestation (kg/ton)
T1	9.67±1.69a	90.33±1.84a	12.54±1.69ab	87.46±2.11ab	15.55±1.73a	125.82±2.98a
T2	9.01±1.69a	90.99±1.84a	10.92±1.69a	89.08±2.11ab	13.20±1.73a	124.43±2.98a
T3	13.60±1.69ab	86.40±1.84ab	14.75±1.69ab	85.25±2.11ab	9.34±1.73ab	164.35±2.98ab
T4	10.89±1.69a	89.11±1.84a	14.06±1.69ab	85.94±2.11ab	7.34±1.73ab	176.31±2.98ab
T5	11.79±1.69a	88.21±1.84a	12.64±1.69ab	87.36±2.11ab	5.33±1.73ab	169.42±2.98ab
T6	30.80±1.69c	69.20±1.84c	34.55±1.69c	65.45±2.11c	3.91±1.73c	423.45±2.98c
T7	9.72±1.69a	90.28±1.84a	10.70±1.69a	89.30±2.11a	10.86±1.73a	126.26±2.98a
T8	11.16±1.69a	88.84±1.84a	12.05±1.69ab	87.95±2.11ab	9.43±1.73ab	129.63±2.98ab
T9	18.22±1.69b	81.78±1.84b	17.58±1.69b	82.42±2.11b	6.11±1.73b	189.97±2.98b
T10	48.32±1.69d	51.68±1.84d	46.08±1.69d	53.92±2.11d	1.71±1.73d	532.23±2.98d

Table (3): Economics of the different treatments against *Tuta absoluta* in tomato field, in season of 2012

Treatment	Price L.E./1Kg	Amount of loss in L.E./ton	Productively per feddan yield in L.E.	Control costsL.E./fed
T1	2	219.4	26896	1800
T2	2	225.2	22362	1560
T3	2	295	16654	600
T4	2	300.6	12516	2200
T5	2	278	11210	1960
T6	2	666.6	4888	1000
T7	2	230.6	19804	1500
T8	2	232.2	16918	1260
T9	2	324.6	10430	100
T10	2	957.2	2580	0

Table (4): Economics of the different treatments against *Tuta absoluta* in tomato field, in season of 2013

Treatment	Price L.E./1Kg	Amount of loss in L.E./ton	Productively per feddan yield in L.E.	Control costs L.E./fed
T1	1.5	188.73	23325	1800
T2	1.5	186.65	19800	1560
T3	1.5	246.53	14010	600
T4	1.5	264.47	11010	2200
T5	1.5	254.13	7995	1960
T6	1.5	635.18	5865	1000
T7	1.5	189.39	16290	1500
T8	1.5	194.44	14145	1260
T9	1.5	284.96	9165	100
T10	1.5	798.35	2565	0

Economics of the different treatments against *Tuta absoluta* in tomato field

Results in tables (3&4) indicated highly significant differences between the control and the other 9 studied treatments for tomato fruit infestation by *T. absoluta* in both seasons 2012 and 2013.

Present results in table (3) showed that *Trichogramma* releases, with 120,000 parasitoids/ fed + Coragen was the best treatment and highly effective for reducing the *T. absoluta* damage as well increasing the fruit yield, recording the lowest mean amount of loss in L.E./ton (219.4) and highest income of yield per feddan yield in (L.E. 26896). On the other hand, the control cost/fed reached L.E.1800. The highest income by applying this treatment may be due to early foliage protection, increasing the natural role of the egg parasitoid *Trichogramma* by extensive number of releases and treatment with Coragen, which gave early protection and continued up to the end of the season.

The *Trichogramma* + Emamectin benzoate came second in efficacy for decreasing the mean amount of loss (225.2 L.E./ton) and high total income per feddan yield (22362 L.E.). The control cost of treatment reached L.E.1560/ fed. The pheromone + Coragen ranked third for protection based on the same criteria.

Data of season 2013 (Table 4) indicated that treatments followed almost the same arrangement considering costs and income as that of the early season (2012). Significant differences were also evident between either of the applied treatments and control. Statistical analysis of the present results (*Trichogramma* release + Emamectin) proved to be the best treatment and most effective comparing with the other tested treatments concerning the lowest mean amount of loss (L.E.186.65/ton) and the control costs (L.E. 1560/feddan) (Table, 4).

The *Trichogramma* + Coragen treatment occupied the 1st rank of efficacy as it caused highest income of yield (L.E. 23325/fed.), whereas the amount of yields loss was L.E.188.73/ton and the control costs were L.E. 1800/feddan (Table, 4).

From the previous results, it could be concluded that use of 12 releases of *Trichogramma* at a rate of 120,000/fed. + Coragen or Emamectin benzoate is suggested to be recommended to insure higher yield and lower rate of damage to tomato fruits by *T. absoluta.*

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