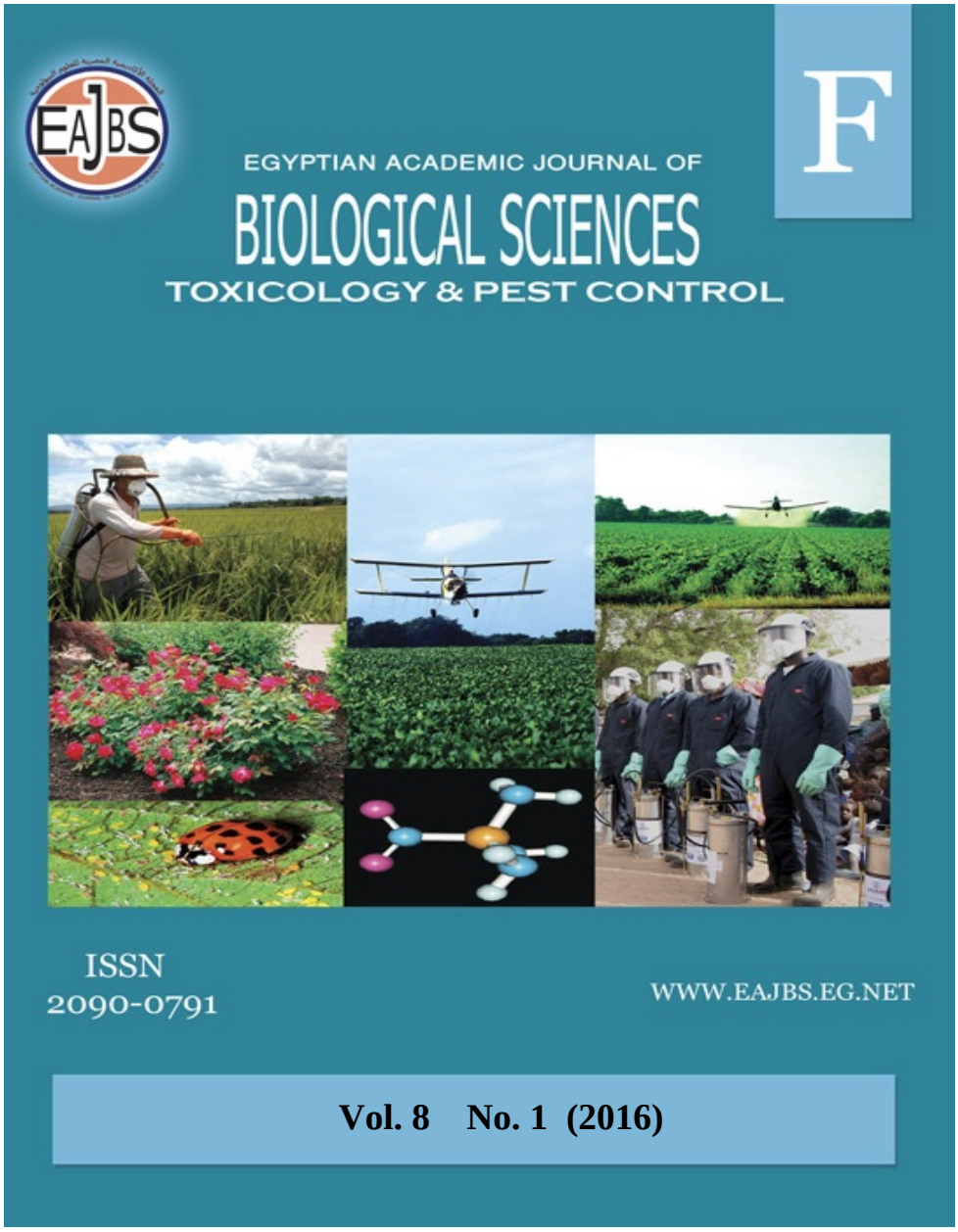

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Integrated Pest Management of Leafminer Moth,*Tuta absoluta* on Tomato Plants

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ABSTRACT

Different control programs were conducted on spring and summer seasons, 2013 to determine the effectiveness of these programs against the leafminer, *Tuta absoluta* (Meyrick) in tomato crop as follow: program A (Chemical+ Pheromone); B (Spinosad+ *Trichogramma*+ Pheromone); C (Neem+ *Trichogramma* + Pheromone); D (BT+ *Trichogramma*+Pheromo); E (Oil+*Trichogramma*+ Pheromone) and F (Control)". Results indicated that highly significant differences between different programs during the two seasons (spring and summer). Program (B) "Spinosad + *Trichogramma* + Pheromone" was more efficient than other programs in reduction *T. absoluta* during two seasons. The results obtained that the numbers of catches natural enemies in spring season less than summer season. In addition, program A "Coragen 20%+Pheromone" was more toxic to different species of natural enemies than the other programs compared with control (untreated) on spring and summer seasons. The results obtained that the numbers of catches natural enemies in spring season less than summer season using sweeping net, except catching Coccinellidae in spring more than catching in summer season.Program A "Coragen 20%+Pheromone" was more toxic to different species of natural enemies than the other programs on two seasons. Highest yield production in spring comparison with summer season in all control programs. The maximum yield production in program B "Spinosad+ *Trichogramma*+ Pheromone), whereas, in summer season the maximum production yield obtained after treated with Spinosad + *Trichogramma* + Pheromone. The maximum weight of 100 fruits after applied program B "Spinosad + *Trichogramma* + Pheromone". But in summer season the maximum weight was found after applied program B "Spinosad + *Trichogramma* + Pheromone". The percentage of fruits were higher in summer than spring seasons. In spring season the maximum number of fruits/plant after treated program B "Spinosad + *Trichogramma* + Pheromone". While the maximum number of fruits/plant in summer season in program C "Neem + *Trichogramma* + Pheromone".

INTRODUCTION

Tomato is the most important vegetable plant throughout the world; this plant is more sensitive to most pests. The tomato leafminer, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is the most important constraints to tomato production where this crop plays an important role in farming production both under plastic greenhouse and open field tomatoes (Gabl and Hausdorf, 2013; Megido *et al.* 2012 and Ouardi, 2012).

Larvae damage the leaves creating perforations in the form of galleries, since they feed on mesophyll tissues (França *et al.,* 2000). New shoots, flowers and fruits are also attacked. Different strategies might be applied in an Integrated Pest Management (IPM) program to control *T. absoluta* outbreaks including insecticides and biological control and the association of both. Studies have being done on the use of synthetic sex pheromones in order to monitor population levels and trigger applications of chemicals on the right moment (Michereff Filho *et al.*, 2000; Gomide *et al.*, 2001; Salas, 2004). Chemical control has been the main method of control used against *T. absoluta* and growers normally choose the insecticide in a diversity of options officially registered and recommended (França *et al.*, 2000). The effectiveness of insecticides alone might be sometimes impaired because of the mine-feeding behavior of larvae or deficient spraying technology (Lietti *et al.*, 2005). However, it is important to point out that tomato leafminer is not the only pest found injuring tomato plants. Other important pests that also normally attack tomato are the serpentine leafminer, *Liriomyza* spp., and the small tomato borer, *Neoleucinodes elegantalis* (Guenée). Since most of time these pests occur together in the tomato fields, the broad-spectrum feature of insecticides turns to be very important.

The aim of this work, study apply the integrated pest management against *Tuta absoluta* such as insecticides, sex pheromones, parasitoids, microbial insecticides and botanical extracts during spring and summer seasons, 2013.

MATERIALS AND METHODS

Field experimental design

The experiments were carried out in Etay-El-Baroud Agriculture Research station, Beheira Governorate. Tomato plants were replanted in two seasons, first season March 2013 (spring season) and second season June 2013 (summer season). In each season six treatments were conducted, each treatment was divided into plots; the area of plot was 182 m^2. The completely randomized block design was utilized in the initiated experimental traits with four replicates for each treatment (25 leaves/replicate) as well as the untreated check. Each plot was separated from the adjacent one by half-meter belt to minimize the interference of spray drift from one treatment to another. The treatments were five periods (7/03, 18/03, 29/03, 9/4 and 20/04/2013) during the spring season plantation and (21/06/2012, 02/07/2013, 13/07, 24/07 and 05/08/2013) during summer season plantation in 2013. The evaluation of the control methods based on reduction percentages were calculated according to Henderson and Tilton equation (1955).

Treatments:

Six treatments were used for controlling *T. absoluta*:

(1) *Bacillus thuringiensis* (200 g/Feddan) + *Trichogramma* (three cards) + Pheromone.
(2) Neem (75 ml/100 ml) + *Trichogramma* (three cards) + Pheromone.
(3) Spinosad (35 ml/Feddan) + *Trichogramma* (three cards) + Pheromone.
(4) Mineral oil (120 ml/Feddan) + *Trichogramma* (three cards) + pheromone.
(5) Chemical (Coragen 20% 60 ml/Feddan) + pheromone.
(6) Untreated check (Control).

Assess infection and sampling:

Twenty five plants were collected after 2, 5, 7 and 10 days after treatments. The actual presence of *T. absoluta* was recorded after application according to (Willcocks and Bahgat, 1937).

Chemicals used:

Pheromone: (3E, 8E, 11Z –14 AC (C16 H26 O2), (E, Z, Z) –3, 8, 11 – Tetradecatrienyl acetate was obtained from Plant Protection Research Institute, Agriculture Research Center, Cairo, Egypt.

Insecticides:

- *Bacillus thuringiensis* var. *kurstaki*, 33×10^6 C.F.U/1ml with rate of application (4800 ml/ feddan).
- Spinosad (Tracer24) with rate of application (35 ml/Feddan).
- Azadirachtin 0.03 %, (Neemix 4.5%) with rate of (75 ml/100 ml water).
- Mineral oil with rate (120 ml/Feddan).
- Chlorantraniliprole (Coragen 20%) with rate (60ml/feddan).

Trichogramma:

Egg parasitoids with rate (70 to 75 adult/m^2) was implemented according to (Gaffar, 2013 &Cabello *et al.,* 2009).

Traps used:

Pheromone traps: synthetic sex pheromones consist of a triangular-shaped body (manufactured of paper or plastic) opened at both ends, a removable sticky insert placed inside on the floor of the triangle, and a pheromone lure suspended above the sticky insert typically using a pin). The population abundance male of *T. absoluta*, was recorded in both control and treated fields using delta sticky trap baited with one capsule containing *T. absoluta* pheromone. Baited traps were hung at the top level of the plant canopy and the baits renewed at intervals of 30 days, throughout the sampling period. The sticky plate was changed every 7 days, checked and the numbers of captured adult males were counted and recorded.

Yellow stick size (15 × 20 cm) were coated with a special sticky on T-shaped sticks at 20 cm heights in the tomato fields. The traps were positioned in the same rows of plots. The crop rows and traps were aligned in an east to west direction. Natural enemies were Coccinellidae, Aphid lion, Syrphidae, Tachini (*Gonia capita*) and *Hemianax ephippige* .

Sweep net size (38 cm diameter, mesh) were used by swinging the net through the plant at 180 along a 100 m transect. The predator collected was placed into a killing jar containing ethyl acetate for 10-15 minutes then transferred plastic bags. The bag contents were emptied to the top sieve and all sieves were shaken for a few seconds. Each sieve was emptied to a white plastic sorting tray and using a magnifying glass and forceps, all predator were transferred to a Petri dish for identification

Determine the yield of tomato crop and infection

Tomato yield of fruits determined on two plantation, tomato fruit were collected from each plot and weight then recorded in kg/plot and calculated per feddane. Concerning of fruits infection, 100 fruits from each plot were collected and examined, the larva of *T. absoluta* were recorded, and the percentage of reduction fruits were calculated according to the method by Henderson and Tilton equation (1955).

Statistical analysis:

The results were expressed as mean ±S.D. All data were done with the Statistical Package for Social Sciences (SAS institute, 1988). The results were analyzed using one way analysis of variance (ANOVA) followed by Duncan's test for comparison between different treatment groups. Statistical significance was set at $p \leq 0.05$.

RESULTS AND DISCUSSION

Controlling leafminer, *Tuta absoluta* on tomato plants using different programs:

Results in Table (1) shows the reduction percentages during spring and summer plantations, 2013. Results indicated that highly significant differences between different programs

during the two seasons (spring and summer) 2013. Program (B) "Spinosad + *Trichogramma* + Pheromone" was more efficient (4.5 mal/trap/week) than other programs, while programs D and C "*Bt* +*Trichogramma*+Pheromo and Neem+ *Trichogramma*+Pheromone" came after that (5.5 and 5.8 mal/trap/week), whereas, program E "Oil+ *Trichogramma*+Pheromone" came the least one (23.8 male/trap/week), respectively during summer season. In the same trend it was observed during summer season.

Relative comparison between the different programs in reduction *T. absoluta* mal moth captured in sex attractant traps during spring and summer seasons 2013 (Table, 1) indicated that mean number of *T. absoluta* during summer season was higher than in spring season. The obtained data agree with those obtained by Filho *et al*. (2000); Colegio *et al*. (2001) & Coco and Delrio (2012).

Table 1: Weekly mean No. of catches moths of the leafminer, *Tuta absoluta* on tomato plants after treatments with different programs using pheromone traps in spring and summer plantation seasons during 2013.

Mean No. of male moths/trap/week													
Inspection Date	**Spring season**						**Inspection Date**	**Summer**					
	A	**B**	**C**	**D**	**E**	**F**		**A**	**B**	**C**	**D**	**E**	**F**
15/3/2013	1	4	6	7	10	25	**30/6/2013**	3	5	8	7	28	36
22/3	3	4	5	6	9	24	**7/7/2013**	4	8	9	9	70	388
29/3	2	3	6	7	15	26	**14/7**	7	4	7	5	68	96
7/4/2013	4	5	9	8	17	31	**21/7**	8	7	8	9	72	89
14/4	6	7	11	9	19	27	**28/7**	7	6	9	8	68	91
21/4	8	9	7	6	22	35	**2/8/2013**	8	8	11	11	65	92
28/4	10	7	6	8	26	33	**9/8**	6	7	7	9	64	90
5/5/2013	13	4	5	4	39	41	**16/8**	8	8	9	8	66	98
13/5	19	6	9	7	43	42	**23/8**	9	6	8	7	71	86
20/5	16	4	6	5	39	37	**30/8**	7	7	8	5	62	68
27/5	12	1	2	3	34	32	**7/9/2013**	5	6	6	4	57	61
4/6/3013	14	0	4	2	36	36	**14/9**	7	5	9	8	76	87
Mean	**9.0**	**4.5**	**5.8**	**5.5**	**23.8**	**29.8**	**Mean**	**7.7**	**7.0**	**8.9**	**8.1**	**69.7**	**89.3**
F	144.2						**F**	151.9					
LSD $_{0.05}$	0.69						**LSD $_{0.05}$**	0.71					
SE	0.18						**SE**	0.15					

A =Chemical+Pheromone
B =Spinosad+Trichogramma+Pheromone
C =Neem+Trichogramma+Pheromone
D =*BT*+Trichogramma+Pheromo
E =Oil+Trichogramma+Pheromone
F = Control

Statistical analysis in Table (1) indicated that highly significant difference between the different programs of *T. absoluta* male moth captured in sex attractant traps during spring and summer seasons 2013were F = 144.2 and LSD = 0.69 in spring season, while in summer season, F = 151.9 and LSD = 0.15 (Table, 1).

Effect of different programs in reduction the leafminer, *Tuta absoluta* larvae infesting tomato plants:

Data in Table (2) showed that the effect of different control programs on reduction the larvae of *T. absoluta* after 2, 5, 7 and 10 days during spring season, 2003. Comparing the different control programs showed that the percent reduction of larval infestation after 1st application indicated that programs D and C "*BT*+Pheromo and Neem+*Trichogramma*+Pheromone" gave reduction% 75.4 and 71.2, with mean No. of larvae 1.0 and 0.8/25 plants, respectively. On the other hand, the other

three programs (A, B and E "Chemical+Pheromone, Spinosad+ *Trichogramma*+Pheromone and Oil+ *Trichog-ramma*+ Pheromone") gave reduction% 64.8, 64.8 and 50.0%, with mean No. of larvae 1.5, 0.3 and 2.5/25 plants, respectively.

Table 2: Efficacy of different programs in controlling the leafminer, *Tuta absoluta* on tomato plants during spring season, 2013.

Period after application (days)	Programs										
	A		B		C		D		E		F
	No.	R%	No.	R%	No.	R%	No.	R%	No.	R%	No.
1st application											
2	0.0	100	1.0	50.0	1.0	50	0.0	100	1.0	50.0	2.0
5	0.0	100	1.0	66.7	0.0	100	1.0	66.7	1.0	66.7	3.0
7	2.0	66.0	1.0	80.0	2.0	60	2.0	60.0	2.0	60.0	5.0
10	4.0	50.0	3.0	62.5	2.0	75	2.0	75.0	6.0	25.0	8.0
Mean	**1.5**	**64.8**	**0.3**	**64.8**	**0.8**	**71.2**	**1.0**	**75.4**	**2.5**	**50.0**	**4.0**
2nd application											
2	2.0	84.3	3.0	86.9	2	84.6	3.0	76.9	8	38.5	13
5	3.0	81.2	2.0	87.5	4	75.0	5.0	68.7	14	12.5	16
7	4.0	80.0	3.0	85.0	6	70.0	4	80.0	16	20.0	20
10	6.0	71.4	5.0	80.9	4	80.9	5	76.2	18	15.0	21
Mean	**3.25**	**79.3**	**2.5**	**85.0**	**3.5**	**77.6**	**4.25**	**75.4**	**14**	**21.5**	**17.5**
3rd application											
2	5	82.7	3	89.6	4	86.2	5	82.7	26	10.3	29
5	6	84.6	5	87.2	7	82.0	6	84.6	36	7.7	39
7	10	77.3	6	86.4	9	79.5	8	81.8	39	11.4	44
10	9	81.2	5	89.5	8	83.3	9	81.2	43	10.4	48
Mean	**7.5**	**81.4**	**4.75**	**88.2**	**7**	**82.7**	**7**	**82.6**	**36**	**9.9**	**40**
4th application											
2	9	83.6	11	80.0	10	81.8	12	78.2	49	10.9	55
5	10	83.0	11	81.3	14	93.9	12	79.6	53	10.2	59
7	13	79.4	10	84.1	12	80.9	11	82.5	57	9.5	63
10	19	72.0	7	79.7	8	88.2	9	86.7	62	8.8	68
Mean	**12.75**	**79.5**	**9.75**	**81.3**	**11**	**86.0**	**11**	**81.7**	**55.25**	**9.8**	**61.3**
General mean	**4.0**	**79.8**	**3.5**	**79.7**	**4.5**	**79.4**	**4.7**	**78.8**	**21.6**	**22.9**	**24.6**
F	**166.74**										
LSD 0.05	**0.55**										

No. = No. of larvae/25 plants
R% = Reduction %
A =Chemical+Pheromone
B =Spinosad+Trichogramma+Pheromone
C =Neem+Trichogramma+Pheromone
D =BT+Trichogramma+Pheromo
E =Oil+Trichogramma+Pheromone
F = Control

After the 2nd application data shows the percent reduction of larval infestation in programs B gave reduction% 85.0, with mean No. 2.5 larvae/25 plants, whereas, in programs A, B and D gave reduction% 79.3, 77.6 and 75.4%, with mean No. 3.25, 3.5 and 4.25 larvae/25 plants, respectively, finally, program E gave the least effectiveness with reduction% 21.5 with mean No. 14.0 larvae/25 plants.

In case the 3rd application data indicated that the percent reduction of larval infestation in programs B, C, D and A gave reduction% 88.2, 82.6, 82.7, and 81.4, with mean No. 4.75, 7.0, 7.0, and 7.5 larvae/25 plants, whereas, in program E gave reduction% 9.9, with

mean No. 36 larvae/25 plants, respectively.

The 4th application data indicated that the percent reduction of larval infestation in programs A, B, C and D gave reduction% 79.8, 79.7, 79.4 and 78.8 with mean No. 4.0, 3.5, 4.5, and 4.7 larvae/25 plants, whereas, in program E gave reduction% 22.9, with mean No. 21.6 larvae/25 plants, respectively. This results agreement with **(Oliveriva *et al*., 2009 and Gaffar, 2012).**

Statistical analysis in Table (2) indicated that highly significant difference between the different programs in controlling *T. absoluta* during spring season 2013 were F = 166.74 and LSD = 0.55.

Data in Table (3) showed that the effect of different control programs on reduction the larvae of *T. absoluta* after 2, 5, 7 and 10 days during summer season, 2003.

Table 3: Efficacy of different programs in controlling the leafminer, *Tuta absoluta* on tomato plants during summer season, 2013.

Period after application (days)	Programs										
	A		B		C		D		E		F
	No.	R%	No.	R%	No.	R%	No.	R%	No.	R%	No.
1st application											
2	0.0	100	0.0	100	0.0	100	1.0	100	1.0	100	2.0
5	0.0	100	0.0	100	0.0	100	1.0	100	1.0	50.0	2.0
7	2.0	100	2.0	100	2.0	100	2.0	80.0	2.0	60.0	5.0
10	4.0	87.5	2.0	87.5	2.0	87.5	2.0	75.0	6.0	25.0	8.0
Mean	**1.5**	**86.8**	**1.0**	**86.8**	**1.5**	**86.8**	**1.5**	**88.7**	**2.5**	**58.7**	**4.3**
2nd application											
2	1.0	90.9	0.0	100	1.5	90.9	2.0	81.8	7.0	36.4	11.0
5	2.0	85.7	1.0	92.8	2.0	85.7	3.0	78.6	12.0	14.3	14.0
7	3.0	83.3	2.0	88.9	3.0	83.3	3.0	83.3	14.0	22.2	18.0
10	5.0	73.7	3.0	84.2	2.0	89.4	2.0	79.4	16.0	15.8	19.0
Mean	**2.8**	**83.4**	**1.5**	**91.8**	**2.0**	**87.2**	**2.5**	**83.3**	**12.3**	**22.2**	**15.5**
3rd application											
2	3.0	88.0	2.0	92.0	2.0	92.0	3.0	81.8	19.0	24.0	25.0
5	5.0	83.9	3.0	90.3	4.0	87.1	3.0	90.3	22.0	29.0	31.0
7	6.0	82.3	4.0	88.2	5.0	85.3	6.0	82.3	24.0	29.4	34.0
10	7.0	82.1	3.0	92.3	6.0	84.6	7.0	82.1	27.0	30.8	39.0
Mean	**5.3**	**84.1**	**3.0**	**90.7**	**4.3**	**87.2**	**4.8**	**85.7**	**23.0**	**38.3**	**32.3**
4th application											
2	8.0	81.4	7.0	83.7	8.0	81.4	9.0	79.1	30.0	30.2	43.0
5	9.0	80.8	10.0	78.7	11.0	76.7	10.0	78.7	32.0	31.9	47.0
7	10.0	80.8	8.0	84.3	9.0	82.4	8.0	84.3	43.0	15.7	51.0
10	17.0	67.8	6.0	88.7	7.0	86.8	7.0	86.8	47.0	11.3	53.0
Mean	11.0	77.6	7.8	83.8	8.75	81.8	8.5	82.2	38.0	22.3	48.5
General mean	**4.8**	**83.0**	**3.3**	**8.4**	**4**	**85.7**	**4.3**	**84.9**	**18.9**	**35.8**	**25.1**
F	**131.4**										
LSD 0.05	**0.65**										

No. = No. of larvae/25 plants
R% = Reduction %
A =Chemical+Pheromone
B =Spinosad+Trichogramma+Pheromone
C =Neem+Trichogramma+Pheromone
D =BT+Trichogramma+Pheromo
E =Oil+Trichogramma+Pheromone
F = Control

Comparing the different control programs showed that the percent reduction of larval infestation after 1st application indicated that programs D, B, C and A gave reduction% 88.7, 86.8, 86.8 and 86.8 with mean No. of larvae 1.5, 1.5, 1.0 and 1.0/25 plants, respectively. On the other hand, E program gave reduction% 58.7, with mean No. of larvae 2.5/25 plants, respectively. The same trend was observed in the next applications.

Statistical analysis in Table (3) indicated that highly significant difference between the different programs in controlling *T. obsoluta* during summer season 2013 were F = 131.4 and LSD = 0.65.

Efficacy of traps to catches natural enemies in tomato fields during applied different control programs:

The current research were used sticky trap and sweep net in tomato fields to determine efficacy of these traps in catching natural enemies and their relationships with toxicity of pesticides.

Yellow sticky traps:

The results in Table (4) recorded weekly number of natural enemies (Coccinellidae, Aphid lion, Syrphidae, *Hemianax ephippige* and *Nesidiocoris tenuis*) catches by yellow sticky traps on tomato plants during spring and summer seasons, 2013. The results obtained that the numbers of catches natural enemies in spring season less than summer season.

Table 4: Weekly numbers of catches by yellow sticky traps on tomato plants during spring and summer plantation, 2013.

Program	Mean numbers of Natural enemies									
	Spring					Summary				
	Coccinellidae	Aphid lion	Syrphidae	Hemianax ephippige	Nesidiocoris tenuis	Coccinellidae	Aphid lion	Syrphidae	Hemianax ephippige	Nesidiocors tenuis
A	2.6	2.5	3.8	2.0	1.0	4.8	1.3	3.7	3.5	3.0
B	9.0	2.6	5.3	4.7	2.0	9.2	6.0	4.8	5.8	3.0
C	7.3	3.0	5.8	4.3	1.8	10.4	6.0	5.7	7.8	2.8
D	9.7	3.7	6.4	4.7	1.5	10.9	4.6	7.5	7.3	4.5
E	10.9	5.5	6.9	6.1	2.6	10.9	6.1	7.1	7.2	5.0
F	12.2	6.8	7.6	7.6	3.7	11.4	6.7	7.1	7.6	4.6
Mean	0.11	4.01	0.01	0.03	0.02	58.9	5.1	6.0	6.5	3.8
F value	178.5	69.8	188.3	443.5	443.1	121.3	47.5	134.0	410.3	398.2
LSD 0.05	0.44	0.38	0.05	0.13	0.08	0.39	0.57	0.04	0.19	0.09

A =Chemical+Pheromone
B =Spinosad+Trichogramma+Pheromone
C =Neem+Trichogramma+Pheromone
D =BT+Trichogramma+Pheromo
E =Oil+Trichogramma+Pheromone
F = Control

In addition, program A "Coragen 20%+Pheromone" was more toxic to different species of natural enemies than the other programs compared with control (untreated) on spring and summer seasons.

Statistical analysis in Table (4) indicated that highly significant difference between the different programs in toxicity of natural enemies were F = 178.5, 69.8, 188.3, 443.5 and 443.1 and LSD = 0.44, 0.38, 0.05, 0.13 and 0.08 between Coccinellidae, Aphid

lion, Syrphidae, *Hemianax ephippige* and *Nesidiocoris tenuis* comparing between spring and summer seasons 2013, respectively.

Sweep net traps:

The results in Table (5) recorded weekly number of natural enemies (Coccinellidae, Aphid lion, Syrphidae, *Hemianax ephippige* and *Nesidiocoris tenuis*) catches by sweeping net on tomato plants during spring and summer seasons, 2013. The results obtained that the numbers of catches natural enemies in spring season less than summer season, except catching Coccinellidae in spring more than catching in summer season. In addition, program A "Coragen 20%+Pheromone" was more toxic to different species of natural enemies than the other programs compared with control (untreated) on spring and summer seasons.

Table 5: Weekly numbers of catches by sweeping net on tomato plants during spring and summer plantation, 2013

Program	Mean numbers of natural enemies									
	Spring					Summary				
	Coccinellidae	Aphid lion	Syrphidae	Hemianax ephippige	Nesidiocoris tenuis	Coccinellidae	Aphid lion	Syrphidae	Hemianax ephippige	Nesidiocors tenuis
A	4.8	8.9	3.0	4.0	7.3	4.0	5.7	2.6	2.4	1.5
B	21.3	13.1	5.3	5.0	3.9	9.9	8.6	6.3	58	2.5
C	26.5	15.3	5.4	5.4	5.3	9.8	10.5	7.4	7.9	3.0
D	28.3	17.6	6.6	7.5	7.0	12.4	12.4	8.4	9.1	3.3
E	29.9	21.3	10.8	10.0	7.4	14.6	12.0	9.8	9.6	4.1
F	30.7	20.6	12.1	9.7	9.8	16.8	13.6	9.2	11.3	4.1
Mean	**23.6**	**0.10**	**0.05**	**0.05**	**0.01**	**11.2**	**10.5**	**7.3**	**7.7**	**3.1**
F value	**699.8**	**458.6**	**887.4**	**524.4**	**3981.0**	**546.8**	**364.3**	**734.2**	**489.5**	**356.8**
LSD 0.05	**0.68**	**0.40**	**0.22**	**0.20**	**0.07**	**0.63**	**0.40**	**0.22**	**0.19**	**0.58**

A =Chemical+Pheromone
B =Spinosad+Trichogramma+Pheromone
C =Neem+Trichogramma+Pheromone
D =BT+Trichogramma+Pheromo
E =Oil+Trichogramma+Pheromone
F = Control

Statistical analysis in Table (4) indicated that highly significant difference between the different programs in toxicity of natural enemies the programs and between spring and summer seasons 2013, respectively.

In comparing between yellow sticky trap and sweep net, the results in Tables (4&5) showed that, the sweep net more efficient than yellow sticky trap on spring and summer plantations. The obtained results agree with those obtained with results indicate by that (Ekrem and Ramazan 2004; Ebrahim, 2007; Natwicic *et al*., 2007 and Walker *et al*., 2012).

Effects of different control programs on *Tuta absoluta* and its yield production of tomato:

- **Total fruit yield**

Data in Table (6) showed the highest yield production in spring comparison with summer season in all control programs. The maximum yield production was 21320 Kg/Feddan in case program B "Spinosad+ Trichogramma+Pheromone), following by treatments "Coragen 20% + pheromone"; "Neem + Trichogramma + Pheromone", "BT + Trichogramma + Pheromone" and "Mineral oil + Trichogramma + Pheromone" with

19760, 17160, 13000 and 10920 Kg/Feddan, respectively, comparison with untreated program "57020 Kg/Feddan" in spring season.

Table 6: Effect of different control programs on *Tuta absoluta* and its yield production of tomato during spring and summer seasons, 2013.

Yield production (Kg/Feddan)													
Spring							Summer						
Harvest	**A**	**B**	**C**	**D**	**E**	**F**	**harvests**	**A**	**B**	**C**	**D**	**E**	**F**
First	4160	4680	3120	2080	2600	1040	**First**	3960	4360	2920	2860	2460	960
Second	4680	4160	2600	2600	2080	520	**Second**	4480	3960	2300	2800	1860	480
Third	4160	4680	4680	3120	2600	2080	**Third**	3180	4280	4240	4460	2420	590
Fourth	3640	3640	3640	3120	2080	1560	**Fourth**	3340	3440	3520	4240	1760	470
Fifth	3120	4160	3120	2080	1560	520	**Fifth**	2820	3860	2930	2450	1340	480
Total	19760	21320	17160	13000	10920	57020	**Total**	17770	19900	15910	16810	9840	2980

A =Chemical+Pheromone
B =Spinosad+Trichogramma+Pheromone
C =Neem+Trichogramma+Pheromone
D =BT+Trichogramma+Pheromo
E =Oil+Trichogramma+Pheromone
F = Control

Whereas, in summer season the maximum production yield obtained with 19900 Kg/Feddan after treated with Spinosad + Trichogramma + Pheromone program following by Coragen 20% + Pheromone with 17770 Kg/Feddan; then BT + Trichogramma + Pheromone with 16810 Kg/Feddan; Neem + Trichogramma + Pheromone with 15910 Kg/Feddan and Mineral oil + Trichogramma + Pheromone with 9840 Kg/Feddan comparison with untreated program (2980 Kg/Feddan). This results agreement with Araki and Ito (2004), Balemi (2008), Adekiya and Agbede (2009), Lobu *et al*. (2012), Matter and Sabbour (2013), Sepat *et al*. (2013) and Yeboah *et al.* (2014).

- **Average weight of 100 fruits:**

Data shown in Table (7) showed that the weight of 100 frits was highest in spring season comparing with summer season.

Table (7): Effect of different control programs on *Tuta absoluta* and its fruit weight of tomato during spring and summer seasons, 2013.

100 fruit weight													
Spring							Summer						
Harvest	**A**	**B**	**C**	**D**	**E**	**F**	**Harvests**	**A**	**B**	**C**	**D**	**E**	**F**
First	5112	5204	5154	5144	4671	4204	**First**	5094	5073	4982	4998	4671	4184
Second	5119	5211	5115	5163	4680	4103	**Second**	5102	5104	5009	5009	4655	4012
Third	5124	5217	5122	5171	4687	3873	**Third**	5004	5177	5024	5103	4623	3777
Fourth	5118	5216	5104	5083	4773	3881	**Fourth**	4896	5181	5117	5007	4594	3678
Fifth	5074	5198	5094	5072	4681	3810	**Fifth**	5195	5011	5066	4876	4476	3645
Total	**5109.4**	**5209**	**5117.8**	**5126.6**	**4698.4**	**3974.2**	**Total**	**5058.2**	**5109.2**	**5039.6**	**4998.6**	**4603.8**	**3859.2**

A =Chemical+Pheromone
B =Spinosad+Trichogramma+Pheromone
C =Neem+Trichogramma+Pheromone
D =BT+Trichogramma+Pheromo
E =Oil+Trichogramma+Pheromone
F = Control.

The maximum weight of 100 fruits after applied program B "Spinosad + *Trichogramma* + Pheromone" was 5209 g, followed by program D "BT + *Trichogramma* + Pheromone" with 5126.6 g then program C "Mineral oil + *Trichogramma* + Pheromone" with 5117.8 g, after that program A "BT + *Trichogramma* + Pheromone" weight of 100 fruits gave 5109.4 g, program C "Neem + *Trichogramma* + Pheromone" with 5117.8 g, and program E "Mineral oil + *Trichogramma* + Pheromone" 4698.4 g.

But in summer season the maximum weight was found after applied program B "Spinosad + *Trichogramma* + Pheromone" 5109.2 g followed by program A "Coragen 20% + Pheromone" 5058.2 g, then program C "Neem + *Trichogramma* + Pheromone" 5039.6 g, while, program D "BT + *Trichogramma* + Pheromone" gave 4998.6 g and program E "Mineral oil + *Trichogramma* + Pheromone" gave 4603.8 g comparison with control program (3859.2 g).

- **Percentage of fruits infection:**

The percentage of fruits infection of tomato after application with different control programs in spring and summer seasons, shown in Table (8). The present study indicated that the percentage of fruits were higher in summer than spring seasons. The program E "Mineral oil + *Trichogramma* + Pheromone" was included highest percentage of fruits infection with larvae in summer and spring seasons with 35.2 and 36.2%, respectively. But the lowest percentage recorded after application with program A "Chemical + Pheromone" in summer and spring seasons, with 5.1 and 7.6%, respectively.

Table 8: Percentage of fruit infestation with larvae of the leafminer, *Tuta absoluta* after application with different control programs during spring and summer seasons, 2013.

%Fruits infection (100 Fruit)													
Spring							Summer						
Harvest	**A**	**B**	**C**	**D**	**E**	**F**	**Harvest**	**A**	**B**	**C**	**D**	**E**	**F**
First	4.3	11.7	10.8	15.3	33.8	35.3	**First**	6.6	9.9	8.7	8.6	34.3	37.8
Second	4.9	9.3	9.2	15.7	35.2	37.7	**Second**	6.4	11.1	7.7	10.4	34.7	36.2
Third	5.1	5.1	8.0	14.0	41.3	39.0	**Third**	8.3	6.4	10.0	5.9	39.0	39.3
Fourth	3.2	3.9	9.8	14.6	36.7	40.5	**Fourth**	7.7	6.6	10.7	5.1	34.2	39.7
Fifth	7.8	7.0	8.2	9.4	29.0	35.5	**Fifth**	9.0	5.0	7.3	12.0	29.8	42.0
Mean	5.1	7.4	9.2	13.8	35.2	37.6	**Mean**	7.6	7.8	9.0	8.4	36.2	39.0

A =Chemical+Pheromone
B =Spinosad+Trichogramma+Pheromone
C =Neem+Trichogramma+Pheromone
D =BT+Trichogramma+Pheromo
E =Oil+Trichogramma+Pheromone
F = Control

- **Number of fruits**

Data in Table (9) indicated that the number of fruits/plant after application with different control programs against *T. absolaut* on tomato plants during the spring and summer seasons. In spring season the maximum number of fruits/plant was 8.3 after treated program B "Spinosad + *Trichogramma* + Pheromone", following by application with program A "Coragen 20% + Pheromone" gave 7.6 fruits/plant; then program C "Neem + *Trichogramma* + Pheromone" was 6.5 fruits/plant; after that program D "BT + *Trichogramma* + Pheromone" with 5.0 fruits/plant and finally, program E "Mineral oil + *Trichogramma* + Pheromone) were recorded 4.1 fruits/plant, compared with untreated 2.2 fruits/plant.

In addition, the maximum number of fruits/plant in summer season was 9.5

application program C "Neem + *Trichogramma* + Pheromone" followed by program D "Spinosad + *Trichogramma* + Pheromone" with 6.8 fruits/plant; and least fruits/plant when appilaction with program E "Mineral oil + *Trichogramma* + Pheromone" were recorded 4.2 fruits/plant, compare with control program 2.5 fruits/plant.

Table 9: Effect of different application control programs against the leafminer, *Tuta absolaut* (Meyrick) on the number of fruits/plant on tomato plants during spring and summer seasons, 2013.

Mean Number of fruits/plant													
spring							**Summary**						
Harvest	**A**	**B**	**C**	**D**	**E**	**F**	**Harvest**	**A**	**B**	**C**	**D**	**E**	**F**
First	8.2	8.8	5.2	4.1	4.9	1.8	**First**	4.4	11.3	10.8	10.0	4.8	3.9
Second	8.8	8.2	5.8	4.9	4.1	1.2	**Second**	5.3	9.7	9.2	8.3	4.2	3.1
Third	8.0	8.7	8.9	6.3	4.9	3.7	**Third**	4.7	5.1	8.0	6.7	3.6	2.0
Fourth	7.1	7.3	7.1	5.7	3.8	3.3	**Fourth**	3.9	4.8	9.7	9.4	4.4	1.8
Fifth	5.9	8.1	5.9	4.0	3.2	1.0	**Fifth**	7.1	6.2	8.3	9.6	3.2	1.2
Mean	7.6	8.3	6.5	5.0	4.1	2.2	**Mean**	5.4	7.6	9.5	6.8	4.2	2.5

A =Chemical+Pheromone
B =Spinosad+Trichogramma+Pheromone
C =Neem+Trichogramma+Pheromone
D =BT+Trichogramma+Pheromo
E =Oil+Trichogramma+Pheromone
F = Control

This results agreed with those obtained by Gaffer *et al*. (2012), found that the efficacy of these control methods was recorded on the basis of reduction percentage in the larvae after periods of 2, 5, 7, 10 days from each application. The present results were recoded highly increase in the reduction in summer plantation verification with the number of larvae spring plantation. Reduction percentages in the number of larvae and efficacy of the tested treatments could be descending arranged as follows *Bacillus thuringiensis* + Neem, *B thuringiensis* + *Trichogramma evanescens* + mass trapping, *B thuringiensis* + Trichoderma harzianum, *T. harzianum* + Neem, *T harzianum* + mass trapping and *T. evanescens* + Neem. The corresponding value was 91.88, 90.18, 87.89, 85.69, 80.75 an 84.82 % respectively, during Summer plantation and 88.49, 86.03, 84.78, 83.01, 79.88 and 82.82 % during Spring plantation. On the other hand, using baited traps of males moths using synthetic sex pheromones recorded the highest relative percentage were 10.91 and 10.76 % in spring and summer plantation, respectively. Where the lowest one recorded 2.74 and 2.71 % in spring and summer plantation. The highest healthy yield production recorded 9.555 ton/feddan in case of using *B thuringiensis* + Neem, whereas the lowest healthy yield production recorded 5.580 ton/feddan when using *T. evanescens* + Neem The corresponding general means of cost benefit 3317 and 1589 production in the untreated plot recorded 1.555 ton/ feddan. Reviewing the previous results it could be concluded that *B. thuringiensis* had potential effect when integrated with Neem that increased the reduction in infestation rates with *T. absoluta* larvae. These results supported by Fredon (2009) which revealed *B. thuringiensis* var. Kurstaki (BtK) used for larval control, natural solutions of BtK applied to crops once per week at the end of the day and registered for use against *T. absoluta* larvae on tomatoes in the United States by (Sixmith, 2009). Data of the present study are in accordance with those recorded by Servicio de Sanidad Vegetal-Murcia (2008) which recommend for use Azadirachtin as a preventive spray and for infestation (30 adult catches per

week) of *T. absolutain* Spain. The study performed by Gaffar (2012), are agree with those obtained in this study. He carried out trials in Egypt to evaluate the augmentation releases of egg parasitoids, *T. evanescens* for controlling *T. absoluta* in greenhouses only is not strongly effective on tomato plants but, possibility to be used it in an IPM program.

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