NEW APPROACHES FOR CONTROLLING TOMATO LEAFMINER, *TUTA ABSOLUTA* (MEYRICK) IN TOMATO FIELDS IN EGYPT

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Abstract

Control methods were carried in Baltiem district, Kafrel-Sheikh Governorate from times during both Spring and Summer plantations, 2012. 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 obtained results revealed that the highly increase in the reduction was occurred in Summer plantation verification with the number of larvae in Spring plantation. Based on reduction percentages in the number of larvae, the efficacy of the tested treatments could be descendingly 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 were 91.88, 90.18, 87.89, 85.69, 80.75 and 84.82 % for the above treatments, 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 L.E/feddan, respectively. On the other hand, the healthy yield production in the untreated plot recorded 1.555 ton/ feddan.

Key words: *Tuta absoluta*, sex attractant pheromones, microbial insects, botanical extracts, *Trichogramma*.

INTRODUCTION

Egypt is considered one of the important tomato producer in the world (WPTC, 2011). Tomato leafminer, *Tuta absoluta* (Meyrick) (Gelechiidae: Lepidoptera), is an invasive pest causing severe loss for tomato production in many countries either in open field or green houses. Severely attacked tomato fruits lose their commercial value (EPPO, 2008). The tomato leaf miner, *Tuta* invaded Egypt in the nearest Governorate to Libya (Marsa Mtrooh) in 2009. By 2010 it had reached Giza, coming

well established in all Governorates of Egypt and reaching the border and north part of Sudan on June 2011 (Tamerk, 2011 & Gaffar, 2012). Biological control has been developed and widely applied in different countries such as several South American states, using the oophagous *Trichogramma* parasitoids. Three different species of *Trichogramma* evaluated for reducing the number of *T. absoluta* eggs in Fayoum Governorate, Egypt (Gaffar, 2012). The sex pheromone of *T. absoluta* was identified in the late 1990`s and pheromone blends were subsequently tested aiming their use for field monitoring and mass trapping (Ferrara *et al.*, 2001). Azadirachtin has been recommended for use as a preventive spray and for light infestations of *T. absoluta* in Spain (Van Deventer, 2009). Bio-insecticide, *Bacillus thuringiensis* exhibited a medium to low efficiency on all instars of *T. absoluta*. Azadiractin exhibits extremely low acute mammalian toxicity but it is very effective as control agent for many insect groups (Champagne *et al.*, 1989). Shakeri and Foster (2007) reported that, *Trichoderma harzianum* used as Alcohols Antibiotics Biocontrol Enzymes Insect control Pathology Entomopathogens Insect pathogens. The prevailing situation is globally assessed and the impact on production of healthy crops through the adoption of an Integrated Production and Protection (IPP) approaches is discussed (Papasolomontos, 1998). The environmental conditions are factors influencing insect physiology and behavior. According to Zalom and Wilson (1982) the rate of development is based on the accumulation of heat measured in physiological rather than chronological time. population of the *Tuta absoluta* in Qena governorate gave the highest number of generation as compared to other locations (EL Beheira, Giza and Fayoum governorates) under climate conditions (Aboimeaty *et al.*, 2010).

The objective of this study is to evaluate different control strategies including insecticide alternatives methods to control *T. absoluta* in open field, and calculate the quantity of production and the costs of control for each treatment during Spring and Summer plantation 2012.

MATERIALS AND METHODS

1. Materials used:

Alternative approaches used with integrated method to control *Tuta absoluta*, namely:

A. Synthetic sex pheromones of the tomato leaf miner, *T. absoluta* : 3E, 8E, 11Z – 14 AC (C16 H26 O2), (E, Z, Z) – 3, 8, 11 – Tetradecatrienyl acetate obtained from Koppert Biological system company.

B. Microbial insecticides:

B. 1. Microbial entomopathogenic bacteria:

Trade name: *Bt*, and active ingredient: *Bacillus thuringiensis* var. *kurstaki*, was adjusted to be contain 33 × 10^6 C.F.U/1ml and obtained from Central Laboratory of Organic Agriculture, CLOA/Agriculture Research Center, ARC.

Rate of application: 4800 ml/ feddan.

B. 2. Microbial entomopathogenic fungi:

Trade name: Blightstop, and active ingredient: *Trichoderma harzianum* preparation contains 30 × 10^6 C.F.U/1ml obtained from Central Laboratory of Organic Agriculture, CLOA/ Agriculture Research Center, ARC.

Rate of application: 3600 ml/feddan.

C. botanical extracts:

Trade name: Nimbecidine and active ingredient: Azadirachtin 0.03 %, and found in plant extract Neem tree (*Azadirachta indica* A. Juss.) oil obtained from Gaara-Establishment.

Rate of application: 2880 ml/feddan

D. Egg parasitoid, *Trichogramma evanescens* West.:

The egg parasitoid, *Trichogramma evanescens* used for controlling *T. absoluta* was obtained from Plant Protection Research Institute, Agriculture Research Center, ARC. 70 -75 adult/ m^2were implemented according to (Gaffar, 2012 and Cabello *et al.*, 2009). The rate of release for each treatment was 53400 individuals/release/712 m^2, divided into 18 paper cards, each contained 3000 individuals, approximately. The parasitoid was released on 20/03/2012, 29/03/2012, 09/04/2012 and 18/04/2012 as Spring plantation and on 27/04/2012, 06/05/2012, 15/05/2012 and 24/05/2012 as Summer plantation during the year of 2012.

2. Treatments for field experiments:

Seven treatments (A, B, C, D, E, F and untreated) served to carry out different experiments to compare efficacy of the tested six integrated programs for controlling *T. absoluta*, namely *Bacillus thuringiensis* + Neem, *B. thuringiensis* + *Trichogramma evanescens* + mass trapping, *B. thuringiensis* + *Trichoderma harzianum*, *T. harzianum* + Neem, *T. harzianum* + mass trapping, *T. evanescens* + Neem and control, respectively. Each treatment was planted with 933 tomato seedlings (= 5600 plants/feddan). Where, the corresponding general means of spray reached 800 ml *Bt* + 480 ml Neem/80 L. water, 800 ml *Bt*/80 L. water + 53400 individuals *Trichogramma* parasitoid, 800 ml *Bt* + 600 ml *T. harzianum*/80 L. water, 600 ml *T. harzianum* + 480 ml Neem/80 L. water, 600 ml *T. harzianum*/80 L. water + 53400 individuals *Trichogramma* parasitoid and 480 ml Neem/80 L. water + 53400 individuals *Trichogramma* parasitoid and control.

3. Field experiments:

Field experiments were carried out in a private farm in Baltiem district, Kafrel-Sheikh Governorate, Egypt, during two successive tomato plantations, Spring in Murtada village, Kafrel-Sheikh district and Summer in Al-Chehabia village, Baltiem district plantations of 2012. In both plantations an area 4912 m^2 was cultivated with tomato (Developed orient variety) on March 20th. The experimental area was divided to plots, each of 712 m^2. The completely randomized block design was utilized in the initiated experimental traits with four replicates for each treatment (= 25 leave/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. According to the complete randomized blocks, the experimental area (1 feddan), beside untreated check plot (1/6 feddan). 20 liters volume sprayer was used for microbial insecticides and botanical extracts spraying. Each bio-product was sprayed fourth times on 20/03/2012, 29/03/2012, 09/04/2012 and 18/04/2012 as Spring plantation and on 27/04/2012, 06/05/2012, 15/05/2012 and 24/05/2012 as Summer plantation during the year of 2012. The evaluation of the control methods based on reduction percentages in infestation was determined according to the method adopted by Henderson and Tilton (1955).

4. Estimation of degree-days units:

4.1. Under current climate temperature:

For estimating degree day's unit (DDU), the daily temperature records were obtained from Central Laboratory for Agriculture Climate (CLAC) during the period from 01 January 2012 to 30 June 2012 for the experimental location (Baltiem district, Kafrel-Sheikh Governorate) and the average were calculated to determine number of generations for this pest during the period of experimental.

4.2. Determination of *T. absoluta* thermal units:

Maximum and minimum degrees of temperature were transformed to heat units using the lower threshold temperature (T0) 8°C with 460 (DDU) for *T. absoluta* development Barrientos *et al.*, (1998). Degree day's unit calculations were made to estimate the number of possible generations of *T. absoluta* in the field using the following formula:

DDU = (Max. Mean Temp. + Min. Mean Temp.)/2 – Min. Development Temp.

For *T. absoluta* the minimum threshold for the a development from egg to adult is 8°C and 460 DDU (Barrientos *et al.*, 1998).

5. Statistical analysis:

The data was subjected to analysis of variance (ANOVA) and the means were compared by L.S.D. test at 0.05 levels, using SAS program (SAS Institute, 1988).

RESULTS AND DISCUSSION

Comparisons between the different control methods were carried out on the basis of the reduction percentages in tomato leafminer, *T. absoluta* larvae infested tomato, *Lycopersicon esculentum* Mill. Vegetable plant on basis of reduction percentages in larval infestation:

The experimental trials were implemented to evaluate the role of different methods in controlling *T. absoluta* larvae infested tomato in Spring and Summer plantation during the year, 2012. The control methods used in current study included synthetic sex pheromones (pheromone baited traps), egg parasitoids *T. evanescens* , microbial insecticides and botanical extracts used in integration with Delta traps to monitor population levels and reduce the male *Tuta* moths population. The results were recorded as reduction percentages. The experimental results of Spring plantation are indicated in Table (1).

The obtained results from Spring plantation represented in Table (1) showed that all the control methods had highly reduction percentages over 90% after 10 days after 1stapplication. The highest reduction percentage in the number of larvae was occurred in case of using entomopathogenic bacteria, *B. thuringiensis* combined with botanical extract, Neem. On the other hand, using entomopathogenic fungi, *T. harzianum* combined with mass-trapping of the pest male moths caused the lowest reduction percentage in infestation by larvae as compared with the other control measures.

As shown in Table (1) the general mean reduction percentage in the number of larvae during Spring plantation were 88.49, 86.03, 84.78, 83.01, 79.88 and 82.82% in treatments of *Bacillus thuringiensis* + Neem, *B. thuringiensis* + *Trichogramma evanescens* + mass trapping, *B. thuringiensis* + *Trichoderma harzianum, T. harzianum* + Neem, *T. harzianum* + mass trapping and *T. evanescens* + Neem, respectively.
Data of Summer plantation as shown in Table 2 proved that the application of the previous control methods were more effective in reducing the larval infestation of tomato plants than that in Spring plantation. Similar trend associated to the efficacy of the previous control methods was noticed between Spring and Summer plantations.

Generally, using entomopathogenic bacteria, *B. thuringiensis* combined with botanical extract, Neem exhibited the highest reduction percentage in the number of larvae, where using entomopathogenic fungi, *T. harzianum* combined with mass-trapping recorded lowest reduction percentage in the number of larvae during the two seasons Spring and Summer plantations.

Table 1. Efficacy of insecticidal alternatives against the tomato leafminer, *Tuta absoluta* on tomato plants during Spring plantation in Murtada village, 2012.

Period after applications (days)	% Reduction in the numbers of larvae at indicated treatments					
	A	B	C	D	E	F
1st application						
2	92.70	92.98	85.70	89.47	87.72	97.72
5	96.01	95.01	97.04	97.02	95.0	98.02
7	97.69	97.69	98.46	93.08	91.54	88.98
10	99.15	94.07	94.07	89.83	88.32	81.54
Mean	96.39	95.79	93.82	92.35	90.65	91.57
2nd application						
2	96.43	91.07	86.61	82.14	91.07	86.01
5	90.77	90.77	89.25	89.23	84.62	90.77
7	89.17	90.74	88.89	85.19	77.22	79.17
10	86.39	79.17	81.94	80.55	72.22	73.61
Mean	90.69	87.94	86.67	84.22	81.28	82.39
3rd application						
2	89.02	86.15	78.78	88.31	80.95	82.39
5	86.17	80.59	84.81	78.90	77.72	85.28
7	78.83	79.56	84.66	77.37	73.36	84.39
10	74.87	75.94	72.73	70.59	62.57	75.55
Mean	82.22	80.56	80.25	78.79	73.65	67.91
4th application						
2	84.51	85.21	83.30	81.29	79.58	80.28
5	85.93	82.96	83.70	82.22	76.29	80.74
7	81.48	79.63	75.93	74.07	72.22	75.93
10	70.75	71.43	70.07	68.71	65.99	67.55
Mean	84.67	79.81	78.38	76.67	73.52	76.13
General mean	88.49 [a]	86.03 [ab]	84.78 [bc]	83.01 [c]	79.88 [d]	82.82 [c]
F	13.59					
L.S.D. 0.05	2.4817					

A = *Bacillus thuringiensis* + Neem
B = *B. thuringiensis* + *Trichogramma evanescens* + mass trapping
C = *B. thuringiensis* + *Trichoderma harzianum*
D = *T. harzianum* + Neem
E = *T. harzianum* + mass trapping
F = *T. evanescens* + Neem

Based on general mean of reduction percentages in the number of larvae, the efficacy of the tested treatments could be descendingly arranged as follows *Bacillus thuringiensis* + Neem, *B. thuringiensis* + *Trichogramma evanescens* + mass trapping, *B. thuringiensis* + *Trichoderma harzianum, T. harzianum* + Neem, *T.*

Table 2. Efficacy of insecticidal alternatives against the tomato leafminer, *Tuta absoluta* on tomato plants during Summer plantation in Kafrel-Sheikh district, 2012.

Period after applications (days)	% Reduction in the numbers of larvae at indicated treatments					
	A	B	C	D	E	F
1st application						
2	94.44	91.67	91.05	86.56	84.11	83.33
5	97.01	93.12	92.12	88.86	87.39	85.71
7	98.06	95.17	89.36	91.13	88.03	90.62
10	93.62	94.94	86.02	87.76	79.19	86.12
Mean	95.78	93.73	89.66	88.58	84.68	86.45
2nd application						
2	93.05	91.39	92.67	90.16	88.05	89.17
5	92.71	92.52	90.29	86.29	85.78	85.19
7	90.54	90.03	85.91	84.99	82.41	82.18
10	91.32	87.97	83.89	82.89	78.91	80.01
Mean	91.91	90.48	88.19	86.09	83.79	84.14
3rd application						
2	91.55	88.17	87.55	85.11	82.99	85.34
5	92.29	90.13	91.29	88.29	79.79	86.24
7	87.61	86.25	85.15	86.14	75.96	84.05
10	85.29	80.59	78.02	77.93	70.02	76.39
Mean	89.19	86.29	85.50	84.37	77.18	83.01
4th application						
2	93.94	91.95	91.67	83.18	83.11	82.02
5	92.97	91.89	92.17	90.43	80.06	86.36
7	88.99	89.85	86.14	81.19	76.12	82.11
10	86.59	87.19	82.88	80.05	70.03	79.19
Mean	90.62	90.22	88.22	83.71	77.33	82.42
General mean	91.88 [a]	90.18 [a]	87.89 [b]	85.69 [c]	80.75 [d]	84.01 [c]
F	38.94					
L.S.D. 0.05	2.0384					

A = *Bacillus thuringiensis* + Neem

B = *B. thuringiensis* + *Trichogramma evanescens* + mass trapping

C = *B. thuringiensis* + *Trichoderma harzianum*

D = *T. harzianum* + Neem

E = *T. harzianum* + mass trapping

F = *T. evanescens* + Neem

harzianum + mass trapping and *T. evanescens* + Neem. The corresponding value were 91.88, 90.18, 87.89, 85.69, 80.75 and 84.01%, respectively.

Comparisons on basis of the controlling index and potency levels:

It seems always convenient to consider the efficacy on the degree of controlling the target pest by different control agents via comparing them with a standard agent. In the present work, comparisons among the tested control methods are based on both control index method developed by Sun (1950) and the potency levels expressed as number of folds frequently used in this respect.

Table 3. Relative comparison between insecticidal alternatives for controlling the tomato leafminer *T. absoluta*.

Treatments used	% General reduction during		Control index * during		Potency level ** during	
	Spring	Summer	Spring	Summer	Spring	Summer
Bt + Neem	88.49	91.88	100	100	1.11	1.14
Bt + *Trichogramma* + trap catches	86.03	90.18	97.22	98.15	1.08	1.12
Bt + *Trichoderma*	84.78	87.89	95.81	95.66	1.06	1.09
Trichoderma + Neem	83.01	85.69	93.81	93.26	1.04	1.06
Trichoderma + trap catches	79.88	80.75	89.28	87.89	1.00	1.00
Neem + *Trichogramma*	82.82	84.01	92.68	91.43	1.04	1.04

$$\text{* Control index} = \frac{\text{\% General reduction in the tested treatment}}{\text{\% General reduction in the most promising treatment}} \times 100$$

$$\text{** Potency level} = \frac{\text{\% General reduction in the tested treatment}}{\text{\% General reduction in the least effective treatment}}$$

On the ground of control index as illustrated in Table (3), the efficacy of the tested control methods, *i.e. Bt* integrated with *T. evanescens* and mass trapping of *T. absoluta* male moth, *Bt* integrated with *T. harzianum*, *T. harzianum* integrated with Neem, *T. harzianum* integrated with mass trapping of *T. absoluta* male moth and Neem integrated with *T. evanescens* recorded 97.22, 95.81, 93.81, 89.28 and 92.68%, respectively as effective to *Bt* integrated combined with Neem against *T. absoluta* larvae during Spring plantation and 98.15, 95.66, 93.26, 87.89 and 91.43% as efficient as to *Bt* combined with Neem during summer plantation.

Concerning the potency level expressed as number of folds (Table 3), the efficacy of the tested control methods, *i.e. Bt* combined with Neem, *Bt* combined with *T. evanescens* and mass trapping of *T. absoluta* male moth, *Bt* combined with *T. harzianum*, *T. harzianum* combined with Neem and Neem integrated with *T. evanescens* recorded 1.11, 1.08, 1.06, 1.04 and 1.04 times, respectively as effective as *T. harzianum* integrated with mass trapping of *T. absoluta* male moth against the pest larvae during Spring plantation compared with 1.14, 1.12, 1.09, 1.06 and 1.04 times, respectively as effective as *T. harzianum* integrated with mass trapping of *T. absoluta* male moth against the pest larvae during Summer plantation.

Results in Table (4) showed the relationship between popul... *absoluta* male moths captured in sex attractant baited traps and accum... unit in degrees-days (DD´S) during two plantations, Spring and Summer... illustrated in Table (4) the population density of the male moths w... gradually to reach the reliable occurrence of the 1st generation during the ... March in Spring plantation and first week of May in Summer plantation. The ... this generation was recorded on March, 26th and May, 3rd . The correspondin... number of the captured moths were 219 and 112.5 moths/3 traps/3days,resp... where the accumulative heat units equal 409.02 and 851.22 degr... respectively. After this period the reliable occurrence of the 2nd generation of ... took place in the first week of April and first May to reach its peak on April, ... May, 8th . The corresponding total numbers of the captured moths of th... recorded 435 and 264 male moths/3 traps/3days where the accumulative h... equal ,491.62 and 924.72 degrees-days, respectively. The population densit... male moths decreased in April 9th and increased gradually from April 11th to A... In the half of April to reach its peak on April, 15th and May, 19th. The corre... numbers of captured male moths of this peak recorded 300 and 327 male ... traps/3days when the accumulative heat units equal 636.72 and 1100.27 ... days, respectively. After this period, the population density of the pest was ... to reach its peak on April, 22nd and May, 28th. The trapped moths recorded ... moths/3 traps/3days when the accumulative heat units equal 717.22 and ... degrees-days, respectively. As noticed in Table (4) the total numbers of capt... moths were higher in Spring plantation which reached 3996 male moth th... those during Summer plantation which being 3040.5 male moths/3 traps/3... the whole season. And the highest relative percentage number of captu... were 10.91 and 10.76% in Spring and Summer, respectively. Whereas th... relative percentage number of captured moths recorded 2.86 and 2.71% ... and Summer, respectively.

Data shown in Table (5) demonstrated the highest yield production ... production and cost benefit in Summer plantation recorded in case of co... control method, entomopathogenic bacteria, *B. thuringiensis* combined with ... extract, Neem. On the other hand, using botanical extract, Neem integrated ... parasitoids, *T. evanescens* gave the lowest healthy yield production ... production and cost benefit. The correspondent value of yield production ... production and cost benefit were 9.555 ton/feddan, 3822 L.E/feddan ... L.E/feddan, respectively. The correspondent value of yield production, p... and cost benefit were 5.580 ton/feddan, 2230 L.E/feddan and 1835 L.E/f...

Table 4. Population size of the tomato leafminer, *T. absoluta* male moths monitored by baited sex pheromone traps in tomato fields in Kafrel- Sheikh Governorate during Spring and Summer plantations, 2012.

Mean number of male moths/trap/day at indicated plantation dates													
Inspection dates	Spring				Inspection dates	Summer				% Relative No. of captured moths *		Accumulative heat units in degrees-days (DD's)	
	Trap 1	Trap 2	Trap 3	Total		Trap 1	Trap 2	Trap 3	Total	Spring	Summer	Spring	Summer
22/3	78	62	70	210	29/4	27	30	28.5	85.5	5.27	2.81	376.77	798.87
24/3	78	54	66	198	1/5	32	24	28	84	4.97	2.76	390.27	824.12
26/3	66	80	73	219	3/5	42	33	37.5	112.5	5.49	3.70	409.02	851.72
29/3	31	45	38	114	6/5	22	33	27.5	82.5	2.86	2.71	438.32	896.47
31/3	60	66	63	189	8/5	100	76	88	264	4.74	8.69	450.62	924.72
2/4	98	78	88	264	10/5	52	64	58	174	6.62	5.72	470.37	955.72
4/4	134	156	145	435	12/5	32	49	40.5	121.5	10.91	4.00	491.62	990.22
9/4	43	53	48	144	15/5	71	34	52.5	157.5	3.61	5.18	560.52	1053.47
11/4	74	94	84	252	17/5	86	58	72	216	6.32	7.11	585.62	1070.02
13/4	105	91	98	294	19/5	90	128	109	327	7.38	10.76	605.87	1100.27
15/4	118	82	100	300	21/5	87	103	95	285	7.52	9.37	636.72	1131.67
18/4	71	73	72	216	24/5	78	66	72	216	5.42	7.10	672.22	1179.22
20/4	92	98	95	285	26/5	75	96	85.5	256.5	7.15	8.44	693.22	1211.22
22/4	128	112	120	360	28/5	82	93	87.5	262.5	9.03	8.63	717.22	1244.87
24/4	99	95	97	291	30/5	57	94	75.5	226.5	7.29	7.45	738.57	1278.72
27/4	71	73	72	216	2/6	57	56	56.5	169.5	5.42	5.57	775.02	1331.06
Total	1346	1312	1329	3996	Total	990	1037	1013.5	3040.5	100	100	775.02	1331.06

* Relative number of captured moths = $\frac{\text{No. of captured moths}}{\text{Total No. of captured moths}} \times 100$

Table 5. Estimated yield production of tomato, control costs and cost benefit in the experimental trials of the different control methods during summer plantation, 2012.

Control methods	No. of trials	yield production Ton/feddan	Price of production L.E/feddan	Control costs L.E/feddan	Cost benefit *	Relative cost benefit % **
Bt + Neem	4	9.555 [a]	3822 [a]	505 [b]	3317 [a]	533.3
Bt + *Trichogramma* + trap catches	4	7.8007 [b]	3120 [b]	580 [c]	2540 [c]	408.4
Bt + *Trichoderma*	4	7.152 [c]	2860.8 [c]	250 [f]	2610.8 [b]	419.7
Trichoderma + Neem	4	6.851 [d]	2740.4 [d]	475 [d]	2265.4 [d]	364.2
Trichoderma + trap catches	4	5.988 [e]	2382 [e]	793 [a]	1589 [f]	255.5
Neem + *Trichogramma*	4	5.580 [f]	2232 [f]	397 [e]	1835 [e]	295
Untreated	-	1.555 [g]	622 [g]	-	-	-
F		1597.41	99999.99	13904.60	99999.99	-
L.S.D. 0.05		0.1884	8.4194	4.6504	5.4832	-

* Cost benefit = price of the yield production in L.E /feddan – control cost in L.E/feddan.

** Relative cost benefit % = cost benefit in the treatments /price of the yield production of the untreated plot × 1

...ewing the previous results it could be concluded that *B. thuringiensis* had ... fficacy when integrated with Neem that increased the reduction in infestation ... *absoluta* larvae. These results supported by FREDON-Corse (2009) which ... *thuringiensis* var. Kurstaki (BtK) used for larval control, natural solutions ... ied to crops once per week at the end of the day and registered for use ... *absoluta* larvae on tomatoes in the United States by (Sixmith, 2009). Data ... present study are in accordance with those recorded by Servicio de Sanidad ... Murcia (2003) which recommended for use Azadirachtin as a preventive spray ... infestation (... 30 adult catches per week) of *T. absoluta* in Spain. The study ... by Gaffar (2012), are agree with those obtained in this study. He carried ... in Egypt to evaluate the augmentation releases of egg parasitoids, *T.* ... for controling *T. absoluta* in greenhouses only is not strongly effective on ... but, possibility to be used it in an IPM program.

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إتجاهات حديثة لمكافحة آفة حافرة الطماطم فى حقول الطماطم فى مصر

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يهدف هذا البحث إلى طرق مكافحة مختلفة بإستخدام بدائل المبيدات الحشرية وتشمل الفرمونات الجنسية (مصائد فرمونية)، طفيليات بيض التريكوجراما، المبيدات الميكروبية والمستخلصات النباتية والتى استخدمت بالتكامل فيما بينها مع مصائد دلتا لإستكشاف مستوى التعداد الحشرى. وتم استخدام سبع مساحات لهذه المعاملات تابعة للقطاع الخاص مساحة كل منها ٧١٢ م^2 بمركز بلطيم بمحافظة كفر الشيخ لمكافحة هذه الآفة. نفذت طرق المكافحة بعدد اربع معاملات خلال فصلى الربيع والصيف عام ٢٠١٢. تم تقييم فعالية طرق المكافحة على أساس نسبة خفض الإصابة فى يرقات الآفة وذلك بعد فترات ٢، ٥، ٧ و ١٠ يوم من كل معاملة. أوضحت النتائج زيادة نسبة خفض الإصابة فى العروة الصيفية مقارنة بفصل الربيع. كما أمكن ترتيب فعالية المعاملات تنازلياً كما يلى بكتريا الباسيللس ثورنجنسيز مع النيم، بكتريا الباسيللس ثورنجنسيز مع طفيل التريكوجراما بالتكامل مع مصيدة فرمونية، بكتريا الباسيللس ثورنجنسيز مع فطر التريكودرما، فطر التريكودرما مع النيم، فطر التريكودرما مع مصيدة فرمونية و طفيل التريكوجراما مع النيم. وسجلت القيم المقابلة لخفض فى التعداد كما يلى ٩١,٨٨ و ٩٠,١٨ و ٨٧,٨٩ و ٨٥,٦٩ و ٨٠,٧٥ و ٨٠,٨٢% على التوالى فى العروة الصيفية بينما كانت فى فصل الربيع كما يلى ٨٨,٤٩ و ٨٦,٠٣ و ٨٤,٧٨ و ٨٣,٠١ و ٧٩,٨٨ و ٨٢,٨٢% على التوالى. من ناحية أخرى سجل أستخدام المصائد الفرمونية لجذب ذكور الفراشات بإستخدام الفرمونات الجنسية أعلى نسبة ١٠,٩١ و ١٠,٧٦% فى عروة الربيع والصيف على التوالى. بينما سجلت أقل نسبة إلى ٢,٧٧ و ٢,٧١% فى عروة الربيع و الصيف على التوالى. بينما سجلت أعلى إنتاجية لمحصول الطماطم السليم للثمار ٩,٥٥٥ طن/ فدان فى حالة المكافحة بإستخدام بكتريا الباسيللس ثورنجنسيز والنيم فى حين سجلت أقل إنتاجية للإنتاج السليم للثمار ٥,٥٨٠ طن/ فدان عند إستخدام طفيل التريكوجراما والنيم بينما سجلت ١,٥٥٥ طن/ فدان فى المساحات غير المعاملة. وكان أعلى صافى لعائد الربح ٣٣١٧ جنيه مصرى عند المعاملة بالمركب البكتيرى بالتكامل مع مستخلص النيم وأقلها ١٥٨٩ جنيه مصرى/ فدان عند المعاملة بالمركب الفطرى (التريكودرما) + إصطياد ذكور الفراشات.