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EVALUATION OF SEX PHERMONE AND CHLORANTRANILLIPROLE (Coragen 20% SC)[R] AGAINST THE TOMATO LEAFMINER, *Tuta absoluta* (Myrick) ON TOMATO CROP

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ABSTRACT: Population density and percent reduction of *Tuta absoluta* (Myrick) (Lepidoptera: Gelichiidae) males in an open tomato fields (*Lycopersicon esculentum*,Var. Bito 186) by using sex phermone {tuta 100 N (3mg/capsule)} and chlorantraniliprole (coragen) were evaluated during growing seasons 2015 and 2016 at Abo-kabir District, Sharkia Governorate Egypt. Six plots were treated as followes: chlorantraniliprole alone; 2 phermone traps; 2 phermone traps + chlorantraniliprale; 4 phermone traps; 4 phermone traps + chlorantraniliprole in addition to check control plot. Results showed significant reduction of infestations in all plots during two seasons when plots treated with 4 traps + spraying with chlorantraniliprole than using 2 phermone traps spraying with chlorantraniliprole or plots treated with chlorantraniliprole alone. The efficiency in reducing larve numbers were 92.26, 90.53, 84.41, 66.50 and 63.97% during season 2015, while values were 93.50, 90.68, 84.75, 70.92 and 64.24% in 2016 season in plots treated with 4 phermone traps + chloranthaniliprole, 2 phermone traps +, 4 phermone traps, and 2 phermone traps, respectively. When comparing the efficacy of traps numbers, results showed that using 4 traps was better than two traps/ faddan in catching males which recorded 261.00 and 204.40 males/traps/week and 250.30 and 201.10 males/traps/week during 2015 and 2016 seasons, respectively. For the total yield per faddan, experiments showed that using 4 traps + spraying with chlorantraniliprole was the best treatment than using 2 traps + spraying with during 2015 and 2016 seasons chlorantraniliprole which recorded 39200, 37.70 and 40.00, 33.18 ton/fad. (treatment or plot), respectively. On the other hand using 2 traps/ fad., recorded the lowest yield. These results suggest that (chlorantraniliprole) is necessary in control of tomato leafminer in combination with using 4 phermone traps/fad., for achieving an effective control of this pest.

Key words: Tomato leafminer, Sex phermones, chlorantraniliprole, control.

INTRODUCTION

Tomato crop (*Lycopresicon esculentum*), is the most important vegetable plant throughout the world in farming production under both green house and open field (**Emam and Heikal, 2015**). Tomato leafminer, *Tuta absoluta* (Myrick) (Lepidoptera: Gelechiidae) is the most important pest reducing tomato production. It also feed on other host plants from the solanacae, and was record in western Egypt in late 2009 **(Temerak, 2011)**. Damage of *T. absoluta* was observed both on leaves and fruits of tomato, and on potato leaves. The larvae were found between the upper and lower leaf epidermis, feeding on mesophyll tissues and causing mines or blotches on leaves. Infested fruits had pinholes and larvae were found inside feeding on the pulp (**Taha *et al.*, 2013**). Also, secondary infections by pathogens were noticed in the infested fruits **(Kalleshwaraswamy *et al*., 2015)**.)

Chlorantraniliprole is a member of a new class of insecticides, the anthranilic diamides. It binds to ryanodine receptors (RyR) in insect

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muscles, which results in an uncontrolled release of internal calcium stores from the sarcoplasmic reticulum causing impaired regulation of muscle contraction and leading to feeding cessation, lethargy, paralysis and death in target organisms (**Cordova *et al.*, 2006**). The first means in the control of *T. absoluta* is the use of phermone traps for early detection. Further, the use of sex phermone in water traps has given promising results against the insect. An additional potential economic impact is possible due to disruption of integrated crop management (ICM) practice. Insecticidal control of *T. absoluta* may disrupt ICM, as the insecticides needed to control the pest may negatively affect biological control agents and pollinating bumble bees. New approaches for controlling tomato borer by using an integrated pest management (IPM) program which considered of mass trapping (**Abdelrazek, 2015**), *T. absoluta* males in traps at a density of 8 traps/faddan and weekly application of insecticides. There have been few efforts in using of synthetic phermone of tomato leafminer in Egypt, accordingly in this paper the effectiveness of using traps individually in pest management or combined with insecticides application was investigated. Therefore, keeping the above facts in view an attempt has been made to study the efficiency of sex phermone traps, chlorantraniliprole (Corgen 20% SC) ^{R} insecticide and their combinations for suppression of the tomato leafminer, *T. absoluta (*Myrick), on tomato plants under field conditions.

MATERIALS AND METHODS

Field Experiments Design

The present study evaluated the sex phermone traps, chlorantraniliprole (Coragen 20% SC) insecticide and their combination against the tomato leafminer, *Tuta absoluta (*Myrick), at private farm in Abo-kabir district, Sharkia Governorate, Egypt during two successive seasons of 2015 and 2016 in tomato plants, under field conditions. Six treatments were designed in far distances among them to avoid phermone interfere effects. The area of each experimental treatment was one faddan (4200 m^2) which divided into 4 internal experimental replicates (quarter faddan each). The distance between the traps on each treatment was minimum 30 m. Tomato plants were planted in June of each year. The treatments were, two sex phermone traps, two sex phermone traps + chlorantraniliprole application, four sex phermone traps, four sex phermone traps+ chlorantraniliprole application, chlorantraniliprole alone and control. Sex phermone capsules namely, Tuta 100 N (E3, 28, Z11-tetra decatrienyl acetate; 3 mg concentration), obtained from plant protection institute (phermone unit). Chlorantraniliprole insecticide namely, 3 bromo-chloro-1- (3- chloro- 2 pyridyl, - 2- methyl- b-methyl carbomamyl) pyrazol-5- carboxonlide, as using the recommended field rate 20 g/100 L water. The tested traps were distributed uniformed in the selected severely infested area. Sex phermone traps were placed on the level of 30 cm upon shoot tip of tomato plants from June 18th 2015 to September 4th 2015 and from June 15th 2016 to September 9th 2016, respectively in experimental plots. Coragen was sprayed three times starting in the same time of constructing traps with three weeks interval of the insecticide application. Sex phermone traps were used for trapping male moths and renewed every 21 days, as well as weekly visit to record and remove moths which attracted into the traps. The chlorantraniliprole was sprayed using a Knapsack sprayer motor (40 psi and 25 litters/ replicate) at the recommended rate four times, 20 days interval, starting at 25 June 2015 and 22 June 2016. The efficiency of chlorantraniliprole on the tomato leafminer was recorded weekly. Control plots were sprayed with water only.

Sex Phermone Traps

Water sex phermone traps consist of a plastic container holding water and a phermone Tuta 100 N. The Tuta 100 N is secured above the water with a wire attached at both ends of the container. A small amount of soap (15 ml) was added to the water (4 liters) to reduce surface tension and limit water evaporation; Capsules and water were renewed every 4 weeks.

Plant Samples

The tomato leafminer infestation in each treatment was evaluated by recording numbers of live larvae in 40 leaves or fruits which randomly collected from tomato plants in each plot. The leaves were transferred directly to the laboratory where it were examined using a

binocular microscope and numbers of live moving larvae per leaves were recorded. The percent reduction in infestation were calculated according to Henderson and Teilton equation (**Henderson and Tilton, 1955**) as follows: Percent reduction in infestation.

For recording the damages in leaves and fruits per plant, numbers of live larvae present inside the leaves and damaged fruits were recorded too. Samples were obtained in early morning from field experiment, 40 leaves per replicate according to **Emam and Heikal (2015)**.

Data Analysis

The percentages reduction of plant infestation and efficiency of phermone trap in reduction adults density of *T. absoluta* for all treatments were subjected to simple analysis of variance. The values were analyzed by one way (ANOVA) using **Costat (1985)** statistical software $p<0.01$. Means were separated by **Duncan (1955)** multiple range test which calculated the least significant difference (LSD) between treatments and also between periods against the tomato leafminer.

Also, the evaluation of coefficients involving both traps and sprays were calculated all the bases of the average decrease in the larval population of leaves and the average male population of the treated traps.

RESULTS AND DISCUSSION

Efficiency of Tuta 100 N Phermone and Chlorantraniliprole against *Tuta absoluta*e

Season 2015

Results presented in Table 1 show that number of larvae of tomato leaf miner increased gradually as time elapsed till the end of season but decreased gradually in both treatments (2 traps + coragen and 4 traps + coragen) till 3rd week from application (July 7th) while was continuous effect in treatments (2 and 4 traps) till July 16th which record catch male moths numbers (209, 190) and (273, 398) individually, respectively. Also, the mean numbers of traped males were, 261, 204.4, 174.27 and 166.36 for 4 traps, 2 traps, 2 traps + coragen and 4 traps + coragen, respectively. Significant reduction in *T. absoluta* damage was observed after 2nd, 3rd and 4th spray of chlorantraniliprole alone. The present study also revealed that two sex phermone traps, 2 sex phermone traps + chlorantraniliprole, 4 sex phermone traps, and 4 sex phermone traps + chlorantraniliprole and control recorded 204.4, 174.27, 261.00, 166.36 and 77.36 males/trap, respectively. The percentage of infested plants with *T. absoluta* ranged from 7.74 to 77.36% (Table 1).

The highest percentage of infestation was recorded in June (62.23 and 58.10%) for 2 sex phermone traps and 4 sex phermone traps treatments, respectively. The results showed significant differences in four sex phermone traps/faddan which recorded the highest number of captured males and the lowest infested tomato plants followed by two phermone traps per faddan. Increasing number of phermone traps-lead to increase the captured number of tomato borer males. The percentage of infested tomato plants that recorded were 15.59%, 36.03, 9.47, 33.43 and 7.74% for 2 sex phermone traps, 2 sex phermone traps + chlorantraniliprole, 4 sex phermone traps, 4 sex phermone traps + chlorantraniliprole, chlorantraniliprole, respectively. Using phermone water traps during the period June-September, showed that, the highest trap counts of *T. absoluta* was recorded in June. The increase of male catches in phermone traps during spring (March-April) could be due to temperature increases, as it was recorded previously by **Lacordaire and Feuvrier (2010) and Cherif *et al.* (2013)**. Also, the results showed significant differences in percentage of efficiency 63.97, 90.53, 66.57,92.26 and 84.41%, respectively against the tomato borer during first season 2015.

Chlorantraniliprole and sex phermone were able to overwhelm the pest population until 14 day after treatment which ranged from 48.69 – 71.10% as efficiency percentage. Four sex phermone traps + chlorantraniliprole recorded the same percentage of infested tomato plants and higher percentage of efficiency than 2 sex phermone traps with chlorantraniliprole as compared with control. Statistical analysis showed significant differences between the treatments. Chlorantraniliprole 20% SC showed in a previous report to provide excellent control against *T. absoluta*, in comparison with a bio-pesticide *Bacillus thuringiensis* which provides moderate control **(Cherif *et al.*, 2013)**. The present finding is in corroborates with **Soliman (2015)** who showed that six phermone traps/ faddan recorded the highest number of

Table 1. Effect of Tuta 100 N phermone with and without chlorantraniliprole application the tomato leafminer in tomato plants at Abo-kabir district, Sharkia Governorate during 2015 season

Date (week)	Treatments, (%) infestation and (%) Efficiency at indicated weeks post-treatment														
	Coragen		2 water traps phermone/faddan			2 water traps phermone /faddan + coragen			4 water traps phermone/faddan			4 water traps phermone / faddan + coragen			Control
	Mean No. of larvae/4replecats	Efficiency (%)	Count catching adult	Infestation (%)	Efficiency (%)	Count catching adult	Infestation (%)	Efficiency (%)	Count catching adult	Infestation (%)	Efficiency (%)	Count catching adult	Infestation (%)	Efficiency (%)	
25/6	50.9	49.1	236	62.23	37.77	250	51.15	48.85	397	58.1	41.90	398	56.71	43.29	65.36
2/7	8.39	92.71	255	51.31	48.69	204	13.06	86.94	351	41.50	58.50	235	10.32	89.68	66.50
9/7	13.6	86.4	249	30.15	69.85	209	10.5	89.50	337	35.05	64.95	190	3.35	96.65	70.36
16/7	16.0	84.0	273	29.3	70.70	165	3.1	96.90	298	30.10	96.9	156	4.37	95.63	70.99
23/7	7.45	92.55	203	30.81	69.19	191	0.5	99.50	253	35.89	64.11	110	1.15	98.85	78.06
30/7	12.1	87.9	203	35.15	64.85	167	0.75	99.25	248	29.71	70.29	113	1.00	99.00	77.5
6/8	18.5	81.5	200	2915	70.85	198	1.51	98.49	241	23.41	76.59	129	0.25	99.75	80.16
13/8	5.91	94.19	190	34.42	65.58	150	3.51	96.49	188	29.35	70.65	117	0.19	99.81	80.0
20/8	13.25	86.75	149	28.21	71.79	120	10.05	89.95	185	28.31	71.69	102	0.78	99.22	8266
27/8	16.25	83.75	130	36.8	93.20	134	3.51	96.49	190	31.25	68.75	132	1.58	98.42	90.5
4/9	9.45	9.62	137	28.9	71.10	129	5.99	49.01	183	25.1	74.90	148	5.48	94.52	88.93
Total	17.9	-	2249	-		1926	-	-	2871	-	-	1830	-	-	851.02
Mean	15.59 j	84.41 f	204.4b	36.03t	63.97h	174.27c	9.47k	90.53e	261.00a	33.43i	66.57h	166.36d	7.74k	92.26e	77.36g
Yield	32450 c		25950 e			35700 b			30550 d			39200 a			15100f

By Duncan's Multiple Range Test (DMRT), reduction percentages followed by the same litters are not significant at 5% level*=Count No. before Treatment LSD 0.05% (mean) = 5.728 LSD 0.05% (Yield) = 419.241

captured males and the lowest infested tomato fruits while two phermone traps per faddan recorded the least numbers of males and the highest percentage of infesting tomato fruits. **Abdelrazek (2015)** found that *T. absoluta* attacked all aerial parts of tomato in all growing stages of the crop causing from 80 - 100 % yearly yield lost. Also, **Taha *et al.* (2013)** conducted an experiment toward the development of integrated control program against the tomato leafminer in the summer growing season of 2012 at Manawat village, Giza Governorate, Egypt. They used IPM consisting of mass trapping of *T. absoluta* males in red plastic basin trap at a density of 8 sex phermone traps/ faddan. Percent fruit damage was lower in the field treated with phermone baited water traps.

Season 2016

In 2016, high levels of *T. absoluta* by naturally occurring were detected in the tested traps as shown in Table 2. Results showed the significant differences in the number of captured males which recorded 201.1, 178.3, 196.55, 250.3 and 78.44 male/trap for 2 sex phermone traps, 2 sex

phermone traps + chlorantraniliprole, 4 sex phermone traps, 4 sex phermone traps + chlorantraniliprole and control, respectively. The percentage of infested plants with *T. absoluta* ranged from 9.32 to 78.44% (Table 2). The mean percentages of moth's numbers in two plant traps under spray with chlorantraniliprole were less than that obtained under four sex phermone traps. The mean number of moths which have been cached after 12 weeks were recorded 78.44 moths in check treatment, 16.64 moth's when treated with chlorantraniliprole and recorded 178.30 and 196.55 moths when treated with 2 sex phermone traps and 4 sex phermone traps/faddan together + chlorantraniliprole, respectively.

Also, the results showed that four sex phermone traps used was better than 2 sex phermone traps/faddan in the two tested seasons. Chlorantraniliprole and sex phermone were able to overwhelm the pest population until the 14 day after treatment ranged 51.85–88.85% (in both of coragen and 2 traps + coragen) as efficiency percentages. Significant differences in chlorantraniliprole together with six phermone traps are effective against *T. absoluta*. In the current control practice these insecticides with two or four sex phermone traps are commonly applied at the end of the cultivation period in order to end with a low pest density.

In conclusion, overall results of the present study provided evidence of existing correlations between number of sex phermone traps and number of moths catched which positive and significant by increasing number of phermone traps. Using of chlorantraniliprole insecticide with sex phermone traps decreasing population density and infestation percentage of *T. absoluta* in tomato fields.

Table 2. Effect of Tuta 100 N phermone with and without chlorantraniliprole application the tomato leafminer in tomato plants at Abo-Kabir District, Sharkia Governorate during 2016 season

Date (weekly)	Treatments, (%) infestation and (%) Efficiency at indicated weeks post-treatment														Control
	Coragen		2 water traps phermone/faddan			2 water traps phermone/ faddan+ coragen			4 water traps phermone/faddan			4 water traps phermone/faddan+ coragen			
	Mean No. of larvae/ 4replecats	Efficiency (%)	Count catching adult	Infestation (%)	Efficiency (%)	Count Catching adult	Infestation (%)	Efficiency (%)	Count catching adult	Infestation (%)	Efficiency (%)	Count catching adult	Infestation (%)	Efficiency (%)	
22/6	53.25	46.95	276	49.91	50.19	235	56.22	43.78	342	51.25	48.75	362	48.61	51.39	51.39
29/6	11.15	88.85	246	48.15	51.85	208	48.15	51.85	333	42.91	57.09	321	46.65	56.35	56.35
6/7	13.45	86.55	255	40.91	59.09	200	10.99	89.01	327	38.25	61.75	260	30.00	70.00	59.99
13/7	15.3	84.7	249	38.89	61.11	198	13.5	86.50	298	35.09	64.91	220	28.85	71.15	61.15
20/7	8.0	92.0	230	36.81	63.19	171	2.81	97.19	253	30.28	69.71	199	22.68	77.32	67.32
27/7	9.99	90.4	217	38.19	61.81	188	3.5	96.50	253	31.15	68.85	157	19.89	80.11	80.11
4/8	16.42	83.58	199	36.75	63.25	191	0.25	99.75	215	25.99	74.01	123	11.50	88.50	78.11
11/8	6.42	93.68	173	30.15	69.85	175	0.15	99.85	247	24.21	75.79	119	10.45	89.55	78.5
18/8	12.5	87.5	181	29.89	70.11	169	0.11	99.89	201	19.99	80.01	115	10.00	90.0	79.55
25/8	16.25	83.75	164	27.35	72.65	148	3.15	96.85	198	18.15	81.85	101	10.00	90.00	81.0
2/9	11.38	88.72	122	28.25	71.75	131	2.0	98.00	176	15.85	84.15	79	4.50	95.50	80.10
9/9	8.99	91.01	101	23.99	76.01	125	2.51	97.49	140	15.91	84.09	86	4.85	95.15	89.25
Total	-	-	2413	-		2139	-		3003	-		2162		79.58	95.15
Mean	15.25m	84.75f	201.1b	35.76j	64.24i	178.3d	9.32n	90.68e	250.3a	29.08k	70.92h	196.55c	20.41l	93.50e	78.44g
Yield	31150 c		25500 e			33180 b			31100 d			40000 a			17300 f

By Duncan's Multiple Range Test (DMRT), reduction percentages followed by the same litters are not significant at 5% level
*=Count No. before treatment
LSD 0.05% (mean) = 4.174 LSD 0.05% (Yield) = 541. 458

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تقييم استخدام فرمون جنسي وأحد المبيدات الحشرية ضد ذكور فراشات حافرةأوراق الطماطم *Tuta absoluta*

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تم تقييم استخدام الفرمونات الحشرية في خفض تعداد حشرة صانعة أنفاق أوراق الطماطم في الحقول المفتوحة للطماطم باستخدام مبيد الكورجين والفرمون tuta 100N (٣ ملليجرام/كبسولة) في مركز أبوكبير بمحافظة الشرقية، مصر خلال موسمي ٢٠١٥ و ٢٠١٦ (العروة الصيفية)، تم تصميم خمسة معاملات أستخدم فيها الرش بمبيد الكورجين منفردا ومصيدتان/فدان، مصيدتان/فدان +رش بمبيد كوراجين، ٤ مصائد/فدان و ٤ مصائد/فدان+رش بمبيد كوراجين بالإضافة إلى معاملة المقارنة (الكنترول)، أوضحت النتائج أن الرش بالكوراجين بالإضافة إلى استحدام أربعة مصائد لكل فدان كان أفضل من وضع مصيدتان فقط بالإضافه إلى الرش بالكوراجين يلي ذلك الرش بالكوراجين فقط ثم استخدام أربعة مصائد فقط لكل فدان وأخيراً استخدام مصيدتين فقط/فدان حيث أظهرت نسبة خفض لتعداد ذكور الفراشات ب ٩٢,٢٦، ٩٠,٥٣، ٨٤,٤١ و ٦٦,٥٧ وأخيراً ٦٣,٩٧% ذكر فراشة خلال موسم ٢٠١٥، وخفض قدره ٩٣,٥٠، ٩٠,٦٨، ٨٤,٧٥، ٧٠,٩٢ و٦٤,٢٤% خلال موسم ٢٠١٦، على التوالي، عند مقارنة فاعلية عدد المصائد، أظهرت النتائج أن استخدام ٤ مصائد أفضل من استخدام مصيدتان/فدان لصيد ذكور الفراشات حيث سجلت متوسط وقدرة ٢٦١، ٢٥٠,٣٠ ذكر/٤ مصيدة/ أسبوع و٢٠٤,٤ و٢٠١,١ ذكر/٢ مصيدة/أسبوع خلال موسمي ٢٠١٥ و ٢٠١٦، على التوالي بينما كان الأفضل من حيث الإنتاجية هو استخدام ٤ مصائد + الرش بالكوراجين وهو أفضل من استخدام مصيدتان/فدان + الرش بالكوراجين لصيد ذكور الفراشات بالرغم من أنها سجلت متوسط وقدرة ١٦٦ و ١٩٦,٥٥ ذكر/٤ مصيده/أسبوع ١٧٤,٢٧، و١٧٨,٣٠ ذكر/٢ مصيدة/أسبوع خلال موسمي ٢٠١٥ و ٢٠١٦ ،على التوالي، حيث سجلت ٣٩,٢٠، ٣٥,٧٠ طن/فدان ،٤٠,٠٠ و٣٣,١٨ طن/فدان للمعاملتين الرش بالكوراجين + أربعة مصائد ومصيدتان فقط + الرش بالكوراجين للموسمين ٢٠١٥ و ٢٠١٦ على التوالي بينما كانت معاملة أستخدام مصيدتين فقط/فدان هي الأقل إنتاجية، تظهر نتائج هذه الدراسة أن الكوراجين فعال وضروري في مكافحة صانعة أنفاق أوراق الطماطم بالإضافة إلى إستخدام ٤ من المصائد المائية المزودة بالفرمون الجنسي/فدان للحصول على مكافحه فعالة لهذه الآفة و في نفس الوقت معدل إنتاجية عالي.

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