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Evaluation the efficiency of five sex attractants pheromones on catching the males of Tomato leaf miners, *Tuta absoluta* infesting tomato plants

Emam A S*, Seham M Elmahdy, Afia Y E
Plant Protection Research Institute, A.R.C, Dokki, Giza, Egypt

Abstract
This study was carried out to evaluate the efficiency of five kinds of sex attractant pheromones (Bombykol, Diprionol, Tuta cap, Tuta lure & Tuta 100 N.) in catching the males of Tomato leaf miners, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae). This study was carried out in open field at Perkash region (Giza governorate), Egypt during two seasons 2020 and 2021 on tomato plants, *Lycopersicon esculentum* (var. Lopena). Data obtained showed that the mean numbers of captured males of *T. absoluta* which attracted to the tested pheromones were arranged descending as follow: Tuta cap, Bombykol, Diprionol, Tuta lure & Tuta 100 N, respectively. Whereas in season 2020 the mean numbers of captured males of *T. absoluta* which attracted to the five tested pheromones (Tuta cap, Bombykol, Diprionol, Tuta lure &Tuta 100 N.) were 49.9, 23.8, 17.4, 13.7 and 11.6 respectively. While in season 2021 the mean numbers of captured males of *T. absoluta* which attracted to the five tested pheromones were: 45.8, 21.2, 14.9, 11.9 & 9.6 respectively. Also, data obtained showed that the mean number of male captured of *T. absoluta* (adult/trap) in season 2020 was higher than in season 2021. Statistical analyses showed that were highly significant differences between the five tested kinds of sex pheromones in catching *T. absoluta* males at both of the two tested seasons.

Keywords: pheromones, *Tuta absoluta*, tomato plants, bombykol, diprionol, tuta cap, tuta lure & tuta 100 N

Introduction
Tomato (*Lycopersicon esculentum*) fruits consider one of the most important vegetables crops in Egypt and all over the world which cultivated in both of the open fields and under glasshouse conditions. Also, its cultivated area increased gradually during the last years, especially in the new reclaimed areas for purposes local consumption and exportation to the foreign markets. Goda *et al.* (2015) [4] reported that tomato (*Solanum lycopersicum* L.) is universally one of the most important vegetable crops worldwide and in Egypt, the crop is cultivated annually in 2-3 plantations in the season.

Tomato plants infested with large scale of different insects such as, Tomato leaf miners, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) which consider one of the most damaging insects infesting tomato plants and other vegetables crops both in the open fields and under greenhouse conditions whereas it causes numerous damage in both quantity and quality for these crops (Gabl and Hausdorf, 2013; Megido *et al*. 2012 and Ouardi *et al*. 2012) [3, 5, 8]. Tomato is the main host plant of *T. absoluta* it attacks other crop plants of the nightshade family such as potato, eggplant and tobacco, Desneux (2010) [2]. The larva feeds voraciously upon tomato plants, producing large galleries in leaves, burrowing in stalks, and consuming apical buds and green and ripe fruits. It is capable of causing a yield loss of 100% and larvae of this insect feeding on all parts of tomato plants and make injury to all stages of tomato plants. It makes many miners in leaves, stems, shoot tips and fruits, that cause grate injury in yield of the production regions (Viggiani *et al.,* 2009 and Sanninol *et al.*, 2012) [12, 11]. *T. absoluta* was found for the first time in July 2009 at Nubaria (Beheira Governorates), Egypt, whereas after that it recorded in a several Egyptian regions such as Al-Wadi Al-Gadid, Alexandria, El-Sharkyia and El- Qalyoubia Governorates (Bekheit and Impiglia 2011) [1]. Chemical insecticides are routinely applied as control strategies against this pest with serious disadvantages particularly the risk of occurrence of resistant biotypes of the pest, reduced profits from high insecticide costs and destruction of natural enemies population. Thus, complementary strategies of pest management aiming to reduce the use of insecticides through an efficient monitoring of pest population in order to correct timing of pesticide application need to be tested including the use of pheromone. Lastly, Goda *et al.* (2015) [4] in Egypt reported that The Tomato Leaf miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is one of the recent devastating pests attacking tomato crop worldwide, and it is a new exotic pest in Egypt in 2009. The present study aimed to test five sex attractant pheromones on catching the males of Tomato leaf miners *T. absoluta* and determine which those pheromones could be used for monitoring and/ or controlling this dangerous insect pest.

Materials and Methods

Experimental design

This study was carried out to evaluate efficiency five kinds of sex pheromones (Bombykol, Diprionol, Tuta cap, Tuta lure and Tuta 100 N.) in catching the males of Tomato leaf miners, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae). The present study was conducted on tomato plants *Lycopersicon esculentum* (var. Lopena) during seasons 2020, 2021 in the open fields during the period from 1stMarch to the last of May (three monthes) at Perkash region (Giza governorate), Egypt. Every pheromone was tested in both of the two tested seasons at five feddans (five replicates) four replicates with pheromone and the fifth replicate was left as control (free of pheromones). The tested pheromones (Bombykol, Diprionol Tuta lure and Tuta 100 N.) were used Delta trap (yellow sticky paper) while the fifth pheromone Tuta cap was used (water trap), Figure (1). We used two traps per feddan for each pheromone of five pheromones. Each replicate contains two traps arranged in the wind direction; the distance between the two traps was about 300 m nearly. The captured moths of *T. absoluta* were collected weekly and counted until the end of the experiment both in the two seasons.

Delta trap Water trap

Fig 1: Delta trap and water trap

The tested pheromones

The pheromones used in the present experiments were:

1. Bombykol (E10, Z 12) - 10, 12 - hexadecadien - 1- ol)
2. Diprionol (Acetate or propionate 3,7- dimethyl-2- pentadecanol)
3. Tuta cap (long life Tetradecatrieny acetate, E, Z, Z - 3, 8, 11)
4. Tuta lure (Tetradecatrieny, acetate E3, Z8, Z11.5 mg concentration).
5. Tuta 100 N (Tetradecatrienf E, Z, Z- 3, 8, 11- 3 mg concentration).

Statistical analysis

The mean number of captured *T. absoluta* males was analyzed statistically using a one-way analysis of variance. When ANOVA indicates that significant differences were found, ($P<0.05$) means were separated by a Least Significant Difference Test (LSD).

Results and Discussion

First season 2020

Data obtained which tabulated in Table (1) and graphically illustrated in Fig. (2) show the weekly mean numbers of captured males of *T. absoluta* catching by the five tested sex pheromone traps throughout the period from 1stMarch to the last of May during season 2020. Data obtained show also that Tuta cap sex pheromone (water trap) considered the most effective pheromone in catching the captured males of *T. absoluta* whereas numbers of it ranged from135.2 adult/trap in 1st March decreased to3.5 adults/trap in the end of May. Then the Bombykol sex pheromone was in the second degree whereas numbers of the captured males of *T. absoluta* ranged from75.3 adult/trap in 1st March decreased to2.1 adults/trap in the end of May. Then Diprionol sex pheromone was in the third degree whereas numbers of the captured males of *T. absoluta* ranged from60.5 adult/trap in 1st March decreased to1.5 adults/trap in the end of May. Then Tuta lure sex pheromone was in the fourth degree whereas numbers of the captured males of *T. absoluta* ranged from45.5 adult/trap in 1st March decreased to0.7 adults/trap in the end of May. Lastly, Tuta 100 N. sex pheromone was in the last degree whereas numbers of the captured males of *T. absoluta* ranged from42.8 adult/trap in 1st March decreased to0 adults/trap in the end of May. Also data obtained showed that the mean numbers of captured males of *T. absoluta* which attracted to the five tested pheromones were arranged descending as follow: Tuta cap, Bombykol, Diprionol, Tuta lure & Tuta 100 N, respectively. Whereas the mean numbers of captured males of *T. absoluta* which attracted to the five tested pheromones were 49.9, 23.8, 17.4, 13.7 and 11.6 respectively.

Table 1: The weekly mean numbers of captured males of *T. absoluta* catching by five sex pheromone traps during season 2020

Date	Tuta cap	Bombykol	Diprionol	Tuta lure	Tuta 100 N.
1/3/2020	135.2	75.3	60.5	45.5	42.8
8/3/2020	121.4	63.4	49.3	37.4	33.7
15/3/2020	95.3	51.2	34.5	30.2	27.5
22/3/2020	81.5	40.5	28.7	21.6	18.4
29/3/2020	70.6	29.3	19.5	16.3	14.9
5/4/2020	57.5	20.3	12.7	11.7	10.8
12/4/2020	45.4	13.5	9.8	8.1	6.3
19/4/2020	32.5	10.4	8.3	6.3	3.7
26/4/2020	21.4	8.5	6.5	4.5	2.5
3/5/2020	13.5	7.3	4.7	3.7	1.6
10/5/2020	9.2	5.2	3.9	2.6	.8
17/5/2020	7.5	3.7	2.3	1.8	.3
24/5/2020	5.2	2.5	2.0	1.2	0
31/5/2020	3.5	2.1	1.5	0.7	0
Total	699.7	333.2	244.2	191.6	163.3
Mean	49.9	23.8	17.4	13.7	11.6
F (0.05)	673.82				
L.S.D	1.5507				

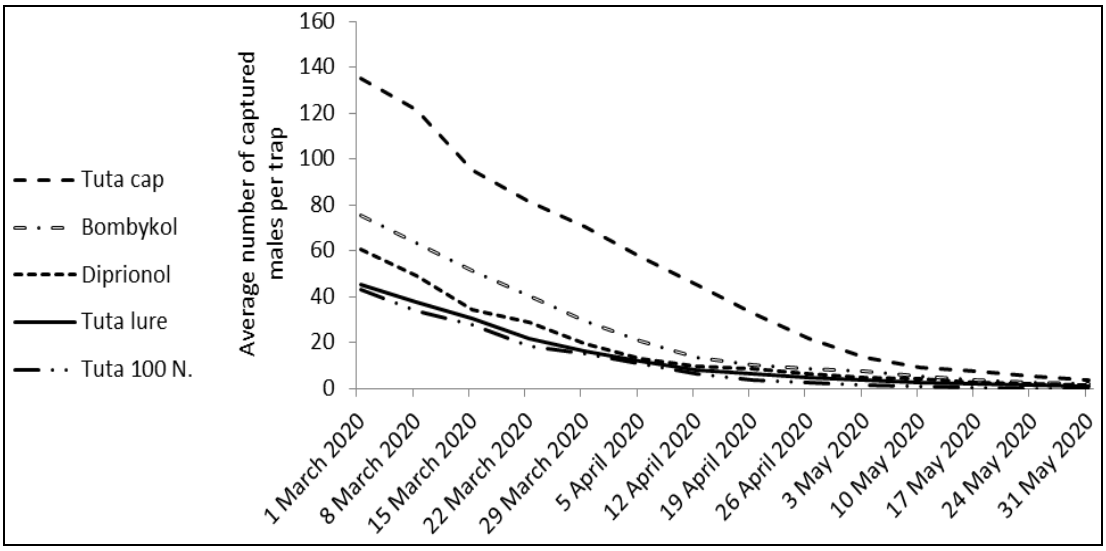

Fig 2: The weekly mean numbers of captured males of *T. absoluta* catching by five sex pheromone traps during season 2020

Second season 2021

Data obtained which tabulated in Table (2) and graphically illustrated in Fig. (3) show the weekly mean numbers of captured males of *T. absoluta* catching by the five tested sex pheromone traps throughout the period from 1stMarch to the last of May during season 2021. As the same trend data obtained show also that Tuta cap sex pheromone (Water trap) considered the most effective method in catching the captured males of *T. absoluta* whereas numbers of it ranged from125.5 adult/trap in 1st March decreased to1.5 adults/trap in the end of May. Then the Bombykol sex pheromone was in the second degree whereas numbers of the captured males of *T. absoluta* ranged from72.5 adult/trap in 1st March decreased to0 adults/trap in the end of May. Then Diprionol sex pheromone was in the third degree whereas numbers of the captured males of *T. absoluta* ranged from56.3 adult/trap in 1st March decreased to0 adults/trap in the end of May. Then Tuta lure sex pheromone was in the fourth degree whereas numbers of the captured males of *T. absoluta* ranged from 43.2 adult/trap in 1st March decreased to0 adults/trap in the end of May. Lastly, Tuta 100 N. sex pheromone was in the last degree whereas numbers of the captured males of *T. absoluta* ranged from38.5 adult/trap in 1st March decreased to0 adults/trap in the end of May. Also data obtained showed that the mean numbers of captured males of *T. absoluta* which attracted to the five tested pheromones were arranged descending as follow: Tuta cap, Bombykol, Diprionol, Tuta lure & Tuta 100 N, respectively. Whereas the mean numbers of captured males of *T. absoluta* which attracted to the five tested pheromones were 45.8, 21.2, 14.9, 11.9 and 9.6 respectively.

Table 2: The weekly mean numbers of captured males of *T. absoluta* catching by five sex pheromone traps during season 2021

Date	Tuta cap	Bombykol	Diprionol	Tuta lure	Tuta 100 N.
1/3/2021	125.5	72.5	56.3	43.2	38.5
8/3/2021	110.3	60.3	44.5	35.6	26.7
15/3/2021	90.7	50.7	31.7	28.4	22.9
22/3/2021	78.3	37.5	25.3	19.5	15.3
29/3/2021	66.5	25.3	17.5	14.3	11.4
5/4/2021	53.9	17.9	12.3	9.2	7.9
12/4/2021	40.5	11.5	8.1	6.5	5.7
19/4/2021	28.7	8.6	5.7	4.3	3.2
26/4/2021	19.5	5.9	3.5	2.8	1.8
3/5/2021	10.8	3.1	2.7	1.5	1.2
10/5/2021	7.5	2.2	1.9	1.0	0
17/5/2021	4.3	1.5	0	0	0
24/5/2021	3.7	0	0	0	0
31/5/2021	1.5	0	0	0	0
Total	641.7	297.0	209.5	166.3	134.6
Mean	45.8	21.2	14.9	11.9	9.6
F(0.05)	585.21				
L.S.D	1.2220				

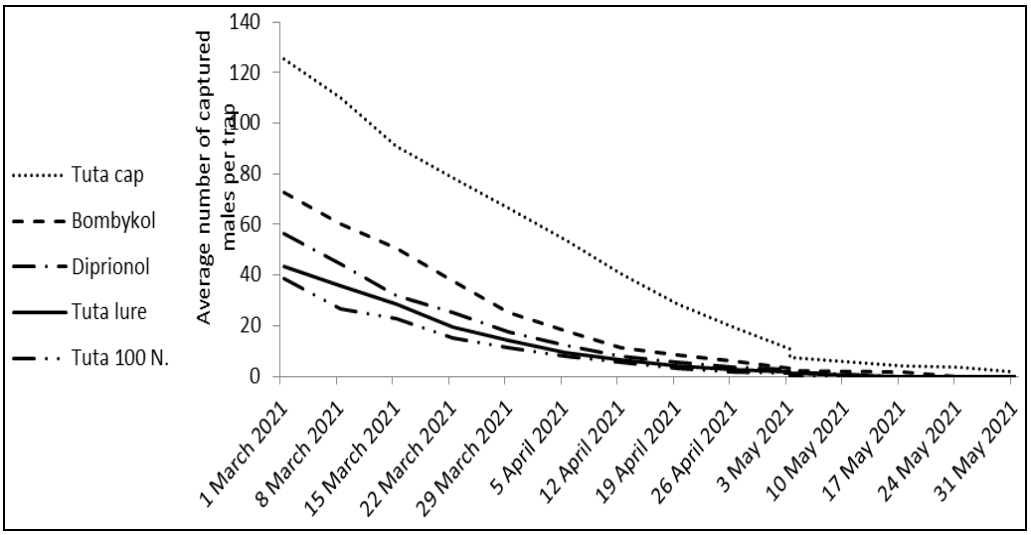

Fig 3: The weekly mean numbers of captured males of *T. absoluta* catching by five sex pheromone traps during season 2021

Statistical analysis showed that were highly significant differences between the five kinds of sex pheromones "Bombykol, Diprionol, Tuta cap, Tuta lure and Tuta 100 N" in catching capturing *T. absoluta* males at both of the two tested seasons 2020, 2021. Whereas the F (0.05) and L.S.D values in both of the two tested seasons were (673.82, 1.5507) and (585.21, 1.2220) respectively.

The obtained results are agreed with those obtained by Wyatt (1998) [13] who found lepidoptera pheromones have been successfully used for insect monitoring and mating disruption of insects**.** Also, found virgin females of tomato leaf miner releases a sex pheromone that strongly attracts males. Also, Patricia *et al.* (2009) [9] detected that pheromone traps seem to be the most ideal alternatives in controlling this pest. The use of sexual pheromones to interfere with reproduction process of the insect offers a non-traditional way to manage Lepidoptera and other insect species. Miguel *et al*. (2000) [6] found in the field evaluation demonstrate that the addition of the minor pheromone component (3E, 8Z)-tetradecadine- 1- acetate to the major components (3E, 8Z, 11Z)- tetradecatrin- 1- acetate does not significantly increase the trap catches of *T. absoluta* males in the field. The triene acetate itself is highly attractive. The addition of two isomers of the minor to the major component did not significantly alter the number of the males caught in the traps. Also, Rudy *et al*. (2013) [10] reported that *Tuta absoluta* pest originates from South America considered to be one of the most damaging invasive pests of tomatoes in the Mediterranean Basin countries of Europe and North Africa. And reported the importance of sex pheromone-based control strategies, and this strategies used to control, population monitoring, mass annihilation and mating disruption techniques. Namvar and Gharaei (2019) [7] reported that *Tuta absoluta* that a new pest has fast and wide distribution became one of the most damaging agents of tomato especially in open fields, and found that pheromone traps was an effective technique in control of that pest.

Conclusion

Results obtained showed effectiveness five sex attractant pheromones on catching the males of Tomato leaf miners *T. absoluta* and determine which those pheromones could be used for monitoring and/ or controlling this dangerous insect pest. Data obtained showed that the five tested pheromones were arranged descending according to the mean numbers of captured males of *T. absoluta* which attracted to them as follow: Tuta cap, Bombykol, Diprionol, Tuta lure & Tuta 100 N, respectively.

List of Abbreviations

Var: Variety
T: Tuta
&: and.

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