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Evaluation of efficiency of pheromone traps and lures against South American tomato leaf miner, *Tuta absoluta* (Meyrick) on tomato

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Abstract
Field studies were conducted to evaluate the efficacy of pheromone trap types, height of trap erection, pheromone lure concentrations and replacement period on trap catches of *Tuta absoluta* in farmers' field during *rabi*, 2016-2017 in Piler and Kalikiri mandal of Chittoor district, Andhra Pradesh. Among the three trap types, Delta traps installed at crop canopy level with two milligram lure concentration replaced every one month were caught maximum moth catches of *T. absoluta* when compared to sleeve and wota T traps installed at crop canopy level, 30 and 60 cm above the crop canopy level. In response to pheromone lure efficacy, two milligram pheromone lure replaced with 30 days interval caught highest moth catches and lowest moth catches recorded at one milligram lure replaced with 45 days interval.

Keywords: *Tuta absoluta*, Delta trap, Wota T trap, Sleeve trap and Tomato

1. Introduction
South American tomato leaf miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is devastating pest of tomato (*Lycopersicon esculentum*, Miller). The oligophagous pest associated with solanaceous crops can reduce yield and quality of tomato in newly invaded areas 80-100 % both in field and greenhouse conditions if control measures are not applied [6]. The pest caused serious damage to tomato during entire crop growing period and it considered as key threat to production on worldwide. The most widespread use of pheromones has been monitoring of endemic pest species' adult populations [6]. The pest caused serious damage to tomato during entire crop growing period and it considered as key threat to production on worldwide. The traps with composed of pheromones lures which make it possible to attract and capture adult males, one can distinguished several types of traps, trap with pheromone of the delta, sleeve and wota T trap [15]. Pheromone traps play important role in monitoring *T. absoluta* moth catches and also alert the farmers by giving early warning of the infestation levels [3]. Pheromone lure concentration and changing interval may influence the efficacy of pheromone trap. Since, there are many factors that can affect the efficiency of pheromone traps as a management method, so it is important to conduct studies, to compare the effectiveness of the pheromone trap types, efficacy and longevity of pheromone lures in tomato crop under field conditions.

2. Materials and Methods
Field experiments were carried out during *rabi*, 2016-2017 in farmers' field at Piler and Kalikiri mandals in Chittoor district, Andhra Pradesh. Sweakar hybrid was transplanted with spacing of 60 × 60 cm. The delta, sleeve and wota T traps were installed 30 days after transplanting of tomato seedlings in farmer's field at Piler. The traps were installed in the field at a distance of 30 m between the traps by using Randomized Block Design with nine treatments having three replications. All the traps were kept in position by hanging them to on staked tomato thread. The sticky liner was changed for every 45 days. Moth catches were recorded at weekly interval. Delta traps baited with one mg, two mg and three mg lure concentrations were used as test concentrations with a different changing interval of 15, 30 and 45 days in farmers field at Kalikiri. Pheromone lures used during the present experimentation was supplied by Pheromone Chemicals, Hyderabad.

The pheromone lure composition of *T. absoluta* was (3E, 8Z, 11Z) -3, 8, 11-tetra decatrienyl acetate and (3E, 8Z)-3, 8- tetra decadienal acetate 90 per cent and 10 per cent, respectively [2, 13]. The observations were recorded from 44th meteorological standard week to 5th meteorological standard week and the same were analyzed in Random Block Design using analysis of variance (ANOVA).

3. Results and Discussion

3.1 Pheromone trap type and height of erection evaluation

The adult moth activity of *T. absoluta* was monitored using pheromone traps during *rabi*, 2016-2017 in tomato ecosystem. The different treatment combinations have the aim to improve of the types of *T. absoluta* trappings. The mean monthly and overall mean moth catches data was depicted in figure 1 and Table 1. The results were indicated that there are significant differences between the various treatments (P= 0.05). The treatment T_7 (105.08 moths/trap) maximum number of moth catches while, treatment T_9 (1.51) was caught lowest number of moth catches during investigation period. Maximum number of mean monthly moth catches was recorded in November and minimum number was recorded in January month. The overall mean moths trapped data showed that, the treatment, T_7 (58.94 moths/trap) caught highest moth catches and lowest moth catches recorded in T_3 (5.83), T_6 (3.92) and T_9 (1.94) treatments and also insignificance between treatments. Treatments T_1 (50.22) and T_3 (48.94) caught better moth catches data but insignificant difference noticed between the treatments. T_2 (29.69) and T_4 (28.03) treatments also caught good moths number but insignificance noticed in between the treatments. Treatment, T_5 (23.06) showed significant difference with treatment T_2 but insignificance noticed with T_4 (28.03) treatment. The delta trap recorded highest moth catches when compared to sleeve and wota T trap under field conditions. The delta trap installation is simple, sticky nature and moths were easy to enter into the trap.

The pheromone trap types are source of variation in population fluctuation *T. absoluta* moths. In 2013, Soliman *et al* [12], reported that delta trap (1107 moths/trap) caught more moth catches than wota T trap (765 moths/trap). The results are in line with Braham [3] delta trap caught significant more moth catches of *T. absoluta* than wota T trap during summer season. Our findings also in accordance with Cocco *et al* [5], delta trap (105.30 moths/trap) was superior to wota T trap in trapped moth catches of *T. absoluta* during Kharif. The results are also at par with another study Radhika and Padmalatha [10] who observed that delta traps were superior to sleeve and wota T trap in trapping of groundnut leaf miner, *Aproaerema modicella* in groundnut.

The data obtained with regard to trap height was presented in Table 1. The present findings revealed that among different traps erected at tested heights, at crop canopy proved to be the most optimum erected height for better trap efficiency. The mean trap catches obtained from the traps arranged at crop canopy (58.94 moth catches/trap) were found to be more as compared to other trap height tested. Maximum moth activity was observed at crop canopy and the pheromone stimulated male moths enter into the traps directly without hindrance from any vegetation. The traps erected above crop canopy at different heights were recorded lesser in number moth catch of *T. absoluta*. This is probably because the moths could not reach the pheromone source at those test heights. These results were in conformity with reports of Lazgeen *et al.* [8] who reported that maximum moth catches recorded at crop canopy level. These findings are in line with Mahmoud *et al.* [9] who reported that maximum trapped moth catches at crop canopy level when compared to traps erected at 20 and 50 centimetres above the crop canopy level. Our findings are also in accordance with Taha *et al.* [14] and Harbi *et al.* [7] observed that maximum number of *T. absoluta* moth catches recorded in traps erected at crop canopy level in tomato.

Table 1: Effect of pheromone trap type and erection height on *T. absoluta* moth catches in tomato during *rabi*, 2016

Treatments	Mean monthly moth catches/trap			Overall mean moth catch/trap
Trap type and height of erection	November	December	January	
T_1: Delta trap installed at 30 cm above the crop canopy	85.00	42.83	22.83	50.22
T_2: Sleeve trap installed at 30 cm above the crop canopy	61.58	22.25	5.25	29.69
T_3: Wota T trap installed at 30 cm above the crop canopy	9.17	4.00	4.33	5.83
T_4: Delta trap installed at 60 cm above the crop canopy	46.08	26.42	11.58	28.03
T_5: Sleeve trap installed at 60 cm above the crop canopy	43.08	22.83	3.25	23.06
T_6: Wota T trap installed at 60 cm above the crop canopy	6.17	2.50	3.08	3.92
T_7: Delta trap installed at crop canopy	105.08	43.42	28.33	58.94
T_8: Sleeve trap installed at crop canopy	98.83	34.67	13.33	48.94
T_9: Wota T trap installed at crop canopy	13.83	5.58	7.83	9.08
SE.m.±	2.38	5.12	1.51	1.94
C.D. (P = 0.05)	7.144	15.360	4.537	5.542

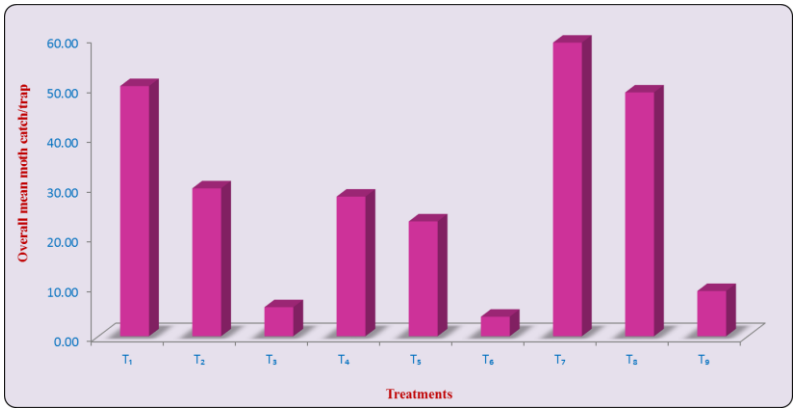

Fig 1: Effect of pheromone trap type and erection height on *T. absoluta* moth catches in tomato during *rabi*, 2016

Pheromones lure concentrations and replacement period evaluation

The pheromone lure efficacy influences on fluctuation of moth catches of *T. absoluta* and results were presented in Table 2 and Figure 2. The obtained data revealed that treatment T_4 (two mg septum replaced for every 15 days) recorded significantly higher moth catches (41.36 moths/trap) than all other treatments. The treatments T_5 (two mg septum replaced for every 30 days), T_8 (three mg septum replaced for every 30 days), T_7 (three mg septum replaced for every 15 days) and T_9 (three mg septum replaced for every 45 days) with 35.22, 34.69, 32.18 and 30.48 moths/trap, respectively and all these were on par with each other. There is no significant difference between T_6 (two mg septum replaced for every 45 days), T_2 (one mg septum replaced for every 30 days) and T_1 (one mg septum replaced for every 15 days) with 27.49, 25.93 and 22.84 moths/trap, respectively and all these treatments were on par with each other. The treatment T_3 (one mg septum replaced for every 45 days) recorded lowest number of moth catches (21.12 moths/trap) and which was showed insignificance with T1 and T2 treatments.

The delta trap baited with two mg pheromone lure replaced for every 30 days (35.22 moths/trap) were recorded highest moth catches and lowest moth catches were recorded in treatment one mg pheromone lure replaced for every 45 days with 21.12 moth/trap during entire period of experimentation. The present findings were in conformity with reports of Athanassiou *et al*. [1], revealed that two mg lure effective against for *P. gossypiella* in cotton, while, Sateesh *et al*. [11], found that that three and two mg lure more effective against *L. orbonalis* in brinjal and Taha *et al.* [14], reported that 1.5 and three mg lure effective against *T. absoluta* in tomato.

The present findings revealed that changing frequency of pheromone lure for 30 days gave good number of moth catches than 45 days after changing frequencies. The pheromone trap catches gradually decreased with increasing of replacement period of pheromone lure. The present findings were in conformity with those reports of Lazgeen *et al*. [8], and Braham [3], revealed that 28 days was optimum period for replacement of pheromone lure against *T. absoluta* in tomato grown in the farmers' field.

Table 2: Effect of different lure concentrations and frequency of replacement of pheromone lure on moth catches of *T. absoluta* in tomato during *rabi*, 2016

Treatments	Mean monthly moth catches/trap			Overall mean moth catch/trap
Lure concentration and interval	November	December	January	
T_1 : 1 mg septum replaced for every 15 days	36.50	20.62	11.42	22.84
T_2 : 1 mg septum replaced for every 30 days	41.00	25.62	11.17	25.93
T_3 : 1 mg septum replaced for every 45 days	36.83	18.02	8.50	21.12
T_4 : 2 mg septum replaced for every 15 days	75.08	34.33	14.67	41.36
T_5 : 2 mg septum replaced for every 30 days	59.00	31.07	15.58	35.22
T_6 : 2 mg septum replaced for every 45 days	44.33	27.47	10.67	27.49
T_7 : 3 mg septum replaced for every 15 days	59.50	22.22	14.83	32.18
T_8 : 3 mg septum replaced for every 30 days	62.25	26.73	15.08	34.69
T_9 : 3 mg septum replaced for every 45 days	60.33	23.27	7.83	30.48
SE.m.±	5.00	3.05	0.91	1.98
C.D. (P = 0.05)	14.991	9.149	2.728	5.617

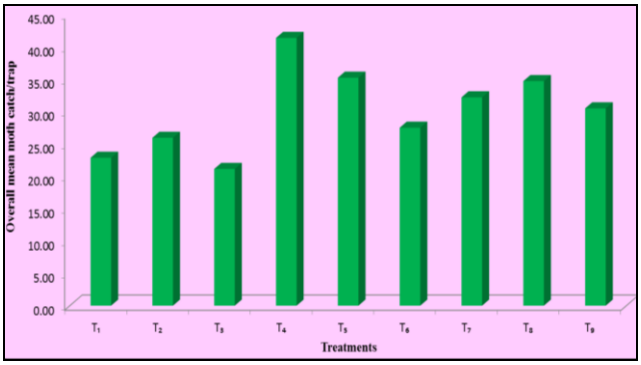

Fig 2: Effect of different concentrations and frequency of replacement of pheromone lure on moth catches of *T. absoluta* in tomato during *rabi*, 2016

4. Conclusion

The present investigation revealed that populations of South American tomato leaf miner, *T. absoluta* moth catches were influenced by the type of trap, pheromone lure efficacy and longevity. It can be concluded that population of *T. absoluta* was build up during November and suddenly decreased in January because moth populations was very low in that month. Delta trap showed more efficacy than sleeve and wota T trap in trapping of moths. The two milligram pheromone lure replaced for every 30 days was caught more catches than one milligram pheromone lure replaced with every 45 days. Delta trap installed at crop canopy level baited with two milligram lure was best for monitoring of *T. absoluta* in tomato crop under field conditions.

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