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# Efficiency of Different Colored Traps Baited with Pheromone in Capturing Tomato Adult Moth, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) during Summer Plantation

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**Abstract:** Effects of trap color, trap direction and trap position on the tomato moth, *Tuta absoluta* (Meyrick) captures was evaluated. Each trap was baited with a pheromone capsule type Q lure-TUA®. White pheromone traps caught more moths than yellow, blue, green and red traps. Significant differences between mean catches by white trap and other colored traps were observed. The trap when located at south or center of the infested area caught more moths than when located at west, east or north although there are insignificant differences between mean catches at each direction. The collective catch of *T. absoluta* moths by the traps rested on the ground was more than that of the two other positions (50 and 100 cm above the ground) where comparison test of catches showed significant differences between 0cm position (rested on the ground) and other two positions.

**Key words:** Tomato Moth · Trap color · Trap direction · Trap position · *Tuta absoluta*

## INTRODUCTION

Tomato crop is considered one of the most economic horticultural crops in the world. In Egypt, it is produced by about 10 million tones and about seventy percent of the production destination for consumption and the rest are industrialized. Mostly, tomato brings the highest gross financial return to the farmers in Egypt. Tomato moth, *Tuta absoluta* (Meyrick), is a neotropical oligophagous insect belongs to family Gelechiidae (Lepidoptera), which associated with Solanaceous crops. Since the 1960s, this insect became one of the key pests of tomato crop in South America [1]. Presence of *T. absoluta* in Europe was initially reported in eastern Spain in late 2006 [2] where after, this pest has been recorded in Morocco and Tunisia [3]. In Egypt, *T. absoluta* was found for the first time in July 2009 at Nubaria, Beheira Governorate, Egypt where after it is recorded in several Egyptian regions, Al-Wadi Al- Gadid, Alexandria, El-Sharkyia and El- Qalyoubia Governorates [4]. Since the initial detection, tomato moth has become the most serious pest causing severe damage to tomato in invaded area. Conspicuous economic losses and rapid spreading along the areas of traditional tomato production, promote this pest as the most serious agricultural threat to Egyptian tomato production. Since its introduction, chemical control has been the main method for controlling this pest in all infested areas and the farmers have tried to decrease its injury by applying insecticides two times till several times a week especially in highly infested areas. This unrespect use of insecticides has accompanied by serious problems concerning with human health and ecological pollution. In order to avoid or at least reduce the indiscriminate use of insecticides in the infested fields, it is essential to develop an alternative method for monitoring the population of *T. absoluta*. 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 [5]. These pheromones are species-specific and highly selective and since they are not toxic and represent no health risks to humans and animals, they have valuable tools in controlling this pest. The use of pheromone traps for mass trapping of insects as a control method has been registered by El-Sayed *et al.*

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[6]. Since there are many factors that can affect the efficiency of pheromone traps as a control method, it is important to conduct studies that confirm the effectiveness of pheromone traps as a control technique. This explain the objective of this study which evaluating the effect of different trap colors, trap heights and trap directions on the number of captured moths of *T. absoluta*.

## MATERIALS AND METHODS

The present investigation was carried out at new land region of Berneshit, Giza Governorate. Nursery-plants of tomato (GS variety), 30 days old were planted in an area of one faddan (one faddan= 0.42 ha) in the first week of June, 2012. The tomato plants were grown in rows 50 cm wide and nursery-plants were sown in hills, 30cm apart, one nursery-plant was planted in each hill.

**Preparing the Pheromone Traps:** We used handmade traps consists of a plastic container measuring 30x30x50cm holding water and a pheromone capsule type Qlure-TAU® (PH-937-1RR, Russell IPM formulates, USA) was hung on the upper side of the container. The container was opened by a hall (30 x 30 cm) in the four sides and 25 traps were used for the tested area.

**Experiment 1:**
**Determination of the Optimum Color of Pheromone Traps for Capturing Tomato Moth:** Twenty five traps with different colors, yellow, white, blue, green and red were used for this experiment (five traps/color). The traps were distributed randomly between tomato plants at constant height (30cm above the ground) and constant distance (16m between them). The captured moths were collected weekly and counted till the end of the crop.

**Experiment 2:**
**Determination of the Optimum Direction of Pheromone Traps for Capturing Tomato Moths:** The white traps were selected for this and other experiments according to the results of experiment No.1. The white traps were fixed at 30 cm height in the four original directions (East, West, North and South) beside the center to cover all the tested area. Five traps were used for each direction or placement at 16 m apart. The captured moths were collected weekly and counted till the end of the crop.

**Experiment 3:**
**Determination of the Optimum Height of the Pheromone Traps for Capturing the Tomato Moths:** Fifteen white traps were fixed at three heights from the ground, 0 cm (rested on the ground) 50 and 100 cm above the ground and five traps were used for each height. The captured moths in each trap were collected weekly and counted till the end of the crop.

**Statistical Analysis:** The effect of different colors, positions and directions of pheromone traps on *T. absoluta* catches during summer plantation were analyzed using Statistix 9 (Statistix analysis software) [7], which were performed with General Linear Model's procedure with pheromone trap treatments as a fixed effect; interaction between treatments and investigation dates were also studied. This procedure computes the analysis of variance for *T. absoluta* catches. The F test assumes that the within- group variances are the same for all groups. The null hypothesis of these tests is that different colors, heights and directions of pheromone traps are equal. A large F test and corresponding small p-value (less than 0.05) is evidence that there are differences, by using Tukey test to compare means of treatments.

## RESULTS AND DISCUSSION

The use of colored pheromone traps considered one of the most effective control measures against lepidopterous pests. In this study, using of colored pheromone traps against *Tuta absoluta*, a new pest of tomato in Egypt, exhibited promising results.

**Experiment 1:**
**Determination of the Optimum Color of Pheromone Traps for Capturing Tomato Moth:** Table 1 show the mean numbers of monthly catches of *T. absoluta* moths in the pheromone traps with different colors, red, yellow, white, blue and green, till the end of experiment. It is observed that the minimum numbers of *T. absoluta* moths were caught during June in all colored traps indicating to starting the infestation and appearance of *T. absoluta* moths while the maximum numbers were caught during August in all traps. Also, white trap caught higher number of moths than other traps during the whole tested months, yellow trap came in the second order while the three other traps, red, blue and green are approximately equal in their efficiency for attraction *T. absoluta* moths and less efficient in comparison to white and yellow traps. This result indicates that white color of pheromone trap considered the most preferable color for *T. absoluta* moths. The previous results were assured statistically (Fig. 1) where the means of monthly catches of both white

Table 1: Mean ± SE of *Tuta absoluta* caught in pheromone traps with different colours

| Month | Red | Yellow | White | Blue | Green |
|---|---|---|---|---|---|
| June | 361.5±53.7 | 393.0±51.4 | 388.5±53.8 | 342.0±62.4 | 310.0±57.6 |
| July | 1218.5±203.0 | 1726.1±178.0 | 2539.8±203.0 | 1407.7±135.0 | 1323.0±133.0 |
| August | 1794.2±255.0 | 3591.0±277.0 | 5032.4±308.0 | 1827.7±199.0 | 2100.1±175.0 |
| September | 768.7±75.0 | 2750.2±101.0 | 4883.1±111.0 | 1634.3±65.0 | 1066.7±45.0 |

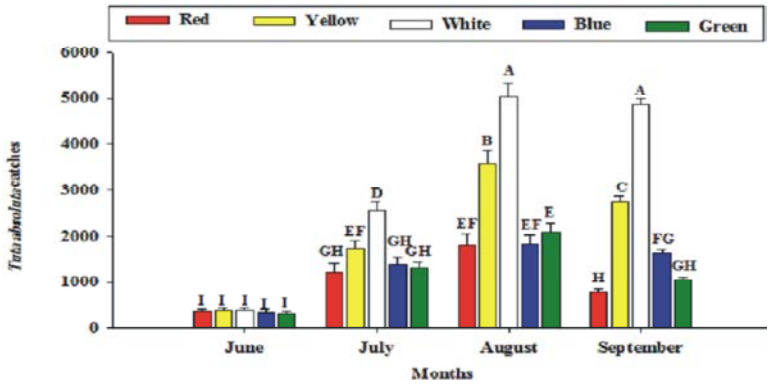


Fig. 1: Variances between catches of *Tuta absoluta* in pheromone traps with different colors

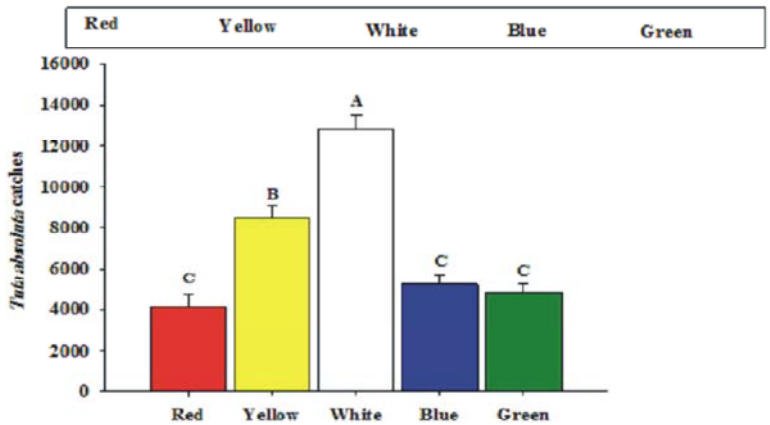


Fig. 2: Collective mean catches of *Tuta absoluta* moths for each color of pheromone trap

and yellow traps are slightly different from one another while significant differences between means of monthly catches of white and yellow traps from one point and other three traps from another point were noticed.

Again, the collective catches of *T. absoluta* moths for each colored trap during the whole period of experiment which illustrated in Fig. 2, where the collective means of catches of both white and yellow traps are slightly significantly different while there are significant differences between collective means of white trap and other three traps, red, blue and green. Physiologically, the spectra reflection of specific color can affect the discrimination and direction of the insect to that color. Results of Christos *et al.* [8] on *Palpita unionalis* are closed with our results where they found that among the four colored traps tested, white and yellow traps were most effective where white and yellow colors revealed strong light reflectance, 90% at 370–450 nm and 75% at 500–550 nm, respectively. Also, the spectral sensitivity of *Heliothis zea* and *H. virescens* are high at wavelength 360 nm peak at 540–580 nm and decline sharply at wavelength 600nm [9]. In contrast, traps with lower spectral reflectance, especially at wavelength <560 nm catch significantly more codling moths than white traps that have high level of reflectance [10]. Results on *Tuta absoluta* are in contrast with our results where they stated that red trap with 39.7% reflectance at 612.1 nm wavelength caught the greatest number of moths [11]. Green and yellow traps caught more Grab Root Borer (GRB) moths than other traps (white and blue) and the males prefer green and yellow pheromone-baited traps [12]. While, red traps were most effective in trapping moths of *Helicoverpa armigra*, *Earis insulana* and *Plutella xylostella*, while yellow pheromone traps

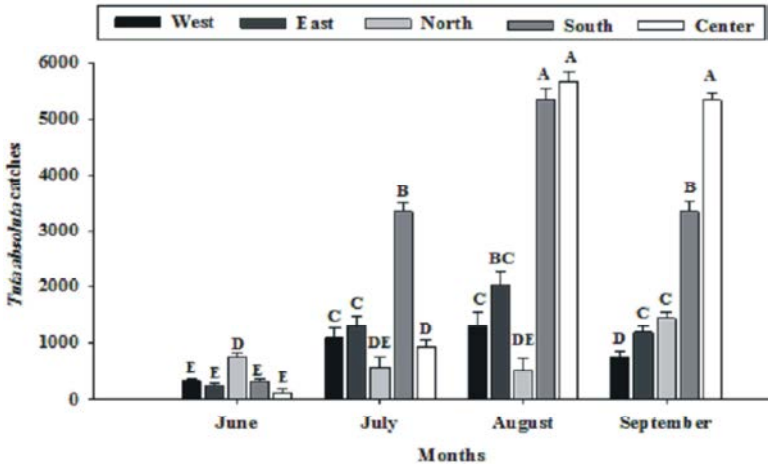


Fig. 3: Variances between catches of *Tuta absoluta* at different directions of white pheromone traps

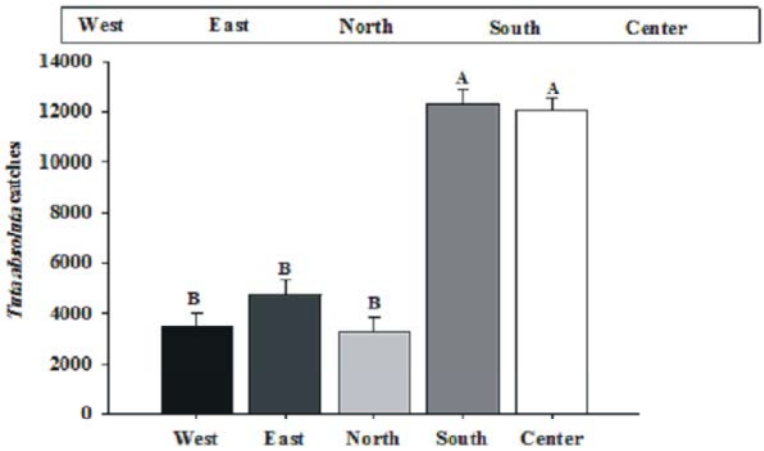


Fig. 4: Collective mean catches of *Tuta absoluta* moths for each direction of white pheromone trap

attracted maximum number of *Spodoptera littoralis* moths [13]. Although the above results contrast sharply, they demonstrate the impotence of considering the visual stimuli of lepidopterous moths in the design of pheromone traps and further study is required however, to answer the question as to why *T. absoluta* moths are more attracted to white and yellow traps than to the other traps. According to the present results white traps were selected for further studies.

**Experiment 2:**

**Determination of the Optimum Direction of White Traps in Capturing *T. absoluta* Moths:** Table 2 show the mean number of *T. absoluta* moths caught by white pheromone traps located in different directions; West, East, North, South and center of the tested area. The minimum number of attracted moths was recorded in June at all directions and the highest number was recorded in August at all directions also. Data in Table 2 assure that there is proportional increase in the number of attracted moths of *T. absoluta* from June till August in all positions. Statistically, there are significant differences between the numbers of the collected moths during the months of collection in all positions (Fig. 3). On the other hand, the collective number of attracted moths at each position during the whole period of experiment is illustrated in Fig. 4, from which it is observed that the trap when was located at the south or the center of the field attracted more moths than when located at east, west or north direction. Also, there are two groups, A and B, in which the means are not significant from one another. Trapping location in the field is one of the most decisive factors that affect the monitoring because the response of moths can be sensitive to trap placement [14] and there are many researches on the effect of trap location on the attraction of lepidopterous pests. In the contrary of the present results more adults of *Palpita unionalis* were caught in traps placed at the periphery of the groves than those that

Table 2: Mean ± SE of *Tuta absoluta* caught at different directions of white pheromone traps

| Month | West | East | North | South | Center |
|---|---|---|---|---|---|
| June | 314.0±45.6 | 223.5±52.7 | 757.5±59.8 | 292.3±64.3 | 107.3±59.3 |
| July | 1088.7±187.0 | 1297.2±167.0 | 554.3±198.0 | 3339.4±153.0 | 917.7±128.0 |
| August | 1307.2±249.0 | 2019.4±258.0 | 497.4.4±228.0 | 5344.2±207.0 | 5674.5±169.0 |
| September | 748.7±89.5 | 1189.9±105.0 | 1439.1±114.0 | 3336.6±174.0 | 5333.7±145.0 |

Table 3: Mean ± SE of *Tuta absoluta* caught at different position of white pheromone traps

| Month | 0 cm | 50 cm | 100 |
|---|---|---|---|
| June | 1169.6±76.6 | 807.2±64.8 | 325.0±48.3 |
| July | 3966.8±145.5 | 2543.7±132.0 | 1566.4±111.5 |
| August | 5570.6±231.0 | 3973.2±198.0 | 2395.1±187.5 |
| September | 4442.0±199.0 | 3355.0±175.0 | 2716.4±164.7 |

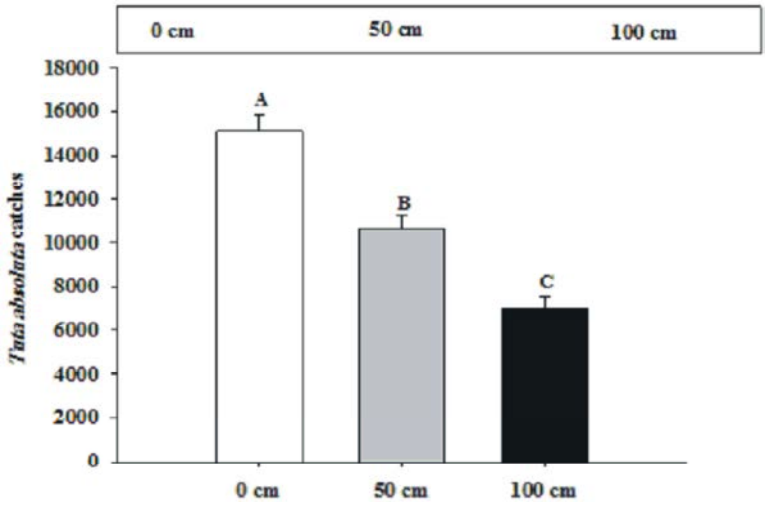


Fig. 5: Collective mean catches of *Tuta absoluta* moths at each position of white pheromone trap

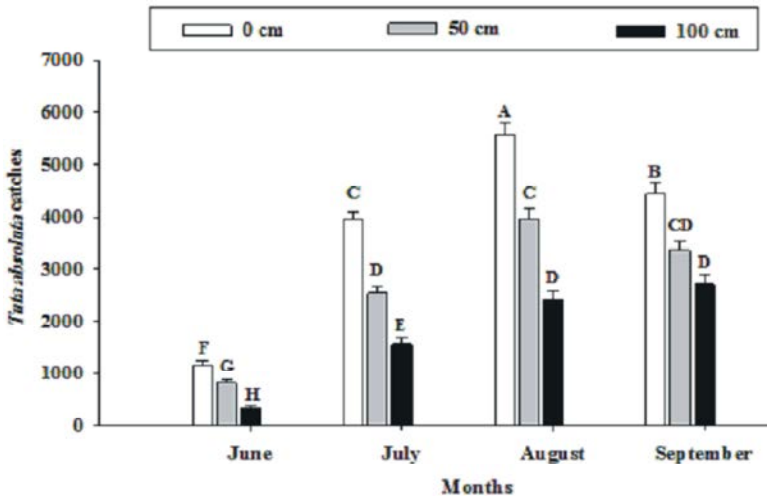


Fig. 6: Variances between catches of *Tuta absoluta* at different position of white pheromone traps

placed in the center [8]. Traps placed on the perimeter of the canopy caught significantly more codling moth than traps placed within the canopy and surrounded by foliage and traps placed adjacent to uninjured fruits caught significantly more moths than traps placed away from fruits [15]. In agreement with the present findings, more males of *Anarsia lineatella* were caught in the traps placed in south quadrant of the trees than other

quadrants, the analysis showed that there were insignificant differences between quadrants and response to traps at the anterior of the orchard was significantly higher than that to traps in perimeter orchard [16].

**Experiment 3:**

**Determination of the Optimum Position of the Pheromone Traps for Capturing *T. absoluta* Moths:** Table 3 show the mean numbers of *T. absoluta* moths caught by white pheromone traps placed at different positions from the ground. Maximum mean numbers of moths caught by traps rested on the ground (1169.6, 3966.8, 5570.6 and 4442.0 moths) during June, July, August and September, respectively, while minimum mean numbers of moths were caught by traps 100 cm above the ground (325.0, 1566., 2395.1 and 2716.4 moths) at the same previous months, respectively. It is observed that the higher number of moths, during the whole period of experiment, was caught when the trap was rested on the ground (0 cm) than other two positions (50 and 100 cm above the ground). Fig. 5 assure the previous results where the collective catch of *T. absoluta* moths during the whole period of experiment by the trap rested on the ground was more than that of the two other positions. Statistically, comparison test of catches for months showed that the means are not significantly different from one another while comparison test of catches for positions showed significantly different from one another (Fig. 6). More significantly adults of codling moth (Lepidoptera: Tortricidae) were caught in traps placed high versus low on the tree [15]. Traps baited with Chemtica lures and placed at 1.5 m above the ground caught more significantly males of *Spodoptera frugipedra* (Lep.: Noctuidae) than traps placed at a height of 2 m [17]. Significantly more moths of *Aarsia lineatella* were caught in traps hung at a height of 3.0 m above the ground than at any other level [16]. In contrast, trap height had no significant effect on the catch of potato tuber moth (PTM) [18]. In agreement with the present findings traps at 0.3 m above the ground caught more PTM adults than traps at 1.0 m [19].While, there are no differences between three heights ground level, 0.4 and 0.8 m above the ground [20]. On the other hand, the trap height is one of the most important aspects of trap development, along with trap density and trap position with respect to vegetation [21].

## CONCLUSIONS

The results of the current study make up the first quantative work concerning a long-term monitoring of *T. absoluta* with pheromone traps. This study shows that trap color, trap direction and trap height are characteristics that strongly affect the response of *T. absoluta* moths to pheromone-baited traps. In particular, combination of white and yellow traps baited with Qlure-TAU when rested on the ground and placed in the center of the field was more effective than the other trap combinations examined. These findings should be taken into account when developing a monitoring system. Development and optimization of trapping system for *T. absoluta* would be a useful tool in providing field-specific information and correct estimates of adult emergence and timing of the control measures.

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