



Effect of trap color on captures of *Tuta absoluta* moths (Lepidoptera: Gelechiidae)

Taha, A. M.¹; Homam B. H.¹; Afsah, A. F. E.¹ and
Fatma. M. EL-Sharkawy²

1- Vegetable Pests Department, Plant Protection Research Institute,
A.R.C., Egypt.

2- Photometry Department, National Institute of Standards, Egypt.

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ABSTRACT

Field experiments were conducted to determine the attractive action of different colors (red, yellow, green, and blue) to *Tuta absoluta* moths and to assess the influence of trap color on their capture moths in sex pheromone baited traps.

The results demonstrate that *T. absoluta* moths can distinguish between colors, where the red sticky traps with 39.7% reflectance at 612.1 nm dominant wavelength caught the greatest number of moths, recording 46.89% of the total moths captured, while the yellow sticky traps caught the fewest number of moths recording only 13.99 %. Delta and water pan traps of red color baited with commercial sex pheromone captured 1.58 and 1.52 times, respectively more male *T. absoluta* moths than such traps of yellow color baited with the same sex pheromone. The results demonstrate that the red color can be used to enhance the effectiveness of sex pheromone traps for capturing male *T. absoluta* moths. Further research is recommended for better understanding of the effect of trap color on the diversity and abundance of non target insects captured.

1. INTRODUCTION

The tomato leafminer *Tuta absoluta* (Lepidoptera: Gelechiidae) is a geotrophically oligophagous pest of solanaceous crops (Lietti *et al.*, 2005). It is native to South America but in the last few years it has spread rapidly throughout several countries in the Mediterranean basin. It is a devastating pest of tomato; larvae can cause losses up to 100% due to attack to fruits (Soaza *et al.*, 1992). Because of the leafmining behavior of larvae, sprayed insecticides and besidis main biological control agent, the oophagous parasitoid wasp *Trichogramma* sp. are effective only during a short time from egg stage to the first instar larvae. Successful control of the pest therefore depends on accurate monitoring as treatments must be applied during the oviposition and egg hatching periods. An optimal standardized sex pheromone design of trap is vital in developing a useful monitoring system for this pest. There are many factors affecting catches of several moth species in sex pheromone baited traps emphasizing trap characteristics (type, size, pheromone dose per trap and colour). The influence of trap colour on the capture of some noctuid pests in sex pheromone baited traps has been discussed in terms of attraction (i.e. moths are more strongly attracted to traps of certain colour).

McLaughlin *et al.* (1975) found that, traps of low spectral reflectance were more effective in capturing *Trichoplusia ni* (Hubner) and *Pseudoplusia includens* (Walker). Moreover, Mitchell *et al.* (1989) mentioned that visual stimuli tended to overcome a normally strong attraction response to a powerful olfactor stimulant sex pheromone, while Parra-Pedrazzoli *et al.* (2009) found that the models and colour of the traps do not interfere with male *Phyllocnistis citrella* Stainton moth capture efficiency. Trap colour was not previously reported to be a specific factor influencing the capture of *T. absoluta* moth.

The two objectives of our study were as follows: (1) to determine colour preference of *T. absoluta* moth and, (2) to evaluate the influence of sex pheromone trap colour on the attractiveness of male *T. absoluta* moth.

2. MATERIAL AND METHODS

Three experiments were performed at Farmer's field of El-Manawat village, Giza Governorate, Egypt, where tomato was planted in an overlapping manner all year round.

Experiment 1: the first experiment was conducted to determine the attractive action of different colours to *Tuta absoluta* moths. Plastic board traps (22.5 by 35 cm.) of yellow, green, red and blue colours were tested. All traps were coated on one face with a thin layer of insect adhesive (stikem special). Three traps of each colour were fastened vertically to stakes just above the plant canopy on 6 April 2011 in a randomized pattern. Trapping surface (the surface that was covered with stikem) faced towards the east. The distance between the traps was 1 meter. *Tuta absoluta* moths on each trap surface were counted on 10, 14, 18, 22, 26, and 30 April, 4 and 8 May 2011. After each count, the stikem was removed and replaced and the traps were rerandomized.

Experiments 2 and 3: Two experiments were conducted to assess the influence of

traps colour on the capture of *T. absoluta* males in sex pheromone-baited traps. Delta-shaped and water pan traps of red and yellow colours (colours that provided the greatest and the lowest moth captures observed in the previous experiment) were baited with 0.5 mg of the synthetic pheromone (E3, Z8, Z11-tetradecatrienyl acetate (Chemtica, Heredia, Costa Rica).

In the second experiment (20 September -17 October 2011), three Delta traps (25 x11x9 cm.) of each colour were suspended from wooden stakes just above the plant canopy.

In the third experiment (19-28 October) three plastic basins with 30 cm. diameter of each colour were used as water pan traps filling with 0.3% detergent and baited with lure ca. 1.0 cm. above the water. Traps were ranked on the tops of 20 cm. wood sticks and placed just above the plant canopy.

All the traps of experiments 2 and 3 were randomly assigned to position within a straight line (6 m. between traps) that was perpendicular to prevailing wind (N dedocer erew sehctac htoM .)htuoS→htro)sroloc(stnemtaert eht dna syad 4-3 yreve .noitcelloc hcae retfa dezimodnarer erew erew tnmirepxe hcae fo setacilper eerhT .detcudnoc

The spectra reflectance of samples (2.3x2cm) of the various colored traps was determined using a Shimadzu 3101 PC recording reflectance spectrophotometer. The surfaces were scanned at wavelength from 380-780, with monochromator slit within set at 5 nm and operated at a scan rate of 100 nm./min. to obtain maximum accuracy.

To show the variance between the studied treatments, the obtained data were Statistically analyzed using F. test according to Fisher (1944), Sendecor (1957) and Sendecor and Cochran (1972).

3. RESULTS

The spectral reflectance pattern of traps differed sharply among different colors

(Table 1 and Fig. 1). The yellow traps had 76.0 % reflection at 576.8 nm dominant wavelength. The red traps reflected 39.7 % of the incident light at 612.1 nm dominant wavelength. The green traps had 31.76 %

reflection at dominant wavelength of 527.2 nm while blue traps reflected only 19.68% of the incident light at 479.5 nm dominant wavelength.

Table 1: Parameters of trap colors

Color sample	Reflection %	Dominant wavelength	Purity %
Blue	19.68 %	479.5 nm	35.9
Green	31.76 %	527.2 nm	46.5
Yellow	76.00 %	576.8 nm	70.2
Red	39.70 %	612.1 nm	73.9

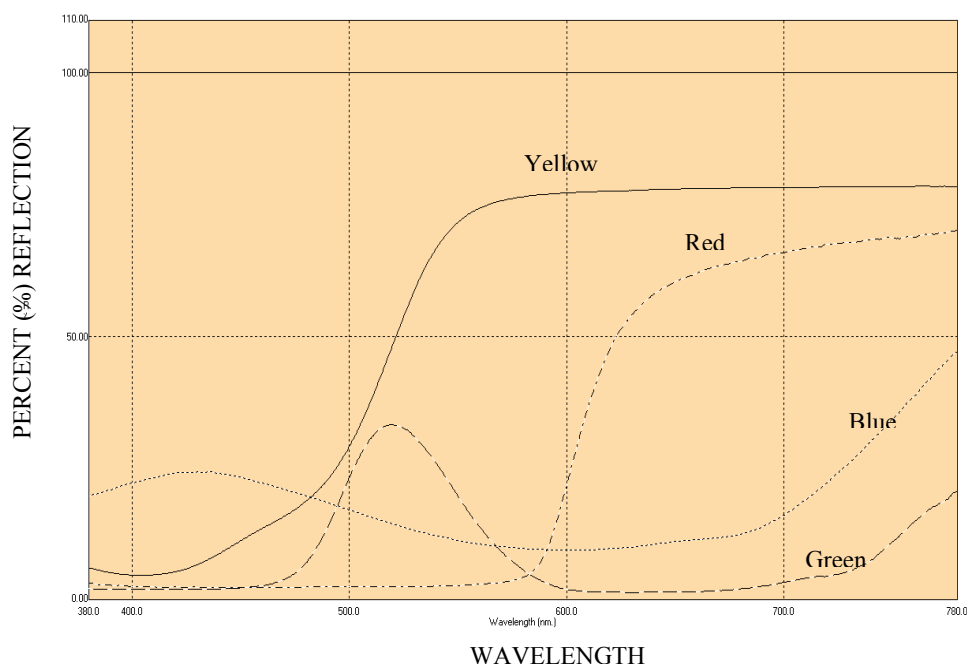


Fig. 1: Percent reflectance of plastic traps of red, green, blue and yellow colors.

The total catch of *Tuta absoluta* moths for all traps examined throughout the first experiment was 1836 moths, while the mean catch per trap/observation were (35.88, 17.58, 12.33 and 10.71) for trap colors (red, blue, green, and yellow), respectively. Fig. (2) shows the influence of trap color on the attractiveness of moths.

Color preference of *T. absoluta* moths was indicated by the numbers caught on the sticky traps. Significant differences were found in the mean capture of moths among

all colors of sticky traps. Red sticky traps had the greatest captures representing 46.89% of the total moths captured and differed significantly from all other trap colors.

Blue sticky traps captured significantly more moths (22.98%) than the yellow traps which caught only 13.99% of the total moths captured, whereas there was no difference between the blue traps or green traps which caught nearly 16.12% of the total moths captured.

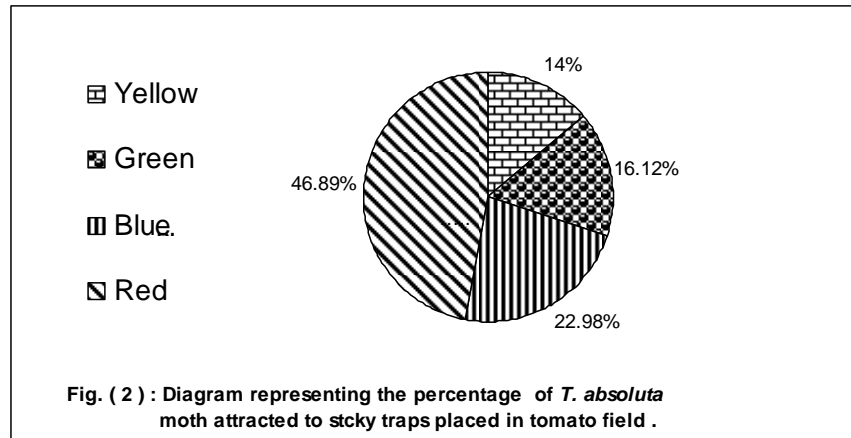
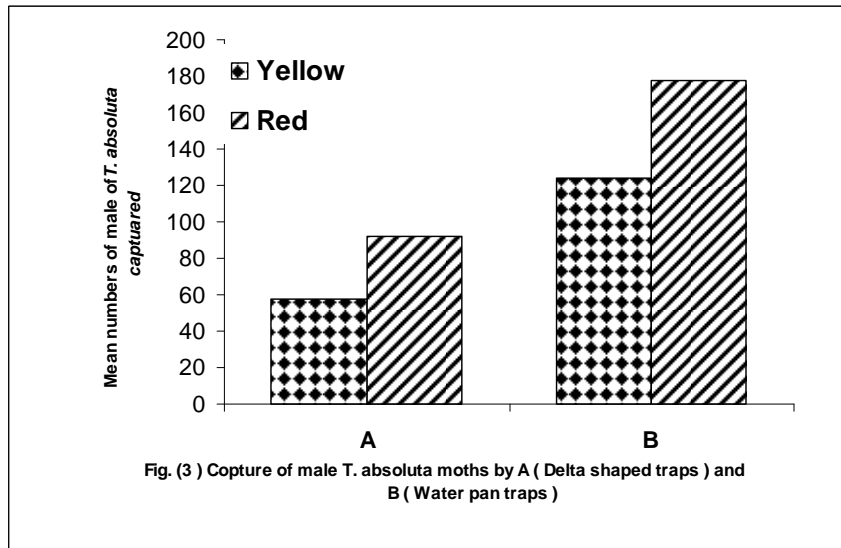


Fig. (3) shows the influence of trap color on the capture of *T. absoluta* male moths in sex pheromone baited traps. Red delta traps captured 1.58 times more male moths than yellow delta traps and was 37.04% more efficient than the yellow delta

traps. Similar pattern of captured to that of delta traps was observed in water pan traps. Red water pan traps captured 1.52 times more male moths than yellow water pan traps and was about 32.95% more efficient than yellow water traps.



4. DISCUSSION

This study is the first report so far on the effect of trap color and pheromone trap color on capture of *T. absoluta* moths. Trap color has been reported to be a significant factor affecting catches of several other moth species (Medrek *et al.*, 1972; Aget, 1973; Melaughlin *et al.*, 1975; Childers *et al.*, 1979; Mitchell *et al.*, 1989; Kinght and fisher 2006). These are nocturnal species, so we

expect that *T. absoluta* moths may respond similarly.

Our data showed that the mean catch of *T. absoluta* moths per trap/ observation were (35.88, 17.58, 12.33 and 10.71) for trap colors (red, blue, green, and yellow), respectively. However, the correlation of our traps reflectance data and their relative capture of such moths show that the red sticky traps with 39.7% reflection at dominant wavelength of 612.1nm caught

more moths than blue, green and yellow traps. A similar pattern of capture to that in the sticky traps was observed in both delta and water pan traps baited with sex pheromone traps, where delta and water pan traps of red color captured significantly more moths than delta and water pan traps of yellow color. In view of the above results, it is clear that *T. absoluta* moths can distinguish between red, green, blue, and yellow color. So the trap color per se is attractive to moths. Visual detection of colored traps by moths may occur at morning and late afternoon. Mantagne (1999) reported that adult *T. absoluta* are most active at dusk and dawn and rest among leaves of the host during the day. Mitchell *et al.*, (1989) stated that visual stimuli tended to overcome a normally strong attraction response to a powerful olfactory stimulant-sex-pheromone. However, a positive correlation between the spectral sensitivity of a night-flying moth's compound eyes and the most effective trap color does not always exist (Agee, 1973; Mitchell *et al.*, 1989). The spectral sensitivity of *Heliothis zea* and *H. virescens* (F.) are high at wavelengths > 360nm peak at 540- 580nm and decline sharply at wavelengths > 600nm. Melaughlin *et al.* (1975) found that traps with low spectral reflectance were more effective in capturing *Trichoplusia ni* (Hubner) and *Pseudopiusia includens* (Walker). In the same direction Knight and Miliczky (2003) mentioned that traps with lower spectral reflectance, especially at wave lengths < 560nm catch significantly more codling moths than white traps that have high levels of reflectance at wavelengths > 420nm.

Although the above results contrast sharply, they demonstrate the impotence of considering the visual stimuli of nocturnal moths in the design of sex pheromone traps.

In conclusion, red traps in our study appeared to be the most attractive color for monitoring *T. absoluta* moths and can be used to enhance the effectiveness of pheromone baited traps. Further research is recommended for a better understanding of

the effect of trap color on the diversity and abundance of non target insects captured.

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