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**Attraction of Various Sticky Color Traps to *Thrips tabaci* Lindeman  
(Thysanoptera: Thripidae) and *Empoasca decipiens* Paoli  
(Homoptera: Cicadellidae) in Cotton**

N. Demirel and A.E. Yıldırım

Department of Plant Protection, Faculty of Agriculture, Mustafa Kemal University,  
31034, Antakya, Hatay, Turkey

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**Abstract:** The onion thrips, *Thrips tabaci* Lindeman (Thysanoptera: Thripidae), leafhoppers, *Empoasca decipiens* Paoli (Homoptera: Cicadellidae) are significant common pests on cotton crops in Turkey. A two-year study was conducted to evaluate the relative attraction of thrips and leafhopper species to various color traps in the cotton growing areas of Hatay province. In 2006, two trials consisting of yellow, orange, blue, red, white and green color traps were conducted in Kırkhan district. In 2007, the first trial containing blue, orange, red and yellow color traps was conducted in Kırkhan district. The second trial including blue, white, yellow and green color traps was conducted in Reyhanlı district. The yellow sticky color traps were significantly attractive for thrips species in 2006, but not in 2007. In 2007, the blue sticky color traps were significantly attractive for species in both trials. On the other hand, in the second trial in 2007, the white sticky color traps were significantly attractive for thrips species. The green and red color traps were not attractive for thrips species. The yellow sticky color traps were significantly attractive for leafhoppers species in 2006-2007. The orange sticky color traps were the second attractive for leafhoppers species in 2006 and 2007. The green sticky color traps at the last trial were significantly attractive for leafhoppers species in 2007, while they were not attractive previous three trials. The white, blue and red sticky color traps were not attractive for them in both years. In conclusion, the yellow, blue and white sticky color traps for thrips species and the yellow and orange sticky color traps for leafhoppers species are strongly suggested for monitoring their population densities in cotton crops.

**Key words:** Onion thrips, *Thrips tabaci* Lindeman, leafhoppers, *Empoasca decipiens* Paoli, color traps, cotton

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## INTRODUCTION

The onion thrips, *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) (Mart, 2005) and the leafhopper, *Empoasca decipiens* Paoli (Homoptera: Cicadellidae), are significant common pests on cotton crops in Turkey (Atakan *et al.*, 2004; Atakan and Canhilal, 2004; Karut *et al.*, 2005). Thrips species have minute, slender-bodies with rasping-sucking mouthparts (Borrer *et al.*, 1989; Olkowski *et al.*, 1991; Mound and Kibby, 1998). They are significant plant feeder (Borrer *et al.*, 1989; Olkowski *et al.*, 1991; Bournier, 1994; Mound and Kibby, 1998; Atakan, 2003; Mart, 2005). Therefore, plant growth, crop maturity and seed-cotton yield can decrease due to the thrips feeding (Atakan, 2003; Cook *et al.*, 2003; Mart, 2005).

These leafhopper species are small, slender insects that disperse rapidly when disturbed (Flint, 1998) and both adults and nymphs run sideways (Flint, 1998; Mart, 2005). During their feeding

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**Corresponding Author:** N. Demirel, Department of Plant Protection, Faculty of Agriculture, Mustafa Kemal University, 31034, Antakya, Hatay, Turkey Fax: 90-326-245 58 32

process, they apparently introduce a toxin that impairs photosynthesis (Matthews, 1994). This causes the edges of leaves to curl downwards, the leaf to become yellowish and then redden, before drying out and shedding (Matthews, 1994; Mart, 2005). Severe hopper burn can severely stunt young plants and reduce yields (Matthews, 1994).

The color trap attractiveness and capture rates of thrips depend on species (Kirk, 1984) and trap color (Cho *et al.*, 1995). The various color traps are commonly used for monitoring thrips species on many cultivated crops (Beckham, 1969; Lu, 1990; Carrizo, 2001; Liu and Chu, 2004; Atakan and Canhilal, 2004; Chen *et al.*, 2004). The white and blue plastic and gold aluminum foils were the most attractive color traps for thrips species (Beckham, 1969). In a different study, pale blue color traps were the most attractive traps for onion thrips comparing with the white, green, yellow, gray and red ones (Lu, 1990). In addition, the blue and white color traps were more attractive for *T. tabaci* than orange and black color traps (Carrizo, 2001). Liu and Chu (2004) reported that the blue cup traps were more attractive for *T. tabaci* than the white plastic cup traps. On the other hand, the yellow sticky traps were significantly attractive for the western flower thrips on cotton crops (Atakan and Canhilal, 2004; Chen *et al.*, 2004). A range of sticky color traps are commonly used for monitoring leafhopper species on many cultivated crops (Alverson *et al.*, 1977; Kersting *et al.*, 1997; Flint, 1998; Chu *et al.*, 2000; Lessio and Alma, 2004; Raja and Arivudainambi, 2004). The yellow sticky color traps were significantly more attractive for *Macrostelus fascifrons* (Stål), *Norvelina seminuda* (Say), *Paraphlepsis* spp., *Erythroneura* spp. and *Exitianus exitiosus* (Uhler) species than white, green, blue and red sticky color traps (Alverson *et al.*, 1977). Similarly, the yellow sticky color traps were significantly attractive for *Circulifer haematoceps* (Mulsant et Rey), *Orosius orientalis* (Matsumura) (Kersting *et al.*, 1997) and *E. fabae* (DeGoover *et al.*, 1998).

The purpose of this study was to evaluate the relative attraction of thrips and leafhoppers species to a range of color traps in cotton fields in Hatay province of Turkey.

## MATERIALS AND METHODS

A two-year study was conducted to evaluate attraction of thrips and leafhoppers species to various sticky color traps in cotton fields in Hatay province of Turkey. In the first year, 2006, two trials were conducted from 18th to 27th August and 31st August to 7th September in Kırıkhan in different locations. Both trials consisted of orange, blue, yellow, green, red and white color traps. In the second year, 2007, two trials were conducted from 20th to 26th August in Kırıkhan and 15th to 22nd September in Reyhanlı districts. The first trial in Kırıkhan district consisted of orange, blue, yellow, green and red color traps. The second trial in Reyhanlı district contained green, yellow, blue and white color traps.

Index cards in the size of 13×10 cm were used as color traps in both trials in 2006 and in the first trial in 2007. The color traps were placed on 80×80 cm wooden stake crosses and separated by 2.5 cm spaces among traps. Both surfaces of each trap were coated with a thin layer of TIBTRAP®. Flat files (LEITZ®) in the sizes of 30×20 cm were used as color traps in the second trial in 2007. In this trial 130×130 cm wooden stake crosses were used to place the color traps on and they were separated by 10 cm along the horizontal. The traps' stakes were placed with a 10 m space between them within the field.

Traps were randomized in a completed design with four replications. Upon collection of sticky color traps, they were wrapped with clear plastic cling film and then transferred to the laboratory to count thrips and leafhoppers species for each evaluation date. Each of the color traps was examined under stereomicroscopic microscope in order to count the adult and nymph stages. Data were subjected to analysis of variance (ANOVA) and the means were separated by Student-Newman-Keuls (SNK) multiple comparison tests ( $p < 0.05$ ) using SAS software (SAS Institute, 1998).

**RESULTS**

A two-year study was carried out to evaluate attraction of thrips and leafhoppers species to various sticky color traps in the cotton fields. In the first year, the yellow sticky color traps caught significantly more thrips species in both trials than blue, orange, green, red and white color traps ( $F = 17.033$ ,  $df = 5,18$ ,  $p = 0.0001$ ;  $F = 5.241$ ,  $df = 5,18$ ,  $p = 0.004$ , respectively) (Table 1). The orange color traps caught the second highest number of thrips in the first trial. However, the green color traps caught relatively low thrips numbers in both trials. The red color traps caught the lowest thrips species in the second trial.

The yellow sticky color traps were significantly attractive for leafhoppers species in both trials ( $F = 3.636$ ,  $df = 5,18$ ,  $p = 0.019$ ;  $F = 3.322$ ,  $df = 5,18$ ,  $p = 0.027$ , respectively) (Table 1). The orange sticky color traps were the second attractive for leafhoppers species in both trials. Conversely, the white, green and blue sticky color traps were less attractive for leafhoppers species in the first trials. Similarly, the white sticky color traps were less attractive for leafhoppers species in the second trials.

In the second year, the blue color traps were significantly attractive for thrips species in both trials ( $F = 7.976$ ,  $df = 4, 15$ ,  $p = 0.001$ ;  $F = 8.421$ ,  $df = 3, 12$ ,  $p = 0.003$ , respectively) (Table 2). The orange color traps caught the second highest number of thrips in the first trial. The white color traps were significantly more attractive than yellow and green ones in the second trial. The green color traps caught the lowest number of thrips species in both trials. Unlike the results of two trials in 2006, the yellow sticky color traps were not significantly attractive for the thrips species.

Table 1: Number of thrips and leafhoppers caught with color traps in cotton plants in Kırkhan, Hatay in 2006

Color trap	No. of <i>T. tabaci</i> ( $\pm$ SE)/traps <sup>y</sup>	No. of <i>E. decipiens</i> ( $\pm$ SE)/traps <sup>y</sup>
<b>Trial 1</b>		
Yellow	599.50 $\pm$ 56.98a	38.23 $\pm$ 6.51 a
Orange	411.50 $\pm$ 8.73 b	32.75 $\pm$ 8.3ab
Blue	355.80 $\pm$ 17.86bc	15.00 $\pm$ 0.81b
Red	273.50 $\pm$ 41.02cd	25.00 $\pm$ 5.00ab
White	284.30 $\pm$ 31.46cd	17.50 $\pm$ 2.84b
Green	213.00 $\pm$ 18.97d	16.25 $\pm$ 2.95b
<b>Trial 2</b>		
Yellow	193.25 $\pm$ 31.94a	21.50 $\pm$ 6.00a
Orange	114.00 $\pm$ 31.09ab	17.50 $\pm$ 2.21ab
Blue	110.75 $\pm$ 5.32ab	12.00 $\pm$ 2.41ab
White	128.25 $\pm$ 19.83ab	7.25 $\pm$ 0.75b
Red	63.75 $\pm$ 15.04b	10.25 $\pm$ 1.10ab
Green	59.50 $\pm$ 10.11b	9.50 $\pm$ 2.06ab

<sup>y</sup>Means within a column not followed by the same letter are significantly different ( $p < 0.05$ ) by SNK

Table 2: Number of thrips and leafhoppers caught with color traps in cotton plants in Kırkhan<sup>a</sup> and Reyhanlı<sup>b</sup> Hatay in 2007

Color trap	No. of <i>T. tabaci</i> ( $\pm$ SE)/traps <sup>y</sup>	No. of <i>E. decipiens</i> ( $\pm$ SE)/traps <sup>y</sup>
<b>Trial 1<sup>a</sup></b>		
Blue	146.75 $\pm$ 8.49a	6.25 $\pm$ 1.31bc
Orange	95.00 $\pm$ 27.33b	9.50 $\pm$ 0.87b
Red	76.50 $\pm$ 15.26bc	4.75 $\pm$ 1.03bc
Yellow	64.50 $\pm$ 8.77bc	14.75 $\pm$ 2.36a
Green	28.25 $\pm$ 7.71c	3.50 $\pm$ 0.96c
<b>Trial 2<sup>b</sup></b>		
Blue	16,668.75 $\pm$ 4703.21a	3.25 $\pm$ 0.75b
White	13,497.00 $\pm$ 1994.65a	5.00 $\pm$ 0.41ab
Yellow	3,408.25 $\pm$ 692.96b	6.50 $\pm$ 0.50a
Green	1,383.00 $\pm$ 167.19b	5.75 $\pm$ 0.63a

<sup>y</sup>Means within a column not followed by the same letter are significantly different ( $p < 0.05$ ) by SNK

The yellow sticky color traps were the most attractive for leafhoppers species in both trials ( $F = 10.151$ ,  $df = 4, 15$ ,  $p = 0.0001$ ;  $F = 5.636$ ,  $df = 3, 12$ ,  $p = 0.012$ , respectively) (Table 2). The orange sticky color traps were the second attractive for both species. The green sticky color traps were the worst attractive for both species. Unlike the prior to trials, the green sticky color traps were significantly attractive for leafhoppers species. However, the blue sticky color traps were the worst attractive for leafhoppers species.

## DISCUSSION

In a previous study, the yellow sticky color traps caught significantly more thrips than blue or white traps (Cho *et al.*, 1995). The yellow sticky color traps were also significantly attractive for the avocado thrips, *Scirtothrips perseae* Nakahara on avocados (Hoddle *et al.*, 2002), the basswood thrips, *Thrips calcaratus* Uzel, pear thrips, *Taeniothrips in-cortesequem* (Uzel) and native basswood thrips, *Neohydatothrips tiliae* on deciduous forests (Hood) (Rieske and Raffa, 2003). Furthermore, Demirel and Cranshaw (2005) reported that the neon yellow color traps were significantly more attractive for *T. tabaci* than yellow, blue, neon green, silver and orange color traps on brassica crops. Conversely, the blue sticky plastic cup traps were significantly attractive for onion thrips, *T. tabaci* in onion fields (Liu and Chu, 2004). Similarly, the blue color traps were the most attractive traps for *F. occidentalis* (Chu *et al.*, 2000; Chen *et al.*, 2004).

In the previous studies were conducted in cotton, sugarbeets, lucerne, yardlong bean and groundnut fields with nine different color traps for evaluating attraction of *Empoasca* spp. adults (Chu *et al.*, 2000). The lime green, yellow and spring green sticky color traps were significantly more attractive for *Empoasca* spp. adults than white, rum, red, woodland green (dark green), true blue and black sticky color traps (Chu *et al.*, 2000). The later study indicated that the yellow with red border sticky color traps were significantly attractive for *Amrasca biguttula biguttula* than red color traps (Raja and Arivudainambi, 2004). On the other hand, the red sticky color traps caught more *S. titanus* than white, yellow or blue (Lessio and Alma, 2004). *Scaphoideus titanus* males were significantly more attracted to red rather than to yellow and white coloured traps.

## CONCLUSIONS

The yellow, blue and white sticky color traps were significantly attractive for thrips species in cotton crops in Hatay province of Turkey. The yellow and orange sticky color traps were significantly attractive for leafhoppers species. Therefore, the yellow, blue and white sticky color traps for thrips species and the yellow and orange sticky color traps for leafhoppers species are strongly suggested for monitoring their population densities in cotton crops.

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