N O T E

Capture of *Bemisia tabaci* (Homoptera: Aleyrodidae) and *Delphastus catalinae* (Coleoptera: Coccinellidae) on Three Colors of Sticky Traps[1]

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The B-biotype sweetpotato whitefly, *Bemisia tabaci* Gennadius (= *B. argentifolii* Bellows and Perring), is a serious pest of row crops, vegetables, ornamentals, and other plants. Yellow sticky traps are commonly used to sample whitefly and other insect pests in the greenhouse and in the field. However, sticky traps have not been generally used for sampling beneficial arthropods. Capture of parasitoids of *Bemisia* whiteflies has been evaluated using yellow sticky traps (Hoelmer et al., 1998, Environ. Entomol. 27: 1039-1044; Simmons 1998, J. Entomol. Sci. 33: 7-14). Yellow sticky traps also were used to survey the relative abundance of several species of coccinellid beetles in corn, *Zea mays* L., fields (Udayagiri et al., 1997, Environ. Entomol. 26: 983-988; Hoffmann et al., 1997, J. Entomol. Sci. 32: 358-369). Large numbers of *Delphastus catalinae* (LeCconte), a coccinellid in the tribe *Serangiini,* were captured on sticky traps in a research greenhouse in which only cultural and biological control measures were used for pest management (pers. obs.). Members of the tribe *Serangiini* are obligate whitefly predators (Gordon 1994, Frustula Entomol. 17: 71-133). Because several colors of sticky traps are used in greenhouses for control and survey of insect pests, it is essential that such management tools do not significantly interfere with released biological control organisms. The objective of this study was to determine the effect of sticky traps of selected colors on the capture of *D. catalinae* as compared with *B. tabaci.*

A laboratory study was conducted in cages, void of a source of food and water, in an environmentally controlled room maintained at 27.5 ± 1°C and 15:9 L:D. Cages were constructed of Plexiglass and were 45 cm wide × 45 cm long × 46 cm high. A door was constructed in the sides of each cage to allow access at the beginning and end of tests. A 1-cm diam hole was drilled in the center of the top of the cage to allow the insertion of insects. Lighting was by fluorescent bulbs (40-W cool white and 40-W Vitalite Duro-test Power-Twist). Two cages were placed under each rack of lights for

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a total of 8 cages. A 20-cm high clay pot was inverted and placed in the center of the cage. A 7.5 × 7.5 cm portion of a Sensor® yellow sticky trap (Whitmire Micro-Gen, St. Louis, MO) was placed on top of the clay pot, and the paper cover was only removed from the top of the sticky card. The amount of light recorded at the top of the clay pot was 555 foot candles as measured with a light meter (model 407026; Phytotronics, Earth City, MO).

Adult female whiteflies (B-biotype *B. tabaci*) were collected from a greenhouse colony which had been maintained on assorted vegetable crops (Simmons, 1994, Environ. Entomol. 23: 381-389). The whiteflies used in the tests were aspirated from collard, *Brassica oleracea* var. *acephala* de Condolle, into a glass tube. Adult *D. catalinae* were similarly collected from the greenhouse, but the gender was not determined. They were purchased commercially in 1999 for greenhouse pest control and have persisted since the original release. Below each rack of lights, 30 *D. catalinae* were released into one cage and 30 whiteflies were released into another cage so that there was one cage of each species below each rack. In each case, the insects were released through the hole in the top of the cage and into the inverted lid of a Petri dish which was suspended 6 cm from the top of the cage. In general, the beetles tended to land on the lid when they were released, while the whiteflies tended to fly to the top of the cage without reaching the lid of the Petri dish. The insects were left in the cages for 20 h. Afterwards, the number of dead insects on the lid of the Petri dish and the number of insects trapped on each sticky card were determined. These dead insects on the Petri dish lid were considered to have been injured during the set up of the test and did not have an opportunity to fly and were not included in the data analysis. The experiment was repeated with pieces of blue Pestrap® sticky trap (Phytotronics, Inc., Earth City, MO), as well as white Great Lakes IPM sticky trap (Great Lakes, Vestaburg, MI) as described above. The sticky surface of the white card treatment was turned upward in the test. A piece of paper was placed on the bottom surface of the blue sticky trap before it was used in the tests while the sticky surface faced upward. As a result, the bottom surface of each color treatment was not sticky. For each color treatment, the experiment was repeated five times. Data on sticky card color were collected for each of the three color treatments using a CR-210 Minolta chroma meter according to CIELAB color space (McGuire 1992, HortScience, 27: 1254-1255). Measurements were obtained from 6 unused sticky cards of each color and the average reading was obtained per color.

A choice test was conducted on the relative capture of each insect species on the three colors of sticky traps which were all cut to the same shape. In a 15-cm diam circular arrangement, each of the three colors of sticky traps was placed adjacent to each other in a pie-like fashion. The sticky trap combination was set up in cages and conditions as described above. Below each rack of lights, 50 female *B. tabaci* were released in one cage and 50 *D. catalinae* were released in the other cage so that there were four cages per species treatment per trial. Counts on capture and mortality were made as described above after 20 h. The test was repeated six times.

The number of dead insects on the Petri dish was subtracted from the total number of insects inserted into the cage; the latter was used in the analyses. The PROC TTEST procedure (SAS Institute, 1999, version 8, SAS Institute, Cary, NC) was used to compare differences between species for percentages of insects captured on the sticky cards after arcsine transformation. For each species in the choice test, the percentages of trapped insects were compared among color treatments using the

Student-Newman-Kuels' test (SAS Institute 1999) after arcsine transformation. The level of significant differences was determined at $P < 0.05$.

Regardless of the color of the sticky trap, a significantly higher percentage of the whiteflies was trapped compared with the beetles (Table 1). Overall, about 8X as many of the whiteflies were captured compared with the beetles. Most (≈94%) of the whiteflies were trapped on yellow sticky traps in the no-choice test. In the color choice test, more whiteflies ($P < 0.001$; df = 2,69; $F = 410.3$) and beetles ($P < 0.05$; df = 2,69; $F = 3.73$) were captured on the yellow sticky traps as compared with the other color traps (Table 2). This is consistent with the performance of the traps in the no-choice test (Table 1). It is well known that whiteflies are highly attracted to yellow (Lloyd 1921, Bull. Entomol. Res. 12: 355-359), but this insect was used as a point of reference for the results on *D. catalinae.* Yellow is the color of sticky traps that are most commonly used for whitefly capture in greenhouses. Both sides of the yellow and the blue cards are sticky and used to capture insects during normal use; however, only one surface of the white trap is sticky. Nevertheless, the amount of sticky area was not a factor in this test. At the end of each sampling period, most of the beetles were seen crawling around in the cage, whereas no live whiteflies were observed. Apparently, the beetles survived longer than the whiteflies in the absence of food and water under the test conditions. Therefore, the capture results of the beetles may overestimate the capture rates as compared with the capture of the whiteflies because of the possible difference in survival during the tests. In related work, Dowell and Cherry (1981, Ent. Exp. Appl. 29: 356-362) reported that using disks coated with Tanglefoot® (Tanglefoot Co., Grand Rapids, MI) in citrus trees, a higher number of coccinellids were captured on yellow than other color traps, but *D. catalinae* was not included in their study.

In conclusion, fewer *D. catalinae* were captured than *B. tabaci,* on either of the three color sticky cards. Although more beetles were captured on the yellow than on the other color sticky traps, the yellow color sticky trap was most effective for whitefly

Table 1. Mean percentages of coccinellids and whiteflies captured in paired no-choice tests with different colors of sticky traps under laboratory conditions for 20 h

Color of sticky card	Color characteristics* h°	C	L	Species	% Captured (±SEM)**
Blue	3.08	4.76	95.6	*Bemisia tabaci*	33.6 ± 4.0
				Delphastus catalinae	5.9 ± 1.2
White	2.08	1.67	100.0	*Bemisia tabaci*	51.2 ± 3.2
				Delphastus catalinae	4.5 ± 0.9
Yellow	6.03	6.7	95.6	*Bemisia tabaci*	94.4 ± 1.5
				Delphastus catalinae	11.7 ± 1.8

* Color characteristics using a Minolta chroma meter measuring in CIELAB; h° = hue angle, C = chroma; L = lightness.

** For blue sticky card test, df = 38, t = −6.55, $P < 0.0001$; for white sticky card test; df = 38, t = −14.01, $P < 0.0001$; for yellow sticky card test, df = 38, t = −34.65, $P < 0.0001$.

Table 2. Percentage of capture of either coccinellids or whiteflies on different colors of sticky cards in choice test under laboratory conditions for 20 h

	Mean % capture on trap colors of		
Insect species	Blue	White	Yellow
Bemisia tabaci	1.8 b	4.2 b	70.5 a
Delphastus catalinae	5.7 ab	5.2 b	8.5 a

Means in a row and followed by different letters are significantly different according to the Student-Newman-Kuels test ($P < 0.05$).

capture. A combination of both yellow sticky traps and *D. catalinae* may be more useful in whitefly population reduction in the greenhouse than either method alone. Namely, even though some beetles may be sacrificed when the sticky cards are used, overall whitefly control may be improved.

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