Response of *Frankliniella occidentalis* (Thysanoptera: Thripidae) and *Trialeurodes vaporariorum* (Homoptera: Aleyrodidae) to fluorescent traps in a cucumber greenhouse

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ABSTRACT

This paper describes the responsiveness of the western flower thrips, *Frankliniella occidentalis* (Pergande) and the greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood) to fluorescent and non-fluorescent colored sticky traps in a cucumber greenhouse. As in previous studies, thrips preferred blue, white or yellow painted traps. The fluorescent pigments Horizon Blue, Saturn Yellow and Arc Yellow were not significantly different in attractiveness from non-fluorescent blue and yellow pigments. Whiteflies preferred non-fluorescent yellow, Saturn Yellow, Arc Yellow and Signal Green traps over the other colors tested. Where a single trap color is desired for sampling both pest species, a yellow pigment with high reflective intensity around 550 nm is recommended.

INTRODUCTION

In greenhouses, the western flower thrips, *Frankliniella occidentalis* (Pergande) preferentially alights on traps painted white, blue or yellow (Vernon and Gillespie, 1990; Brodesgaard, 1989). The degree of response to painted traps has been shown to depend on interactions between wavelengths reflected at 350 nm (ultraviolet), 440 nm (blue) and 550 nm (yellow) (Vernon and Gillespie, 1990). Blue traps attract optimally when the reflectance intensity at 440 nm is high, and the reflectance intensities at 350 and 550 nm are low. Conversely, yellow traps are attractive, but only if wavelength reflectance intensity at 550 nm is above 60 percent, and if reflectance intensities at 350 and 440 nm are low. White traps are attractive to thrips at high reflectance intensities of wavelengths between 400–650 nm, but lose attractiveness with the gradual addition of black or UV.

The multiple regression models derived to explain the relationships between wavelength and thrips response (Vernon and Gillespie, 1990) suggest that blue and yellow traps with an increasing proportion of attractive wavelengths (440 nm and 550 nm, respectively) to non-attractive wavelengths, will be increasingly attractive to *F. occidentalis*. This also suggests that fluorescent blue and yellow pigments, being highly reflective at wavelengths 440 nm and 550 nm, may be more attractive to *F. occidentalis* than the non-fluorescent paints tested by Vernon and Gillespie (1990).

This paper investigates the attractiveness of fluorescent versus non-fluorescent paints to *F. occidentalis* in a cucumber greenhouse. In addition, the attractiveness of these paints to the greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood), is examined with the objective of selecting a single color for simultaneous monitoring of both species.

MATERIALS AND METHODS

The non-fluorescent paints blue 871, yellow 776 and white semi-gloss enamel (Cloverdale Paint and Chemicals Ltd., Surrey, B.C. V8W4Z1, Canada) were applied in two coats to one side of a sheet of white cardboard (56 by 72 cm; 4-ply Railroad Board, Domtar Fine Papers, Toronto, Ontario). The fluorescent paints Rocket Red, Arc Yellow, Saturn Yellow, Signal Green and Horizon Blue (Day-Glo, Color Corporation, Cleveland, Ohio,

Table 1

Trap catch response of western flower thrips, *Frankliniella occidentalis* and greenhouse whiteflies, *Trialeurodes vaporariorum* on 5 fluorescent and 3 non-fluorescent colored sticky traps. Studies were conducted in a cucumber greenhouse from 21–22 August, 1989.

	F. occidentalis[1]					*T. vaporariorum*[1]	
COLOR:	Females	S.E.	Males	S.E.	Sex Ratio M:F	Mean	S.E.
Rocket Red	9.5 a	1.20	0.8 a	0.25	1:11.9	0.3 a	0.15
Arc Yellow	19.8 b	1.84	2.6 b	0.40	1:7.6	4.0 b	1.20
Saturn Yellow	29.7 cd	2.50	7.0 c	1.45	1:4.2	11.1 c	3.52
Signal Green	8.0 a	0.80	0.9 a	0.41	1:8.9	14.3 c	6.73
Horizon Blue	75.5 e	7.91	6.2 c	1.16	1:12.2	0.0 a	0.00
Yellow 776	23.3 bc	2.66	3.9 bc	0.59	1:6.0	14.1 c	5.32
Blue 871	75.4 e	10.18	4.8 bc	1.10	1:15.7	0.0 a	0.00
Non-UV White	40.9 d	5.21	6.8 c	1.24	1:6.0	0.5 a	0.27

1. Means followed by the same letter within a column are not significantly different (Duncan's multiple range test; P = .05).

44103) were applied in one coat to cardboard previously painted with one coat of white semi-gloss enamel. The spectral reflectance profiles (350–700 nm) of all non-fluorescent colors used was measured relative to a white magnesium oxide standard using a Cary 17 recording spectrophotometer. Reflectance spectra for the fluorescent colors were obtained from the manufacturer and all spectra are shown in Fig. 1. The painted sheets were cut into 8.5 × 17 cm rectangles, folded into squares, and coated with Stikem Special (Seabright Enterprises, Emeryville, CA, 94608).

The study was done from 21–22 August, 1989 in a commercial cucumber greenhouse infested with *F. occidentalis* and *T. vaporariorum*. The traps were clipped to the top 8.5 cm of upright 1 × 3 × 30 cm garden lathes which were fixed 38 cm apart to a horizontal 4 × 4 × 300 cm board. These trap stands, painted black, were positioned above and between two rows of mature cucumbers. Traps were 2.4 m above ground and 0.6 m above the crop, with opposing sticky sides facing north and south. The experiment was conducted using a randomized complete block design with ten replicates. Transmission of light through a sample of the greenhouse glass was measured previously (Vernon and Gillespie, 1990), and was from 90 to 97% efficient in transmitting wavelengths between 350–700 nm. Transmission of higher energy UV wavelengths dropped sigmoidally from 90% at 350 nm to 0% at 300 nm.

Data were subjected to an analysis of variance after log10 (X + 1) transformation, and means were ranked by Duncan's (1955) multiple range test at P = 0.05.

RESULTS AND DISCUSSION

Significant differences in alighting by *F. occidentalis* on the 8 different colored traps were observed for males (F = 16.19; df 7, 63; P = .0001) and females (F = 63.23; df 7, 63; P = .0001). Of the non-fluorescent colors, blue 871 traps caught significantly more females than yellow 776 or white traps (Table 1). This result is consistent with the results of Vernon and Gillespie (1990), who tested the same colors in the same greenhouse. The fluorescent pigments Horizon Blue, Saturn Yellow and Arc Yellow were not significantly different from their non-fluorescent blue and yellow counterparts. Signal Green and Rocket Red were the least attractive pigments tested. Similar trends in trap preference were evident for males, except that significant differences were not observed in alightment on the yellow (except Arc Yellow), blue and white traps (Table 1). The male to female sex ratios captured on the fluorescent and non-fluorescent blue traps were higher than those occurring on the yellow and white traps (Table 1). Similar sex ratios were observed on non-fluorescent blue, yellow, and white traps previously tested at the same time of the previous year by Vernon and Gillespie (1990). Reasons for these color specific

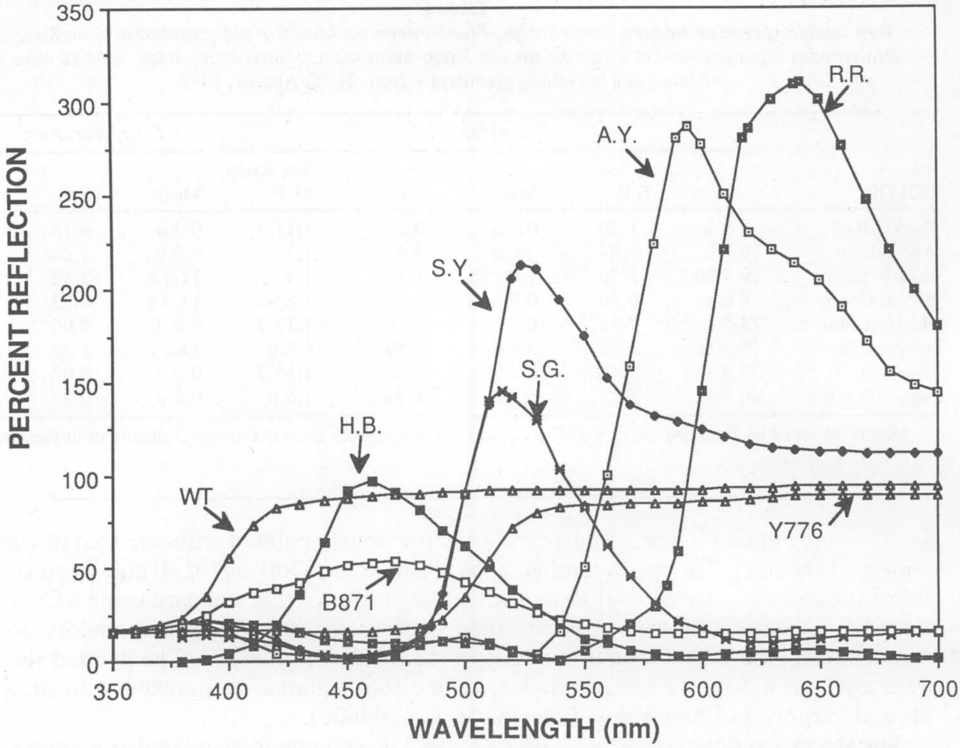

Fig. 1. Spectral reflectance curves of 5 fluorescent and 3 non-fluorescent color pigments used in trapping *F. occidantalis* and *T. vaporariorum* in a cucumber greenhouse. The codes used are: R.R. = Rocket Red; A.Y. = Arc Yellow; S.Y. = Saturn Yellow; S.G. = Signal Green; H.B. = Horizon Blue; WT = non-fluorescent white; B871 = non-fluorescent blue; and Y776 = non-fluorescent yellow.

differences in sex ratio are not known. The results reported herein as well as those of Vernon and Gillespie (1990), however, suggest that subtle differences in color preference or visual behavior may exist between males and females.

The regression models proposed for the attraction of *F. occidentalis* to colored traps (Vernon and Gillespie, 1990), predicted that blue 871 and yellow 776 would be, respectively, 1.82 and 1.05 times more attractive than white. In this study, blue 871 and yellow 776 caught, respectively, 1.84 and 0.57 times more thrips than white traps. The catch on blue 871 traps was closely predicted, but the catch on yellow was lower than predicted, and was considerably lower relative to white than in 12 studies conducted previously (Vernon and Gillespie, 1990; Gillespie and Vernon, 1990; Gillespie, unpublished data). This atypical response to yellow could indicate that the relative response of thrips to yellow and white may be influenced by unknown biotic or abiotic factors presently not considered in the prediction models. Using the manufacturers' spectral reflectance data for Horizon Blue and Saturn Yellow (Fig. 1), the regression models predicted much higher trap responses than actually occurred (i.e., 91.8 and 288.4 times more attractive than white traps, respectively). This may indicate that there is an upper threshold for thrips' visual attraction to blue and yellow colored traps, and that the reflective intensities (RI) of key wavelengths in Horizon Blue and Saturn Yellow, along with their counterparts blue 871 and yellow 776 were at or near to this threshold.

Significant differences (F = 29.26; df 7, 63; P = .0001) in catches of *T. vaporariorum* on the 8 color traps were also observed. Yellow 776, Signal Green, Saturn Yellow and Arc Yellow, with peak RIs between 520 and 590 nm (Fig. 1), were significantly more attractive than Rocket Red, Horizon Blue, blue 871 and white. Saturn Yellow (Peak RI = 527 nm), Signal Green (Peak RI = 518 nm) and yellow 776 (Peak RI = 550 nm) were equivalent in attraction, but significantly more attractive than Arc Yellow (Peak RI = 595 nm). These results compare favorably with those of Vaishampayan *et al.* (1975) who found *T. varporariorum* was most attracted to surfaces with peak RI in the "yellow-green" region (520–610 nm), and that the "blue-violet" (400–480 nm) and "red" (610–700 nm) spectral regions were not attractive and possibly inhibitory to alightment. Our work also compares with that of Affeldt *et al.* (1983), who found that fluorescent Saturn Yellow and Signal Green traps were not significantly different in catches of *T. vaporariorum,* and that these colors were not significantly better than non-fluorescent yellow traps.

These data indicate that blue, yellow and white colored traps are adequate for trapping *F. occidentalis*, and that traps with peak RI between 520–550 (green-yellow) are most attractive for trapping *T. vaporariorium* in greenhouse. Where a single trap is desired for sampling both species, a yellow hue with high RI between 530–550 is preferred. Fluorescent paints, which are more expensive than non-fluorescent paints, would not contribute significantly to the trapping of either species in greenhouses.

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Observations on the biology of the bronze flea beetle *Altica tombacina* (Coleoptera: Chrysomelidae) in British Columbia

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ABSTRACT

Populations of *A. tombacina* were monitored for 2 years at three field sites of varying elevation on Vancouver Island. In 1988, population densities of overwintered adults were greatest at the middle elevation (615m) followed by the highest (830m) and lowest at the low elevation (185m). Egg densities remained below 10/m^2 at 185m but exceeded 200/m^2 in places at 615m and 400/m^2 at 830m. Egg mortality was exceedingly high at all sites ranging from 98% at 185m, 95% at 615m and 99% at 830m; very few larvae appeared to survive. Only 2 adults were counted the following spring at the lowest elevation where eggs and larvae were exceedingly difficult to find. No life stages could be found at either of the higher elevation sites. Cold weather early in June, 1988, appeared to be responsible