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Source: Florida Entomologist, 86(4) : 420-423

Published By: Florida Entomological Society

URL: https://doi.org/10.1653/0015-4040(2003)086[0000:AOCPCB]2.0.CO;2

ATTRACTION OF COLORED PLASTICIZED CORRUGATED BOARDS TO ADULT STABLE FLIES, *STOMOXYS CALCITRANS* (DIPTERA: MUSCIDAE)

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ABSTRACT

The attraction of colored plasticized corrugated boards covered with adhesive to trap adult stable flies was investigated on Florida panhandle beaches. Colors consisted of blue, red, orange, and three types of white (horizontal ribbed, vertical ribbed, or opaque). Boards measured 67.3 cm (length) by 31.7 cm (height) and were placed on slotted wooden stakes, 30 m apart, along a linear transect. Fly collections were significantly ($P < 0.05$) greater on blue boards than on orange and white but there was no difference between red and blue boards. Spectral reflectance of boards peaked at 503 nm for blue, 638 nm for red, while orange and the 3 types of white boards peaked at about 630 nm. Blue boards exhibited the lowest reflective intensity when compared with the rest of the colors. Because stable flies were collected from all boards it is surmised that the boards provided leeward surfaces on which to land or remain perched in the windy beach environment. Significantly more flies were collected from the leeward side of boards compared with the windward side. Moreover, the boards may have provided vertical platforms for adult stable fly assembly, thermoregulation, and/or mating. Adhesive-treated corrugated plasticized boards may be a suitable method for luring stable flies away from human or animal hosts in recreation areas to reduce annoyance from biting pests.

Key Words: traps, management, control, behavior, biting fly

RESUMEN

La atracción de los adultos de la mosca de establo hacia tablas plastificadas de colores y corrugadas y cubiertas con un adhesivo para atrapar las moscas fue investigada en las playas del noroeste de la Florida. Los colores consistieron en azul, rojo, anaranjado, y tres clases de blanco (cordoncillado horizontalmente, cordoncillado verticalmente, u opaco). La tablas median 67.3 cm (de largo) por 31.7 cm (de alto) y fueron puestas sobre estacas de madera con una ranura separadas por 30 m, por un transecto lineal. El número de moscas recolectadas fueron significativamente mayores ($P < 0.05$) en las tablas en azul que en las tablas anaranjadas o blancas pero no habia una diferencia entre las tablas rojas y las azules. La reflexión espectral de las tablas fue más alta en 503 nm para la azul, 638 nm para la roja, mientras que la más alta para la anaranjada y las tres clases blancas fueron arrededor de 630 nm. Las tablas azules exhibieron la intensidad reflectiva más baja cuando fue comparada con el resto de los colores. Puesto que las mosca de establo fueron recolectadas de todas las tablas, se asume que las tablas proveen superficies sotaventos para aterrizar o quedar posadas en el ambiente airoso de la playa. El número de las moscas recolectadas del lado sotavento de las tablas fue significativamente mayor comparado con el lado barlavento. Además, las tablas pudieron proveen plataformas verticales para la congregación de los adultos de la mosca de establo, la termoregulación y/o el apareamiento. Las tablas plastificadas corrugadas tratadas con adhesivo pueden ser un método apropiado para atraer las moscas del establo fuera de los hospederos humanos y animales en áreas de recreo para reducir las picaduras de estas plagas.

Adult stable flies (*Stomoxys calcitrans* [L.]) are primarily blood-feeding pests of cattle. These flies, however, can be serious biting pests of humans when their primary animal hosts are absent. Oftentimes stable flies negatively impact the use of recreational areas (Newson 1977). Congregations of host-seeking stable flies, primarily associated with cold front passage, occur regularly on Florida's panhandle beaches from late summer through fall (King & Lenert 1936; Hogsette et al. 1987). A considerable amount of research has been conducted on the biology and management of this pest in an effort to minimize its impact on tourism (Simmons 1944; Hogsette et al. 1981; Dukes & Hallmon 1984; Hogsette et al. 1987; Jones et al. 1991).

The major control effort is targeted against adult fly populations because stable fly larval habitats are not present along the beaches. Aerially applied insecticides provide only temporary control and are constrained by prevailing weather conditions. Moreover, public concern and environmental issues associated with area-wide application of pesticides within or near coastal ecosystems is increasing. Methods that minimize the application of pesticides while allowing individuals to manage biting pests in their immediate environment may be advantageous. This study was initiated to evaluate the attractiveness of colored corrugated plasticized boards covered with adhesive, as traps, against adult stable flies on Florida panhandle beaches.

Materials and Methods

This study was conducted on a sandy beach on the Gulf of Mexico (Panama City Beach), Bay County, Florida where stable flies often congregate after the passage of cold fronts. Corrugated plasticized boards, 67.3 cm length by 31.7 cm height (Aluma Panel, Cumming, GA), were evaluated as trapping surfaces. Plastic boards were used because they were easily obtainable and would retain their rigidity in the high humidity and winds of coastal environments. Each board was composed of two outer smooth surfaces sandwiched between an inner series of parallel grooves and ridges (referred to here as "ribbing") to strengthen the material. Red, blue, orange, and 3 types of white (i.e., horizontal ribbing or vertical ribbing, visible through the boards when held up to a bright light, and opaque no visible ribbing) were obtained from the manufacturer. These colors were chosen for testing based on previous work by Agee and Patterson (1983), Waldbillig (1968), Williams (1973), Ruff (1979), and Mihok et al. (1995). Evaluation of ribbing orientation on the white boards corresponded to work conducted by Pickens (1991) with electrocution grids. He recorded that flies were attracted to high-contrast, narrow width, multiple-edge patterns. The red, blue, and orange boards were horizontally ribbed in order to prevent buckling by winds on the beach. The ribbing was not visible through those panels.

Boards were completely covered with a thin, approximately 0.3 cm^3, film of brushable Tangletrap Insect Coating© (Tanglefoot, Grand Rapids, MI) and placed vertically about 60 cm from the ground surface in slotted 5 cm by 5 cm by 122 cm wooden stakes. Stakes were placed 30 m apart in an east to west linear transect parallel to the shoreline approximately 50 m from the water's edge. Each board faced north-south (i.e., into the wind) with the longest edge parallel with the ground.

From September 18 through November 14, during 1996 and 1998, boards were set out when stable flies were observed on the beaches, usually within 24 h after passage of a cold front with sustained northerly winds. After 24 h, the total number of flies on each side of the board was counted separately and recorded. Boards were randomly placed along the transect and used once for each 24 h collection period. The 24-hr collection period used 3 of each color and type of board for a total of 18 panels. Wind speed was monitored using an electronic anemometer (Turbo MeterF, Ben Meadows Co., Atlanta, GA) and averaged 9.3 ± 0.3 km/hr while wind direction during testing was primarily north-northwest.

Reflectance measurements of the colored boards used a USB 2000 Fiber Optic Spectrophotometer (Ocean Optics, Inc., Dunedin, FL) a UV2 UV-Vis detector, 1.2 mm lens, 25 um slit, and its bundled software that reads from 200 to 850 nm. A 12 volt tungsten bulb was attached to the top of an acrylic plastic box, 3 cm away from and angled at 35 degrees to a horizontal surface containing the flat sample (10 cm square). A fiber optic cable was set 3 cm away from the same flat sample, and angled 35 degrees to it, pointed at the center of the light spot produced by the tungsten bulb. The reference standard was black polyester cloth, and the sample measurements were subtracted from the intensities recorded for this standard from 400 to 850 nm using Excel and a laptop PC.

Statistical Analyses

The mean number of flies per color and side, per year, was transformed via $\sqrt{x} + 1$ before analysis and subjected to analysis of variance (SAS Institute 1990). No significant interaction between year and panel color was observed for data collected during both years ($F = 0.45$; df 5, 492; $P = 0.814$). Therefore, data were summarized by color. In addition, no significant interaction between year and panel surface was observed for fly collection data from leeward and windward board surfaces ($F = 0.07$; df 5, 984; $P = 0.996$). Data were pooled and compared by board surface. Mean separation of fly data from board surface, by color, used Student-Neuman-Keuls ($P < 0.05$), whereas Student's t ($P < 0.05$) was used to compare overall fly numbers on leeward and windward board surfaces (Sokal & Rohlf 1981). The overall data set consisted of 14 collection days for each year.

Results and Discussion

Significantly more stable flies were collected from blue boards compared with orange or the 3 types of white boards (Table 1). There was no difference between the number of flies on the blue or red boards. Also stable fly abundance on red, orange, and the three types of white boards did not differ from each other. Flies on white boards with horizontal or vertical ribbing were not significantly different, nor did the opacity of the board increase collections. Spectral analyses revealed that the reflectivity of blue boards peaked at 503 nm, at 638 nm for red, at 630 nm for orange and opaque, while the white horizontal and vertical ribbed boards peaked at 632 nm (Fig. 1). Blue ex-

TABLE 1. COMPARISON OF MEAN STABLE FLY (±SE) ABUNDANCE ON ADHESIVE-TREATED PLASTICIZED CORRUGATED BOARDS OF VARIOUS COLORS AND ORIENTATIONS ON A FLORIDA PANHANDLE BEACH ALONG THE GULF OF MEXICO.

Treatment	n	Mean no. flies (±SE)[a]
Blue	84	209.7 ± 23.4 a
Red	84	194.6 ± 27.9 ab
White (opaque)	84	125.9 ± 16.2 b
White (horizontal ribbing)	84	120.2 ± 17.2 b
White (vertical ribbing)	84	123.6 ± 17.4 b
Orange	84	125.6 ± 20.4 b
Overall board orientation		
Board facing leeward side	504	116.0 ± 7.0 A
Board facing windward side	504	33.9 ± 2.7 B

[a]Means followed by the same letter are not significantly different (>0.05) using Student-Newman-Keuls test (for lower case letters) or t-test (for upper case letters).

hibited the lowest reflectance intensity compared with the rest of the other colors.

Stable fly preference for variously colored and reflective surfaces have been reported by a variety of workers. Williams (1973) showed that translucent Alsynite panels were more effective at capturing stable flies than panels painted either red or black. Ruff (1979) found white flat panels of the same material were most attractive while horizontally corrugated gold panels were least attractive. Cilek (2002) reported that unpainted inflated beach balls (with blue, yellow, red, and white diamond-shaped panels) covered with adhesive were more attractive than solid white, black or black/white balls. Mihok (2002a) reported that cloth traps with vertical blue and black contrasting surfaces appeared to attract *Stomoxys* spp. in Kenya. Also traps composed of pure cotton dyed with phthalogen blue, that exhibited low reflectance at a peak wavelength of 466 nm, would be the ideal for attracting these species (Mihok 2002b).

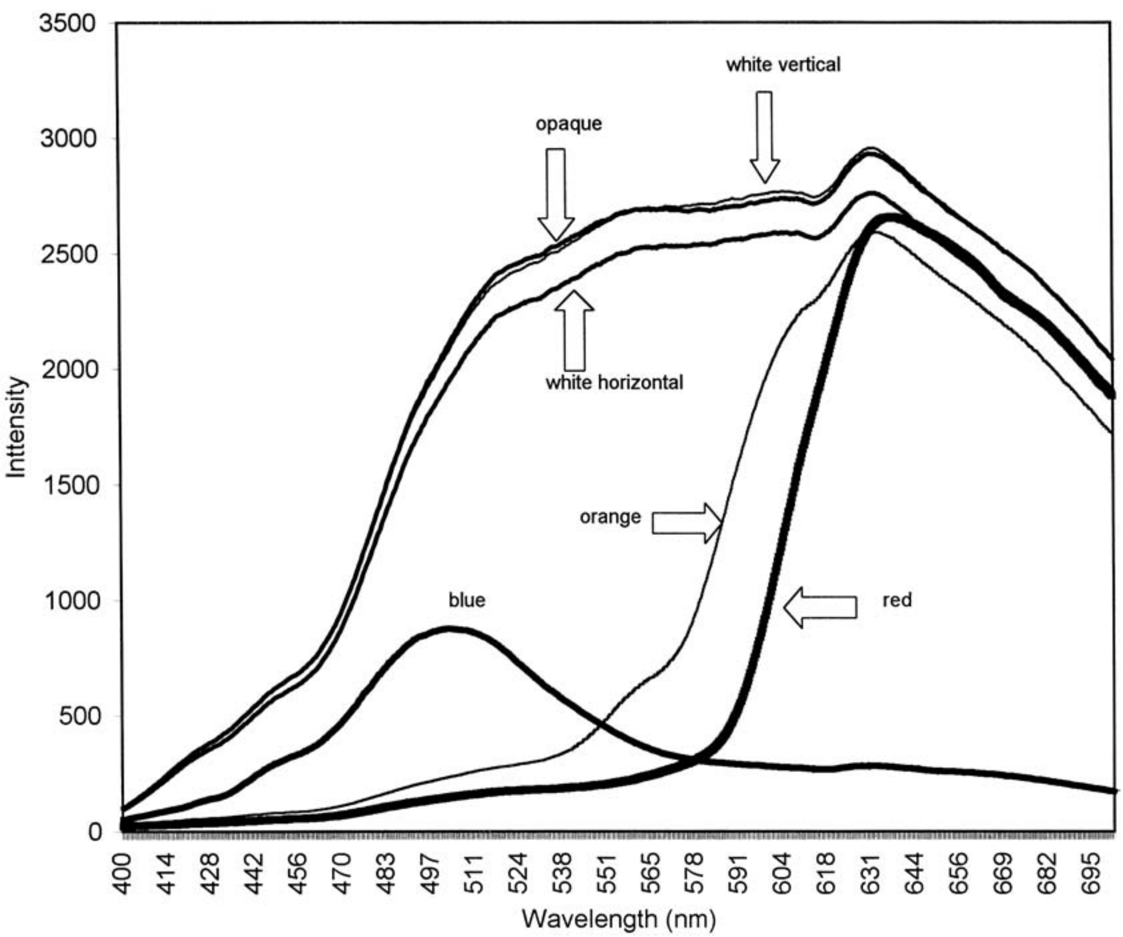

Fig. 1. Spectral reflectance curves of various colors and types of plasticized corrugated boards.

Agee and Patterson (1983) cited several authors who felt that some species of biting flies landed preferentially on low-reflective surfaces rather than on certain colors. Later, Allan et al. (1987) stated that host-seeking stable flies were attracted to low-intensity wavelengths ranging from 360 nm [UV] to 550 nm [blue-green]. This explained the reason why *S. calcitrans* collections were greatest on blue boards. It is unknown why the blue and red boards were not significantly different when collection abundance was compared. Although these two colors substantially differed in intensity and wavelength reflectance peaks, greater variation occurred between these fly collections than collections from the rest of the colored boards.

Each board probably provided leeward windbreaks that allowed flies to land and remain perched in the windy environment. In fact, stable fly abundance was significantly greater on the leeward side of boards compared with the windward side (Table 1). Broce et al. (1991) reported that stable flies often oriented, and preferably landed, on the leeward side of objects. But just as importantly, these panels may have provided vertical platforms for adult stable fly assembly, thermoregulation, and/or mating (Buschman & Patterson 1981).

It was not the intent of this study to examine stable fly trapping efficiency of the colored boards with that of a trap standard (e.g., Alsynite cylinders [Broce 1988]). However, because the Alsynite cylinder is a standard method to sample stable flies it may be of interest to compare the flies caught per cm^2 of both traps in similar habitats. Cilek (2002) reported that adhesive-treated Alsynite cylinders placed on northwest Florida beaches caught an average of 0.004 ± 0.001 flies per cm^2 while the colored boards, in this study, averaged 0.070 ± 0.004 flies per cm^2.

Adhesive-treated plasticized corrugated boards proved to be a quick and inexpensive way to trap stable flies in the coastal environs. This type of board is readily available in a variety of sizes and colors from local print and office supply sources so that the general public could fabricate this trap to reduce annoyance from host-seeking flies. Whether this trap would be useful to reduce stable flies on beach and other recreational areas, or animal facilities, warrants further investigation.

Acknowledgments

I thank Mary Ann Olson and Jamie Coughlin for their assistance in data collection. Special appreciation is extended to Dave Carlson, USDA, Center for Medical, Agricultural, and Veterinary Entomology, Gainesville, for conducting the spectral analyses. This study was conducted under research/collecting permits 08239621 and 98073111 from the Florida Department of Environmental Protection, Division of Recreation and Parks.

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