A Non-Sticky Trap for Tarnished Plant Bug (Heteroptera: Miridae)[1]

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Abstract A simple trap that does not require the use of sticky material to capture tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), is described. The 28 × 11 cm (diam) cylindrical trap was constructed by cutting and joining sections from two 2-L clear plastic soft drink bottles and gluing screened entrance cones from commercially-available boll weevil (*Anthonomus grandis* Boheman) traps in each end. Five sticky trap designs were tested, and the sticky trap that captured the most plant bugs was compared to the non-sticky trap. With virgin females plus green bean pods (*Phaseolus vulgaris* L.) as bait, the non-sticky traps captured only males, but females comprised 11% of the capture on the sticky traps. Females comprised 40% of the capture on sticky traps baited with green bean pods only. Opaque traps shaped like the clear traps were inferior to the clear traps. The non-sticky trap should facilitate testing of potential components of the pheromone of tarnished plant bug, and perhaps that of *L. hesperus* Knight. The combination of a synthetic plant bug pheromone and a non-sticky trap may lead to a practical method of monitoring or estimating populations.

Key Words Sticky trap, non-sticky trap, live trap, cotton insect, Miridae, Heteroptera

The first tarnished plant bugs, *Lygus lineolaris* (Palisot de Beauvois), reported to be captured in female-baited traps were entangled by sticky material smeared on vinyl sheets (Scales 1968). Since that report, sticky material has been used on female-baited tarnished plant bug traps of various designs. Strong et al. (1970) constructed a trap by fitting screen cones into each end of a 1.9-L cylindrical ice cream carton, the inner surface of which was coated with a sticky material to prevent escape of captured *L. hesperus* Knight. Slaymaker and Tugwell (1984) described a cylindrical, sticky-coated tarnished plant bug trap 15.6 cm in diam and 20.5 cm long that was constructed from a 59 × 20.5 cm rectangle of laminated cardboard. Scott and Snodgrass (2000) used a sticky-coated white non-UV reflecting cardboard rectangle (16 by 20 cm) above a cylinder containing virgin females.

Prokopy et al. (1979) found that unbaited, sticky-coated non-UV reflecting white or Zoecon Yello (Zoecon Corporation, Palo Alto, CA) rectangles (14 × 20 cm) were most effective in capturing tarnished plant bugs in apple orchards. Tarnished plant bugs have been captured in water-pan traps in sugarbeet fields (Landis and Fox 1972) and even in a light trap at a lighthouse 5.3 km offshore (MacCreary 1965).

The sticky material used to coat tarnished plant bug traps, while effective, tends to

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be pervasive and bothersome for those handling it. The first widely-used boll weevil, *Anthonomus grandis* Boheman, traps were coated with sticky material (Cross et al. 1969). These traps were quickly discarded following the report of an effective, non-sticky trap in which boll weevils remained alive and available for study or colonization after capture (Leggett and Cross 1971). The availability of a mass-produced live trap ended the use of sticky traps for monitoring or suppressing boll weevil populations (Dickerson 1986, Dickerson et al. 1981).

The purpose of the current study was to find an effective non-sticky trap for tarnished plant bugs. Five sticky and four non-sticky trap designs were tested.

Materials and Methods

Virgin females were from a laboratory colony established in 2002 from insects collected near Starkville and Stoneville, MS, from various weed sites, the dominant species being *Erigeron annuus* (L.) or *E. canadensis* L. Using the methodology of Cohen (2000), bugs were reared in Rubbermaid® 7.8-L Servin' Saver (Rubbermaid Home Products Division, Fairlawn, Ohio) rectangular containers in which the solid plastic tops had been cut so that only the top-securing perimeter remained. The perimeter was used to secure the organdy cloth or screen-mesh cloth top that replaced the cut-out plastic portion of the original top. The container was loosely filled with shredded paper to reduce opportunities for cannibalism by keeping bugs separated. They were kept in a room maintained at 28°C, 66% R. H., and a 14:10 (L:D) photoperiod.

Because the pheromone of *L. lineolaris* has not been identified, live females were used as bait. Females within 48 h of adulthood were separated from males under a dissecting microscope (10X) and immediately examined a second time to ensure sexing accuracy. They were placed in 1.9-L containers similar to the rearing containers and were fed green bean pods, *Phaseolus vulgaris* L., until they were placed in traps 7 to 14 d later. Bait females were housed in high-density polyethylene scintillation vials (20 ml, 3 females per vial) with 20 holes large enough to allow ventilation and small enough to retain the bugs. Sections of green bean pods were provided to females, and vials with green bean pods only were used as controls.

Sticky traps. Five types of sticky traps were tested: (1) white, horizontally-oriented 1.9-L cylindrical ice-cream cartons, (2) white, horizontally-oriented 3.8-L cylindrical white ice cream cartons similar to the cylindrical trap of Slaymaker and Tugwell (1984), (3) white, vertically-oriented 3.8-L ice cream cartons, (4) yellow, horizontally-oriented triangular traps with equilateral 6.6 cm sides and 13.4 cm long, and (5) white 16- by 20-cm rectangles like those used by Scott and Snodgrass (2000). Traps were arranged in a randomized block design, with three rows of five trap designs being 17 m apart, and traps within a row being 17 m apart. All traps were baited with females (3 per trap) and green bean pods. The experiment was conducted in Lowndes Co., MS, in a weed field, the dominant tarnished plant bug host being *E. annuus.* Each test was conducted over a 3-d period and replicated three times. Females were replaced for each of the three replications, but the same females remained in the traps over each 3-d period. Counts of captured tarnished plant bugs were made daily. The vertically-oriented trap was not included until the second replication.

Sticky traps versus new non-sticky traps. Non-sticky traps were constructed using 2-L plastic soft drink bottles, either clear (Fig. 1) or semi-transparent green. A 14-cm long by 11-cm (diam) cylinder was cut from the straight section of one bottle

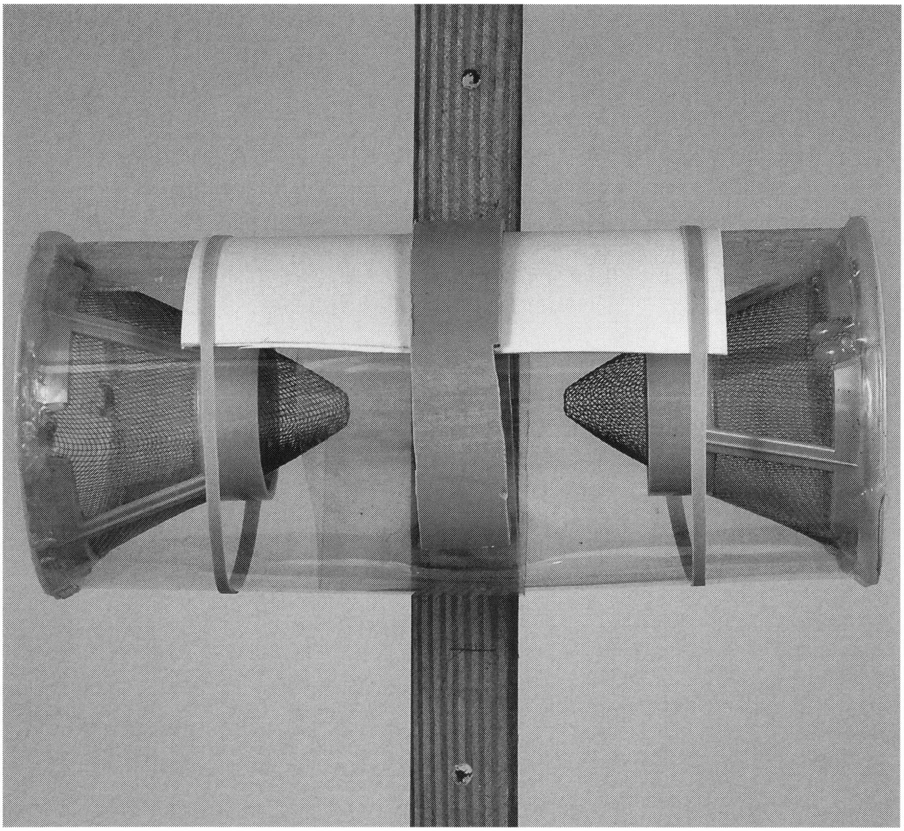

Fig. 1. Tarnished plant bug trap made from two clear plastic 2-L soft drink bottles and boll weevil trap funnels, and secured to wooden stake by short cylinder of polyvinyl chloride pipe. Trap shaded with piece of white ice cream carton held with rubber bands. Photo by Keith Lester, Little Elm, TX.

and a 16.5 cm long cylinder was cut from a second bottle. The longer cylinder included the bottle's upper portion that tapered inward toward the top. The tapered end (about 9.5 cm diam) of the longer cylinder was inserted about 2.5 cm into the straight portion of the shorter cylinder to form a 28-cm long x 11-cm (diam) cylinder. Screened entrance cones from boll weevil traps (Dickerson 1986) were glued, tapered side inward, to each end of the 28-cm cylinder. The two sections of each trap could be pulled apart to insert containers of bait bugs and food and to remove captured insects. Two small holes about 1 cm apart were drilled through the intersection of the two cylinders to allow insertion of a wire used to suspend the vials housing bait females and/or sections of green bean pods. Short sections of polyvinyl chloride pipe (10 cm diam by 3 cm long) were used to secure the traps to wooden stakes (1.9 cm by 3.8 cm by 1.5 m). Pipe sections had approximately 4 cm cut away to allow them to be flexed during insertion of the traps. Holes were drilled in the wooden stakes at selected intervals to adjust trap height just above canopy level.

Four treatments were tested in Oktibbeha Co., MS: (1) non-sticky, female-baited clear traps, (2) non-sticky, female-baited semi-transparent green traps, and (3) sticky, female-baited horizontally-oriented 3.8-L traps, and (4) sticky, horizontally-oriented 3.8-L traps baited with only green bean pods (control). Traps were arranged in a randomized block design with five rows, each row containing one of each treatment. Rows were placed in areas of the field with the most uniform concentrations of *E. annuus* (L.). Rows were at least 17 m apart and traps within a row were 17 m apart. Counts of captured tarnished plant bugs were made daily over the 3-d period of the test.

Clear versus opaque non-sticky traps. In preliminary testing of trap designs, a few tarnished plant bug observed on the funnels of opaque traps did not enter them, whereas, the bugs seemed to enter clear traps more readily. This led to a hypothesis that tarnished plant bugs may be less reluctant to enter a transparent trap. To test this, opaque 1.9-L ice-cream carton traps (23-cm long by 11-cm diam) were constructed to compare them with the clear plastic traps. The opaque traps were constructed much like the clear plastic traps, with no sticky material being applied to them. Strong et al. (1970) had used similar traps for *L. hesperus*, but the inner surfaces of their traps were coated with sticky material to prevent escape of captured bugs. One group of the 1.9-L ice cream carton traps was left its original white color and a second was painted fluorescent yellow. All traps were baited with one green bean pod and three females each. Traps were arranged in a randomized block design with one of each trap type being represented in each of five rows. Rows were 17 m apart, and traps within rows were 17 m apart. Counts of tarnished plant bugs captured were made daily over the 4-d period of the test, and the same females remained in the traps over this period. SAS GLM procedures compared data from all trap designs (SAS Institute, Inc. 1999).

When the transparent traps appeared to be superior to the opaque ones, we tested the possibility that initial trap efficiency may have been equal, but escapes from the opaque traps produced the difference. Strong et al. (1970) had postulated that *L. hesperus* captured in similar traps would "eventually stumble upon the opening of the funnel and escape." Ten adult tarnished plant bugs per trap were placed into eight transparent and eight opaque traps. Numbers of bugs remaining in the traps 48 h later were counted, values were converted to proportions remaining in the traps. Proportions were and arc sin transformed and a t-test was conducted on these transformed data using Microsoft® Excel 2002 (Microsoft Corporation, Redmon, WA).

Results

Sticky traps. Least squares means for tarnished plant bugs captured on the sticky-coated, 3.8-L and 1.9-L horizontally-oriented ice cream cartons, the 3.8-L vertically-oriented ice cream carton, the white rectangular traps, and the triangle traps were 21.3, 16.3, 16.0, 0.7, and 3.0 bugs per trap, respectively (Fig. 2A; $F = 2.05$; df $= 4, 9$; $P = 0.0171$). Although trap captures for the ice cream carton traps tended to be greater than those of either the white rectangle or the triangular traps, the differences were not statistically significant.

Sticky traps versus new non-sticky traps. Least squares means for the clear and semi-transparent green non-sticky traps, the baited sticky trap, and the unbaited sticky trap were 8.2, 6.4, 4.6, and 2.4 tarnished plant bugs per trap, respectively (Fig. 2B; $F = 1.01$; df $= 3, 16$; $P = 0.414$). While these means were not significantly different,

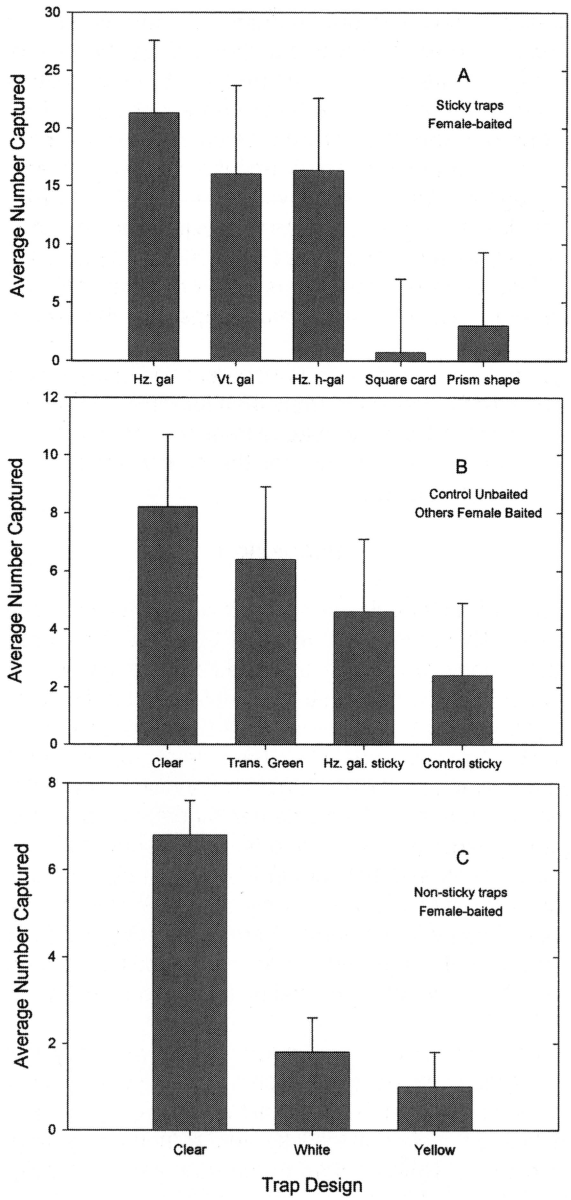

Fig. 2. Average numbers of tarnished plant bugs ± SEM captured on (A) five sticky trap designs (Hz. = horizontally oriented, Vt. = vertically oriented, gal = gallon, h-gal = half gallon), (B) four trap designs (clear non-sticky, transparent green non-sticky, Hz. gal. sticky and control sticky), and (C) three similar trap designs of different colors. Control sticky traps baited with green bean pods only; all other traps baited with green bean pods and three virgin females.

both types of non-sticky traps captured numerically more bugs than the sticky trap, and the control traps captured the lowest number of bugs. No females were captured in the non-sticky traps, while females comprised 11% of the bugs captured on the baited sticky trap and 40% of those captured on the unbaited sticky trap.

Clear versus opaque non-sticky traps. Least squares means for the clear non-sticky trap, the white ice cream carton trap, and the yellow ice cream carton trap were 6.8, 1.8, and 1.0 bugs per trap, respectively (Fig. 2C; $F = 14.97$; df = 2, 12; $P < 0.0005$). Differences in least squares means were significant for the clear traps versus either the white or the yellow opaque traps ($P = 0.0009$ and 0.0003, respectively), but not significantly different for the white versus yellow opaque traps ($P = 0.4995$). Thus, the clear traps captured nearly five times more bugs than the average of the opaque traps.

Of the ten bugs per trap placed in the transparent and opaque traps, 9.75 and 8.13 per trap, respectively, remained in the traps 48 h later ($t = 3.004$, df = 14, $P = 0.009$). Though more bugs escaped from the opaque traps than from the clear traps, the 17% difference in escapes does not account for the nearly 5-fold difference in capture between the clear and opaque traps.

Discussion

A simple non-sticky trap was developed that was effective in capturing tarnished plant bugs in the field. Even though differences between sticky and non-sticky traps were not statistically significant, more tarnished plant bugs were captured in both types of transparent non-sticky traps than in the sticky traps. Thus, trapping efficiency being at least equal, it seems preferable to use traps that do not require a sticky material. Additionally, the clear non-sticky traps were superior to the opaque non-sticky traps in capturing tarnished plant bugs. The reason for the difference is unclear, but the transparency of the more favorable containers may be a factor.

Traps baited with pheromone-producing females should be expected to capture only males. Females comprised 10% of tarnished plant bugs captured on the sticky traps, but the non-sticky traps captured only males, indicating that the capture of females on the sticky traps was incidental. Females landing incidentally on the sticky traps would be immediately captured, while those landing on the non-sticky traps would not. The near 50% sex ratio captured on the control traps shows that incidental capture does occur.

The use of live insects as bait for conspecifics is generally limited to research purposes, because large-scale usage of such a trapping system is impractical. Maintaining live female tarnished plant bugs as bait within traps may become problematic as summer heat increases. For the sticky versus non-sticky trap test, more bait females died in the clear live traps than in the opaque sticky traps, where the bait females were shaded. For the clear versus non-sticky opaque test, however, we shaded bait females in the clear traps with a partial cover cut from a white ice cream carton (Fig. 1). No mortality of the bait females occurred in that test.

Much research has been conducted and is being conducted to identify the sex pheromone of the tarnished plant bug and *L. hesperus* (Aldrich 1988, Chinta et al. 1994, Ho and Millar 2002, Wardle and Borden 2003, Wardle et al. 2003). Using candidate chemicals rather than live females as attractants in the clear traps will negate problems associated with mortality of bait insects and avoid the problems associated with the sticky materials used in tarnished plant bug traps. Isolation, identification, synthesis of the sex pheromone of tarnished plant bugs, followed by its commercial availability, may lead to practical usage of the non-sticky trap to monitor or estimate populations, or to determine when plant bugs are dispersing into commercial crops.

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